INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**ELECTRONICS AND COMMUNICATION ENGINEERING**				
Course Title	**ENGLISH**				
Course Code	AHSC01				
Program	B. Tech				
Semester	I				
Course Type	Foundation				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	2	-	2	-	-
- Course Coordinator	Dr. M.Sailaja, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

II COURSE OVERVIEW:

The principle aim of the course is that the students will have awareness about the importance of English language in the contemporary times and also it emphasizes the students to learn this language as a skill (listening skill, speaking skill, reading skill and writing skill). Moreover, the course benefits the students how to solve their day-to-day problems in speaking English language. Besides, it assists the students to reduce the mother tongue influence and acquire the knowledge of neutral accent. The course provides theoretical and practical knowledge of English language and it enables students to participate in debates about informative, persuasive, didactic, and commercial purposes.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
English	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	LCD / PPT	x	Chalk & Talk	x	Assignments	x	MOOC
✓	Open Ended Experiments	✓	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
37%	Remember
63 %	Understand
-	Apply
-	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

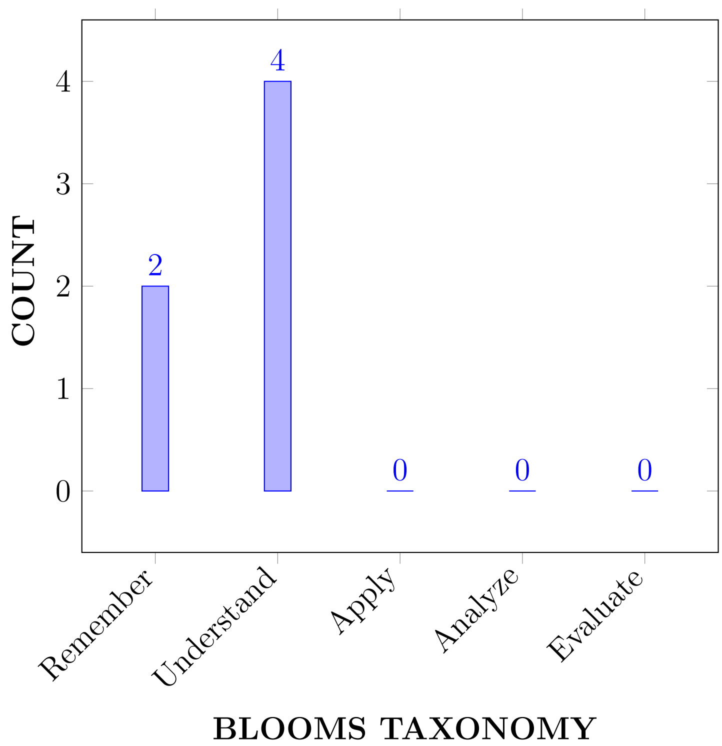
I	Standard pronunciation, appropriate word stress, and necessary intonation patterns for effective communication towards achieving academic and professional targets.
II	Appropriate grammatical structures and also using the nuances of punctuation tools for practical purposes.
III	A critical aspect of speaking and reading for interpreting in-depth meaning between the sentences.
IV	A conceptual awareness on writing in terms of unity, content, coherence, and linguistic accuracy.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Discuss** the prime necessities of listening skill for academic and non-academic purposes.	Remember
CO 2	**Illustrate** appropriate speaking strategies to explain a topic in a clear-cut manner.	Understand
CO 3	**Choose** acceptable language for developing life skills to overcome the challenges at professional platform.	Understand
CO 4	**Interpret** the grammatical aspects effectively in speaking and writing at functional usage.	Understand
CO 5	**Describe** the importance of reading skill and various strategies to enhance professional growth and success.	Remember
CO 6	**Summarize** writing skills for fulfilling the academic and non-academic requirements of various written communicative functions.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 10	**Communication :** Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (Communication). "Students should demonstrate the ability to communicate effectively in writing / Orally." 1. Clarity (Writing); 2. Grammar/Punctuation (Writing); 3. References (Writing); 4. Speaking Style (Oral); 5. Subject Matter (Oral).	5	Seminar/ Conferences/ Research Papers IE/AAT / Discussion

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	-	-
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	-	-
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 2	-	-	-	-	-	-	-	-	-	✓-	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 5	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 6	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 10	Discuss the heeds of functional grammar and punctuation tools in speaking and writing by generating the clarity of an audio text.	5
CO 2	PO 10	Illustrate essential aspects of grammar as well as punctuation marks for speaking or writing towards a discussion on a topic to give the clarity.	5
CO3	PO 10	Choose suitable grammatical structures and punctuation marks at speaking and writing areas maintaining clarity at professional platform.	5
CO4	PO 10	Interpret the grammatical knowledge and punctuation marks systematically towards providing the clarity in speaking and writing.	5
CO5	PO 10	Demonstrate the role of grammar and punctuation marks understanding the meaning between the sentences as well as paragraphs in speaking or writing for a clarity.	5
CO6	PO 10	Describe the clarity of grammatical usage and the obligation of punctuation marks in speaking and writing.	5

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-
CO 2	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-
CO 4	-	-	-	-		-	-	-	-	5	-		-	-	-
CO 5	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-
CO 6	-	-	-	-	-	-	-	-	-	5	-		-	-	- -

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	-	-	-	-	-	-	-	-	100	-		-	-	-
CO 2	-	-	-	-	-	-	-	-	-	100	-	-	-	-	-
CO 3	-		-	-	-	-	-	-	-	100	-	-	-	-	-
CO 4	-	-	-	-		-	-	-	-	100	-	-	-	-	-
CO 5	-	-	-	-	-	-	-	-	-	100	-	-	- -	-	-
CO 6	-	-	-	-		-	-	-	-	100	-		-	-	- -

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq$ C$\leq$ 5% – No correlation

1 -5 <C$\leq$ 40% – Low/ Slight

2 - 40 % <C < 60% –Moderate

3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	-	-	-	-	-	-	-	-	3	-	-	-	-	
CO 2	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO 5	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO 6	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
TOTAL	-	-	-	-	-	-	-	-	-	18	-	-	-	-	-
AVERAGE	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	✓
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	✓
Assignments					

XVII ASSESSMENT METHODOLOGY-INDIRECT:

	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**GENERAL INTRODUCTION AND LISTENING SKILL**
	Introduction to communication skills; Communication process; Elements of communication; Soft skills vs. hard skills; Importance of soft skills for engineers; Listening skills; Significance; Stages of listening; Barriers and effectiveness of listening; Listening comprehension.
MODULE II	**SPEAKING SKILL**
	Significance; Essentials; Barriers and effectiveness of speaking; Verbal and non-verbal communication. Generating talks based on visual prompts; Public speaking; Exposure to structured talks; Addressing a small group or a large formal gathering; Oral presentation; Power point presentation.
MODULE III	**VOCABULARY AND GRAMMAR**
	The concept of Word Formation; Root words from foreign languages and their use in English; Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives; Synonyms; Antonyms; Standard abbreviations; Idioms and phrases; One-word substitutes Sentence structure; Uses of phrases and clauses; Punctuation; Subject verb agreement; Modifiers; Articles; Prepositions.
MODULE IV	**READING SKILL**
	Significance, Techniques of reading, Skimming-Reading for the gist of a text, Scanning - Reading for specific information, Intensive, Extensive reading, Reading comprehension, Reading for information transfer, Text to diagram, Diagram to text.
MODULE V	**WRITING SKILL**
	Significance; Effectiveness of writing; Organizing principles of Paragraphs in documents; Writing Introduction and conclusion; Techniques for writing precisely, Letter writing; Formal and Informal letter writing, E-mail writing, Report Writing.

TEXTBOOKS

1. Handbook of English (Prepared by the faculty of English, IARE).

REFERENCE BOOKS:

1. 1. Norman Whitby, Business Benchmark: Pre-Intermediate to Intermediate – BEC Preliminary, Cambridge University Press, 2nd Edition,2008.
2. Devaki Reddy, Shreesh Chaudhary, Technical English, Macmillan, 1st Edition,2009.
3. Rutherford, Andrea J, Basic Communication Skills for Technology, Pearson Education,2nd Edition, 2010.
4. Raymond Murphy, Essential English Grammar with Answers, Cambridge University Press, 2nd Edition,2010.
5. Dr. N V Sudershan, President Kalam's Call to the Nation, Bala Bharathi Publications, Secunderabad, 1st Edition,2003

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference T1: 4.1
OBE DISCUSSION			
1	Discussion on mapping COs with POs. (OBE)		
CONTENT DELIVERY (THEORY)			
2	Introduction to communication skills.	CO 1	T1:06.06
3	Communication process.	CO 1	T1:06.09
4	Soft skills vs hard skills.	CO 3	T1:09.10
5	Significance of LSRW skills.	CO 1	T1:10.11
6	Significance of listening skill.	CO 1	TI:12.16
7	Different stages of listening.	CO 1	T1:16.18
8	Barriers of listening skill.	CO 1	TI:18.21
9	Different types of listeners.	CO 1	TI:21.22
10	Effectiveness of listening skill.	CO 1	T1:22.24
11	Phonetics: Listening to the sounds of English language.	CO 1	T1:24.29
12	Introduction to speaking skills.	CO 2	T1:30.32
13	Effectiveness of speaking skills.	CO 2	T1:33.34
14	Verbal and non-verbal communication.	CO 2	T1:34.35
15	Generating talks based on visual or written prompts.	CO 2	T1:36.37
16	Developing public speaking skills.	CO 2	T1:38.39
17	Oral presentation with power-point.	CO 3	TI:39.42
18	The concept of word formation.	CO 4	T1:43.100
19	Antonyms and synonyms.	CO 4	TI:49.56
20	Idioms and phrases.	CO 4	TI:57.60
21	One-word substitutes.	CO 4	TI:60.62
22	Root words from foreign languages and their usage in English.	CO 4	TI:60.62
23	Sentence structure.	CO 4	T1:58.62
24	Punctuation tools and their role in a language.	CO 4	TI:63.66
25	Subject-verb agreement.	CO 4	TI:66.69
26	Usage of Adjectives.	CO 4	TI:70.73
27	Significance of articles and their usage.	CO 4	TI:74.75
28	The usage of prepositions.	CO 4	T1:76.77
29	Significance of reading skill.	CO 5	T1:78.79
30	Different techniques of reading skill.	CO 6	T1:80.82
31	How to Read Your Textbook More Efficiently.	CO 6	TI:83.85
32	Different types of reading comprehension.	CO 6	TI:85.86
33	Reading for information transfer.	CO 6	TI:85.96
34	Significance and effectiveness of writing skill.	CO 6	TI:96.98

35	Organizing principles of a paragraph in documents and types of paragraphs.	CO 5	T1:101.103
36	Writing introduction and conclusion.	CO 5	T1:103.103
37	Techniques for writing precis.	CO 8	T1:103.103
38	Introduction to informal letters.	CO 7	TI:105.108
39	Introduction to formal letters.	CO 7	TI:109.110
40	Introduction of email writing and formal and informal emails.	CO 7	TI:111.112
41	Significance of Report Writing.	CO 8	TI: 113. 114
PROBLEM SOLVING/ CASE STUDIES			
42	The aspects to improve listening comprehension Discuss in detail.	CO 1	TI:10,11
43	Different types of listeners with examples.	CO 1	TI: 19,21
44	The sounds of English language	CO 1	TI:23,27
45	verbal communication or written communication.	CO 2	TI: 27,30
46	Various difficulties in public speaking.	CO 2	TI: 32,33
47	Different ways of greeting people in formal and informal situation and discuss how do they matter in communication?	CO 2	TI: 35,37
48	'Oral presentation requires a good planning'.	CO 2	TI:36,38
49	Power point presentation and the ways to make Power point presentation.	CO 2	TI: 37,38
50	Methods that are used to establish the process of building vocabulary with examples from the most used words in spoken English.	CO 4	TI:39,41
51	The usage of idioms and phrases in spoken English.	CO 4	TI: 47,50
52	'Structure proposition-evaluation' -Reading technique.	CO 5	TI:56,58
53	Active reading, detailed reading, and speed-reading techniques used in different situations.	CO 5	TI: 79,81
54	The elements of paragraph writing in detail.	CO 8	TI:100,102
55	Logical bridges and Verbal bridges in writing.	CO 8	TI:102,104
56	Soft skills and Interpersonal Communication.	CO 8	TI:102,104
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Soft skills and Interpersonal Communication.	CO 1	TI 8,9
58	Language acquisition is a process.	CO 1	TI: 11,12
59	Communication.	CO 1	TI: 14,16
60	Time management.	CO 3	TI:9,10
61	Stress management.	CO 3	TI:9,10
DISCUSSION OF QUESTION BANK			
62	Soft Skills for difficult situations in terms of reassurance and reliability.	CO 3	TI:9,10
63	Verbal and non-verbal communication.	CO 2	TI: 34,35
64	Honesty, Respect, Self-Control and Accountability their role in building long lasting interpersonal skills?	CO 3	TI: 9,10

65	Etiquette and manners. Its importance in social, personal and professional communication.	CO 23	TI: 9,10
66	Problem solving and decision making.	CO 3	TI: 9,10

Signature of Course Coordinator **HOD**

INSTITUTE OF AERONAUTICAL ENGINEERING
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COURSE DESCRIPTION

Department	**ELECTRONOICS AND COMMUNICATION ENGINEERING**				
Course Title	**LINEAR ALGEBRA AND CALCULUS**				
Course Code	AHSC02				
Program	B.Tech				
Semester	I				
Course Type	Foundation				
Regulation	UG - 20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Mr. P Shantan Kumar, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
10+2	-	-	Basic Principles of Algebra and Calculus

II COURSE OVERVIEW:

The Linear algebra is a sub-field of mathematics concerned with vectors, matrices, and linear transforms. Calculus is the branch of mathematics which majorly deals with derivatives and integrals. Linear algebra is a key foundation to the field of machine learning. The course includes types of Matrices, Rank, methods of finding rank, Eigen values and Eigen vectors, maxima and minima of functions of several variables, solutions of higher order ordinary differential equations and Fourier series. Matrices are used in computer animations, color image processing. Eigen values are used by engineers to discover new and better designs for the future. The laws of physics are generally written down as differential equations. So, differential equations and Fourier series expansions have wide applications in various engineering and science disciplines. This course enables the students to gain basic knowledge on the mathematics which is used in modeling the real time engineering problems very often.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Linear Algebra and Calculus	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	PPT	✓	Chalk & Talk	x	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in Table: 1.

Table 1: The expected percentage of cognitive level of questions in SEE.

10 %	Remember
30 %	Understand
60 %	Apply
0 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

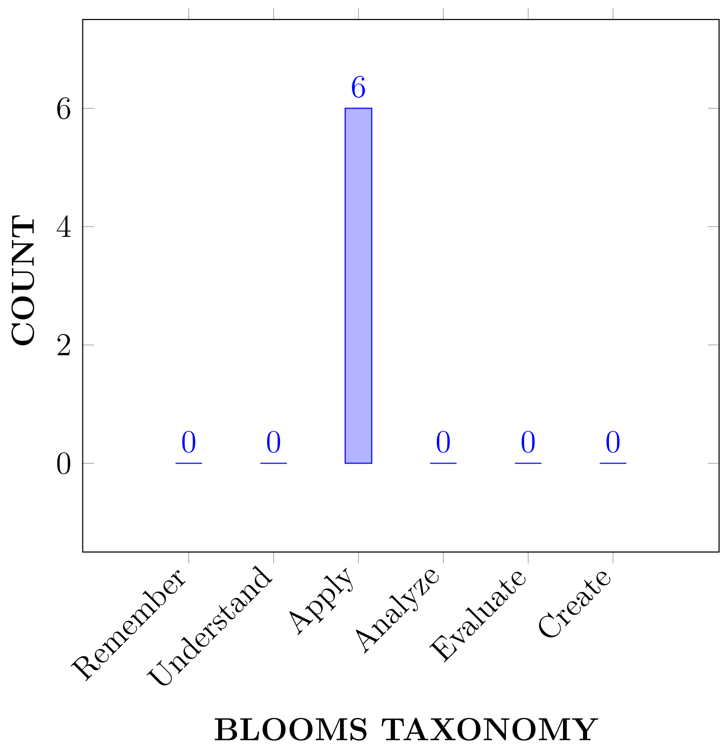
I	The principles of Eigen value analysis and linear transformations, Matrix rank finding methods.
II	The calculus of functions of several variables and the concept of maxima-minima for a three-dimensional surface.
III	The analytical methods for solving higher order differential equations with constant coefficients.
IV	Fourier series expansions in standard intervals as well as arbitrary intervals.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Compute** the rank and inverse of real and complex matrices with elementary transformation methods.	Apply
CO 2	**Use** the Eigen values, Eigen vectors for developing modal and Spectral matrices from the given matrix..	Apply
CO 3	**Make use of** Cayley Hamilton theorem for finding positive and negative powers of the matrix.	Apply
CO 4	**Utilize** the mean–value theorems and partial derivatives in estimating the extreme values for functions of several variables	Apply
CO 5	**Solve** the Second and higher order linear differential equations with constant coefficients by using substitution and method of variation of parameters..	Apply
CO 6	**Apply** the Fourier Series expansion of periodic, even and odd functions in analyzing the square wave, sine wave rectifiers.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Program Outcomes	
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Strength	Proficiency Assessed by
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	-	-
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	-	-
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	✓	-	-	-	-	-	-	-	-	-	-		-	-	-
CO 2	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	✓	-	-	-	-	-	-	-	-	-	-		-	-	-
CO 5	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	✓	✓	-	-	-	-	-	-	-	-	-		-	-	-

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	**Explain** the role of rank and inverse of real and complex matrices in solving **complex engineering problems** by using elementary transformation methods **(principles of mathematics).**	2
CO 2	PO 1	**Determine** the Eigen values, Eigen vectors, Spectral matrix **complex engineering problems modeled by matrices** with help of Characterstic Equation **(principles of mathematics).**	2
	PO 2	**Model** the problem into matrices, prepare precise **statement** of the problem and apply the concepts of Eigen values and Eigen vectors to **develop the solution** and **interpret, validate** the results through proper **documentation**	6
CO 3	PO 1	**Make use of** Cayley Hamilton theorem for finding positive and negative powers of the matrix and apply them in the **complex engineering problems** modeled by matrices **(principles of mathematics).**	2
CO 4	PO 1	**Explain** the mean–value theorems for the single variable functions andthe extreme values for functions of several variables apply them in the **complex engineering problems** Ordinary and Partial derivatives .	2
CO 5	PO 1	**Determine**the solution of **complex engineering problems** modeled by Second and higher order linear differential equations with constant coefficients by using substitution method and method of variation of parameters.	2

	PO 2	**Model** the problem with the help of ordinary differential equations, prepare precise **statement** of the problem and apply method of variation of parameters and other analytical methods to **develop the solution** and **interpret, validate** the results through proper **documentation**	6
CO 6	PO 1	**Build** the Fourier series expansion **for the complex engineering problems** modeled by given periodic, even and odd functions in various intervals with the help of Fourier coefficients formulae **(principles of mathematics).**	2
	PO 2	**Model** the problem with the help of suitable periodic functions, prepare precise **statement** of the problem and apply Fourier series expansions to **develop the solution** and **interpret, validate** the results through proper **documentation**	6

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE	Program Outcomes/No.of Key Competencies Matched												PSO'S		
OUTCOMES	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	6	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	2	6	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	2	6	-	-	-	-	-	-	-	-	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE	PROGRAM OUTCOMES												PSO'S		
OUTCOMES	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	67	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	67	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	67	60	-	-	-	-	-	-	-	-	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - 0% $\leq$ C $\leq$ 5% – No correlation
1 - 5% $<$ C $\leq$ 40% – Low/ Slight
2 - 40 % $<$ C $<$ 60% –Moderate
3 - 60% $\leq$ C $<$ 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	18	9	-	-	-	-	-	-	-	-	-	-	-	-	-
AVERAGE	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assign-ments	-	Seminars	-
Labora-tory Practices	-	Student Viva	-	Mini Project	-	Certifica-tion	-
Term Paper	-	Tech - talk	✓	Concept Video	PO 1, PO 2	-	-

XVII ASSESSMENT METHODOLOGY-INDIRECT:

x	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**THEORY OF MATRICES**
	Real matrices: Symmetric, Skew-Symmetric and Orthogonal matrices; Complex matrices: Hermitian, Skew- Hermitian and Unitary matrices; Elementary row and column transformations, finding rank of a matrix by reducing to Echelon form and Normal form; Finding the inverse of a matrix using Gauss-Jordan method
MODULE II	**LINEAR TRANSFORMATIONS**

	Cayley-Hamilton theorem: Statement, verification, finding inverse and powers of a matrix; Linear dependence and independence of vectors; Linear transformation; Eigen values and Eigen vectors of a matrix; Diagonalization of matrix.
MODULE III	**FUNCTIONS OF SINGLE AND SEVERAL VARIABLES**
	Mean value theorems: Rolle's theorem, Lagrange's theorem, Cauchy's theorem-without proof; Functions of several variables: Partial differentiation, Jacobian, functional dependence, maxima and minima of functions with two variables and three variables. Method of Lagrange multipliers.
MODULE IV	**HIGHER ORDER LINEAR DIFFERENTIAL EQUATIONS**
	Linear differential equations of second and higher order with constant coefficients. Non-homogeneous term of the type f(x) = e^{ax} , sinax , cosax , x^n , e^{ax}v(x) and Method of variation of parameters.
MODULE V	**FOURIER SERIES**
	Fourier expansion of periodic function in a given interval of length 2π; Fourier series of even and odd functions; Fourier series in an arbitrary interval;

TEXT BOOKS

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36^{th} Edition, 2010
2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
3. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint 2010.

REFERENCE BOOKS:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9^{th} Edition, John Wiley & Sons, 2006.
2. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
3. D. Poole, Linear Algebra: A Modern Introduction, 2^{nd} Edition, Brooks/Cole, 2005.

WEB REFERENCES:

1. https://nptel.ac.in/courses/111/108/111108157/

COURSE WEB PAGE:

1. lms.iare.ac.in

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Outcome based education	-	-
CONTENT DELIVERY (THEORY)			
2	Theory of Matrices: Types of Real Matrices	CO 1	T2:32.1 R1:4.1
3	Real Matrices: Symmetric, Skew-Symmetric Matrices	CO 1	T2:32.1 R1:4.2
4	Real Matrices: Orthogonal Matrices	CO 1	T2:32.1 R1:4.3
5	Complex Matrices: Hermitian, Skew- Hermitian	CO 1	T2:32.1 R1:4.3
6	Complex Matrices: Unitary Matrices	CO 1	T2:32.5 R1:4.6
7	Elementary Operations: Elementary Row and Column Transformations	CO 1	T2:32.5 R1:4.6
8	Rank of a Matrix by Echelon Form	CO 1	T2:32.4 R1:4.5
9	Rank of a Matrix by Normal Form	CO 1	T2:32.7 R1:4.8
10	Inverse of a Matrix by Gauss-Jordan Method	CO 1	T2-7.1 R1:7.4
11	Eigen Values of a Matrix	CO 2	T2-7.1 R1:7.4
12	Eigen Vectors of a Matrix	CO 2	T2-7.1 R1:7.4
13	Diagonalization of Matrix by Linear Transformation.	CO 2	T2:7.1 R1:7.4
14	Cayley-Hamilton Theorem- Statement, Verification	CO 3	T2:7.1 R1:7.4
15	Applications of Cayley – Hamilton: Finding Inverse and Powers of a Matrix	CO 3	T3-2.9 R1:2.1
16	Linear Dependence and Independence of Vectors	CO 2	T3-2.5 R1:2.8
17	Mean Value Theorems:1: Rolle's Theorem	CO 4	T3-2.5 R1:2.8
18	Mean Value Theorems:2: Lagrange's Theorem	CO 4	T3-2.5 R1:2.8

19	Mean Value Theorems:3: Cauchy's Theorem	CO 4	T3-2.5 R1:2.8
20	Functions of Several Variables: Partial Differentiation	CO 4	T3-2.5 R1:2.8
21	Jacobian Transformations	CO 4	T3-2.61 R1:2.10
22	Functional Dependence	CO 4	T1-7.1 R2:7.5
23	Maxima and Minima of Functions with Two Variables	CO 4	T3-2.61 R1:2.10
24	Maxima and Minima of Functions with Three Variables	CO 4	T1-7.1 R2:7.6
25	Application Method of Lagrange Multipliers	CO 4	T1-7.1 R2:7.7
26	Method of Lagrange Multipliers	CO 4	T3-2.5 R1:2.8
27	Linear Differential Equations of Second and Higher Order with Constant Coefficients	CO 5	T3-2.5 R1:2.8
28	Linear Differential Equations of Second and Higher Order with Constant Coefficients	CO 5	T3-2.5 R1:2.8
29	Non-Homogeneous term of the type F (X) = e^{ax}	CO 5	T3-2.5 R1:2.8
30	Non-Homogeneous term of the type F (X) = Sinax , Cosax	CO 5	T2-7.1 R1:7.4
31	Non-Homogeneous term of the type F (X) = X^n	CO 5	T2:7.1 R1:7.4
32	Non-Homogeneous term of the type F (X) = e^{ax}v(X)	CO 5	T2:7.1 R1:7.4
33	Method of Variation of Parameters	CO 5	T3-2.9 R1:2.1
34	Fourier Expansion of Periodic Function in a Given Interval of Length 2π	CO 6	T3-2.5 R1:2.8
35	Fourier Expansion of Periodic Function in a Given Interval of Length (-π,π)	CO 6	T3-2.5 R1:2.8
36	Fourier Series of Even Functions in a Given Interval of Length (-π,π)	CO 6	T2:7.1 R1:7.4
37	Fourier Series of Odd Functions in a Given Interval of Length (-π,π)	CO 6	T3-2.9 R1:2.1
38	Fourier Series in an Arbitrary Interval (0,2l)	CO 6	T3-2.5 R1:2.8
39	Fourier Series in an Arbitrary Interval (-l,l)	CO 6	T2:7.1 R1:7.4
40	Half- Range Fourier Sine Expansions in a Given Interval of Length (0,π)	CO 6	T3-2.9 R1:2.1

41	Half- Range Fourier Cosine Expansions in a Given Interval of Length (0,π)	CO 6	T3-2.5 R1:2.8
PROBLEM SOLVING/ CASE STUDIES			
42	Rank of the Matrix by Echelon and Normal Form	CO 1	T2:32.1 R1:4.2
43	Eigen Values and Eigen Vectors of The Matrix	CO 2	T2:32.1 R1:4.3
44	Finding Powers of the Matrix by Cayley Hamilton Theorem	CO 3	T2:32.1 R1:4.3
45	Finding Spectral Matrix by Linear Transformation.	CO 2	T2-7.1 R1:7.4
46	Jacobian Transformation in Cartesian and Polar Forms	CO 4	T2-7.1 R1:7.4
47	Finding Functional Relationship.	CO 4	T2:7.1 R1:7.4
48	Finding Critical Points.	CO 4	T2:7.1 R1:7.4
49	Solving Non-Homogeneous Differential Equations.	CO 5	T3-2.5 R1:2.8
50	Solving Second Order Non-Homogeneous Differential Equations by Method of Variation of Parameters.	CO 5	T3-2.5 R1:2.8
51	Finding Fourier Series	CO 6	T3-2.5 R1:2.8
52	Fourier Expansion of Periodic Function in a Given Interval of Length 2π	CO 6	T3-2.5 R1:2.8
53	Fourier Expansion of Periodic Function in a Given Interval of Length (-π,π)	CO 6	T3-2.61 R1:2.10
54	Fourier Series in An Arbitrary Interval (-l,l)	CO 6	T2:7.1 R1:7.4
55	Finding Fourier Sine Series in Interval (0,l)	CO 6	T3-2.9 R1:2.1
56	Finding Fourier Cosine Series in Interval (0,l)	CO 6	T3-2.5 R1:2.8
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Real, Complex Matrices and Rank of a Matrix	CO 1	T3-2.5 R1:2.8
58	Eigen Values and Eigen Vectors, Diagonalization	CO 2,C0 3	T3-2.5 R1:2.8
59	Mean Value Theorems, Jacobian Transformations, Functionally Dependent and Independent	CO 4	T3-2.5 R1:2.8
60	Higher Order Differential Equations	CO 5	T3-2.5 R1:2.8
61	Fourier Series (Even, Odd, Neither Functions)	CO 6	T3-2.61 R1:2.10

DISCUSSION OF QUESTION BANK			
62	Theory of Matrices	CO 1	T2:7.1 R1:7.4
63	Linear Transformations	CO 2,C0 3	T3-2.9 R1:2.1
64	Functions of Several Variables	CO 4	T3-2.5 R1:2.8
65	Higher Order Differential Equations	CO 5	T2:32.1 R1:4.3
66	Fourier Series.	CO 6	T2-7.1 R1:7.4

Signature of Course Coordinator **HOD, ECE**
Mr. P Shantan Kumar, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**ELECTRONICS AND COMMUNICATION ENGINEERING**				
Course Title	**ENGINEERING PHYSICS**				
Course Code	AHSC03				
Program	B.Tech				
Semester	I				
Course Type	Foundation				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	4	3	1.5
Course Coordinator	Ms.Sujani Singavarapu, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
10+2	-	-	Basic Principles of Physics

II COURSE OVERVIEW:

This course is structured specifically to make the students understand some of the core topics in physics essential for further studies in engineering. It focuses on illustrating and developing an understanding of the interplay between problem solving and their practical applications which include experimental techniques and modern equipment. The topics include quantum mechanics, semiconductors, LASER and fiber optics,light and optics, harmonic oscillations and waves in one dimension. At the end, this course helps students to appreciate the diverse real-time applications in technological fields in respective branches.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Engineering Physics	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
66.7 %	Understand
33.3 %	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	-

VI COURSE OBJECTIVES:

The students will try to learn:

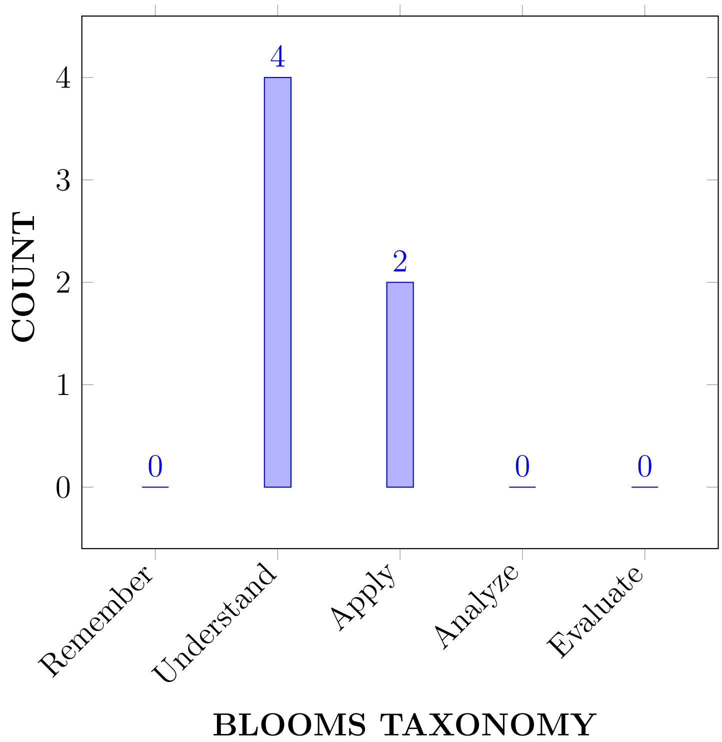
I	Basic formulations in wave mechanics for the evolution of energy levels and quantization of energies for a particle in a potential box with the help of mathematical description.
II	Fundamental properties of semiconductors including the band gap, charge carrier concentration, doping and charge carrier transport mechanisms.
III	Simple optical setups and experimental approaches of light and LASER using its interaction with matter.
IV	Basic comparative studies between different harmonic oscillators and different waves using such relationships on practical problems.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Apply** the concepts of dual nature of matter and Schrodinger wave equation to a particle enclosed in simple systems.	Understand
CO 2	**Demonstrate** the classification of solids and important aspects of semiconductors in terms of carrier concentration and Fermi level.	Apply
CO 3	**Compare** the concepts of LASER and normal light in terms of mechanism and working principles for applications in various fields and scientific practices.	Understand
CO 4	**Explain** functionality of components in optical fiber communication system by using the basics of signal propagation, attenuation and dispersion.	Understand
CO 5	**Interpret** the phenomenon of interference and diffraction by using the principles of wave motion and superposition.	Understand
CO 6	**Make use of** the concept of simple harmonic motion and arrive at expressions for damped, forced harmonic oscillators and wave equations by using necessary mathematical formulations.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	CIE/AAT
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	1	Laboratory experiments

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	✓	✓	-	✓	-	-	-	-	-	-	-	-	✓	-	-
CO 3	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-	-
CO 6	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Outline** drawbacks of classical mechanics,basic principles of dual nature of matter wave,derive mathematical equation of matter waves and come to conclusion of quantization of energy used in quantum dots.	3
	PO 2	**Explain** the given **problem statement** and **formulate** quantum confinement problems related to particle enclosed in small dimension from the provided **information** and **data** in reaching substantial conclusions by the **interpretation of results**	4
CO 2	PO 1	**Illustrate** the charge transport mechanism in intrinsic and extrinsic semiconductors using energy level diagrams,calculate their charge carrier concentration and use those expressions to integrate with other engineering disciplines.	3
	PO 2	**Explain** the given problem statement and formulate mobility and conductivity aspects of a material from the provided information and data in reaching substantial conclusions **by the interpretation** of **Hall coefficient value.**	4
	PO 4	**Identify** the use of semiconductors under study and their conduction mechanism for the **research based knowledge** and **technological development.**	2
	PSO 1	**Make use of** the knowledge of **charge transport mechanism** in semiconductors **to build Embedded systems.**	1
CO 3	PO 1	**Compare** the concepts of LASER and normal light in terms of mechanism and **working principles** for **applications** in different fields and **scientific practices.**	3
CO 4	PO 1	**Explain** functionality of components in optical fiber communication **system** by using the **basics** of signal propagation, attenuation and dispersion.	3
	PO 2	**Identify the given problem** and **formulate** expressions for acceptance angle and numerical aperture with the given **information and data** by applying principles of information propagation through optical wave guides.	4
CO 5	PO 1	**Outline** the **scientific principles** of light and its propagation evolution of different theories, and use the principles of wave motion and superposition using **mathematical principles** to understand the interference and diffraction phenomena in light	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 4	**Explain** from **technical literature the knowledge of the equipment** on which scientists performed experiments to understand the superposition of light and pattern formation by relating it to conditions for constructive and destructive interference.	2
CO 6	PO 1	**Outline** the basic **scientific principles** of force and characteristics of a simple harmonic oscillator to understand the forces acting on given oscillator to arrive at equations of damped,forced oscillators and wave equations using basic **mathematical principles**	3
	PO 2	**Explain** how damping and forced oscillations happen in a system and **identify the problems** and advantages for different conditions of damping.	4

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	4	-	2	-	-	-	-	-	-	-	-	1	-	-
CO 3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	2	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	40	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	100	40	-	18	-	-	-	-	-	-	-	-	35	-	-
CO 3	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	100	40	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	100	-	-	18	-	-	-	-	-	-	-	-	-	-	-
CO 6	100	40	-	-	-	-	-	-	-	-	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation
1 -$5 < C \leq 40\%$ – Low/ Slight
2 - $40\ \% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	3	-	2	-	-	-	-	-	-	-	-	1	-	-
CO 3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	2	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	18	12	-	4	-	-	-	-	-	-	-	-	1	-	-
AVERAGE	3	3	-	2	-	-	-	-	-	-	-	-	1	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	-	Tech Talk	✓		

XVII ASSESSMENT METHODOLOGY-INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**QUANTUM MECHANICS**
	Introduction to quantum physics, De-broglie's hypothesis, Wave-particle duality, Davisson and Germer experiment, Time-independent Schrodinger equation for wave function, Physical significance of the wave function, Schrodinger equation for one dimensional problems–particle in a box.
MODULE II	**INTRODUCTION TO SOLIDS AND SEMICONDUCTORS**
	Introduction to classical free electron theory and quantum theory, Bloch's theorem for particles in a periodic potential (Qualitative treatment), Kronig-Penney model (Qualitative treatment), classification: metals, semiconductors, and insulators. Intrinsic and extrinsic semiconductors, Carrier concentration, Dependence of Fermi level on carrier-concentration and temperature, Hall effect
MODULE III	**LASERS AND FIBER OPTICS**
	Characteristics of lasers, Spontaneous and stimulated emission of radiation, Metastable state, Population inversion, Lasing action, Ruby laser, He-Ne laser and applications of lasers. Principle and construction of an optical fiber, Acceptance angle, Numerical aperture, Types of optical fibers (Single mode, multimode, step index, graded index), Optical fiber communication system with block diagram and Applications of optical fibers .

MODULE IV	**LIGHT AND OPTICS**
	Principle of superposition of waves, Young's double slit experiment, Fringe width, Newton's rings. Fraunhofer diffraction from a single slit, double slit (extension to N slits) and diffraction grating experiment.
MODULE V	**HARMONIC OSCILLATIONS AND WAVES IN ONE DIMENSION**
	Simple harmonic oscillator, Damped harmonic oscillator, Forced harmonic oscillator. Transverse waves and Longitudinal wave equation, Reflection and transmission of waves at a boundary, Harmonic waves.

TEXTBOOKS

1. P.K.Palanisamy, "Engineering Physics", SCITECH publications, 2nd Edition,2010.
2. R. K. Gaur, S. L. Gupta, "Engineering Physics", Dhanpat Rai Publications, 8th Edition, 2001.
3. Dr. K. Vijaya Kumar, Dr. S. Chandralingam, "Modern Engineering Physics", Chand & Co. New Delhi, 1st Edition, 2010.
4. Manoj.K.Harbola, T.Vijaya Krishna, T. Madhu Mohan," Engineering Physics", Cengage Publications,1st Edition, 2010.

REFERENCE BOOKS:

1. H.J. Pain, "The Physics of Vibrations and Waves", Wiley, 2006.
2. Ghatak, "Optics", McGraw Hill Education, 2012.
3. O. Svelto, "Principles of Lasers", Springer Science & Business Media, 2010.

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
	OBE DISCUSSION		
1	Introduction to outcome based education.	-	
	CONTENT DELIVERY (THEORY)		
2	Introduction to quantum physics- Black body radiation, Planck's law, Photoelectric effect, Compton effect	CO 1	T1:6.1 R1:1.12.1,
3	De-Broglie's hypothesis,	CO 1	T1:6.3 R1:1.16
4	Wave-particle duality -Matter wave concept	CO 1	T1:6.2 R1:1.13.1
5	Davisson and Germer experiment	CO 1	T1:6.4.1 R1:1.13.2
6	Time-independent Schrodinger equation for wave function	CO 1	T1:6.6 R1:1.13.3
7	Born interpretation of the wave function	CO 1	T1:6.6.1 R1:1.17.1
8	Schrodinger equation for one -dimensional problems– particle in a box.	CO 1	T1:6.7 R1:1.17.3

9	Introduction to classical free electron theory & quantum theory.	CO 2	T1:7.2 R1:1.17.3
10	Bloch's theorem for particles in a periodic potential,	CO 2	T1:7.4 R1:2.3
11	Kronig-Penney model (Qualitative treatment)	CO 2	T1:7.5 R1:2.3
12	Types of electronic materials: metals, semiconductors, and insulators	CO 2	T1:7.6,7.7 R1:2.6.2
13	Intrinsic semiconductors - concentration of electrons in conduction band.	CO 2	T1:8.3.1 R1:2.8
14	Intrinsic semiconductors - concentration of holes in valence band	CO 2	T1:8.3.2 R1:2.9.2
15	Extrinsic semiconductors- Carrier concentration in N-Type	CO 2	T2:8.5 R1:2.10
16	Extrinsic semiconductors- Carrier concentration in P- Type	CO 2	T1:8.6 R1:2.10
17	Dependence of Fermi level on carrier-concentration and temperature	CO 2	T1:8.5,8.6 R1:2.10.2
18	Hall effect	CO2	T1:8.9 R1:2.32
19	Introduction and characteristics of LASER	CO 3	T1:12.1. R1:8.2
20	Spontaneous and stimulated emission of radiation,Meta stable state, Population inversion, Lasing action	CO 3	T1:12.2 R1:8.3.3
21	Ruby laser,He-Ne laser	CO 3	T1:12.3, R1:8.7.2
22	Applications of LASER	CO 3	T1:12.8 R1:8.7.2
23	Principle and construction of an optical fiber	CO 4	T1:13.2 R2:12.24
24	Acceptance angle, Numerical aperture	CO 4	T1:13.2 R3:12.25
25	Types of optical fibers (Single mode, multimode, step index, graded index)	CO 4	T1:13.3 R3:3.2
26	Optical fiber communication system with block diagram	CO 4	T1:13.7 R3:3.2
27	Applications of optical fibers .	CO 4	T1:13.12 R1:8.10
28	Principle of Superposition of waves	CO 5	T4:4.3 R1:8.11.1
29	Young's double slit experiment	CO 5	T4:4.7 R1:8.11.2
30	Newton's rings	CO 5	T4:4.14 R1:8.12.1
31	Fraunhofer diffraction from a single slit	CO 5	T4:4.19 R1:8.12.2
32	Fraunhofer diffraction from a Double slit	CO 5	T4:4.21 R1:8.20

33	Fraunhofer diffraction from diffraction grating	CO 5	T4:4.22 R1:8.19
34	Simple Harmonic Oscillators	CO 6	T4:2.3 R1:8.77
35	Damped harmonic oscillator	CO 6	T4:2.8,2.9 R1:7.2
36	Forced mechanical oscillators	CO 6	T4:2.14 R1:7.7
37	Impedance, Steady state motion of forced damped harmonic oscillator	CO 6	T4:2.17 R1:7.8
38	Transverse wave on a string, the wave equation on a string	CO 6	T4:3.3 R1:7.9.2
39	Longitudinal waves and the wave equation	CO 6	T4:3.7 R1:7.9.1
40	Reflection and transmission of waves at a boundary	CO 6	T4:3.4 R1:7.10
41	Harmonic waves	CO 6	T4:3.6 R1:7.11, 11.1
PROBLEM SOLVING/ CASE STUDIES			
1	Solving problems on De-Broglie wavelength	CO 1	T1:6.3 R1:1.161
2	Solving problems on Schrodinger equation for one dimensional problems–particle in a box.	CO 1	T1:6.6 R1:1.161
3	Solving problems on Physical significance of the wave function	CO 1	T1: 6.6.1 R1:1.161.
4	Solving problems on Carrier concentration	CO 2	T1:8.3-6, R1:2.8,2.10
5	Solving problems onFermi level	CO 2	T1:8.5,8.6 R1: 2.10
6	Solving problems on Hall Effect	CO 2	T1:8.9, R1: 2.32
7	Solving problems on Lasers	CO 3	T1: 12.3 R3:12.26
8	Solving problems on Acceptance angle & Numerical aperture	CO 4	T1: 13.2 R3:12.26
9	Solving problems on Refractive indices of core and cladding, fractional refractive index change	CO 4	T1: 13.3 R3:12.26
10	Solving problems on Youngs double-slit	CO 5	T4: 4.7 R1:8.12.1
11	Solving problems on Fringe width	CO 5	T4: 4.7 R1:8.12.1
12	Solving problems on Newton rings	CO 5	T4: 4.14 R1:8.12.1
13	Solving problems on Diffraction grating	CO 5	T4: 4.22 R1:8.12.1

14	Solving problems on Simple Harmonic Oscillator	CO 6	T4:2.3 R1: 8.78
15	Solving problems on Harmonic waves	CO 6	T4:3.6 R1: 7.9.3
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Definitions and Terminology on Quantum mechanics	CO 1	T1:6.1-6.7 R1:1.161.
2	Definitions and Terminology on Introduction to Solids and Semiconductors	CO 2	T1:7.2-7, 8.3-9 , R1: 2.8, 2.10
3	Definitions and Terminology on Lasers and Fiber Optics	CO 3, CO 4	T1: 12.1-12.9,13.2-13.12 R3:12.26
4	Definitions and Terminology on Light and Optics.	CO 5	T4: 4.3-4.22 R1:8.12.1
5	Definitions and Terminology on Harmonic Oscillations and Waves in One Dimension	CO 6	T4:2.3-3.7 R1: 8.78, 7.9.3
DISCUSSION OF QUESTION BANK			
1	Discussion of questions in Quantum Mechanics.	CO 1	T1:6.1-6.7 R1:1.161.
2	Discussion of questions in Solids and Semiconductors.	CO 2	T1:6.1-6.7 R1: 2.8, 2.10
3	Discussion of questions in LASER and Fiber Optics.	CO 3, CO 4	T1: 12.1-12.9,13.2-13.12 R3:12.26
4	Discussion of questions in Light and Optics.	CO 5	T4: 4.3-4.22 R1:8.12.1
5	Discussion of questions in Harmonic oscillators and Waves in one dimension.	CO 6	T4:2.3-3.7 R1: 8.78, 7.9.3

Signature of Course Coordinator **HOD,FE**
Ms.Sujani Singavarapu, Assistant Professor

COURSE DESCRIPTION

Department	Electronics and Communication Engineering				
Course Title	Python Programming				
Course Code	ACSC01				
Program	B.Tech				
Semester	I	ECE			
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Mr. B Dilip chakravarthy, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC01	I	NIL

II COURSE OVERVIEW:

This course introduces students to writing computer programs. This course presents the principles of structured programming using the Python language, one of the most increasingly preferred languages for programming today. Because of its ease of use, it is ideal as a first programming language and runs on both the PC and Macintosh platforms. However, the knowledge gained in the course can be applied later to other languages such as C and Java. The course uses iPython Notebook to afford a more interactive experience. Topics include fundamentals of computer programming in Python,object-oriented programming and graphical user interfaces.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Python Programming	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
33.3 %	Remember
50 %	Understand
16.66 %	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

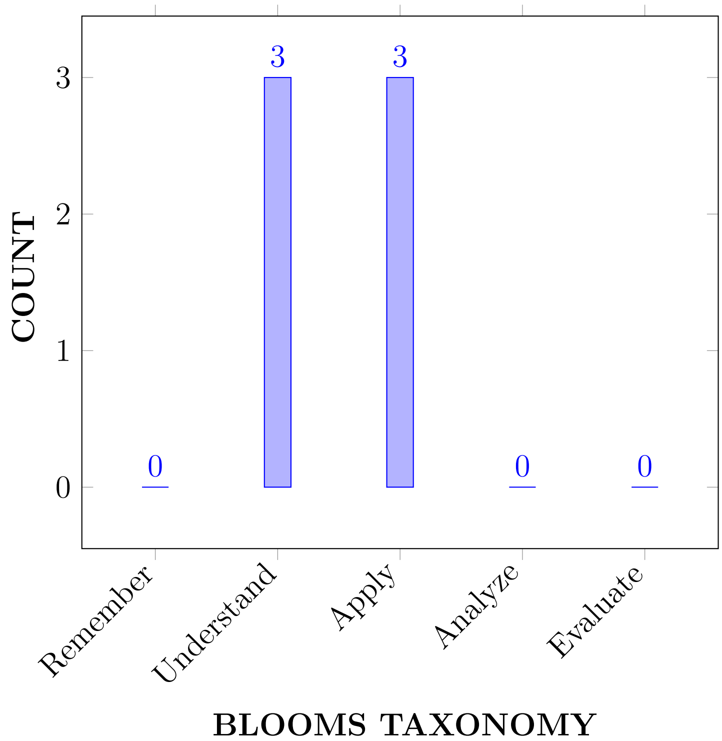
I	**Acquire programming skills in core Python**
II	**Acquire Object-oriented programming skills in Python.**
III	**Develop the skill of designing graphical-user interfaces (GUI) in Python.**
IV	**Develop the ability to write database applications in Python.**
V	**Acquire Python programming skills to move into specific branches - Internet of Things (IoT), Data Science, Machine Learning (ML), Artificial Intelligence (AI) etc.**

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Demonstrate** the basic concepts of python programming with the help of data types,operators, expressions, and console input/output.	Understand
CO 2	**Make use of** control statements for altering the sequential execution of programs in solving problems.	Apply
CO 3	**Demonstrate** operations on built-in container data types (list, tuple, set, dictionary) and strings.	Understand
CO 4	**Illustrate** operations and applications on strings with the help of built in functions.	Understand
CO 5	**Solve** the problems by using modular programming concepts through functions.	Apply
CO 6	**Identify** object oriented programming constructs for developing large, modular and reusable real-time programs.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature,and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/SEE
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIE/SEE
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques,resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations.	3	CIE/SEE
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations,and give and receive clear instructions..	3	Tech Talk/Open Ended Experiments/Concept Vedios
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	3	CIE/SEE

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	3	Tech talk /Open ended experiments
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	3	Tech talk /Open ended experiments

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	✓	-	-	-	-	✓	-	-	✓		-
CO 2	✓	✓	✓	-	✓	-	-	-	-	✓	-	-	✓	-	✓
CO 3	✓	-	✓	-	✓	-	-	-	-	-	-	-	✓	-	✓
CO 4	✓	-	✓	-	✓	-	-	-	-	✓	-	✓	✓	-	✓
CO 5	✓	✓	✓	-	✓	-	-	-	-	-	-	-	✓	-	-
CO 6	✓	✓	✓	-	✓	-	-	-	-	✓	-	✓	✓	-	✓

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Understand (knowledge) the basic concept of operators, precedence of operators and associativity while evaluating mathematical expressions in program statements. These concepts provide an insight into expression evaluation by applying the principles of mathematics and science.	3
CO 1	PO 5	With the help of modern engineering tools we can easily Understand the basic concept of operators, precedence of operators and associativity while evaluating mathematical expressions in program statements These concepts provide an insight into expression evaluation by applying the principles of mathematics and science.	1
CO 1	PO 10	Extend the knowledge of Python programming to communicate effectively with the Engineering community and society at large.	3
CO 1	PSO 1	Understand features of procedural as well as object-oriented programming while writing and analyzing computer programs in the areas related to Machine Learning, Big data and Artificial Intelligence	3
CO 2	PO 1	By applying the knowledge of mathematics,science and engineering fundameentals we can effectively use control statements.	3
CO 2	PO 2	Apply control statements in problem indentification,statement and validation .	5
CO 2	PO 3	Apply control statements to investigate and understand different complex engineering problems complex problems efficiently.	8
CO 2	PO 5	By applying control statements to model complex engineering activities	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 2	PO 10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions	3
CO 2	PSO 1	Apply features of procedural as well as object-oriented programming while writing and analyzing computer programs in the areas related to Machine Learning, Big data and Artificial Intelligence	3
CO 2	PSO 3	Acquire sufficient knowledge of object-oriented concepts and apply it in real-time for building successful career and doing higher studies.	3
CO 3	PO 1	Summarize indexing and slicing mechanisms for extracting a portion of data in a sequence using principles of mathematics, and engineering fundamentals.	3
CO 3	PO 3	Demonstrate the importance of indexing mechanisms in sequences such as lists, strings, sets, tuple and dictionary while developing solutions for complex engineering problems and design system using principles of mathematics, science, and engineering fundamentals. Use creativity to develop more innovative solutions.	6
CO 3	PO 5	Demonstarte lists,tuples and dictionaries With the usage of modern tools	1
CO 3	PSO 1	Summarize indexing mechanisms to design and develop efficient real-time computational problems.	3
CO 3	PSO 3	Infer sufficient knowledge of container data types and apply it in real-time for building successful career and doing higher studies.	3
CO 4	PO 1	Demonstrate different modules/packages in Python while developing solutions using the fundamentals of mathematics, science, and engineering.	3
CO 4	PO 3	Understand the usage of modules/packages while developing solutions for complex engineering problems and design system using principles of mathematics, science, and engineering fundamentals. Use creativity to develop more innovative solutions.	8
CO 4	PO 5	Interpret different string functions by using modern tools	1
CO 4	PO 10	Extend the focus to understand the usage of modules/packages and communicate effectively with the Engineering community and with society at large.	3
CO 4	PO 12	Summarize string handling functions to implement in project management	7
CO 4	PSO 1	Demonsrtate different modules to understand, design and analyze computer programs in reducing time and space complexities of various applications.	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 4	PSO 3	Illustrate modern computer tools in implementing string handling mechanisms for various applications to become a successful professional in the domains.	3
CO 5	P0 1	Make use of parameter passing and different types of arguments in user-defined functions to design efficiently modular programs by applying the knowledge of mathematics, science, Engineering fundamentals.	3
CO 5	P0 2	Apply modular programming concepts for problem identification,formulation and data collection .	8
CO 5	PO 3	Select strong foundation of writing efficient modular programs using parameter passing mechanisms for career building by understanding the requirements and communicating effectively with engineering community.	7
CO 5	PO 5	Develop different functions by using modern tools	1
CO 5	PSO 1	Develop design and analyse python programming in the areas of concept of passing of parameters and arguments in functions to do modular programming.	3
CO 6	PO 1	Apply scientific principles and methodologies, Mathematical principles and other engineering disciplines for the procedural and object-oriented programming concepts used in Python.	3
CO 6	PO 2	Apply object oriented concepts in problem indentification,statement and validation .	7
CO 6	PO 3	Identify the need of object-oriented concepts while developing solutions for complex engineering problems and design system using principles of mathematics, science, and engineering fundamentals. Use creativity to develop more innovative solutions..	7
CO 6	PO 5	Develop object oriented principles using modern tools	1
CO 6	PO 10	Apply the knowledge of Python programming to communicate effectively with the Engineering community and society at large.	3
CO 6	PO 12	Identify the need of object oriented principles for preparation ad ability to engage in independent and lifelong learning	6
CO 6	PSO 1	Focus on writing programs using procedural and object oriented concepts for applications such as computational geometry, machine learning, Big data and AI by understanding and applying the engineering principles learning	3
CO 6	PSO 3	Acquire sufficient knowledge of object-oriented concepts and apply it in real-time for building successful career and doing higher studies.	3

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	1	-	-	-		3	-		3	-	-
CO 2	3	5	8	-	1	-	-	-	-	3	-	-	3	-	3
CO 3	3		6		1	-	-	-	-	-	-	-	3	-	3
CO 4	3	-	8	-	1	-	-	-	-	3	-	7	3		3
CO 5	3	8	7	-	1	-	-	-	-	-	-	-	3	-	-
CO 6	3	7	7	-	1	-	-	-	-	3	-	6	3	-	3

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	12	1	3	2
CO 1	100	0.0	0.0	0.0	100	0.0	0.0	0.0	0.0	60	0.0	0.0	100	0.0	0.0
CO 2	100	50	80	0.0	100	0.0	0.0	0.0	0.0	60	0.0	0.0	100	0.0	100
CO 3	100	0.0	60	0.0	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100	0.0	100
CO 4	100	50	80	0.0	100	0.0	0.0	0.0	0.0	60	0.0	88	100	0.0	100
CO 5	100	80	70	0.0	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100	0.0	0.0
CO 6	100	80	70	0.0	100	0.0	0.0	0.0	0.0	60	0.0	75	100	0.0	100

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -5 $<C \leq 40\%$ – Low/ Slight

2 - 40 % $<C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	3	-	-	-	-	3	-	-	3	-	-
CO 2	3	2	3	-	3	-	-	-	-	3	-	-	3	-	3
CO 3	3	-	3	-	3	-	-	-	-	-	-	-	3	-	3
CO 4	3	-	3	-	3	-	-	-	-	3	-	3	3	-	3
CO 5	3	2	3	-	3	-	-	-	-	-	-	-	3	-	-
CO 6	3	3	3	-	3	-	-	-	-	3	-	3	3	-	3
TOTAL	18	7	15	-	18	-	-	-	-	12	-	6	18	-	12
AVERAGE	3.0	2.3	3	-	3.0	-	-	-	-	3.0	-	3.0	3.0	-	3.0

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	case studies	-
Assignments	-	Open ended experiments	✓		

XVII ASSESSMENT METHODOLOGY-INDIRECT:

-	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**Introduction to Python**
	Introduction to Python: Features of Python, History and Future of Python, Working with Python – interactive and script mode, Identifiers and Keywords, Comments, Indentation and Multi-lining, Data types – built-in data types, Operators and Expressions, Console Input/Output, Formatted printing,Built-in Functions, Library Functions.
MODULE II	**DECISION CONTROL STATEMENTS**
	Selection/Conditional Branching Statements: if, if-else, nested if, if-elif-else statement(s), Basic Loop Structures/ Iterative Statements – while and for loop, Nested loops, break and continue statement, pass Statement, else Statement used with loops..
MODULE III	**CONTAINER DATA TYPES**
	Lists: Accessing List elements, List operations, List methods, List comprehension; Tuples: Accessing Tuple elements, Tuple operations, Tuple methods, Tuple comprehension, Conversion of List comprehension to Tuple, Iterators and Iterables, zip() function. Sets: Accessing Set elements, Set operations, Set functions, Set comprehension;Dictionaries: Accessing Dictionary elements, Dictionary operations, Dictionary Functions, Nested Dictionary, Dictionary comprehension.s.
MODULE IV	**STRINGS AND FUNCTIONS**
	Strings: Accessing string elements, string properties, string operations. Functions: Communicating with functions, Variable Scope and lifetime, return statement, Types of arguments, Lambda functions, Recursive functions..
MODULE V	**CLASSES AND OBJECTS**
	Classes and Objects – Defining Classes, Creating Objects, Data Abstraction and Hiding through Classes, Class Method and self Argument, Class variables and Object variables, init() and de () method, Public and private data members, Built-in Class Attributes, Garbage Collection. OOPs Features:Abstraction, Encapsulation, Inheritance, and Polymorphism.

TEXTBOOKS:

1. Reema Thareja, "Python Programming - Using Problem Solving Approach", Oxford Press, 1st Edition, 2017.
2. Dusty Philips, "Python 3 Object Oriented Programming", PACKT Publishing, 2nd Edition,2015.

REFERENCE BOOKS:

1. Yashavant Kanetkar, Aditya Kanetkar, "Let Us Python", BPB Publications, 2nd Edition, 2019.
2. Martin C. Brown, "Python: The Complete Reference", Mc. Graw Hill, Indian Edition, 2018.
3. Michael H. Goldwasser, David Letscher, "Object Oriented Programming in Python", Prentice Hall, 1st Edition, 2007.
4. Taneja Sheetal, Kumar Naveen, "Python Programming – A Modular Approach", Pearson, 1st Edition, 2017
5. Nageswar Rao, "Core Python Programming", Dreamtech Press, 2018.

COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference T1: 4.1
OBE DISCUSSION			
	Discussion on mapping COs with POs. (OBE)		
CONTENT DELIVERY (THEORY)			
1-2	Introduction to Python: Features of Python, History and Future of Python	CO 1	T1:3.1 –3.3
3-4	Working with Python – interactive and script mode, Identifiers and Keywords, Comments, Indentation and Multi-lining, Databtypes – built-in data types	CO 1	T1:3.4-3.9
5-8	Operators and Expressions	CO 1	T1:3.12
9-10	Console Input/Output, Formatted printing, Built-in Functions, Library Functions	CO 1	T1:3.15
11-14	Control Statement(s)	CO 2	T1: 4.1 –4.8
15-17	Lists and Tuples	CO 3	T1:3.15
18-19	Conversion of List comprehension to Tuple, Iterators and Iterables, zip() function	CO 3	T1:3.15
20-21	Sets, Dictionaries:	CO 3	T1:3.15
22-23	Nested Dictionary, Dictionary comprehension	CO 3	T1:3.15
24-25	Strings: Accessing string elements, string properties, string operations	CO 4	T1: 6.1 –6.8
26-27	Functions: Communicating with functions, Variable Scope and lifetime, return statement	CO 5	T1:5.1 –5.5

28-29	Types of arguments, Lambda functions, Recursive functions	CO 5	T1:5.6 –5.8
30-31	Classes and Objects – Defining Classes, Creating Objects	CO 6	T1 : 9.1 – 9.3
32-33	Data Abstraction and Hiding through Classes, Class Method and self Argument	CO 6	T1: 9.2 – 9.4
34-36	Class variables and Object variables, init() and del () method	CO 6	T1:9.5 – 9.7
37-38	Public and private data members, Built-in Class Attributes, Garbage Collection	CO 6	T1:9.8 – 9.13
39-41	OOPs Features: Abstraction, Encapsulation, Inheritance, and Polymorphism	CO 6	T1:10.1-10.3
PROBLEM SOLVING/ CASE STUDIES			
1	Data Types	CO 1	T1:3.7.1-3.7.4
2	Operators and Expressions	CO 1	T1:3.12.1-3.12.10
3	Built-in Functions , Library functions	CO 1	T1:6.4-6.10
4	Conditional branching Statements	CO 2	T1:4.1-4.2
5	Iterative Statements	CO 2	T1:4.3-4.8
6	Lists	CO 3	T1:8.2-8.2.10
7	Tuples	CO 3	T1:8.4.1
8	Sets	CO 3	T1:8.5.1
9	Dictionaries	CO 3	T1:8.6.1-8.6.12
10	Strings	CO 4	T1:6.1-6.10
11	Functions	CO 5	T1:5.1:5.10
12	Classes and Objects	CO 6	T1:9.1-9.15
13	__init()__and __del__() method	CO 6	T1:9.4-9.6
14	Inheritance	CO 6	T1:10.1-10.4
15	Polymorphism	CO 6	T1:10.2.1
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Define bound and unbound variable.	CO 1	T1:9.1
2	Define a control structure?	CO 2	T1:4.1-4.8
3	How to slice lists in Python?	CO 3	T1:8.2-8.6
4	Write the syntax of defining a function?	CO 5	T1:5.1-5.2

5	List out the features of object oriented programming.	CO 6	T19.1-9.3
DISCUSSION OF QUESTION BANK			
1	Write the features and applications of Python programming language?	CO 1	T1:3.1-3.3
2	Write a program to calculate the roots of a quadratic equation?	CO 1	T1:3.5-3.7
3	Write a program to remove all duplicate elements from a list?	CO 3	T1:8.2-8.6
4	Write a program that accepts a string from user and redisplays the same string after removing vowels from it?	CO 4	T1:6.1-6.3
5	Write a program that has a class Person string name and date of birth (DOB) of a person. The program should subtract the DOB from today's date to find out whether a person is eligible for vote or not?	CO 6	T1:9.1-9.3

Course Coordinator
B Dilip Chakravarty

HOD CSE(CS)

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Course Title	**ENGLISH LANGUAGE AND COMMUNICATION SKILLS LABORATORY**				
Course Code	AHSC04				
Program	B.Tech				
Semester	I	ECE			
Course Type	Foundation				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	2	1
Course Coordinator	Dr. M.Sailaja, Associate Professor				

I COURSE OVERVIEW:

This lab course is designed to introduce the students to create wide exposure on language learning techniques regarding the basic elements of Listening, Speaking, Reading and Writing. In this lab the students are trained in communicative English language skills, phonetics, word accent, word stress, rhythm and intonation, oral presentations, extempore and Prepared-seminars, group-discussions, presenting techniques of writing, participating role plays, telephonic etiquettes, asking and giving directions, information transfer , debates, description of persons, places, objects etc; . The lab encourages the students to work in a group, engage in peer-reviews and inculcate team spirit through various exercises on grammar, vocabulary, and pronunciation games etc. Students will make use of all these language skills in academic, professional and real time situations.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
English Language and Communication Skills Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Sofware based
20 %	To test the perfection of primary tonic stress accent, pre-tonic secondary stress accent and post-tonic secondary stress accent.
20 %	To test the performance to achieve neutralization of accent.
20 %	To test the awareness while pronouncing gemination, elision and assimilation.
20 %	To test the presentation skills in the ICS laboratory.
20 %	To test the subject knowledge through viva.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Sofware based**

Objective	Analysis	Design	Conclusion	Viva	Total
4	4	4	4	4	20

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
-	-	-	-	-	-

VI COURSE OBJECTIVES:

The students will try to learn:

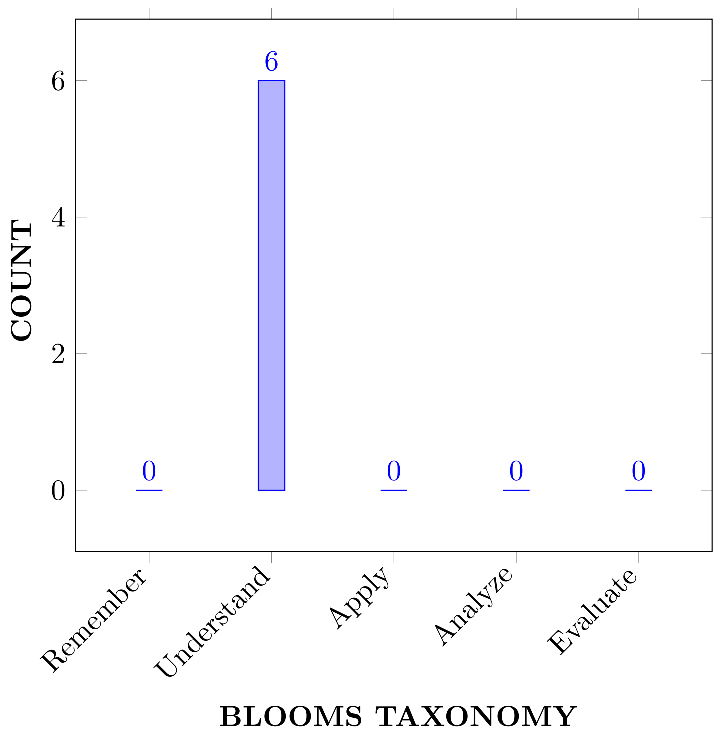
I	Facilitate computer-assisted multi-media instructions to make possible individualized and independent language learning.
II	The critical aspect of speaking and reading for interpreting in-depth meaning of the sentences.
III	Use language appropriately for social interactions such as public speaking, group discussions and interviews.
IV	Habituate using English speech sounds, word accent, intonation and rhythm.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Discuss** the prime necessities of listening skill for improving pronunciation in academic and non-academic purposes.	Understand
CO 2	**Summarize** the knowledge of English phonetics for speaking accepted language and describe the procedure of phonemic transcriptions and intonation patterns.	Understand
CO 3	**Express** about necessity of stressed and unstressed syllables in a word with appropriate length and clarity.	Understand
CO 4	**Explain** how writing skill fulfill the academic and non-academic requirements of various written communicative functions.	Understand
CO 5	**Generalize** appropriate concepts and methods from a variety of disciplines to solve problems effectively and creatively.	Understand
CO 6	**Classify** the roles of collaboration, risk-taking, multi-disciplinary awareness, and the imagination in achieving creative responses to problems.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	3	Day-to-day evaluation / CIE/SEE
PO 10	**Communicate:** effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (Communication).	5	Day-to-day evaluation / CIE/SEE

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	-	-
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	-	-
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	-	-

3 = High; 2 = Medium; 1 = Low

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 10	Discuss the heeds of functional **grammar** and **punctuation** tools in **speaking** and **writing** by generating the **clarity** of an audio text.	5
CO 2	PO 9	Define the meaning of **individual work** and **team work** and also participate effectively to develop **leadership** qualities among the **diverse teams** in **multidisciplinary** settings.	5
CO 3	PO 10	Describe the **clarity** of **grammatical** usage and the obligation of **punctuation** marks in **speaking** and **writing**.	5
CO 4	PO 10	Choose suitable **grammatical** structures and **punctuation** marks at **speaking** and **writing** areas maintaining **clarity** at professional platform.	5
CO 5	PO 10	Interpret the **grammatical** knowledge and **punctuation** marks systematically towards providing the **clarity** in **speaking** and **writing**.	5
CO 6	PO 10	Demonstrate the role of **grammar** and **punctuation** marks understanding the meaning between the sentences as well as paragraphs in **speaking** or **writing** for a **clarity**.	5

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES			PSO'S
	PO 9	PO 10	-	PSO
CO 1	-	5	-	-
CO 2	3	-	-	-
CO 3	-	5	-	-
CO 4	-	5	-	-
CO 5	-	5	-	-
CO 6	-	5	-	

XII ASSESSMENT METHODOLOGY DIRECT:

Laboratory Practices	PO 9, PO 10	Student Viva	PO 9, PO 10	Certification	-
Assignments	-	-	-	-	

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK I	**INTRODUCTION ABOUT ELCS LAB..**
	Introducing Self and Introducing Others – feedback.
WEEK II	**INTRODUCTION TO PHONETICS AND PRACTICING CONSONANTS**
	Describing a person or place or a thing using relevant adjectives – feedback.
WEEK III	**PRACTICING VOWEL SOUNDS.**
	JAM Sessions using public address system.
WEEK IV	**STRUCTURE OF SYLLABLES.**
	Giving directions with help of using appropriate phrases – activities.
WEEK V	**WORD ACCENT AND STRESS SHIFTS. – PRACTICE EXERCISES.**
	Starting a conversation, developing and closing appropriately using fixed expressions..
WEEK VI	**PAST TENSE AND PLURAL MARKERS.**
	Role Play activities.
WEEK VII	**WEAK FORMS AND STRONG FORMS.**
	Oral Presentation..
WEEK VIII	**INTRODUCTION TO INTONATION- USES OF INTONATION - TYPES OF INTONATION- PRACTICE EXERCISES.**
	Expresions In Various Situations.
WEEK IX	**NEUTRALIZATION OF MOTHER TONGUE INFLUENCE (MTI).**
	Sharing Summaries Or Reviews On The Topics Of Students' Choice.
WEEK X	**COMMON ERRORS IN PRONUNCIATION AND PRONUNCIATION PRACTICE THROUGH TONGUE TWISTERS.**
	Interpretation Of Proverbs And Idioms.
WEEK XI	**LISENING COMPREHENSION.**
	Etiquettes.

WEEK XII	**TECHNIQUES AND METHODS TO WRITE SUMMARIES AND REVIEWS OF VIDEOS.**
	Writing Messages, Leaflets And Notices Etc.
WEEK XIII	**COMMON ERRORS.**
	Resume Writing.
WEEK XIV	**INTRODUCTION TO WORD DICTIONARY.**
	Group Discussions – Video Recording – Feedback.
WEEK XV	**INTRODUCTION TO CONVERSATION SKILLS.**
	Mock Interviews.

TEXTBOOKS

1. ENGLISH LANGUAGE AND COMMUNICATION SKILLS: LAB MANUAL

REFERENCE BOOKS:

1. . Meenakshi Raman, Sangeetha Sharma, "Technical Communication Principles and Practices", Oxford University Press, New Delhi, 3rd Edition, 2015.

2. Rhirdion, Daniel, "Technical Communication", Cengage Learning, New Delhi, 1st Edition, 2009.

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Introduction About Elcs Lab, Introducing Self And Introducing Others – Feedback.	CO 2	R1: 1.2
2	Introduction To Phonetics And Practicing Consonants, Describing A Person Or Place Or A Thing Using Relevant Adjectives – Feedback.	CO 2	R2: 25-30
3	Practicing Vowel Sounds,Jam Sessions Using Public Address System.	CO 2	R1: 28-29,49-54
4	Structure Of Syllables, Giving Directions With Help Of Using Appropriate Phrases – Activities.	CO 3	R1: 23-38
5	Word Accent And Stress Shifts. – Practice Exercises, Starting A Conversation, Developing And Closing Appropriately Using Fixed Expressions.	CO 3	R1: 2.4
6	Past Tense And Plural Markers,	CO 2	R3: 4.5
7	Weak Forms And Strong Forms,Oral Presentation.	CO 2	R3: 4.6
8	Introduction To Intonation- Uses Of Intonation - Types Of Intonation- Practice Exercises, Expresions In Various Situations.	CO 2	R2: 39-42
9	Neutralization Of Mother Tongue Influence (Mti), Sharing Summaries Or Reviews On The Topics Of Students' Choice.	CO 2	R2: 5.2
10	Common Errors In Pronunciation And Pronunciation Practice Through Tongue Twisters, Interpretation Of Proverbs And Idioms.	CO 2	R1:42-43
11	Lisening Comprehension, Etiquettes	CO 5	R1:44-48

12	Techniques And Methods To Write Summaries And Reviews Of Videos,Writing Messages, Leaflets And Notices Etc.	CO 4	R1:107-110
13	Common Errors, Resume Writing.	CO 4	R1:7.3
14	Introduction To Word Dictionary,Group Discussions – Video Recording – Feedback.	CO 5	R1:7.3
15	Introduction To Conversation Skills,Mock Interviews.	CO 6	R1: 54-58

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments.
1	**Effective listening skills can be used in professional and personal platforms in future.**
2	**By learning LSRW skills, students can enhance desired language skills to fulfill their needs.**
3	**Practicing presentation skills will boost confidence at work place.**
4	**The overall experiments of the laboratory will lead to be an effective communicator.**
5	**The Students will develop critical comprehensive skills to solve the career related problems in future.**

Signature of Course Coordinator **HOD**
Dr. M.Sailaja, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING
COURSE DESCRIPTION

<table>
<tr><td>Course Title</td><td colspan="5">PHYSICS LABORATORY</td></tr>
<tr><td>Course Code</td><td colspan="5">AHSC05</td></tr>
<tr><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>Semester</td><td>I</td><td colspan="4">ECE</td></tr>
<tr><td>Course Type</td><td>FOUNDATION</td><td colspan="4"></td></tr>
<tr><td>Regulation</td><td>IARE - UG 20</td><td colspan="4"></td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>3</td><td>1.5</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Mr. K Saibaba, Assistant Professor</td></tr>
</table>

I COURSE OVERVIEW:

This lab course provides hands on experience in a number of experimental techniques and developscompetenceintheinstrumentationtypicallyusedinphysics.This also develops student's expertise in applying physical concepts to practical problem and in learning about experimental techniques with advanced equipments. This laboratory includes experiments involving electromagnetism and optoelectronics.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
-	-	-	Basic principles of physics	1.5

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Physics laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing Further Experiments

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks for internal assessment and 70 marks for semester end lab examination. Out of 30 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day-to-day performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end lab examination for 70 marks shall be conducted by two examiners, one of them being Internal Examiner and the other being External Examiner, both nominated by the principal from the panel of experts recommended by Chairman, BOS.

The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component	**Laboratory**		Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

A. Experiment Based

Objective	**Analysis**	**Design**	**Conclusion**	**Viva**	**Total**
2	2	2	2	2	10

B. Programming Based

Purpose	**Algorithm**	**Program**	**Conclusion**	**Viva**	**Total**
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

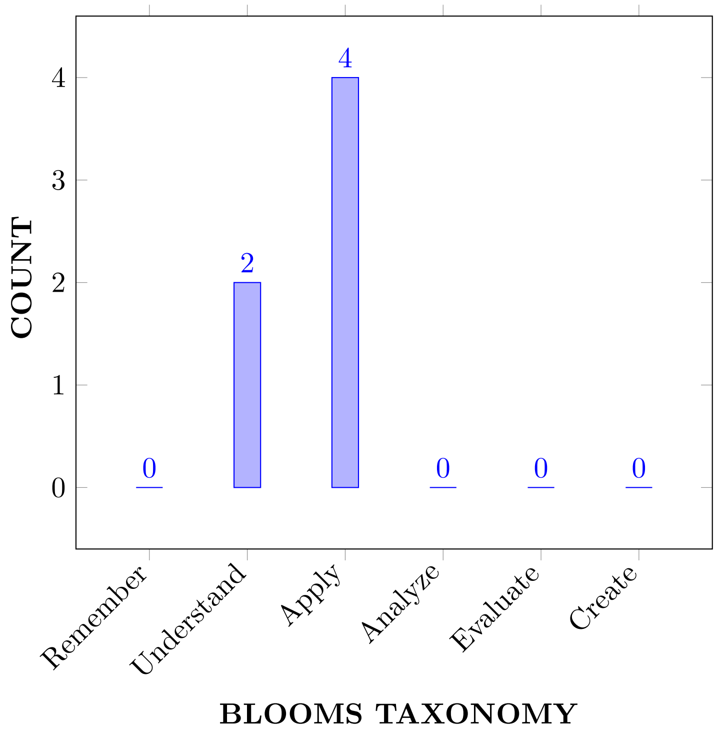
I	To familiarize with the lab facilities, equipment, standard operating procedures.
II	About the different kinds of functional electric and magnetic materials which paves a way for them to use in various technical and engineering applications.
III	The analytical techniques and graphical analysis to study the experimental data for optoelectronic devices.
IV	The applications of variation in the intensity of light due to natural phenomena like interference and diffraction.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Identify** the type of semiconductor using the principle of Hall Effect and also determine the energy gap of a semiconductor diode.	Apply
CO 2	**Illustrate** principle, working and application of wave propagation and compare results with theoretical harmonics and overtones.	Understand
CO 3	**Investigate** the energy losses associated with a given Ferro magnetic material and also magnetic field induction produced at various points along the axis of current carrying coil.	Apply
CO 4	**Examine** launching of light through optical fiber from the concept of light gathering capacity of numerical aperture.	Understand
CO 5	**Utilize** ththe phenomena of interference and diffraction for the determination of various parameters like radius of curvature of convex lens, wavelength of laser light and width of single slit.	Apply
CO 6	**Investigate** V-I/L-I characteristics of various optoelectronic devices like Light Emitting Diode, Photodiode to understand their basic principle of functioning as well as to infer the value of Planck's constant.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Laboratory experiments, internal and external lab examinations.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Laboratory experiments, internal and external lab examinations.
PO 4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	Laboratory experiments, internal and external lab examinations.

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications		

3 = High; 2 = Medium; 1 = Low

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Identify basic principle of Hall effect and make use of mathematical expression for Hall coefficient to deduce the type of semiconductor.	2
	PO 2	Understand the given problem statement of identification of type of semiconductor and formulate Hall coefficient from experimental collection of information and data in reaching substantial conclusions by the interpretation of results.	4
	PO 1	Determine the energy gap of a semiconductor diode by making use of graphical analysis of current versus temperature curve.	2

CO 2	PO 1	Recall the theory of propagation of longitudinal and transverse waves and make use of number of loops formation in string to determine frequency of an electronically maintained tuning fork.	2
	PO 2	Understand the given problem statement of stationary wave propagation and formulate harmonics and overtones of fundamental frequency from experimental collection of information and data in reaching substantial conclusions by the interpretation of results.	4
CO 3	PO 1	Explain the variation of magnetic field at various points along the axis of current carrying coil and make use of mathematical expression of Tangent's law using Stewart Gee's apparatus.	2
	PO 2	Understand the given problem statement of current loop and formulate magnetic field induction at various points along the axis of current loop from experimental collection of information and data in reaching substantial conclusions by the interpretation of results.	4
	PO 1	Investigate the energy losses associated with a given ferromagnetic material and make use of graphical representation of hysteresis loop exhibited by magnetic material.	2
	PO 2	Understand the given problem statement of energy losses associated with a given ferromagnetic material and formulate hysteresis loop from experimental collection of information and data in reaching substantial conclusions by the interpretation of results.	4
	PO 4	Apply simulation tool to get hysteresis curve of a ferromagnetic material and understand energy losses associated with material.	1
	PSO 3	Make use of modern simulation tool to get information about energy losses associated with a ferromagnetic material.	1
CO 4	PO 1	Interpret launching of light through optical fiber and make use of mathematical expression for analyzing light gathering capacity through numerical aperture.	2
	PO 4	Make use of optical fiber trainer kit and understand conversion of electrical to light energy..	1
CO 5	PO 1	Explain the concept of interference in Newton's rings and make use of it to determine the radius of curvature of convex lens.	2
	PO 4	Make use of microscope to get Newton's rings and understand the phenomenon of interference in reflected light.	1
	PO 1	Recollect the phenomena of diffraction from N-slits and make use of it for the determination of wavelength of a given laser.	1

	PO 1	Understand the phenomenon of single slit diffraction and make use of it to determine the slit width by using laser light as monochromatic source.	1
CO 6	PO 1	Explain the V-I characteristics of light emitting diode and infer the value of planck's constant by plotting temperature versus current curve.	2
	PO 1	Understand the phenomenon of recombination of electron-hole pair and determine the value of threshold voltage of a given LED.	2
	PO 1	Illustrate the variation of photo current with light intensity in a photo diode.	1

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES			PSO'S
	PO 1	PO 2	PO 4	PSO 3
CO 1	3	2	-	-
CO 2	3	2	1	-
CO 3	3	-	-	1
CO 4	3	2	1	-
CO 5	3	-	1	-
CO 6	3	2	1	-

3 = High; 2 = Medium; 1 = Low

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK 1	**HAL LEFFECT (LORENTZFORCE)**
	Determination of charge carrier density.
WEEK 2	**MELDE'S EXPERIMENT**
	Determination of frequency of a given tuning fork
WEEK 3	**STEWART GEE'S APPARATUS**
	Magnetic field along the axis of current carrying coil – Stewart and Gee's method.
WEEK 4	**B-H CURVE WITH CRO**
	To determine the value of retentivity and coercivity of a given magnetic material.
WEEK 5	**ENERGY GAP OF A SEMICONDUCTOR DIODE**
	Determination of energy gap of a semiconductor diode.
WEEK 6	**PHOTO DIODE**
	Studying V-I characteristics of Photo Diode.
WEEK 7	**OPTICAL FIBER**
	Evaluation of numerical aperture of a given optical fiber.
WEEK 8	**WAVELENGTH OF LASER LIGHT**
	Determination of wavelength of a given laser light using diffraction grating.
WEEK 9	**PLANK'S CONSTANT**
	Determination of Plank's constant using LED.
WEEK 10	**LIGHT EMITTING DIODE**
	Studying V-I Characteristics of LED.
WEEK 11	**NEWTONS RINGS**
	Determination of radius of curvature of a given plano - convex lens.
WEEK 12	**SINGLE SLIT DIFFRACTION**
	Determination of width of a given single slit.

TEXTBOOKS

1. 1 CL Arora, "Practical Physics", S Chand and Co.,New Delhi, 3rd Edition,2012.
2. 2 Vijay Kumar, Dr. T. Radha krishna, "Practical Physics for Engineering Students", S M Enterprises, 2nd Edition, 2014.

REFERENCE BOOKS:

1. 1 CF Coombs,"Basic Electronic Instrument Handbook", McGraw - HillBookCo.,1972.
2. 2 CH Bernardand CD Epp, John Wiley and Sons, " Laboratory Experiments in College Physics" Inc.,NewYork,1995.

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Determination of charge carrier density.	CO 1	T1:13.5
2	Determination of frequency of a given tuning fork.	CO 2	T1:13.5
3	Determination of Magnetic field along the axis of current carrying coil – Stewart and Gee's method.	CO 3, CO 4	TT1:14.7
4	Determination of the energy loss per unit volume of a given magnetic material per cycle by tracing the Hysteresis loop.	CO 3	T1:15.7
5	Determination of energy gap of a semiconductor diode.	CO 1	T1:16.8
6	Studying V-I Characteristics of Photo Diode.	CO 6	T1:16.9
7	Evaluation of numerical aperture of a given optical fiber.	CO 4	T1:17.9
8	Determination of wavelength of a given laser light using diffraction grating.	CO 5	T1:18.10
9	Determination of Plank's constant using LED.	CO 6	T1:19.10
10	Studying V-I characteristics of LED	CO 6	T1:19.9
11	Determination of radius of curvature of a given Plano-convex lens.	CO 5	T1:23.10
12	Determination of width of a given single slit.	CO 5	T1:23.10

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	To determine the wavelength of different colored light using white light source by Newton's ring method
2	To study the bending losses and transmission losses of an optical Fiber
3	To observe the dispersion of prism by using spectrometer.
4	Study the characteristics of Laser diode.
5	To illustrate the interference pattern produced from the air wedge.
6	To determine the voltage current characteristics of solar cell

Signature of Course Coordinator **HOD,ECE**
Mr.K Saibaba, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043
ELECTRONICS AND COMMUNICATION ENGINEERING
COURSE DESCRIPTION

Course Title	**PYTHON PROGRAMMING LABORATORY**				
Course Code	ACAC02				
Program	B.Tech				
Semester	I	ECE			
Course Type	Core				
Regulation	IARE - UG 20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Ms Jalaja Vishnubhotla, Assistant Professor CSE (AI&ML)				

I COURSE OVERVIEW:
This course introduces students to writing computer programs. This course presents the principles of structured programming using the Python language, one of the most increasingly preferred languages for programming today. Because of its ease of use, it is ideal as a first programming language and runs on both the PC and Macintosh platforms. However, the knowledge gained in the course can be applied later to other languages such as C and Java.The course uses iPython Notebook to afford a more interactive experience. Topics include fundamentals of computer programming in Python, object-oriented programming and graphical user interfaces.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSC02	I	-

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
PYTHON PROGRAMMING LABORATORY	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

X	Demo Video	X	Lab Worksheets	X	Viva Questions	X	Probing further Questions

V EVALUATION METHODOLOGY:
Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

I	Acquire programming skills in core Python.
II	Acquire Object-oriented programming skills in Python.
III	Develop the skill of designing graphical-user interfaces (GUI) in Python.
IV	Develop the ability to write database applications in Python
V	Acquire Python programming skills to move into specific branches - Internet of Things (IoT), Data Science, Machine Learning (ML), Artificial Intelligence (AI) etc.

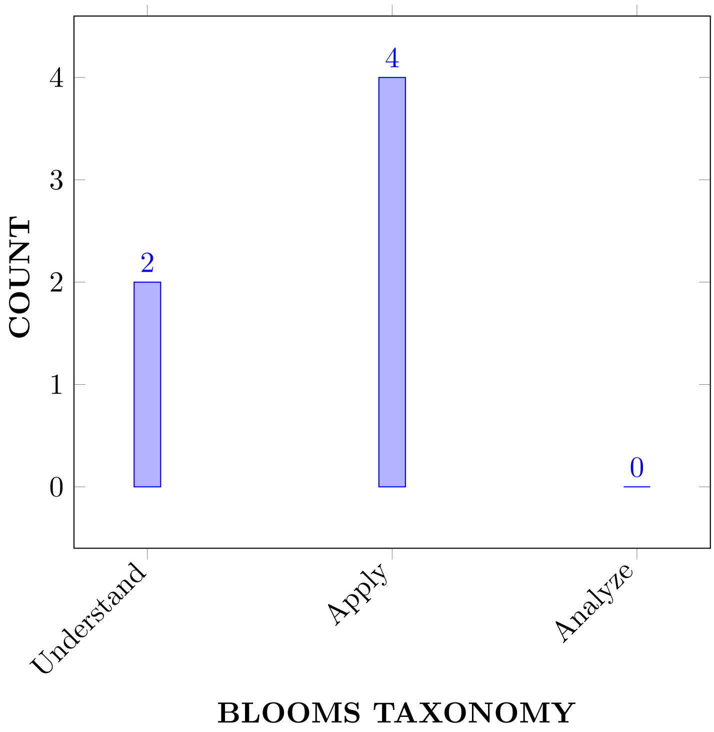
VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Demonstrate** the basic concepts of python programming with the help of data types, operators and expressions, console input/output	Understand
CO 2	**Make use of** control statements for altering the sequential execution of programs in solving problems.	Apply
CO 3	**Demonstrate** operations on built-in container data types (list, tuple, set, dictionary) and strings.	Understand

CO 4	**Make use of** operations and applications on strings with the help of built in functions	Apply
CO 5	**Solve** the problems by using modular programming concepts through functions.	Apply
CO 6	**Identify** object-oriented programming constructs for developing large, modular and reusable real-time programs	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE / SEE/ Lab Exercises
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIE / SEE/ Lab Exercises
PO 5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	3	CIE / SEE/ Lab Exercises

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	3	Lab Exercises
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs		
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	3	Lab Exercises

3 = High; 2 = Medium; 1 = Low

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	**Justification for mapping (Students will be able to)**	No. of Key Competencies
CO 1	PO 1	Demonstrate the data types of Python Programming by understating their importance and applicability (apply) in. **solving (complex) engineering problems by applying the principles of Mathematics and Engineering.**	3
	PO 2	Demonstrate the data types of Python Programming **with provided information and data in reaching substantiated conclusions by the interpretation of results.** .	3

	PO 5	Demonstrate the data types,operators,expressions and console I/O of Python Programming **for solving problems with the help of built in functions in Python programming**.	3
	PSO 3	Use datatypes,operators and expressions of Python Programming **in solving mathematical and statistical problems**	3
CO 2	PO 1	Illustrate the usage of control statements in solving real world problems **by applying principles of Mathematics, Science and Engineering.**	3
	PO 2	Illustrate the usage of control statements in solving real world problems **for visualizing the distribution of data in solving analysis problems.** .	2
	PO 5	Illustrate the usage of control statements along with built in functions of Python programming **for visualizing distribution of data with the help of built in function in Python programming language** .	3
	PSO 3	Use real time data to implement machine learning basics with Python programming **by analyzing the data and its relationships.** .	3
CO 3	PO 1	Illustrate the operations on built in container data types and strings **by applying the principles of Mathematics, Science and Engineering.** .	3
	PO 2	Illustrate the operations on built in container data types and strings in solving (complex) data centric engineering problems **from the provided information and substantiate with the interpretation of variations in the results.** .	3
	PSO 3	Implement the Python Programming basics **by exploring data analysis to solve complex problems.** .	3
CO 4	PO 1	Conclude the insights of data using exploratory data analysis **by applying the principles of Mathematics, Science and Engineering.**.	3
	PO 5	Define the list of operations on strings using built in functions **Find the different ways to model data and understand the limitations.**.	2
	PSO 3	Implement all string related operations using Python Programming programming **by exploring data limitations for generating predictions.** .	3
CO 5	PO 1	Apply the Modular Approach real world problems **by understanding the concepts of functions and code reusability**.	3
	PO 3	Understand the given problem statement and formulate (complex) engineering system **for developing a modular approach in solving problems that meet specified needs**.	2
	PO 5	Make use of functions **for creating the concept of code reusability**.	3

	PSO 3	Understand the concept of modularity by implementing different user defined and built functions **from real world problems to visualize the data to analyze the complexity.**.	3
CO 6	PO 1	Apply the knowledge of **engineering fundamentals**, and an **Mathematics and Engineering fundamentals principles to create a object oriented model on real time problems**.	3
	PO 3	Apply object oriented and modular concepts on **solving real world problems** reaching **and reusable conclusions**.	3
	PSO 3	Use built in functions in Python **for solving modular and reusable real time problems**.	3

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE	PROGRAM OUTCOMES				PROGRAM OUTCOMES		
OUTCOMES	PO 1	PO 2	PO 3	PO 5	PSO 1	PSO 2	PSO 3
CO 1	2		2	3			3
CO 2	3		3				3
CO 3	3	2	3				3
CO 4	3		3				3
CO 5	3	2	3				3
CO 6	3	2	3				3

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK 1	**OPERATORS**
	a.Read a list of numbers and write a program to check whether a particular element is present or not using membership operators. b. Read your name and age and write a program to display the year in which you will turn 100 years old c. Read radius and height of a cone and write a program to find the volume of a cone d.Write a program to compute distance between two points taking input from the user (Hint: use Pythagorean theorem)
WEEK 2	**CONTROL STRUCTURES**
	a. Read your email id and write a program to display the no of vowels, consonants, digits and white spaces in it using if…elif…else statement. b. Write a program to create and display a dictionary by storing the antonyms of words. Find the antonym of a particular word given by the user from the dictionary using while loop c. Write a Program to find the sum of a Series 1/1! + 2/2! + 3/3! + 4/4! +…….+ n/n!. (Input :n = 5, Output : 2.70833)
WEEK 3	**LIST**
	a. Read a list of numbers and print the numbers divisible by x but not by y (Assume x = 4 and y = 5). b. Read a list of numbers and print the sum of odd integers and even integers from the list.(Ex: [23, 10, 15, 14, 63], odd numbers sum = 101, even numbers sum = 24) c. Read a list of numbers and print numbers present in odd index position. (Ex: [10, 25, 30, 47, 56, 84, 96], The numbers in odd index position: 25 47 84) d. Read a list of numbers and remove the duplicate numbers from it. (Ex: Enter a list with duplicate elements: 10 20 40 10 50 30 20 10 80, The unique list is: [10, 20, 30, 40, 50, 80])
WEEK 4	**TUPLE**
	a. Given a list of tuples. Write a program to find tuples which have all elements divisible by K from a list of tuples. testlist = [(6, 24, 12), (60, 12, 6), (12, 18, 21)], K = 6, Output : [(6, 24, 12), (60, 12, 6)] b. Given a list of tuples. Write a program to filter all uppercase characters tuples from given list of tuples. (Input: testlist = [("GFG", "IS", "BEST"), ("GFg", "AVERAGE"), ("GfG",), ("Gfg", "CS")], Output : [(GFG, IS, BEST)]). c. Given a tuple and a list as input, write a program to count the occurrences of all items of the list in the tuple. (Input : tuple = ('a', 'a', 'c', 'b', 'd'), list = ['a', 'b'], Output : 3)
WEEK 5	**SET**

	a.Write a program to generate and print a dictionary that contains a number (between 1 and n) in the form (x, x*x). b.Write a program to perform union, intersection and difference using Set A and Set B. c.Write a program to count number of vowels using sets in given string (Input : "Hello World", Output: No. of vowels : 3) d.Write a program to form concatenated string by taking uncommon characters from two strings using set concept (Input : S1 = "aacdb", S2 = "gafd", Output : "cbgf").
WEEK 6	**DICTIONARY**
	a. Write a program to do the following operations: i. Create a empty dictionary with dict() method ii. Add elements one at a time iii. Update existing keys value iv. Access an element using a key and also get() method v. Deleting a key value using del() method b. Write a program to create a dictionary and apply the following methods: i. pop() method ii. popitem() method iii. clear() method c.Given a dictionary, write a program to find the sum of all items in the dictionary
WEEK 7	**STRINGS**
	a. Given a string, write a program to check if the string is symmetrical and palindrome or not. A string is said to be symmetrical if both the halves of the string are the same and a string is said to be a palindrome string if one half of the string is the reverse of the other half or if a string appears same when read forward or backward. b. Write a program to read a string and count the number of vowel letters and print all letters except 'e' and 's'. c. Write a program to read a line of text and remove the initial word from given text. (Hint: Use split() method, Input : India is my country. Output : is my country) d. Write a program to read a string and count how many times each letter appears. (Histogram)
WEEK 8	**USER DEFINED FUNCTIONS**
	a. A generator is a function that produces a sequence of results instead of a single value. Write a generator function for Fibonacci numbers up to n. b.Write a function mergedict(dict1, dict2) to merge two Python dictionaries. c.Write a fact() function to compute the factorial of a given positive number. d.Given a list of n elements, write a linearsearch() function to search a given element x in a list.
WEEK 9	**BUILT-IN FUNCTIONS**

	a. Write a program to demonstrate the working of built-in statistical functions mean(), mode(), median() by importing statistics library b. Write a program to demonstrate the working of built-in trignometric functions sin(), cos(), tan(), hypot(), degrees(), radians() by importing math module c. Write a program to demonstrate the working of built-in Logarithmic and Power functions exp(), log(), log2(), log10(), pow() by importing math module.
WEEK 10	**CLASS AND OBJECTS**
	a.Write a program to create a BankAccount class. Your class should support the following methods for i) Deposit ii) Withdraw iii) GetBalanace iv) PinChange b.Create a SavingsAccount class that behaves just like a BankAccount, but also has an interest rate and a method that increases the balance by the appropriate amount of interest (Hint:use Inheritance). c.Write a program to create an employee class and store the employee name, id, age, and salary using the constructor. Display the employee details by invoking employeeinfo() method and also using dictionary dict. d.Access modifiers in Python are used to modify the default scope of variables. Write a program to demonstrate the 3 types of access modifiers: public, private and protected.
WEEK 11	**MISCELLANEOUS PROGRAMS**
	Write a program to find the maximum and minimum K elements in Tuple using slicing and sorted() method (Input: testtup = (3, 7, 1, 18, 9), k = 2, Output: (3, 1, 9, 18)) b. Write a program to find the size of a tuple using getsizeof() method from sys module and built-in sizeof() method c.Write a program to check if a substring is present in a given string or not d. Write a program to find the length of a string using various methods: i. Using len() method ii. Using for loop and in operator iii. Using while loop and slicing
WEEK 12	**ADDITIONAL PROGRAMS - FILE HANDLING**
	a. Write a program to read a filename from the user, open the file (say firstFile.txt) and then perform the following operations: i. Count the sentences in the file. ii. Count the words in the file. iii. Count the characters in the file. b. Create a new file (Hello.txt) and copy the text to other file called target.txt. The target.txt file should store only lower case alphabets and display the number of lines copied c.Write a Python program to store N students records containing name, roll number and branch. Print the given branch students details only.

TEXTBOOKS

1. Michael H Goldwasser, David Letscher, “Object Oriented Programming in Python”, Prentice Hall, 1st Edition, 2007.
2. Yashavant Kanetkar, Aditya Kanetkar, “Let us Python”, BPB publication, 1st Edition, 2019

3. Ashok Kamthane, Amit Kamthane, "Programming and Problem Solving with Python", McGraw Hill Education (India) Private Limited, 2018.
4. Taneja Sheetal, Kumar Naveen, "Python Programming – A modular approach", Pearson, 2017

REFERENCE BOOKS:

1. www.oikostat.ch.
2. https://realpython.com/python3-object-oriented-programming//
3. https://python.swaroopch.com/oop.html#syllabus.
4. https://python-textbok.readthedocs.io/en/1.0/ObjectOrientedProgramming.html/

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Operators	CO 1	R1: 1
2	Control structures	CO 1	R3: 2
3	List	CO 2	R1: 7
4	Tuple	CO 2	R1: 8
5	Set	CO 3	R1: 2.4
6	Dictionary	CO 3	R1: 9
7	Strings	CO 4	R1: 10
8	User Defined Functions	CO 4	R3: 15
9	Built in Functions	CO 5	R1: 9
10	Class and Objects	CO5	R1: 10
11	Miscelaneous Programs	CO 6	R4:7
12	Additionaal programs - File Handling	CO 6	R4:10

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Python program to Right rotate a numpy array to n.
2	Python program to multiply all elements in a Dictionary.
3	Python Program to put positive and negative numbers in a seperate list.
4	Python program to remove given key from a Dictionary.

Signature of Course Coordinator **HOD, CSE(AI&ML)**
Ms Jalaja Vishnubhotla, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTION

Course Title	**CHEMISTRY**				
Course Code	AHSC06				
Program	B.Tech				
Semester	II	ECE			
Course Type	FOUNDATION				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	2	-	2	-	-
Course Coordinator	Dr V N S R Venkateswararao, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
10+2	-	-	Basic Principles of chemistry

II COURSE OVERVIEW:

The course discusses elements and compounds and their applied industrial applications. It deals with topics such as batteries, corrosion and control of metallic materials, water and its treatment for different purposes, engineering materials such as plastics, elastomers and biodegradable polymers, their preparation, properties and applications, energy sources and environmental science. Sustainable chemistry that focuses on the design of the products and processes that minimize or eliminate the use and generation of hazardous substances is also included.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Chemistry	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	PPT	✓	Chalk & Talk	x	Assignments	x	MOOCs
x	Open Ended Experiments	x	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with

”either” or ”choice” will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0 %	Remember
50 %	Understand
50 %	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

I	The concepts of electrochemical principles and causes of corrosion in the new development and breakthroughs efficiently in engineering and technology.
II	The different parameters to remove causes of hardness of water and their reactions towards the complexometric method.
III	The polymerization reactions with respect to mechanisms and its significance in industrial applications.

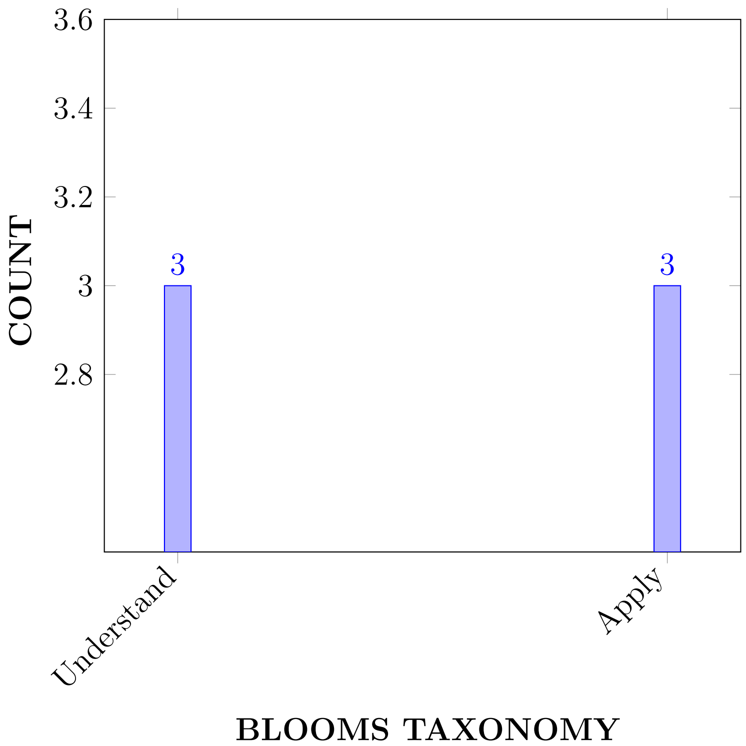
IV	The significance of green chemistry to reduce pollution in environment by using natural resources.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Explain** the electrochemical principles, corrosion process in metals for protection of different metals from corrosion	Understand
CO 2	**Utilize** electrochemical cell parameters, electrochemical active surface area, current and over potential under given condition for calculating the electromotive force and electrode potential.	Apply
CO 3	**Identify** the hardness of water by different treatment methods for finding the hardness causing salts in water.	Apply
CO 4	**Compare** different types of polymerization reactions, mechanism of lubrication for utilizing in industries.	Understand
CO 5	**Make use** of green synthesis methods, different types of solid, liquid and gaseous fuels in terms of calorific value for utilizing in industries and automobiles.	Apply
CO 6	**Outline** the different types of natural resources and their applicability for understanding the effect of pollutants on air, water and soil that cause the environmental pollution.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/SEE/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	1	CIE/SEE/AAT
PO 7	**Environment and sustainability:** understand the impact of the professional engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development. .	3	CIE/SEE/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications	-	-
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	-	-
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓		-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 4	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	✓	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-
CO 6	✓	-	-	-	-	-	✓	-	-	-	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

Course Outcomes (COs)	POs / PSOs	Justification for mapping (Students will be able to)	No. of key compe-tencies
CO 1	PO 1	**Explain** the operation of electrochemical systems in batteries, corrosion process in metals for protecting the metals from corrosion by using **principles of** science for solving **engineering problems**.	2
CO 2	PO 1	**Choose** different electrodes for finding pH of unknown solutions by applying **mathematical** expressions of cell potential by using **principles of science** and mathematics for solving **engineering** problems	3
	PO 2	**Identify** the problem **formulation and abstraction** for calculating electrode potential under non standard conditions by applying Nernst equation from the provided **information.**	2
CO 3	PO 1	**Explain** different treatment methods to produce soft water from raw water for solving **engineering problems** by applying the **principles of science.**	2
	PO 2	**Identify** the problem and formulate for finding the hardness of water in terms of CaCO3 equivalents with given **information and data** by applying **principles of science.**	2
CO 4	PO 1	**Illustrate** different types of polymerization reactions for synthesizing polymers from monomers, different types of lubricants to reduce friction in machines working under various temperature conditions by using **principles of science** for solving **engineering** problems	2
CO 5	PO 1	**Explain** the importance of green synthesis to minimize the generation of hazardous substances, different types of solid, liquid and gaseous fuels with their characteristics and calorific value by applying **mathematical** expressions for finding calorific value using **principles of science** and mathematics for solving engineering problems.	3

	PO 2	**Identify the given problem** and **formulate** for finding the calorific value of fuel with the given **information and data** by applying principles of science.	2
	PO 7	Make use of gaseous fuels like LPG, CNG to reduce the pollutants in atmosphere and know the impact in **socio economic and environmental** contexts for sustainable development.	2
CO 6	PO 1	**Explain** the concept of **living** and non living resources and the utility of these resources, effect of pollutants on air, water and soil that causes the environmental pollution for solving engineering problems by applying the **principles of science**	2
	PO 7	**Make use** of renewable and non renewable resources, control measures for air pollution, water pollution, soil pollution and noise pollution in **socio economic** an **environmental** contexts for sustainable development.	2

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	2	-	-	-	-	2	-	-	-	-	-	-	-	-
CO 6	2	-	-	-	-	-	2	-	-	-	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	66.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	100	20	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	66.6	20	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	66.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	100	20	-	-	-	-	66.6	-	-	-	-	-	-	-	-
CO 6	66.6	-	-	-	-	-	66.6	-	-	-	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

2 - $40\ \% < C < 60\%$ –Moderate

1-5 $< C \leq 40\%$ – Low/ Slight

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	**PROGRAM OUTCOMES**												**PSO'S**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	1	-	-	-	-	3	-	-	-	-	-	-	-	-
CO 6	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
TOTAL	18	3	-	-	-	-	6	-	-	-	-	-	-	-	-
AVERAGE	3	1	-	-	-	-	3	-	-	-	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	PO1,PO2,PO7	SEE Exams	PO1,PO2,PO7	Seminars	PO1,PO2,PO7
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	PO1,PO2,PO7	5 Minutes Video	PO1,PO2,PO7	Open Ended Experiments	PO1,PO2,PO7
Assignments	PO1,PO2,PO7				

XVII ASSESSMENT METHODOLOGY INDIRECT:

X	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

MODULE I	**ELECTROCHEMISTRY AND BATTERIES**
	Electro chemical cells: Electrode potential, standard electrode potential, Calomel electrode and Nernstequation; Electrochemical series and its applications; Numerical problems; Batteries: Primary (Dry cell) and secondary batteries (Lead-acid storage battery, Li-ion battery). Corrosion: Causes and effects of corrosion: Theories of chemical and electrochemical corrosion, mechanism of electrochemical corrosion; Corrosion control methods: Cathodic protection, sacrificial anode and impressed current Cathodic protection; Surface coatings: Metallic coatings- Methods of coating- Hot dipping- galvanization and tinning, electroplating
MODULE II	**WATER TECHNOLOGY**
	Introduction: Hardness of water, causes of hardness; types of hardness: temporary and permanent hardness, expression and units of hardness; estimation of hardness of water by complexometric method; potable water and its specifications, Steps involved in the treatment of water, disinfection of water by chlorination and ozonization; External treatment of water; Ion-exchange process; Desalination of water: Reverse osmosis, numerical problems
MODULE III	**ENGINEERING MATERIALS**
	Polymers-classification with examples, polymerization-addition, condensation and co-polymerization; Plastics: Thermoplastics and thermosetting plastics; Compounding of plastics; Preparation, properties and applications of polyvinyl chloride, Teflon, Bakelite and Nylon-6, 6; Biodegradable polymers. Elastomers: Natural rubber, processing of natural rubber, vulcanization; Buna-s and Thiokol rubber; Lubricants: characteristics of lubricants, mechanism of lubrication – thick film, thin film, extreme pressure lubrication, properties – flash and fire point, cloud and pour point, viscosity and oiliness of lubricants.
MODULE IV	**GREEN CHEMISTRY AND FUELS**
	Introduction: Definition of green chemistry, methods of green synthesis: aqueous phase, microwave method, phase transfer catalyst and ultra sound method. Fuels: definition, classification of fuels ; Solid fuels: coal; analysis of coal: proximate and ultimate analysis; Liquid fuels: Petroleum and its refining; Gaseous fuels: Composition, characteristics and applications of LPG and CNG; Calorific value: Gross Calorific value(GCV) and Net Calorific value(NCV), numerical problems.
MODULE V	**NATURAL RESOURCES AND ENVIRONMENTAL POLLUTION**
	Natural resources: Classification of resources, living and nonliving resources; Water resources: Use and over utilization of surface and ground water, floods and droughts, dams, benefits and problems; Land resources; Energy resources: renewable and non-renewable energy sources, use of alternate energy source. Environmental pollution: Causes, effects and control measures of air pollution, water pollution, soil pollution and noise pollution.

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2. 2. B. Siva Shankar, "Engineering Chemistry", Tata McGraw Hill Publishing Limited, 3rd Edition, 2015.
3. 3. S. S. Dara, Mukkanti, "Text of Engineering Chemistry", S. Chand Co, New Delhi, 12thEdition, 2006.

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	W1
CONTENT DELIVERY (THEORY)			
1	Outcome Based Education.		
2	Recall the concept of electro chemical cells.	CO 1	T1:6.1,R1: 2.6
3	Explain the electrode potential, standard electrode potential, electrochemical series and its applications.	CO 2	T1:6.2,R1: 2.9
4	Derive Nernst equation , numerical problems on cell potential.	CO 2	T1:6.5,R1: 2.6.3
5	Demonstate about calomel electrode. Batteries: primary (dry cell).	CO 1	T1: 6.7, R1:2.12
6	Explain the secondary batteries (Lead-acid storage battery), Li-ion battery.	CO 1	T1:6.12,R1: 2.12
7	Recognize the causes and effects of corrosion, chemical corrosion.	CO 1	T1:7.1, R1:2.14
8	Explain the electrochemical corrosion, mechanism of electrochemical corrosion.	CO 1	T1:7.2, R1:2.17
9	Explain about cathodic protection, sacrificial anode and impressed current.	CO 1	T1:7.14, R1:2.20

10	Apply metallic coatings, methods of coatings, hot dipping, galvanizing , tinning and electroplating.	CO 1	T1:7.14,R1: 2.22
11	Recall the hardness of water, causes of hardness.	CO 3	T1:1.3,R1: 1.4
12	Explain the types of hardness, temporary and permanent, units of hardness.	CO 3	T1:1.3,1.5,
13	Estimation of hardness of water by complexometric method,	CO 3	T1:1.5,R1: 1.6.2
14	Estimation of hardness of water by complexometric method.	CO 3	T1:1.14,R1: 1.6.4
15	Define potable water and its specifications, steps involved in treatment of water, disinfection of water by chlorination and ozonization.	CO 3	T1:1.12,R1: 1.6.5
16	Explain about external treatment of water; ion-exchange process.	CO 3	T1:1.11, R1:1.8.1
17	Explain about desalination of water: reverse osmosis.	CO 3	T1:1.13, R1:1.10
18	Recall polymers-classification with examples and Explain about the polymerization-addition, condensation and co- polymerization	CO 4	T1: 3.5,R1: 3.1
19	Explain the concept of compounding of plastics.	CO 4	T1:1.4, R1: 3.1.4
20	Expalin the preparation, properties and applications of polyvinyl chloride, teflon.	CO 4	T1:3.5,R1: 3.2
21	Explain the bakelite and nylon-6, 6.	CO 4	T1: 3.12,R1: 3.2.2
22	Define biodegradable polymers, synthetic biodegradable polymers.	CO 4	T1:3.14,R1: 3.2.3
23	Explain rubbers, natural rubber its process and vulcanization, Buna-s and thiokol rubber.	CO 4	T1: 3.15, R1:3.2.3
24	Elastomers: Synthetic rubbers,Buna-s and thiokol rubber.	CO 4	T1: 3.22, R1:3,3.4
25	Lubricants: characteristics of lubricants, mechanism of lubrication – thick film, thin film, extreme pressure lubrication.	CO 4	T1: 3.24,R1: 3.5
26	Properties–flash and fire point, cloud and pour point, viscosity and oiliness of lubricants.	CO 4	T1: 3.25,R1: 3.7
27	Definition and importance of green chemistry, methods of green synthesis: aqueous phase method.	CO 5	T5:6.8, T2:1.1
28	Explain the microwave method and phase transfer catalyst.	CO 5	T5: 6.8.3,T2: 8.1
29	Explain the ultra sound method.	CO 5	T5: 6.8.3, T2:9.2
30	Define fuels, classification of fuels and characteristics of a good fuels.	CO 5	T1:4.2, R1:6.2.1
31	Explain solid fuels, coal, Analysis of coal, proximate and ultimate analysis.	CO 5	T1:4.4.1, R1:7.1
32	Explain liquid fuels, petroleum and its refining.	CO 5	T1:4.5.2, R1:15.2
33	Explain the gaseous fuels, Composition, characteristics and applications of LPG and CNG.	CO 5	T1:4.6, R1:9.2

34	Apply the concept of calorific value, gross calorific value (GCV) and Net calorific value(NCV) to find calorific value of fuel, numerical problems.	CO 5	T1:4.8, R1:5.2
35	Recall natural resources: classification of resources, living and nonliving resources.	CO 6	T4:2.1
36	Explain the water resources: use and over utilization of surface and ground water, floods and droughts, Dams, benefits and problems.	CO 6	T4:2.2
37	Define energy resources, renewable and non-renewable energy sources.	CO 6	T4:2.3
38	Explain the alternate energy sources, land resources	CO 6	T4:2.5,5.2
39	Define environmental pollution, causes, effects and control of air pollution.	CO 6	T4: 4.2
40	Explain the causes, effects and control of water pollution.	CO 6	T4: 4.6
41	Explain the causes, effects and control of soil pollution and noise pollution.	CO 6	T4:4.12
PROBLEM SOLVING/ CASE STUDIES			
42	Problems on EMF of voltaic cell	CO 2	T1:6.2,R1: 2.9
43	Problems on EMF of a cell	CO 2	T1:6.5,R1: 2.6.3
44	Problems on electrode potential of the half cell by using Nernst equation	CO 2	T1:6.2,R1: 2.9
45	Problems on electrode potential of EMF of the cell by using Nernst equation.	CO 2	T1:6.5,R1: 2.6.3
46	Problems on temporary and permanent hardness in Degree French.	CO 3	T1:1.5, R1: 1.6.2
47	Problems on temporary, permanent and total hardness in ppm	CO 3	T1:1.14,R1: 1.6.4
48	Problems on the temporary, permanent and total hardness of water in Degree Clark.	CO 3	T1:1.5,R1: 1.6.2
49	Problems on the temporary, permanent and total hardness of water in Mg/L.	CO 3	T1:1.14,R1: 1.6.4
50	Problems on the total hardness in terms of calcium carbonate equivalents by using EDTA method.	CO 3	T1:1.5,R1: 1.6.2
51	Problems on the permanent hardness in terms of calcium carbonate equivalents by using EDTA method.	CO 3	T1:1.14,R1: 1.6.4
52	Problems on the temporary hardness in terms of calcium carbonate equivalents by using EDTA method.	CO 3	T1:1.5,R1: 1.6.2
53	Problems on the higher and lower calorific values of the fuel.	CO 5	T1:4.8, R1:5.2
54	Problems on the gross and net calorific values of the fuel.	CO 5	T1:4.8, R1:5.2
55	Problems on HCV and LCV	CO 5	T1:4.8, R1:5.2
56	Problems on GCV and NCV	CO 5	T1:4.8, R1:5.2

DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Definitions & terminology discussion on electrochemistry and corrosion	CO 1	T1:1.3,R1: 1.4
58	Definitions & terminology discussion on water technology	CO 3	T1: 3.5,R1: 3.1
59	Definitions & terminology discussion on engineering	CO 4	T1: 3.5,R1: 3.1
60	Definitions & terminology discussion on green chemistry and fuels	CO 5	T1:4.2, R1:6.2.1
61	Definitions & terminology discussion on natural resources and environmental pollution	CO 1, CO 6	T4:2.1,2.8
DISCUSSION OF QUESTION BANK			
62	Question bank discussion on electrochemistry and Corrosion	CO 1	T1: 6.1, R1:2.12
63	Question bank discussion on water technology	CO 3	T1:1.3, R1: 1.4
64	Question bank discussion on engineering materials	CO 4	T1: 3.5,R1: 3.1
65	Question bank discussion on green chemistry and fuels	CO5	T1:4.2, R1:6.2.1
66	Question bank discussion on natural resources and environmental Pollution	CO 6	T4:2.1,2.8

Course Coordinator: **HOD, ECE**
Dr V N S R Venkateswararao,Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	ELECTRONICS AND COMMUNICATION ENGINEERING				
Course Title	MATHEMATICAL TRANSFORM TECHNIQUES				
Course Code	AHSC07				
Program	B.Tech				
Semester	II				
Course Type	Foundation				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Mr.Satyanarayana G, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSC02	I	Linear Algebra and Calculus
B.Tech	-	-	-
B.Tech	-	-	-

II COURSE OVERVIEW:

This course focuses on transformations from theoretical based mathematical laws to its practical applications in the domain of various branches of engineering field. The course includes the transformations such as Laplace, Fourier, applications of scalar and vector field over surface, volume and multiple integrals. The course is designed to extract the mathematical developments, skills, from basic concepts to advance level of engineering problems to meet the technological challenges.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Mathematical Transform Techniques	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with

"either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Remember
30 %	Understand
60 %	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

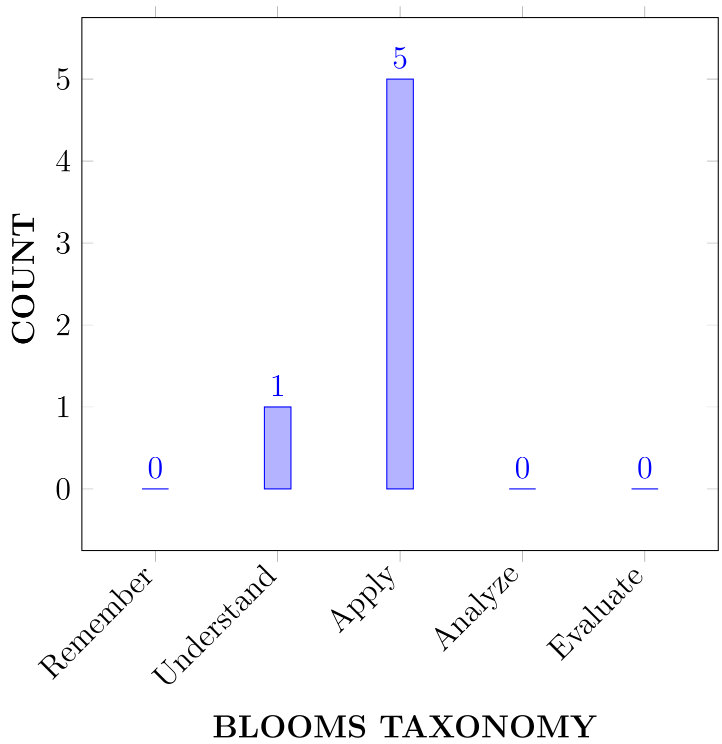
I	The transformation of ordinary differential equations in Laplace field and its applications
II	The operation of non-periodic functions by Fourier transforms.
III	The concepts of multiple integration for finding areas and volumes of physical quantities.
IV	The Integration of several functions by transforming the co-ordinate system in scalar and Vector fields.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Explain** the properties of Laplace and inverse transform to various functions such as continuous, piecewise continuous, step, impulsive and complex variable functions.	Understand
CO 2	**Make use of** the integral transforms which converts operations of calculus to algebra in solving linear differential equations	Apply
CO 3	**Apply** the Fourier transform as a mathematical function that transforms a signal from the time domain to the frequency domain, non-periodic function up to infinity	Apply
CO 4	**Apply** the definite integral calculus to a function of two or more variables in calculating the area of solid bounded regions	Apply
CO 5	**Develop** the differential calculus which transforms vector functions, gradients. Divergence, curl, and integral theorems to different bounded regions in calculating areas.	Apply
CO 6	**Solve** Lagrange's linear equation related to dependent and independent variables the nonlinear partial differential equation by the method of Charpit concern to the engineering field	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

Program Outcomes	
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	2	Seminar/ Conferences/ Research Papers
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	-	-
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	-	-	-	-	-	-	-		-	-	-
CO 2	-	✓	-	✓	-	-	-	-	-	-	-	-	✓	-	-
CO 3	✓	✓	-	-		-	-	-	-	-	-		✓	-	-
CO 4	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	✓	✓	-	-	-	-	-	-	-	-	-	-		-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Explain** the properties of Laplace and inverse transform to to **complex engineering problems** of various functions such as continuous, piecewise continuous, step, impulsive and complex variable functions with **principle of mathematics** .	2
CO2	PO 2	**Describe** the **formulation of** integral transforms (knowledge) which converts **complex engineering problems** using (apply) operations of calculus to algebra along with **basic principles of mathematics** reaching substantiated conclusions by the **interpretation of results** in solving linear differential equations	6
	PO4	**Explain** the integral transforms in solving ordinary differential equations will be **quantitatively measured** by using **MATLAB computer software**.	5
	PSO1	**Describe** the integral transforms concern Electrical Communication and Engineering (apply) which converts operations of calculus to algebra in solving linear differential equations **in the design and implementation of complex systems.**.	2
CO3	PO 1	**Apply** the Fourier transform as a mathematical function that transforms a signal from the time domain to the **complex engineering problems** by the frequency domain, non-periodic function up to infinity with **Principle of Mathematics**	2
	PO2	**Apply** the Fourier transform as a **formulation** of mathematical function in **complex engineering problems** which transforms a non-periodic function using **principles of mathematics** to attain conclusions by the **interpretation of results**	6
	PSO1	**Identify** the properties of complex Fourier transform concern Aeronautical Engineering which **intensifies (apply)** the boundary value problems in the **design and implementation** of complex systems.	2
CO4	PO2	**Apply** the **formulation** of definite integral calculus to a function of **complex engineering problems** of two or more variables using **principle of mathematics** in calculating the area of solid bounded regions by the **interpretation of results**.	6
CO5	PO2	**Develop** the **statement** and **formulation** differential calculus of **complex engineering problems** which transforms vector functions, gradients. Divergence, curl, and integral theorems using **principle of mathematics** to different bounded regions in calculating areas. by **interpretation of results**	6

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO6	PO1	**Solve** Lagrange's linear equation related to **complex engineering problems** such as dependent and independent variables the nonlinear partial differential equation by the method of Charpit concern to the engineering field **Principle of Mathematics**.	2
	PO2	**Describe** the **statement** and **formulation** of Lagrange's linear equation (understand) related to **complex engineering problems**, solutions are attained based on **principles of mathematics** to the **physical problems of engineering** by the **interpretation of results**.	6

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	-	6	-	5	-	-	-	-	-	-	-	-	2	-	-
CO 3	2	6	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 4	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	2	6	-	-	-	-	-	-	-	-	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	66.7	-	-	-	-	-	-	-	-	-	-		-	-	-
CO 2	-	60	-	45	-	-	-	-	-	-	-	-	100	-	-
CO 3	66.7	60	-	-		-	-	-	-	-	-		100	-	-
CO 4	-	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	-	60	-	-		-	-	-	-	-	-		-	-	-
CO 6	66.7	60	-	-	-	-	-	-	-	-	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq$ C$\leq$ 5% – No correlation
1 -5 <C$\leq$ 40% – Low/ Slight
2 - 40 % <C < 60% –Moderate
3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO 2	-	3	-	2	-	-	-	-	-	-	-	-	3	-	-
CO 3	3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO 4	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	3	-	-	-	-	-	-	-	-	-	-		-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	✓
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	✓	5 Minutes Video	✓	Open Ended Experiments	-
Assignments					

XVII ASSESSMENT METHODOLOGY-INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**LAPLACE TRANSFORMS**
	Definition of Laplace transform, linearity property, piecewise continuous function, existence of Laplace transform, function of exponential order, first and second shifting theorems, change of scale property, Laplace transforms of derivatives and integrals, multiplied by t, divided by t, Laplace transform of periodic functions. Inverse Laplace transform: Definition of Inverse Laplace transform, linearity property, first and second shifting theorems, change of scale property, multiplied by s, divided by s; Convolution theorem and applications to ordinary differential equations.
MODULE II	**FOURIER TRANSFORMS**
	Fourier integral theorem, Fourier sine and cosine integrals; Fourier transforms; Fourier sine and cosine transform, properties, inverse transforms, finite Fourier transforms.
MODULE III	**MULTIPLE INTEGRALS**
	Double Integrals: Evaluation of double integrals in Cartesian coordinates and Polar coordinates; Change of order of integration; Area as a double integral; Transformation of coordinate system. Triple Integrals: Evaluation of triple integrals in Cartesian coordinates; volume of a region using triple integration.

MODULE IV	**VECTOR DIFFERENTIAL CALCULUS**
	Scalar and vector point functions; Definitions of Gradient, divergent and curl with examples; Solenoidal and irrigational vector point functions; Scalar potential function. Line integral, surface integral and volume integral, Green's theorem in a plane, Stoke's theorem and Gauss divergence theorem without proofs.
MODULE V	**PARTIAL DIFFERENTIAL EQUATIONS**
	Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions, solutions of first order linear equations; Charpit's method;

TEXTBOOKS

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 36thEdition, 2010.
2. N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, Reprint, 2008.
3. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill New Delhi, 11th Reprint,2010.

REFERENCE BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 9thEdition, 2006.
2. Veerarajan T., "Engineering Mathematics for first year", Tata McGraw-Hill, New Delhi, 2008.
3. D. Poole, "Linear Algebra: A Modern Introduction", Brooks/Cole, 2ndEdition, 2005.
4. Dr. M Anita, "Engineering Mathematics-I", Everest Publishing House, Pune, First Edition, 2016

WEB REFERENCES:

1. http://www.efunda.com/math/math_home/math.cfm
2. http://www.ocw.mit.edu/resourcs/#Mathematics
3. http://www.sosmath.com
4. http://www.mathworld.wolfram.com

COURSE WEB PAGE:

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	**Topics to be covered**	**CO's**	**Reference T1: 4.1**
OBE DISCUSSION			
1	Introduction to outcome based education		
CONTENT DELIVERY (THEORY)			

2	Introduction to Laplace transform	CO1	T1:21.1 , 21.4 R1:5.1
3	First, second shifting theorems and change of scale property of Laplace transforms	CO1	T1:21.2 R1:5.1
4	Laplace transforms of Derivatives, Integrals, multiplication and Division by t to a function	CO1	T1:21.4 R1:5.1
5	Laplace transform of periodic functions	CO2	T1:21.7-21.10 R1:5.2-5.4
6	First, second shifting theorems and change of scale property of Inverse Laplace Transforms	CO1	T1:21.12 R1:5.1,5.6
7	Inverse Laplace transforms of Derivatives, Integrals, multiplication and Division by s to a function	CO2	T1:21.13 R1:5.1,5.3
8	Convolution theorem	CO2	T1:21.13 R1:5.4
9	Application of Laplace Transforms	CO2	T1:21.14 R1:5.5
10	Fourier integrals	CO3	T1:22.1-22.2 R1:10.8
11	Fourier transform	CO3	T1:22.3 R1:10.8
12	Fourier sine transform	CO3	T1:22.4 R1:10.9
13	Fourier Cosine Transforms	CO3	T1:22.5 R1:10.9
14	Properties of Fourier Transforms	CO3	T1:22.4 R1:10.9
15	Inverse Fourier Transform	CO3	T2:15.5 R1:7.5
16	Finite Fourier Transform	CO3	T2:16.5 R1:7.6
17	Infinite Fourier Transform	CO3	T2:16.5 R1:7.6
18	Double integrals in Cartesian form	CO4	T2:10.1 R1:16.1
19	Double integrals in Polar coordinates	CO4	T2:10.1 R1:16.2
20	Change of order of integration	CO4	T2:10.3 R1:16.4
21	Evaluation of Double Integrals for the Bounded Regions	CO4	T2:11.3 R1:16.5
22	Transformation of coordinates system	CO4	T2:11.3 R1:16.5
23	Triple integrals in Cartesian form	CO4	T2:11.3 R1:16.5

24	Volume of a region using triple integration	CO4	T2:11.3 R1:16.5
25	Problems on double and triple integrals	CO4	T2:11.3 R1:16.5
26	Scalar and Vector Point Function(Definitions of Gradient, divergent, curl and Scalar Potential function)	CO5	T2: 11.3 R1:16.11
27	Solenoidal and irrotational vectors	CO5	T1:17.1-17.2 R1:16.1-16.2
28	Line integral	CO5	T2: 11.3 R1:16.11
29	surface integral	CO5	T2: 11.3 R1:16.9
30	volume integral	CO5	T2: 11.4 R1:16.18
31	Green's theorem	CO5	T2: 11.3 R1:16.11
32	Stoke's theorem	CO5	T2: 11.3 R1:16.9
33	Gauss divergence theorem	CO5	T2: 11.4 R1:16.18
34	Elimination of arbitrary constants(Formation of PDE)	CO6	T1:17.1-17.2 R1:16.1-16.2
35	Elimination of arbitrary functions(Formation of PDE)	CO6	T1:17.5-17.6 R1:16.3.1
36	Non-Linear Partial differential equation of first order	CO6	T1:17.1-17.2 R1:16.1-16.2
37	Standard forms I, II ,III and IV	CO6	T1:17.1-17.2 R1:16.1-16.2
38	Non-Linear Partial differential equation of first order Standard forms V	CO6	T1:17.5-17.6 R1:16.3.1
39	Non-Linear Partial differential equation of first order Standard forms VI	CO6	T1:17.1-17.2 R1:16.1-16.2
40	Lagrange's Linear equation- Method of grouping	CO6	T1:17.5-17.6 R1:16.3.1

41	Lagrange's Linear Equation -Method of Multipliers	CO6	T1:17.1-17.2 R1:16.1-16.2
PROBLEM SOLVING/ CASE STUDIES			
42	Solving problems on Laplace Transform of First, second shifting theorems and change of scale property	CO 1	T1:21.1,21.4 R1:5.1
43	Solving problems on Inverse Laplace transforms of derivatives, integrals, multiplied by s, divided by s	CO 2	T1:21.13 R1:5.1,5.3
44	Solving problems on Convolution theorem	CO 2	T1:21.14 R1:5.5
45	Solving problems on Fourier sine and cosine integral	CO 3	T1:22.3 R1:10.8
46	Solving problems on finite Fourier transforms	CO 3	T1:22.4 R1:10.9
47	Solving problems on Evaluation of double integrals in Cartesian coordinates	CO 4	T2:10.1 R1:16.1
48	Solving problems on Transformation of coordinates system	CO 4	T2:10.1 R1:16.2
49	Solving problems on Evaluation of triple integrals in Cartesian coordinates	CO 4	T2:10.1 R1:16.2
50	Solving problems on Solenoidal and irrotational	CO 5	T2:11.3 R1:16.5
51	Solving problems on Green's theorem	CO 5	T2: 11.3 R1:16.11
52	Solving problems on Green's theorem	CO 5	T2: 11.3 R1:16.11
53	Solving problems on Stokes theorem	CO 5	T2: 11.3 R1:16.9
54	Gauss divergence theorem	CO 5	T2: 11.4 R1:16.18
55	Solving problems on formation of partial differential equations by elimination of arbitrary constants	CO 6	T1:17.1-17.2 R1:16.1-16.2
56	Solving problems on formation of partial differential equations by elimination of arbitrary functions	CO 6	T1:17.1-17.2 R1:16.1-16.2
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Definitions and terminology on Laplace transforms	CO 1,2	T1:21.1,21.4 R1:5.1
58	Definitions and terminology on Fourier transforms	CO 3	T1:22.1-22.2R1:10.8
59	Definitions and terminology on multiple integrals	CO 4	T2:15.5 R1:7.5
60	Definitions and terminology on vector calculus	CO 5	T2:10.3 R1:16.4

61	Definitions and terminology on partial differential equations.	CO 6	T1:17.1-17.2 R1:16.1-16.2
DISCUSSION OF QUESTION BANK			
62	Disscussion of Laplace transforms	CO 1,2	T1:21.1,21.4 R1:5.1
63	Disscussion of Fourier transforms	CO 3	T1:22.1-22.2 R1:10.8
64	Disscussion of multiple integrals	CO 4	T2:15.5 R1:7.5
65	Disscussion of vector calculus	CO 5	T2:10.3 R1:16.4
66	Disscussion of partial differential equations	CO 6	T1:17.1-17.2 R1:16.1-16.2

Signature of Course Coordinator **HOD,ECE**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Electronics and Communication Engineering**				
Course Title	**Electrical Circuits**				
Course Code	AEEC02				
Program	B.Tech				
Semester	II				
Course Type	Fundamental				
Regulation	R-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	3	1.5
Course Coordinator	Ms. A Srikanth, Assistant Professor				

I COURSE OVERVIEW:

The course introduces the basic concepts of circuit analysis which is the foundation for all subjects of the electrical and electronics engineering. It includes the basic fundamental laws of electricity and magnetism with an emphasis on resistors, inductors and capacitors (RLC) circuits applied to alternating current (AC) or direct current (DC) of electrical networks. Further This course provides network theorems with different excitations, two-port network and network topology to solve for real-time applications.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHS006	I	Engineering Physics

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Electrical Circuits	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIE examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
40%	Remember
60%	Understand
0%	Apply
0%	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 25 marks for Continuous Internal Examination (CIE) and 05 marks for Quiz / Alternative Assessment Tool (AAT).

Component	Theory			Total Marks
Type of Assessment	CIE Exam	Quiz	AAT	
CIA Marks	20	-	10	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz - Online Examination
Two Quiz exams shall be online examination consisting of 50 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen foor this course is given in table

Concept Video	Tech-talk	Complex Problem Sloving
50%	50%	-

VI COURSE OBJECTIVES:

The students will try to learn:

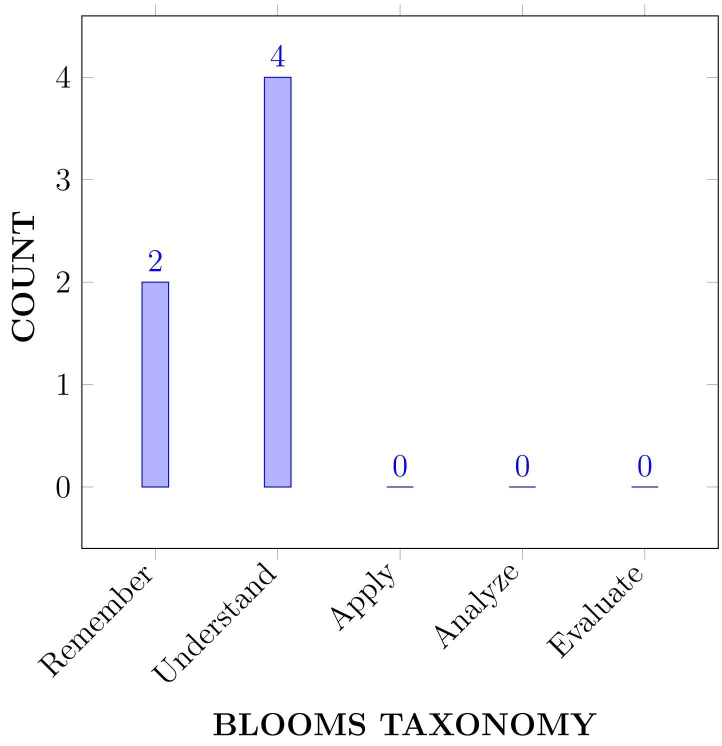
I	The network reduction techniques such as source transformation, mesh analysis, nodal analysis and network theorems to solve different networks.
II	The basic concept of AC circuits for optimization of household and industrial circuitry.
III	The various configurations of electromagnetic induction used in magnetic circuits helps in the winding of electrical machines.
IV	The characteristics of two-port networks and network topologies suitable in power system.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Identify** the basic concepts of electrical quantities such as current, voltage, power, energy of simple DC circuits used in electrical and electronic devices.	Remember
CO 2	**Define** basic terminology of single-phase AC circuits for obtaining mean value, RMS value, form facto, peak facto, impedance, admittance, apparent, real power, reactive power and power factor of electrical circuits.	Understand
CO 3	**Apply** the different laws, series parallel combination of RLC circuits and indirect quantities associated with electrical circuit for determine voltage and currents in resistive circuits containing voltage and current sources.	Understand
CO 4	**Apply** the several theorems for simplify complex network into equivalent network and verify the current, voltage and power in linear bilateral network with the help of DC and AC excitation.	Understand
CO 5	**Describe** the basic fundamental of Electromagnetism, Faraday's laws of Electromagnetic induction, Lenz's law, types of induced emf, self and mutual inductancefor notice the total magnetomotive force and ampere turns values.	Remember
CO 6	**Understand** the two port parameters, network topology and dual network for digital and graphical representation of complex circuits to be measure easily, without solving for all the internal voltages and currents in the different networks.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

Program Outcomes	
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	CIE/Quiz/AAT
PO 4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Assignments

3 = High; 2 = Medium; 1 = Low

X MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	✓	✓	-	✓	-	-	-	-	-	-	-	-	-	-	-
CO 4	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-

XI JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	**PO 1**	Recall the basics of mathematics, engineering sciences and other sciences to understand the concept of DC and AC Circuits.	3
	PO 2	Validate the principles of different laws associated with electrical circuits from obtained principles using basics fundamentals of mathematics and engineering sciences.	5
CO 2	**PO 1**	Recall the basics of mathematics, engineering sciences and other sciences to understand the concept of Kirchhoff's laws	3
	PO 2	Analyze mesh analysis and nodal analysis technique using principles of mathematics, science and engineering fundamentals	5
CO 3	**PO 1**	Recollect the concept of Electrical circuits basics analysis.	3
	PO 2	Describes the diifferent Theorems with AC and DC excitation from obtained principles using basics fundamentals of mathematics and engineering sciences.	5
	PO 4	Conduct Investigations of Complex Problems with AC and DC excitation Use research methods including design of experiments.	5
CO 4	**PO 1**	Apply the knowledge of mathematics, science, engineering fundamentals to the solution of magnetic circuits	3
	PO 2	Describes the fundamental characteristics of electromagnetic induction, self and mutual inductance in the single coil and coupled coils magnetic circuits using basics fundamentals of mathematics and engineering sciences.	5
CO 5	**PO 1**	Recall the basics of mathematics, engineering sciences and other sciences to understand the concept of two port network and graph theory.	3
	PO 2	Validate the principles of different parameters and network topology from obtained principles using basics fundamentals of mathematics and engineering sciences.	5
CO 6	**PO 1**	Recall the basics of mathematics, engineering sciences and other sciences to understand the concept of duality.	3
	PO 2	Describes the fundamental characteristics of mesh analysis and nodal analysis technique using Teo Port Network.	5

XII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO(s)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	5	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	5	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	5	-	5	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	5	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	5	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	5	-	-	-	-	-	-	-	-	-	-	-	-	-

XIII PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO(s)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	50	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	100	50	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	100	50	-	45	-	-	-	-	-	-	-	-	-	-	-
CO 4	100	50	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	100	50	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	100	50	-	-	-	-	-	-	-	-	-	-	-	-	-

XIV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 - $5 < C \leq 40\%$ – Low/ Slight

2 - $40\% < C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO(s)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	2	-	1	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	33	10	-	1	-	-	-	-	-	-	-	-	-	-	-
AVERAGE	3	2	-	1	-	-	-	-	-	-	-	-	-	-	-

XV ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	✓	Tech - Talk	-	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	-	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY-INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities/ Modeling & Experimental Tools in Engineering by Experts		

XVII SYLLABUS:

MODULE I	**INTRODUCTION TO ELECTRICAL CIRCUITS**
	Circuit concept: Basic definitions, Ohm's law at constant temperature, classifications of elements, independent and dependent sources, voltage and current relationships for passive elements, Single phase AC circuits: Representation of alternating quantities, properties of different periodic wave forms, phase and phase difference, concept of impedance and admittance, power in AC circuits.
MODULE II	**ANALYSIS OF ELECTRICAL CIRCUITS**
	Circuit analysis: Source transformation, Kirchhoff's laws, total resistance, inductance and capacitance of circuits, Star - delta transformation technique, mesh analysis and nodal analysis, inspection method, super mesh, super node analysis.
MODULE III	**NETWORK THEOREMS (DC AND AC)**
	Network Theorems: Tellegen's, superposition, reciprocity, Thevenin's, Norton's, maximum power transfer, Milliman's and compensation theorems for DC excitations, numerical problems. Network Theorems: Tellegen's, superposition, reciprocity, Thevenin's, Norton's, maximum power transfer, Milliman's and compensation theorems for AC excitations, numerical problems.
MODULE IV	**MAGNETIC CIRCUITS**
	Magnetic circuits: Faraday's laws of electromagnetic induction, concept of self and mutual inductance, dot convention, coefficient of coupling, composite magnetic circuit, analysis of series and parallel magnetic circuits.
MODULE V	**TWO PORT NETWORK AND GRAPH THEORY**
	Two Port Network: Two port parameters, interrelations, Two port Interconnections. Network topology: Definitions, incidence matrix, basic tie set and basic cut set matrices for planar networks, duality and dual networks.

TEXTBOOKS

1. A Sudhakar, Shyammohan S Palli, “Circuits and Networks”, Tata McGraw-Hill, 4th Edition, 2010.
2. M E Van Valkenberg, “Network Analysis”, PHI, 3rd Edition, 2014.

REFERENCE BOOKS:

1. John Bird, “Electrical Circuit Theory and Technology”, Newnes, 2nd Edition, 2003.
2. C L Wadhwa, “Electrical Circuit Analysis including Passive Network Synthesis”, New Age International, 2nd Edition, 2009.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/104/108104052/

COURSE WEB PAGE:

XVIII COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO(s)	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	-
CONTENT DELIVERY (THEORY)			
2	Introduction to Electrical Circuits	CO 1	T1: 2.1
3	Basic Definitions and Ohm’s Law at Constant Temperature	CO 1	T1:2.4
4	Classifications of Elements	CO 1	T1:2.4
5	Voltage and current relationships for passive elements	CO 1	T1:2.5
6	Introduction to Single phase AC circuits, Representation of alternating quantities	CO 1	T1: 2.1
7	Properties of different periodic wave forms, Phase and phase difference	CO 1	T1:2.4
8	Concept of Impedance, Admittance and Power in AC Circuits	CO 1	T1:2.4
9	Source transformation	CO 2	T1:1.5-1.6
10	Kirchhoff’s laws	CO 2	T1:1.8-1.12
11	Equivalent Values of Series, Parallel R, L & C Networks	CO 2	T1:1.13-1.18
12	Star to Delta or Delta to Star Transformation Technique	CO 2	T1:1.1-1.18
13	Mesh Analysis Solved Technique with simple example and Animation	CO 2	T1:5.1-5.2
14	Nodal analysis Solved Technique with simple example and Animation	CO 2	T1:5.3

15	Inspection Method Solved Technique with simple example and Animation	CO 2	T1:5.7
16	Super mesh analysis Solved Technique with simple example and Animation	CO 2	T1:5.4-5.6
17	Super node analysis Solved Technique with simple example and Animation	CO 2	T1:6.5-6.11
18	Tellegen's theorem for DC excitations Solved Technique with simple example and Animation	CO 3	T1:7.1 -7.4
19	Superposition theorem for DC excitations Solved Technique with simple example and Animation	CO 3	T1:5.3
20	Reciprocity theorem for DC excitations Solved Technique with simple example and Animation	CO 3	T1:5.7
21	Thevenin's theorem for DC excitations Solved Technique with simple example and Animation	CO 3	T1:5.1-5.2
22	Norton's theorem for DC excitations Solved Technique with simple example and Animation	CO 3	T1:5.3
23	Maximum power transfer theorem for DC excitations Solved Technique with simple example and Animation	CO 3	T1:5.7
24	Milliman's theorem for DC excitations Solved Technique with simple example and Animation	CO 3	T1:5.4-5.6
25	Compensation theorem for DC excitations Solved Technique with simple example and Animation	CO 3	T1:6.5-6.11
26	Tellegen's theorem for AC excitations	CO 3	T1:7.1 -7.4
27	Superposition theorem for AC excitations	CO 3	T1:8.4-8.6
28	Reciprocity theorem for AC excitations	CO 3	T1: 8.12-8.15
29	Thevenin's theorem for AC excitations	CO 3	T1:8.4-8.6
30	Norton's theorem for AC excitations	CO 3	T1: 8.12-8.15
31	Maximum power transfer theorem for AC excitations	CO 3	T1:8.4-8.6
32	Milliman's and compensation theorems theorem for AC excitations	CO 3	T1: 8.12-8.15
33	Faraday's laws of electromagnetic induction	CO 4	T1:8.4-8.6
34	Concept of self and mutual inductance	CO 4	T1: 8.12-8.15
35	Dot convention, coefficient of coupling, composite magnetic circuit	CO 4	T1:8.4-8.6
36	Analysis of series magnetic circuits	CO 4	T1: 8.12-8.15
37	Analysis of parallel magnetic circuits	CO 4	T1:8.4-8.6
38	Two port parameters (Z, Y, T, ABCD)	CO 5	T1: 8.12-8.15

39	Two port Interconnections	CO 5	T1:8.4-8.6
40	Incidence matrix, basic tie set and basic cut set matrices for planar networks	CO 5	T1: 8.12-8.15
41	Duality and dual networks	CO 5	T1:8.4-8.6
PROBLEM SOLVING/ CASE STUDIES			
42	Total resistance, inductance and capacitance of circuits	CO 2	T1:10.8
43	Star - delta transformation technique	CO 2	T1:10.9-10
44	Mesh analysis and Nodal analysis	CO 2	T4:10.10
45	Super mesh and Super node analysis.	CO 2	T1:8.2
46	Tellegen's and reciprocity theorems for DC excitations	CO 3	T1:1.1
47	Thevenin's and Norton's theorems for DC excitations	CO 3	T1:1.5-1.6
48	maximum power transfer, Milliman's and compensation theorems for DC excitations	CO 3	T1:1.8-1.12
49	Tellegen's and reciprocity theorems for excitations	CO 3	T1:1.13-1.18
50	Thevenin's and Norton's theorems for AC excitations	CO 3	T1:1.19.1-1.19.2
51	maximum power transfer, Milliman's and compensation theorems for AC excitations	CO 3	T1:1.19.1-1.19.2
52	Dot convention, coefficient of coupling, composite magnetic circuit	CO 4	T1:1.193
53	analysis of series and parallel magnetic circuits	CO 4	T1:1.19.6
54	Two port parameters (Z, Y, T, ABCD)	CO 5	T1:1.19.
55	Incidence matrix, basic tie set and basic cut set matrices for planar networks	CO 5	T1:2.11.1-
56	Duality and dual networks	CO 5	T1:2.11.1-
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Module I	CO 1,2	R4:2.1
58	Module II	CO 3	T4:7.3
59	Module III	CO 4	R4:5.1
60	Module IV	CO 5	T1:7.5
61	Module V	CO 6	T1: 4.1
DISCUSSION OF QUESTION BANK			
62	Module I	CO 1,2	R4:2.1
63	Module II	CO 3	T4:7.3
64	Module III	CO 4	R4:5.1
65	Module IV	CO 5	T1:7.5
66	Module V	CO 6	T1: 4.1

Course Coordinator **HOD,EEE**
Ms. A Srikanth, Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF(s)
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences **(Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations **(Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**
	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	

PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**

PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**
	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	

PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

ANNEXURE - II

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	PSO Statement / Key Competencies Features (KCF)	No. of KCF(s)

PSO 1	Design, develop, fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization. 1. Operate, control and protect electrical power system. 2. Validate the interconnected power system. 3. Ensure reliable, efficient and compliant operation of electrical systems. 4. Familiarize the safety, legal and health norms in electrical system. 5. Adopt the engineering professional code and conduct.	**5**
PSO 2	Focus on the components of electrical drives with its converter topologies for energy conversion, management and auditing in specific applications of industry and sustainable rural development. 1. Control the electric drives for renewable and non-renewable energy sources. 2. Fabricate converters with various components and control topologies. 3. Synthesis, systematic procedure to examine electrical components/machines using software tools. 4. Inspect, survey and analyze energy flow. 5. Control and manage the power generation and utilization. 6. Familiarize the safety, legal and health norms in electrical system. 7. Adopt the engineering professional code and conduct. 8. Explore autonomous power 9. Evolve into green energy and assess results 10. Realize energy policies and education 11. Potential contribution of clean energy for rural development.	**11**
PSO 3	Gain the hands-on competency skills in PLC automation, process controllers, HMI and other computing tools necessary for entry level position to meet the requirements of the employer. 1. Explicit software and programming tools for electrical systems. 2. Adopt technical library resources and literature search. 3. Model, program for operation and control of electrical systems. 4. Constitute the systems employed for motion control. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**ELECTRONICS AND COMMUNICATION ENGINEERING**				
Course Title	PROGRAMMING FOR PROBLEM SOLVING USING C				
Course Code	ACSC04				
Program	B.Tech				
Semester	II				
Course Type	FOUNDATION				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr. J Sirisha Devi, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	-	-	Basic Programming Concepts

II COURSE OVERVIEW:

The course emphasis on the problem-solving aspects in using C programming. It is the fundamental course and is interdisciplinary in nature for all engineering applications. The students will understand programming language, programming, concepts of loops, reading a set of data, step wise refinements, functions, control structures, arrays, dynamic memory allocations, enumerated data types, structures, unions, and file handling. This course provides adequate knowledge to solve problems in their respective domains.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
PPSC	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
20%	Remember
30%	Understand
50%	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

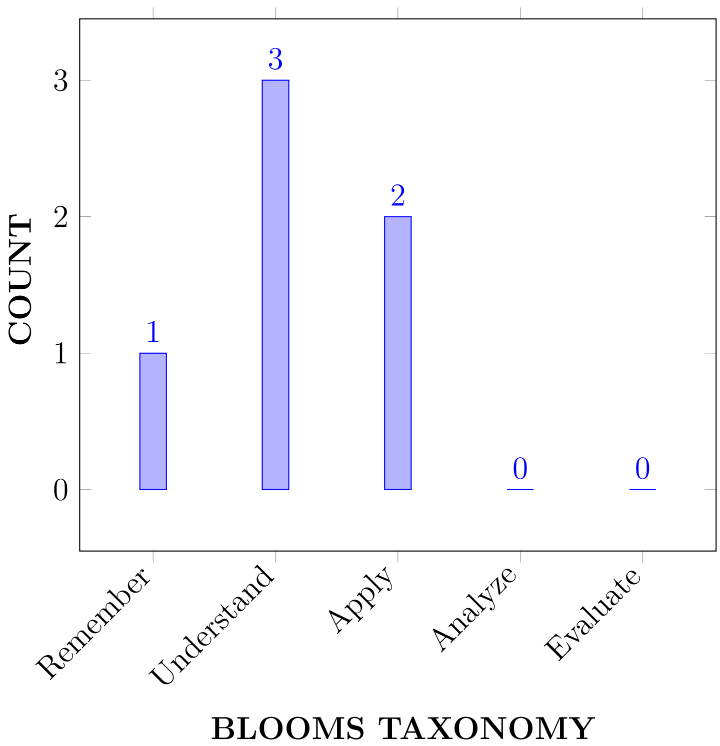
I	Problem-solving through programming.
II	Programming language, programming, reading a set of Data, stepwise refinement, concepts of Loops, Functions, Control structure, Arrays, Structure, Pointer and File concept.
III	To build efficient programs in C language essential for future programming and software engineering courses.
IV	Acquire programming skills in C Programming.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Define** the algorithms and draw flowcharts for solving Mathematical and Engineering problems.	Remember
CO 2	**Construct** programs for decision structures and loops.	Apply
CO 3	**Interpret** various types of functions, arrays, and strings for complex problem solving.	Under-stand
CO 4	**Illustrate** he dynamic memory allocation, structures, unions and enumerations to solve problems.	Under-stand
CO 5	**Interpret** file input and output functions to do integrated programming.	Under-stand
CO 6	**Utilize** the algorithms in C language to real-life computational problems.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	CIE/SEE
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	CIE/SEE
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	2	Open Ended Experiments

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	2	Tech talk/Open ended experiments
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	2	Tech talk/Open ended experiments

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	-	-	-	✓	-	-
CO 2	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	✓	✓	-	-	✓	-	-	-	-	-	-	-	-	-	-
CO 4	✓	✓	-	-	✓	-	-	-	-	-	-		-	-	-
CO 5	✓	-	-	-	✓	-	-	-	-	-	-	-	-	-	-
CO 6	-	-	-	-	-	-	-	-	-	-	-	✓	-	✓	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Developing algorithms and draw flowcharts for solving **mathematical** and **engineering problems** related to **areas of computer science.**	3
	PO 2	Understand the various symbols to **draw** a flowchart, **identify** the appropriate symbols to solve a problem, then **formulate** the solution, and **interpret** the result for the **improvement** of the **solution.**	6
	PSO 1	Understand the features of procedural programming for **designing** and **analyzing** computer programs for **problem-solving.**	3
CO 2	PO 1	Understand branching statements, loop statements, and apply the fundamentals of **mathematics**, **science** and **engineering**.	3
	PO 2	Understand the **problem statement**, **control** the flow of data, **design** the solution and **analyze** the same to **validate** the results in a program to solve **complex** engineering problems.	6
	PO 3	**Recognize** an appropriate control structure to **design** and **develop** a solution for a **real-time** scenario, and **communicating** effectively with engineering community.	5
CO 3	PO 1	Recognize the importance of recursionfor developing programs in real-time scenarios using principles of **mathematics**, and **engineering fundamentals**.	3
	PO 2	Understand the various kinds of **functions**, **identify** the suitable type of function to **solve** a problem, **formulate** the solution, and **interpret** the result for the **improvement** of the solution.	6
	PO 5	Apply techniques of **structured decomposition** to dividea problem into smaller pieces with an understanding of its limitations.	1
CO 4	PO 1	Extend the focus on the usage of heterogeneous data types as a **basic building block** in problem solving using principles of **science**, and **engineering** fundamentals.	3

	PO 2	**Recognize** the representation of the structure, **assess** in solving a problem, **express the solution**, and **analyze** the result for **solution enhancement**.	5
	PO 5	Understand pointers conceptually and apply them in modeling a **complex engineering** activity.	1
CO 5	PO 1	Make a use of an appropriate type of file to store a large volume of **persistent data** and give solution to **engineering problems**.	2
	PO 5	To identify appropriate mode to access a file and run the same **program** multiple times.	1
CO 6	PO 12	**Realize** the need and the desire to **train** and **invest** in autonomous and **lifelong learning** in the widest sense of **technical transition** to achieve **employability expertise** and excel advanced **engineering concepts**.	7
	PSO 2	Attain the **knowledge** and **skills** for employability and to succeed in national and international level **competitive examinations**.	3

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	6	-	-	-	-	-	-	-	-	-	-	3	-	-
CO 2	3	6	5	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	6	-	-	1	-	-	-	-	-	-	-	-		-
CO 4	3	5	-	-	1	-	-	-	-	-	-	-	-	-	-
CO 5	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO 6	-	-	-	-	-	-	-	-	-	-	-	7	-	3	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	60	-	-	-	-	-	-	-	-	-	-	50	-	-
CO 2	100	60	50	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	100	60	-	-	100	-	-	-	-	-	-	-	-	-	-
CO 4	100	50	-	-	100	-	-	-	-	-	-	-	-	-	-
CO 5	66	-	-	-	100	-	-	-	-	-	-	-	-	-	-
CO 6	-	-	-	-	-	-	-	-	-	-	-	58	-	50	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -$5 < C \leq 40\%$ – Low/ Slight

2 - 40 % $<C<$ 60% –Moderate
3 - 60% $\leq$ C $<$ 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 2	3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	3	-	-	3	-	-	-	-	-	-	-	-		-
CO 4	3	2	-	-	3	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO 6	-	-	-	-	-	-	-	-	-	-	-	2	-	2	-
TOTAL	15	11	2	-	9	-	-	-	-	-	-	2	2	2	-
AVERAGE	3	2.7	2.5	-	3	-	-	-	-	-	-	2	2	2	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	-				

XVII ASSESSMENT METHODOLOGY-INDIRECT:

-	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	INTRODUCTION
	Introduction to components of a computer: Memory, processor, I/O Devices, storage, operating system; Concept of assembler, compiler, interpreter, loader and linker. **Idea of Algorithms:** Algorithms, Flowcharts, Pseudo code with examples, From algorithms to Programs. **Introduction to C Programming Language:** History of C, Basic structure of a C program, Process of compiling and running a C program; C Tokens: Keywords, Identifiers, Constants, Strings, Special symbols, Variables, Data types; Operators, Precedence of Operators, Expression evaluation, Formatted Input/Output functions, Type Conversion and type casting.
MODULE II	CONTROL STRUCTRES
	Decision Making Statements: Simple if, if-else, else if ladder, Nested if, switch case statement; **Loop control statements:** for, while and do while loops, nested loops; **Unconditional Control Structures:** break, continue and goto statements.

MODULE III	**ARRAYS AND FUNCTIONS**
	Arrays: Introduction, Single dimensional array and multi-dimensional array: declaration, initialization, accessing elements of an array; Operations on arrays: traversal, reverse, insertion, deletion, merge, search; **Strings:** Arrays of characters, Reading and writing strings, String handling functions, Operations on strings; array of strings. **Functions:** Concept of user defined functions, Function declaration, return statement, Function prototype, Types of functions, Inter function communication, Function calls, Parameter passing mechanisms; Recursion; Passing arrays to functions, passing strings to functions; Storage classes.
MODULE IV	**POINTERS AND STRUCTURES**
	Pointer: Basics of pointers, Pointer arithmetic, pointer to pointers, array of pointers, Generic pointers, Null pointers, Pointers as functions arguments, Functions returning pointers; Dynamic memory allocation. **Structures:** Structure definition, initialization, structure members, nested structures, arrays of structures, structures and functions, structures and pointers, self-referential structures; Unions: Union definition, initialization, accessing union members; bit fields, typedef, enumerations, Preprocessor directives.
MODULE V	**FILE HANDLING AND APPLICATIONS IN C**
	File Handling: Concept of a file, text files and binary files, streams, standard I/O, formatted I/O, file I/O operations, error handling, Line I/O, miscellaneous functions; Applications in C.

TEXTBOOKS

1. Byron Gottfried, "Programming with C", Schaum's Outlines Series, McGraw Hill Education, 3rd Edition, 2017

2. Reema Thareja, "Programming in C", Oxford university press, 2nd Edition, 2016.

REFERENCE BOOKS:

1. W. Kernighan Brian, Dennis M. Ritchie, "The C Programming Language", PHI Learning, 2nd Edition, 1988.

2. Yashavant Kanetkar, "Exploring C", BPB Publishers, 2nd Edition, 2003.

3. Schildt Herbert, "C: The Complete Reference", Tata McGraw Hill Education, 4th Edition, 2014.

4. R. S. Bichkar, "Programming with C", Universities Press, 2 nd Edition, 2012.

5. Dey Pradeep, Manas Ghosh, "Computer Fundamentals and Programming in C", Oxford University Press, 2nd Edition, 2006.

6. Stephen G. Kochan, "Programming in C", Addison-Wesley Professional, 4th Edition, 2014.

WEB REFERENCES:

1. https://www.nptel.ac.in/courses/108106073/

2. https://www.iare.ac.in

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Discussion on Outcome Based Education, CO, PO and CO-PO Mapping		
CONTENT DELIVERY (THEORY)			
2	Understand components of a computer	CO 1	T2: 1.1-1.2, R4: 1.1-1.3
3	Identify and apply algorithms and flowcharts for problem solving	CO 1	T2: 2.1-2.2, R4: 1.4
4	Understand pseudo code for a given problem	CO 1	T2: 2.1-2.2
5	Understand the basic structure, process of compiling and running a C program	CO 1	T2: 2.1-2.2,
6	Understand keywords, identifiers, constants, strings, special symbols, variables	CO 1	T2: 1.4 -1.5, R4: 2.1 - 2.4
7	Define the data types, and operators to write C Program	CO 1	T2: 2.1-2.2
8	Understand precedence of operators, expression evaluation	CO 1	T2: 2.3-2.6
9	Understand formatted input/output functions, Type Conversion and type casting in C Programming	CO 1	T2: 2.3-2.7
10	Identify and apply decision making statements in C programming	CO 2	T2: 3.1-3.5
11	Identify and apply loop control structures in C programming	CO 2	T2: 5.2-5.3
12	Identify and apply unconditional control structures in C programming	CO 2	T2: 6.1-6.6
13	Understand single dimensional array and multi-deimensional array: declaration, initialization, accessing	CO 3	T2: 6.7
14	Operations on arrays: traversal, reverse, insertion	CO 3	T2: 8.1-8.2, R4: 15.1
15	Operations on arrays: deletion, merge, search	CO 3	T2: 8.3, R4: 15.1
16	Arrays of characters, Reading and writing strings, String handling functions	CO 3	T2: 11.1-11.5
17	Operations on strings: array of strings	CO 3	T2: 4.1-4.5
18	Concept of user defined functions, Function declaration	CO 3	T1: 7
19	return statement, Function prototype	CO 3	T2: 6.9

20	Types of functions, Inter function communication	CO 3	T1: 10, T2:10.1-10.2
21	Function calls, Parameter passing mechanisms, Recursion	CO 3	T2: 10.3-10.4, R4:8.3-8.4
22	Passing arrays to functions, passing strings to functions	CO 3	T2:10.5
23	Storage classes	CO 3	T1: 8.9, R4:8.6.3
24	Basics of pointers, Pointer arithmetic	CO 4	T2: 3.1, R4:11.1
25	Pointer to pointers	CO 4	T2: 3.2
26	Array of pointers	CO 4	T2: 3.2
27	Generic pointer, Null pointers	CO 4	T2: 3.3
28	Pointers as function arguments, Functions returning pointers	CO 4	T2: 3.4-3.5
29	Dynamic memory allocation	CO 4	T2: 6.1-6.6
30	Structure definition, initialization, structure members	CO 4	T2: 12.3-12.4, R4:13.4
31	Nested structures	CO 4	T2: 12.3-12.4, R4:13.4
32	Arrays of structures, structures and functions	CO 4	T2: 2.1-2.2, R4:13.2
33	Structures and pointers, self-referential structures	CO 4	T2: 2.1-2.2
34	Union, bit fields, typedef	CO 4	T2: 12.4
35	Enumerations, Preprocessor directives	CO 4	T1: 8.9, T2: 2.3-2.5
36	Concept of a file, text files and binary files, streams	CO 5	T2: 10.4, R4:14.1-14.4
37	Standard I/O, formatted I/O, file I/O operations	CO 5	T2: 10.4, R4:14.1-14.4
38	Error handling	CO 5	R3: 12.1 - 12.3
39	Line I/O, miscellaneous functions	CO 5	R3: 12.1 - 12.3
40	Applications of C	CO 6	R4: 17
PROBLEM SOLVING/ CASE STUDIES			
1	Write a program in C that takes minutes as input, and display the total number of hours and minutes.	CO 1	T2:2.3-2.6

2	Write a program in C that reads a forename, surname and year of birth and display the names and the year one after another sequentially.	CO 1	T2:2.3-2.7
3	Write a C program to find the third angle of a triangle if two angles are given.	CO 2	T2:3.1-3.5
4	Write a program in C to display the such a pattern for n number of rows using a number which will start with the number 1 and the first and a last number of each row will be 1.	CO 2	T2:5.2-5.3
5	Write a program in C to find the prime numbers within a range of numbers.	CO 2	T2:5.2-5.3
6	Write a program in C to display the n terms of harmonic series and their sum.	CO 2	T2:6.1-6.6
7	Write a program in C to display the pattern like right angle triangle using an asterisk.	CO 2	T2:5.2-5.3
8	Program to accept N integer number and store them in an array AR. The odd elements in the AR are copied into OAR and other elements are copied into EAR. Display the contents of OAR and EAR	CO 3	T2: 6.7
9	Write a C program to illustrate how user authentication is made before allowing the user to access the secured resources. It asks for the user name and then the password. The password that you enter will not be displayed, instead that character is replaced by '*'	CO 3	T2: 8.3, R4:15.1
10	Write a C program to accept a matric and determine whether it is a sparse matrix. A sparse martix is matrix which has more zero elements than nonzero elements	CO 3	T2: 8.1-8.2, R4: 15.1
11	Write a C program to accept a amtric of order MxN and sort all rows of the matrix in ascending order and all columns in descendng order	CO 3	T2: 6.7
12	Write a C program to accept a set of names and sort them in an alphabetical order, Use structures to store the names	CO 4	T2:12.3-12.4, R4:13.4
13	Write a C program to find the sum of two one-dimensional arrays using Dynamic Memory Allocation	CO 4	T2:6.1-6.6
14	Write a program in C to find the content of the file and number of lines in a Text File.	CO 5	T2:10.4, R4:14.1-14.4
15	Write a program in C to replace a specific line with another text in a file.	CO 5	T2:10.4, R4:14.1-14.4
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Module I- Components of computers, C programming language	CO 1	T2:1.1-2.6, R4:1.1-2.4
2	Module II- Control structures	CO 2	T2:3.1-6.6

3	Module III- Arrays, Strings and Functions	CO 3	T1:7, T2:6.7-11.5
4	Module IV- Pointers and Structures	CO 4	T2:3.1-6.6, R4:11.1-13.4
5	Module V- File handling functions	CO 5	T2:10.4, R4:14.1-14.4, R3:12.1-12.3
	DISCUSSION OF QUESTION BANK		
1	Module I- Components of computers, C programming language	CO 1	T2:1.1-2.6, R4:1.1-2.4
2	Module II- Control structures	CO 2	T2:3.1-6.6
3	Module III- Arrays, Strings and Functions	CO 3	T1:7, T2:6.7-11.5
4	Module IV- Pointers and Structures	CO 4	T2:3.1-6.6, R4:11.1-13.4
5	Module V- File handling functions	CO 5	T2:10.4, R4:14.1-14.4, R3:12.1-12.3

Signature of Course Coordinator **HOD,CSE**
Dr. J Sirisha Devi, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING
COURSE DESCRIPTION

Course Title	**ENGINEERING WORKSHOP PRACTICE**				
Course Code	AMEC04				
Program	B.Tech				
Semester	II	ECE			
Course Type	FOUNDATION				
Regulation	IARE - UG 20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	2	1
Course Coordinator	Mr. Gooty Rohan, Assistant Professor				

I COURSE OVERVIEW:

Engineering workshop Practice is intended to enhance the learning experience of the student about engineering tools for cutting and measuring used in a workshop. Students are expected to gain experience in hands on training as well as knowledge to carry out a particular process for making a product using the basic manufacturing devices used in Workshop.

II COURSE PRE-R‘EQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
-	-	-	-	-

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Engineering Workshop Practice	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing Further Experiments

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks for internal assessment and 70 marks for semester end lab examination. Out of 30 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day-to-day performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end lab examination for 70 marks shall be conducted by two examiners, one of them being Internal Examiner and the other being External Examiner, both nominated by the principal from the panel of experts recommended by Chairman, BOS.

The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component	**Laboratory**		Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

A. Experiment Based

Objective	**Analysis**	**Design**	**Conclusion**	**Viva**	**Total**
2	2	2	2	2	10

B. Programming Based

Purpose	**Algorithm**	**Program**	**Conclusion**	**Viva**	**Total**
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

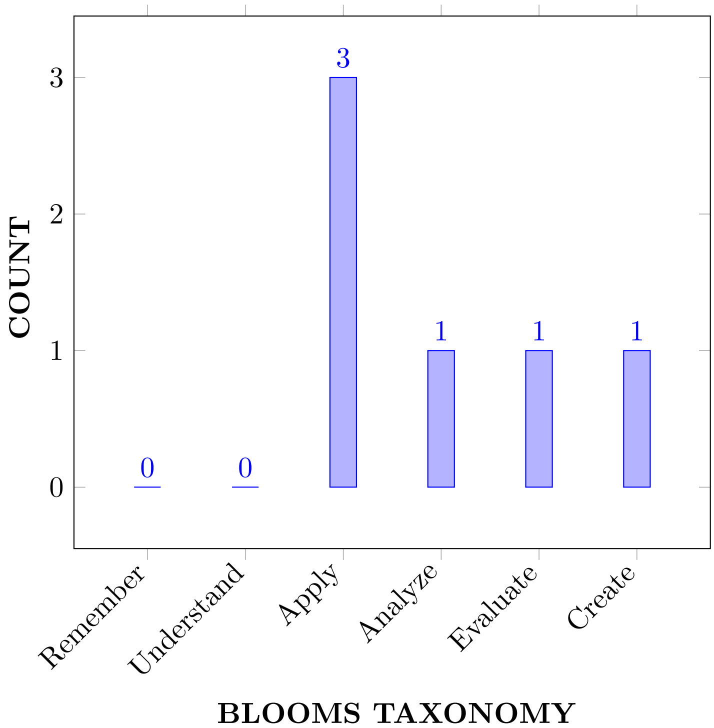
I	The application of jigs and fixtures, measuring, marking and cutting tools in various types of manufacturing processes.
II	The preparation of different joints in carpentry and fitting and also familiarizes wood working machinery.
III	The concepts of forming processes by forging, black-smithy and tin-smithy with an application extracts of Engineering Drawing.
IV	The standard electrical wiring practices for domestic and industrial appliances.
V	The current advancements in developing the prototype models through digital manufacturing facilities.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Identify** the conventional representation of materials and machine elements for making a desired product with given work piece.	Apply
CO 2	**Determine** the ability to Produce Fitting jobs as per specified dimensions in addition to demonstrating proficiency with hand tools common in fitting.	Evaluate
CO 3	**Create** a desired shape with given metal rod by using fire and furnaceto convert given shape into useable elements using basic blacksmith techniques.	Create
CO 4	**Organize** the moulding techniques along with suitable tools for producing casting of different and complex shapes using various patterns.	Apply
CO 5	**Develop** the various engineering and household products by using tin simthy instruments/machinesfor manufacturing the tin boxes, cans, funnels, ducts etc., from a flat sheet of metal.	Apply
CO 6	**Compare** various electrical circuits by using conduit system of wiring to prepare different types of electrical connection on the given circuit boards using appropriate electrical tools.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Lab Exercises
PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	CIA
PO 5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	2	Lab Exercises
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	3	SEE

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 3	Make use of Advanced Structural Analysis and Project Management Software for creating Modern Avenues to succeed as an Entrepreneur, Pursue Higher Studies and Career Paths.	2	Lab Exercises

3 = High; 2 = Medium; 1 = Low

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Apply the knowledge of engineering fundamentals to join given wooden pieces according to given sketch to develop required joint.	1

	PO 3	Conversion of given design into a practical output using design solution for complex engineering problems and design system components	2
	PO 5	Develop the given resources and engineering tools into proper fitment as given in the diagrammatical representation.	2
	PO 11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	2
	PSO 3	Make use of Experimental tools for Building Career Paths towards Innovation Startups, Employability in different mechanical trades.	2
CO 2	PO 1	Apply the knowledge of engineering fundamentals to join given metal pieces according to given sketch to develop required joint.	1
	PO 5	Develop the given resources and engineering tools into proper fitment as given in the diagrammatical representation.	2
	PO 11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	2
	PSO 3	Make use of Experimental tools for Building Career Paths towards Innovation Startups, Employability in different mechanical trades.	2
CO 3	PO 1	Apply the knowledge of engineering fundamentals to make metal rod into given required shape according to given sketch to develop required joint.	1
	PO 5	Develop the given resources and engineering tools into required shape as given in the diagrammatical representation.	2
	PSO 3	Make use of Experimental tools for Building Career Paths towards Innovation Startups, Employability in different mechanical trades.	2
CO 4	PO 1	Apply the knowledge of engineering fundamentals to make the casting product from given materials according to given sketch to develop required shape.	1
	PO 3	Conversion of given design into a practical output using design solution for complex engineering problems and design system components.	2
	PO 11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	2
CO 5	PO 5	Develop the given resources and engineering tools into required shape as given in the diagrammatical representation.	2

	PO 11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	2
CO 6	PO 1	Apply the knowledge of engineering fundamentals to make the required electrical connection according to given circuit diagram to develop connection.	1
	PO 5	Develop the given resources and engineering tools into proper fitment as given in the diagrammatical representation.	2
	PO 11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	2
	PSO 3	Make use of Experimental tools for Building Career Paths towards Innovation Startups, Employability in different mechanical trades.	2

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE	PROGRAM OUTCOMES				PSO'S
OUTCOMES	PO 1	PO 3	PO 5	PO 11	PSO 3
CO 1	1	2	2	2	2
CO 2	1	-	2	2	2
CO 3	1	-	2	-	2
CO 4	1	2	-	2	-
CO 5	-	-	2	2	-
CO 6	1	-	2	2	2

3 = High; 2 = Medium; 1 = Low

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	PO 1, PO 3, PSO 3	SEE Exams	PO 1,PO 3, PO 5, PSO 3	Seminars	-
Laboratory Practices	PO 1,PO 3, PO 5, PSO 3	Student Viva	PO 1, PO 5	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK 1	**CARPENTRY-I**
	Batch I: Preparation of Tenon joint as per given dimensions. Batch II: Preparation of Mortise joint as per given taper angle.
WEEK 2	**CARPENTRY-II**
	Batch I: Preparation of dove tail joint as per given taper angle. Batch II: Preparation of lap joint as per given dimensions.
WEEK 3	**FITTING - I**
	Batch I: Make a straight fit for given dimensions. Batch II: Make a square fit for given dimensions.
WEEK 4	**FITTING - II**
	Batch I: Make a V fit for given dimensions. Batch II: Make a semicircular fit for given dimensions.
WEEK 5	**BLACKSMITHY- I**
	Batch I: Prepare S-bend for given MS rod using open hearth furnace. Batch II: Prepare J-bend for given MS rod using open hearth furnace.
WEEK 6	**BLACKSMITHY- II**
	Batch I: Prepare Fan hook for given dimensions. Batch II: Prepare Round to Square for given dimensions.
WEEK 7	**MOULD PREPARATION-I**
	Batch I: Prepare a wheel flange mould using a given wooden pattern. Batch II: Prepare a bearing housing using an aluminum pattern.
WEEK 8	**MOULD PREPARATION-II**
	Batch I: Prepare a bearing housing using an aluminum pattern. Batch II: Prepare a wheel flange mould using a given wooden pattern.
WEEK 9	**TINSMITHY- I**
	Batch I: Prepare the development of a surface and make a rectangular tray for given dimensions. Batch II: Prepare the development of a surface and make a round tin for given dimensions.
WEEK 10	**TINSMITHY- II**
	Batch I: Prepare the development of a surface and make a Square Tin, for given dimensions. Batch II: Prepare the development of a surface and make a Conical Funnel for given dimensions.
WEEK 11	**ELECTRICAL WIRING-I**
	Batch I: Make an electrical connection of two bulbs connected in series. Batch II: Make an electrical connection of two bulbs connected in parallel.
WEEK 12	**ELECTRICAL WIRING-II**
	Batch I: Make an electrical connection of one bulb controlled by two switches connected. Batch II: Make an electrical connection of tube light.

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2. Kalpakjian S, Steven S. Schmid, Manufacturing Engineering and Technology, Pearson Education India Edition, 4th Edition, 2002.
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1. Gowri P. Hariharan, A. Suresh Babu, Manufacturing Technology – I, Pearson Education, 2008.
2. Roy A. Lindberg, Processes and Materials of Manufacture, Prentice Hall India, 4th Edition, 1998.
3. Rao P.N., Manufacturing Technology, Vol. I and Vol. II, Tata McGraw-Hill House, 2017.

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Tenon joint and Mortise joint.	CO 1, CO 2	T1:1.4, R1:1.2
2	Dove tail joint and Lap joint.	CO 1, CO 2	T1:1.5, R1:1.3
3	Straight fit and Square fit.	CO 3, CO 4	T2:12.2, R2:13.1
4	V fit and Semicircular fit.	CO 3, CO 4	T2:12.3, R2:13.4
5	S-bend and J-bend.	CO 5, CO 6	T3:9.1, R3:3
6	Fan and Round to Square shape.	CO 5, CO 6	T3:9.1, R3:3
7	Wheel flange and bearing housing.	CO 7, CO 8	T4:1.9, R2:1.8
8	Bearing housing and Wheel flange.	CO 7, CO 8	T4:2, R2:1.9
9	Rectangular tray and Round tin.	CO 9, CO 10	T5:1.4, R1:1.2
10	Make a Square Tin and Conical Funnel.	CO 9, CO 10	T5:1.7, R2:1.3
11	Series connection and parallel Connection.	CO 11, CO 12	T4:1.4, R1:1.2

12	One bulb controlled by two switches and tube light connection.	CO 11, CO 12	T5:7.1, R3:3.8

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	**Divided Tenon Joint:** It is the simplest form of Mortise and tenon joint and this joint is made by fitting a short tenon into a continuous groove. This joint has the advantage of being easy to cut and is often used to make cabinet doors and other light duty frame and panel assemblies.
2	**Cross Fitting:** It is the fundamental of type of fitting which are used fitting trade and it is formed by joining the two inclined shaped cut specimens together and is often used to join the universal bearings.
3	**Hexagonal Headed Bolt:** Hexagonal bolts are large bolts with a six-sided head used to fasten wood to wood, or metal to wood. These will have a tendency to spin as you tighten them.
4	**Open scoop:** Open scoop is used for accurately dispensing powders and granules hygienically. It is suitable for any hygienic application.
5	**T-Pipe Joint:** T-pipe is a type of fitting which is T-shaped having two outlets at 90 degrees to the main line. It is short piece of pipe with a lateral outlet.it is widely used as pipe fittings.
6	**Grooved Pulley:** Grooved pulley often used to for holding a belt, wire rope or rope and incorporated into a pulley. These sheave pins on a axle or bearing inside the frame of the pulley. This allows wire or rope to move freely, minimizing friction and wear on the cable.
7	**Bell Indicator circuit:** Bell indicator circuit is used where a bell and buzzers are needed to control from different locations. Bell indicator circuit is also known as hoteling circuit where an electric bell is controlled from more than one locations.

Signature of Course Coordinator **HOD,ECE**
Mr.Gooty Rohan, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING
COURSE DESCRIPTION

Course Title	**PROGRAMMING FOR PROBLEM SOLVING LABORATORY**				
Course Code	ACSC05				
Program	B.Tech				
Semester	II	ECE			
Course Type	Foundation				
Regulation	IARE-R20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mr. P Ravinder, Assistant Professor				

I COURSE OVERVIEW:

The course covers the basics of programming and demonstrates fundamental programming techniques, customs and terms including the most common library functions and the usage of the preprocessor. This course helps the students in gaining the knowledge to write simple C language applications, mathematical and engineering problems. This course helps to undertake future courses that assume this programming language as a background in computer programming. Topics include variables, data types, functions, control structures, pointers, strings, arrays and dynamic allocation principles. This course in reached to student by power point presentations, lecture notes, and lab involve the problem solving in mathematical and engineering areas..

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSB02	I	-

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Computer Programming Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

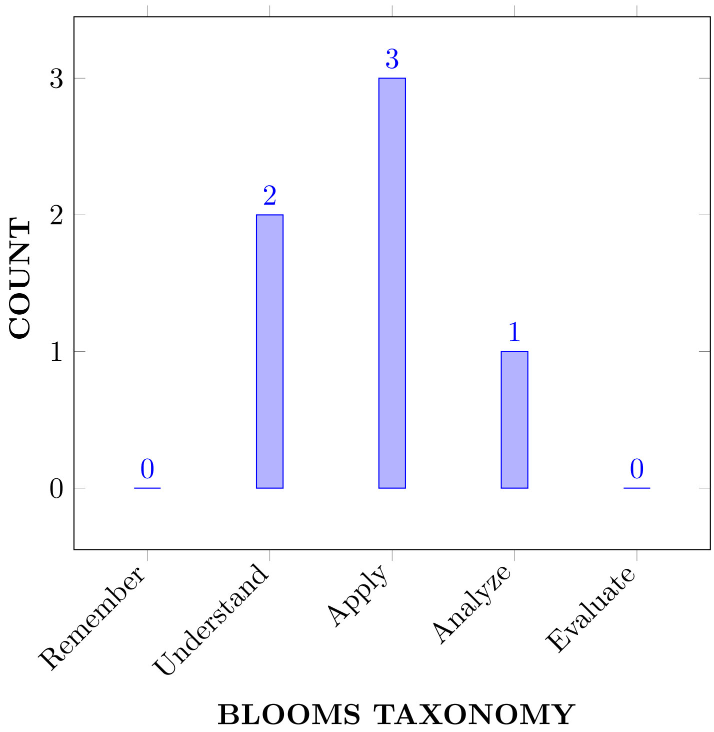
I	The hands on experience in design, develop, implementation and evaluation by using Asymptotic notation.
II	The demonstration knowledge of basic abstract data types (ADT) and associated algorithms for organizing programs into modules using criteria that are based on the data structures of the program.
III	The practical implementation and usage of non linear data structures for solving problems of different domain.
IV	The knowledge of more sophisticated data structures to solve problems involving balanced binary search trees, AVL Trees, B-trees and B+ trees, hashing.
V	The graph traversals algorithms to solve real-world challenges such as finding shortest paths on huge maps and assembling genomes from millions of pieces

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Demonstrate** problem solving steps in terms of algorithms, pseudocode and flowcharts for Mathematical and Engineering problems. .	Understand
CO 2	**Make use** the concept of operators, precedence of operators, conditional statements and looping statements to solve real time applications.	Apply
CO 3	**Demonstrate** the concept of pointers, arrays and perform pointer arithmetic, and use the pre-processor.m.	Understand
CO 4	**Analyze** the complexity of problems, modularize the problems into small modules and then convert them into programs.	Apply
CO 5	**Implement** the programs with concept of file handling functions and pointer with real time applications of C.	Apply
CO 6	**Explore** the concepts of searching and sorting methods with real time applications using c	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:**Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Viva-voce/Laboratory Practices
PO 2	**Problem analysis:**Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Viva-voce/Laboratory Practices
PO 3	**Design/development of solutions:**Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Viva-voce/Laboratory Practices
PO 5	**Modern Tool Usage:**Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.	2	Viva-voce/Laboratory Practices

PO 10	**Communication:**Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	Viva-voce/Laboratory Practices
PO 12	**Life-long learning:**Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	2	Viva-voce/Laboratory Practices

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications. .	2	Viva-voce Laboratory Practices
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs .	2	Viva-voce Laboratory Practices
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications. .	2	Viva-voce Laboratory Practices

3 = High; 2 = Medium; 1 = Low

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Understand (knowledge) the basic concept of algorithm analysis which provides theoretical estimates for the resources needed by any algorithm for a given computational problem. These estimates provide an insight into reasonable directions of search for efficient algorithms by applying the principles of **mathematics and science**	3
	PO 5	Understand the (given **knowledge**) appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.	3

CO 2	PO 1	Understand (knowledge)the basic concept of algorithm analysis which provides theoretical estimates for the resources needed by any algorithm for a given computational problem. These estimates provide an insight into reasonable directions of search for efficient algorithms by applying the principles of **mathematics and science.**	3
	PO 5	Understand the (**knowledge**) appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.	2
CO 3	PO 1	Understand (**knowledge**) the basic concept of algorithm analysis which provides theoretical estimates for the resources needed by any algorithm for a given computational problem. These estimates provide an insight into reasonable directions of search for efficient algorithms by applying the principles of **mathematics and science.**	3
	PO 5	Understand the (knowledge) appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.	3
CO 4	PO 1	Describe (knowledge) the use sorting techniques as a basic building block in algorithm design and problem solving **using principles of mathematics, science, and engineering fundamentals.**	3
	PO 5	Understand the **knowledge** appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.	2
	PO 10	Apply (knowledge) concept of dimensional analysis and similarity parameters for predicting physical parameters (understanding) for the fluid flow analysis used in designing prototypes devices (apply) solving design problems by applying the **communicating effectively with engineering community.**	3
CO 5	PO 1	Outline the importance of searching algorithms to retrieve an element from any data structure where it is stored by **understanding and applying the fundamentals of mathematics, science and engineering.**	3
	PO 10	Understand the use of searching techniques that retrieve information stored within some data structure by **communicating effectively with engineering community**.	2
CO 6	PO 1	Outline the importance of searching algorithms to retrieve an element from any data structure where it is stored by **understanding and applying the fundamentals of mathematics, science and engineering**	2

	PO 10	Understand the use of searching techniques that retrieve information stored within some data structure by **communicating effectively with engineering communit.**	3

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES				
	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	3	3	4	2	
CO 2	3	4	5	2	
CO 3	3	3	4	2	3
CO 4	3	3	3	2	2
CO 5	2	4	5	4	2
CO 6	3	5	3	3	2

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	PO 1, ,PO 2, PO 3, PSO 1	SEE Exams	PO 1,PO 3, PO 5, PSO 1	Seminars	-
Laboratory Practices	PO 1,PO 2, PO 3, PO 5,PO 10, PSO 1	Student Viva	PO 1, PO 5	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK I	**OPERATORS AND EVALUATION OF EXPRESSIONS**
	a. Write a C program to check whether a number is even or odd using ternary operator. b. Write a C program to perform the addition of two numbers without using + operator. c. Write a C program to evaluate the arithmetic expression ((a + b / c * d - e) * (f - g)). Read the values a, b, c, d, e, f, g from the standard input device. d. Write a C program to find the sum of individual digits of a 3 digit number. e. Write a C program to read the values of x and y and print the results of the following expressions in one line: i. (x + y) / (x - y) ii. (x + y)(x - y)
WEEK II	**CONTROL STRUCTURES**
	a. Write a C program to find the sum of individual digits of a positive integer. b. A Fibonacci sequence is defined as follows: The first and second terms in the sequence are 0 and 1.Subsequent terms are found by adding the preceding two terms in the sequence. Write a C program to generate the first n terms of the sequence. c. Write a C program to generate all the prime numbers between 1 and n, where n is a value supplied by the user. d. A character is entered through keyboard. Write a C program to determine whether the character entered is a capital letter, a small case letter, a digit or a special symbol using if- else and switch case. The following table shows the range of ASCII values for various characters. Characters ASCII values A – Z 65 – 90 a – z 97 – 122 0 – 9 48 – 57 Special symbols 0 – 47, 58 – 64, 91 – 96, 123 – 127 If cost price and selling price of an item is input through the keyboard, write a program to determine whether the seller has made profit or incurred loss. Write a C program to determine how much profit or loss incurred in percentage.
WEEK III	**CONTROL STRUCTURES**
	a. Write a C program to find the roots of a quadratic equation. d. Write a C program to check whether a given 3 digit number is Armstrong number or not. e. Write a C program to print the numbers in triangular form 1 1 2 1 2 3
WEEK IV	**ARRAYS**
	a. Write a C program to find the second largest integer in a list of integers. b. Write a C program to perform the following: i. Addition of two matrices ii. Multiplication of two matrices c. Write a C program to count and display positive, negative, odd and even numbers in an array. d. Write a C program to merge two sorted arrays into another array in a sorted order. e. Write a C program to find the frequency of a particular number in a list of integer.
WEEK V	**STRINGS**

	a. Write a C program that uses functions to perform the following operations: i. To insert a sub string into a given main string from a given position. ii. To delete n characters from a given position in a given string. b. Write a C program to determine if the given string is a palindrome or not. c. Write a C program to find a string within a sentence and replace it with another string. d. Write a C program that reads a line of text and counts all occurrence of a particular word. e. Write a C program that displays the position or index in the string S where the string T begins, or 1 if S doesn't contain T. .
WEEK VI	**FUNCTIONS**
	a. Write C programs that use both recursive and non-recursive functions i. To find the factorial of a given integer. ii. To find the greatest common divisor of two given integers. b. Write C programs that use both recursive and non-recursive functions i. To print Fibonacci series. ii. To solve towers of Hanoi problem. c. Write a C program to print the transpose of a given matrix using function. d. Write a C program that uses a function to reverse a given string. .
WEEK VII	**POINTERS**
	a. Write a C program to concatenate two strings using pointers. b. Write a C program to find the length of string using pointers. c. Write a C program to compare two strings using pointers. d. Write a C program to copy a string from source to destination using pointers. e. Write a C program to reverse a string using pointers. .
WEEK VIII	**STRUCTURES AND UNIONS**
	a. Write a C program that uses functions to perform the following operations: i. Reading a complex number ii. Writing a complex number iii. Addition and subtraction of two complex numbers iv. Multiplication of two complex numbers. Note: represent complex number using a structure. b. Write a C program to compute the monthly pay of 100 employees using each employee's name, basic pay. Print the employees name and gross salary. c. Create a Book structure containing book id, title, author name and price. Write a C program to pass a structure as a function argument and print the book details. d. Create a union containing 6 strings: name, home address, hostel address, city, state and zip. Write a C program to display your present address. e. Write a C program to define a structure named DOB, which contains name, day, month and year. Using the concept of nested structures display your name and date of birth. .
WEEK IX	**ADDITIONAL PROGRAMS**

	a. Write a C program to read in two numbers, x and n, and then compute the sum of this geometric progression: 1+x+x2+x3+... +xn . For example: if n is 3 and x is 5, then the program computes1+5+25+125. Print x, n, the sum. Perform error checking. For example, the formula does not make sense for negative exponents if n is less than 0. Have your program print an error message if n¡0, then go back and read in the next pair of numbers of without computing the sum. Are any values of x also illegal? If so, test for them too. b. 2s complement of a number is obtained by scanning it from right to left and complementing all the bits after the first appearance of a 1. Thus 2's complement of 11100 is 00100. Write a C program to find the2 s complement of a binary number. c. Write a C program to convert a Roman numeral to its decimal equivalent. E.g. Roman number CD is equivalent to 400. .
WEEK X	**PREPROCESSOR DIRECTIVES**
	a. Define a macro with one parameter to compute the volume of a sphere. Write a C program using this macro to compute the volume for spheres of radius 5, 10 and 15 meters. b. Define a macro that receives an array and the number of elements in the array as arguments. Write a C program for using this macro to print the elements of the array. c. Write symbolic constants for the binary arithmetic operators +, -, *, and /. Write a C program to illustrate the use of these symbolic constants.
WEEK XI	**FILES**
	a. Write a C program to display the contents of a file. b. Write a C program to copy the contents of one file to another. c. Write a C program to reverse the first n characters in a file, where n is given by the user. d. Two files DATA1 and DATA2 contain sorted lists of integers. Write a C program to merge the contents of two files into a third file DATA i.e., the contents of the first file followed by those of the second are put in the third file. e. Write a C program to count the no. of characters present in the file
WEEK XII	**COMMAND LINE ARGUMENTS**
	a. Write a C program to read arguments at the command line and display it. b. Write a C program to read two numbers at the command line and perform arithmetic operations on it. c. Write a C program to read a file name at the command line and display its contents.

TEXTBOOKS

1. Sutton, G.P., et al., —Rocket Propulsion Elements, John Wiley Sons Inc., New York, 1993

2. Martin J.L Turner , Rocket Space Craft Propulsion, Springers oraxis publishing, 2001

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1. Mathur, M., and Sharma, R.P., —Gas Turbines and Jet and Rocket Propulsion, Standard Publishers, New Delhi 1998

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XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Calibration of Venturimeter and Orifice meter.	CO 1	R1: 1.2
2	Determination of pipe flow losses in rectangular and circular pipes.	CO 2	R2: 3.5
3	Verification of Bernoulli's theorem	CO 3	R1: 3.4
4	Determination of Reynolds Number of fluid flow	CO 4	R1: 2.2
5	Determine the reaction forces produced by the change in momentum.	CO 5	R1: 2.4
6	Determine the efficiencyand draw theperformance curves ofcentrifugal pump.	CO 6	R3: 4.5
7	Determine the efficiencyand draw theperformance curves of reciprocating pump.	CO 6	R3: 4.6
8	Determine the performance characteristics of pelton wheel under constant head.	CO 6	R2: 5.1
9	Determine the performance characteristics of Francis turbine.	CO 6	R2: 5.2
10	Determine the rate of flow through weir.	CO 7	R1: 7.1
11	Determine the rate of flow through Nothches.	CO 7	R1:7.2
12	Determine the rate of flow through a Orifice meter	CO 7	R1:7.3

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	**Twin vortex formation:** Demonstration of twin vortex formation and calculation of vortex size for different geometries.
2	**Open channel:** Demonstration of streamline at different angle of attack and calculation of separation point for different Reynolds number.
3	**Capillary action:** By modeling capillary action using two cups of water and a paper towel, you'll gain a better understanding of the importance of this process in trees.
4	**Buoyancy** Calculation of meta center and displacement volume for various geometries and materials.
5	**Flow through pipes:** Encourage students to design and analyze flow through pipes using ANSYS

Signature of Course Coordinator **HOD,ECE**
Mr. P Ravinder, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Electronics and Communication Engineering**				
Course Title	**Electronic Devices and Circuits**				
Course Code	AECC01				
Program	B.Tech				
Semester	III				
Course Type	Core				
Regulation	IARE-UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Mr. B Naresh, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSC03	I	Engineering Physics
B.Tech	AEEC02	II	Electrical Circuits

II COURSE OVERVIEW:

This course provides the constructional features and principle of operation of the basic semiconductor devices such as diodes, bipolar and unipolar transistors. It intended to provide the biasing configurations of the semiconductor devices to provide temperature stability. Analytical skills to configure semiconductor devices for the applications - rectifiers, clippers, voltage regulators, clampers and amplifiers.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Electronic Devices and Circuits	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
50%	Understand
33%	Apply
17%	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	-

VI COURSE OBJECTIVES:

The students will try to learn:

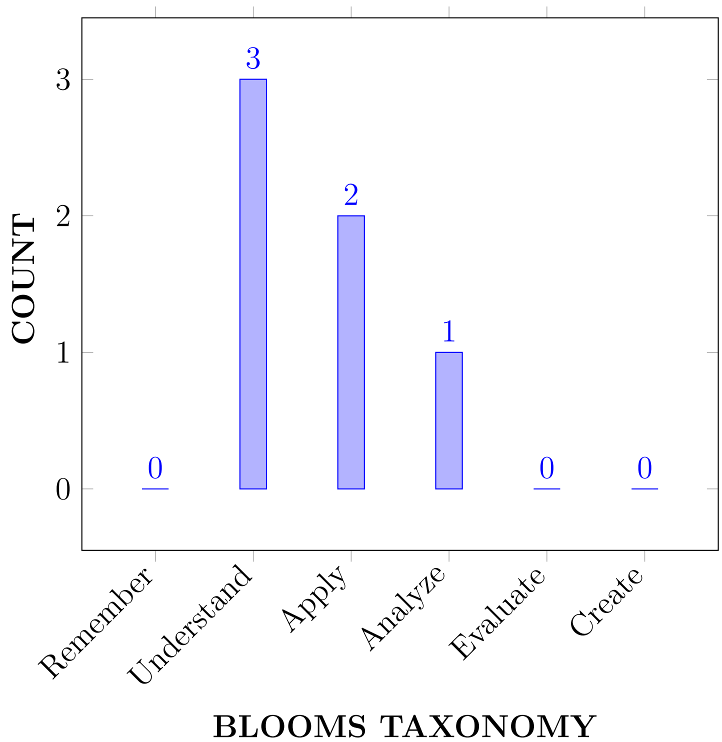
I	The operational principles, characteristics of semiconductor devices and circuits for rectification, amplification, conditioning and voltage regularization of signals.
II	The analytical skills needed to model analog and digital integrated circuits (IC) at discrete and micro circuit level.
III	The foundations of basic electronic circuits necessary for building complex electronic hardware.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Illustrate** the characteristics of semiconductor devices for determining the device parameters such as resistances, current gain and voltage gain.	Understand
CO 2	**Apply** the pn junction characteristics for the diode applications such as switch,rectifiers, Clippers and Clampers.	Apply
CO 3	**Examine** DC and AC load line analysis of BJT and FET amplifiers for optimal operating level regardless of input, load placed on the device.	Analyze
CO 4	**Extend** the biasing techniques for bipolar and uni-polar transistor amplifier circuits considering stability condition for establishing a proper operating point.	Understand
CO 5	**Utilize** low frequency model for estimation of the characteristic parameters of BJT, FET amplifier circuits.	Apply
CO 6	**Demonstrate** the working principle of special purpose semiconductor diodes and transistors for triggering and voltage regulation applications.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE/CIE/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	SEE/CIE/AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	SEE/CIE/AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	SEE/CIE/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	2	AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 2	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 3	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 4	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 5	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 6	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Illustrate the volt-ampere characteristics **(knowledge)** of semiconductor devices to derive **mathematical model** for diode current, static and dynamic resistance by applying the principles of **mathematics** and **scientific principles** for solving complex engineering problems.	2
	PO 2	Understand the given **problem statement** and **formulate** the static and dynamic resistance from the volt-ampere characteristics of the semiconductor devices using **experimental design**	3
	PO 10	**Communicate orally** on semiconductior device functionalities and **write** effective reports on characteristics of diode,BJT and MOSFEts	2
CO 2	PO 1	Apply the pn junction characteristics for the diode applications of diode as switch, clippers, Clampers and rectifiers by analyzing complex engineering problems using the principles of **mathematics, scintific principles and methodology**	2
	PO 2	Understand the given the diode application **problem statement** and finding the **implementation** of rectifier,clipper and clamper circuits by using diode	2
	PO 3	Undertsnad the **user needs**, then define a **problem and identify the constraints** then **manage the design process** using diode as rectifiers for **awareness of the framework of relevant engineering activities, safety issues**	4
	PO 10	**Communicate orally** on appliactions of semiconductor diode and **write** effective reports on electronic circuits using diode	2
	PSO 1	Formulate and Evaluate the rectifier circuit applications in the field of **Intelligent Embedded and robotics**	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 3	PO 1	Understand DC and AC load line analysis of different amplifiers for optimal operating level by applying **mathematical, science principles and methodology** for solving the optimum operating point in amplifiers	2
	PO 2	Understand the given **problem statement** for DC and AC load line analysis using **experimental design** for **validating** the amplifier analysis.	3
	PO 10	**Communicate orally** on load line analysis of semiconductor devices and **write** effective reports on optimum operating point of amplifiers	2
CO 4	PO 1	Understand the **mathematical principles** for design the biasing techniques for BJT, JFET and MOSFETs amplifier circuits for stable operation by applying the **methodology**	2
	PO 2	Understand the **problem statement** of biasing techniques for BJT, JFET and MOSFETs amplifier and **formulation** of proper operating point for **validating** the amplifiers and **interpret** the results.	4
	PO 3	**Define a problem and identify constraints** of amplifier circuits to satisfy the **user needs** to develop the **sustainable development** in amplifiers.	3
	PO 10	**Communicate orally** on biasing methids for BJT and FETS and **write** effective reports on stability factors with biasing approaches for transistors	2
	PSO 1	Formulate the amplifier circuits using BJT and FET for **developing real time problems** and **digital circuits**	2
CO 5	PO 1	Estimate the characteristic parameters of BJT, FET amplifier circuits using **mathematical principles** for solving complex engineering problems using low frequency model by applying **Scientific methodology.**	2
	PO 2	Analyze small signal analysis **problem statements** of BJT, FET amplifier circuits for **experimental design** for **validation** and **interpretation** of results.	4
	PO 10	**Effective presentation and speaking style** on small signal analysis and **write subject matter effectively** on amplifiers using BJT and FETS.	2
CO 6	PO 1	undertand the working principle of special purpose semiconductor devices by applying **Scientific principles and methodology.**	1
	PO 10	**Effective presentation and speaking style** on zener diode, tunnel diode , SCR and UJT then **write subject matter effectively** on characteristics of special semiconductor devices.	2

*__Note__: Refer appendix-I for key competencies

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	2	3	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 2	2	2	4	-	-	-	-	-	-	2	-	-	2	-	-
CO 3	2	3	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 4	2	4	3	-	-	-	-	-	-	2	-	-	2	-	-
CO 5	2	4	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 6	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	66.7	30	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 2	66.7	20	40	-	-	-	-	-	-	40	-	-	40	-	-
CO 3	66.7	30	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 4	66.7	40	30	-	-	-	-	-	-	40	-	-	40	-	-
CO 5	66.7	40	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 6	33.3	-	-	-	-	-	-	-	-	40	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation
1 -$5 < C \leq 40\%$ – Low/ Slight
2 - $40\% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	1	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 2	3	1	2	-	-	-	-	-	-	2	-	-	2	-	-
CO 3	3	1	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 4	3	2	1	-	-	-	-	-	-	2	-	-	2	-	-
CO 5	3	2	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 6	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-
TOTAL	**16**	**7**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**12**	**-**	**-**	**4**	**-**	**-**
AVERAGE	**2.7**	**1.4**	**1.5**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**-**	**-**

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	✓
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	Concept Video	✓	Open Ended Experiments	✓
Assignments	-				

XVII ASSESSMENT METHODOLOGY-INDIRECT:

X	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts	-	-

XVIII SYLLABUS:

MODULE I	**DIODE AND APPLICATIONS**
	Diode - Static and Dynamic resistances, Equivalent circuit, Load line analysis, Diffusion and Transition Capacitances, Diode Applications: Switch-Switching times. Rectifier - Half Wave Rectifier, Full Wave Rectifier, Bridge Rectifier, Rectifiers With Capacitive Filter, Clippers-Clipping at two independent levels, Clampers-Clamping Operation, types, Clamping Circuit Theorem, Comparators.
MODULE II	**BIPOLAR JUNCTION TRANSISTOR (BJT)**
	Principle of Operation and characteristics - Common Emitter, Common Base, Common Collector Configurations, Operating point, DC & AC load lines, Transistor Hybrid parameter model, Determination of h-parameters from transistor characteristics, Conversion of h-parameters.
MODULE III	**TRANSISTOR BIASING AND STABILIZATION**
	Bias Stability, Fixed Bias, Collector to Base bias, Self-Bias, Bias Compensation using Diodes and Transistors. **Analysis and Design of Small Signal Low Frequency BJT Amplifiers:** Analysis of CE, CC, CB Amplifiers and CE Amplifier with emitter resistance, low frequency response of BJT Amplifiers, effect of coupling and bypass capacitors on CE Amplifier.
MODULE IV	**JUNCTION FIELD EFFECT TRANSISTOR**
	Construction, Principle of Operation, Pinch-Off Voltage, Volt- Ampere Characteristic, comparison of BJT and FET, Biasing of FET, FET as Voltage Variable Resistor, MOSFET Construction and its Characteristics in Enhancement and Depletion modes.
MODULE V	**FET AMPLIFIERS**
	Small Signal Model, Analysis of CS, CD, CG JFET Amplifiers. Basic Concepts of MOSFET Amplifiers. **Special Purpose Devices:** Zener Diode - Characteristics, Voltage Regulator; Principle of Operation - SCR, Tunnel diode, UJT, Varactor Diode.

TEXTBOOKS

1. S Salivahanan, N Suresh Kumar " Electronic Devices and Circuits", 2nd Edition, 2018, McGraw Hill Education.
2. J. Millman and Christos C. Halkias, "Integrated Electronics", International Student Edition , 2008, Tata McGraw Hill Publications.
3. David A. Bell, "Electronic Devices and Circuits", 5th Edition, Oxford University Press.

REFERENCE BOOKS:

1. R.L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuits", 9th Edition, 2006, PEI/PHI.
2. B.P.Singh, Rekha Singh, "Electronic Devices and Circuits", 2nd Edition, 2013, Pearson Publisher.
3. K. Lal Kishore, "Electronic Devices and Circuits", 2nd Edition, 2005,BS Publisher.
4. Anil K. Maini and Varsha Agarwal, "Electronic Devices and Circuits", 1stEdition, 2009, Wiley India Pvt. Ltd.

COURSE WEB PAGE:

https://lms.iare.ac.in/index?route=course/details&course id=350

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping		-
CONTENT DELIVERY (THEORY)			
2	pn Junction Formation, Biasing of pn Junction and its characteristics	CO 1	T1: 2.1
3	Diode Resistances, Equivalent circuit	CO 1	T1: 2.6
5	Load line analysis , Diffusion and Transition Capacitances	CO 1	T1: 2.7
6	Half Wave Rectifier	CO 2	T1: 3.2.1
7	Full Wave Rectifier	CO 2	T1: 3.2.2.
8	Bridge Rectifier	CO 2	T1: 3.2.3
9	Rectifiers With Capacitive Filter	CO 2	T1: 3.6
11	Positive peak and negative peak Clippers operation	CO 2	T1: 6.15
12	Clipping at two independent levels	CO 2	T1:5.13-5.14 R5: 8.2
14	Positive peak and negative peak Clampers	CO 2	R5: 8.5-8.6
15	Clamping Circuit Theorem	CO 3	R5: 8.5-8.6
17	Principle of Operation of BJT	CO 1	T1: 4.2

19	Common Emitter Configuration with characteristics	CO 1	T1: 4.4
20	Common Base Configuration with characteristics	CO 1	T1: 4.4
21	Common Collector Configuration with characteristics	CO 1	T1: 4.4
22	Transistor current components and relation among current gains	CO 1	T1: 4.3
23	Operating point, DC & AC load lines	CO 3	T1: 5.2, 5.3
25	Transistor Hybrid parameter model	CO 5	T1: 6.3
26	Transistor biasing and stabilization	CO 4	T1: 5.4, 5.5
27	Fixed Bias	CO 4	T1: 5.4.1
29	Collector to Base bias	CO 4	T1: 7.2-7.3
31	Self-Bias	CO 4	T1:5.4.3
33	Bias Compensation using Diodes and Transistors	CO 4	T1: 5.6
34	Exact Analysis of transistor amplifier using low frequency model	CO 5	T1: 6.6
35	Approximate Analysis of transistor amplifier using low frequency model	CO 5	T1:6.8
36	Analysis of CE amplifier with emitter resistance using low frequency model	CO 5	T1:6.9
39	Effect of coupling and bypass capacitors on CE Amplifier	CO 5	T1:6.13
40	Construction, Principle of Operation of JFET, Comparison of BJT and FET	CO 1	T1:4.12
42	Volt- Ampere Characteristic of JFET, Pinch-Off Voltage	CO 1	T1:4.13
43	Biasing of FET	CO 4	T1: 5.9
44	MOSFET Construction and its Characteristics in Enhancement mode	CO 1	T1: 4.15
45	MOSFET Construction and its Characteristics in Depletion mode	CO 1	T1:4.16
46	Analysis of generalized JFET Amplifier	CO 5	T1: 6.15
47	Analysis of CS JFET Amplifier	CO 5	T1:6.16
49	Analysis of CD JFET Amplifier	CO 5	T1:6.17
51	Analysis of CG JFET Amplifier	CO 5	T1: 6.18
53	Zener Diode - Characteristics, Voltage Regulator	CO 6	T1: 2.9,2.11
54	Principle of Operation - SCR	CO 6	T1: 2.16
55	Tunnel diode	CO 6	T1: 2.12
56	UJT operation ,Varactor Diode operation	CO 6	T1: 2.19,2.18
PROBLEM SOLVING/ CASE STUDIES			
4	Related to Diode current and its resistance calculation	CO 1	T1: 2.3
10	Rectifier parameters estimation	CO 2	T2:2.6
13	Clipper circuits	CO 2	T2:2.9
16	Clamper circuits	CO 2	T2:2.10
24	Load line analysis of BJT	CO 3	T2:5.3

18	Current gain of transistor configuration	CO 1	T1:4.3
28	Transistor fixed biasing	CO 4	T2:5.4.1
30	Transistor collector to base biasing	CO 4	T2:5.4.3
32	Transistor self-biasing	CO 4	T1:5.4.5
37	CE Transistor amplifier analysis	CO 5	T1:6.14
38	CB Transistor amplifier analysis	CO 5	T1:6.14
39	CC Transistor amplifier analysis	CO 5	T1:6.14
47	CS Amplifier analysis	CO 5	T1:6.16
49	CD Amplifier analysis	CO 5	T1: 6.17 R5: 4.4
52	Zener diode regulator	CO 6	T1: 2.11
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Diode applications	CO 1, CO 2	DT
58	Bipolar Junction Transistor (BJT)	CO 1	DT
59	Transistor biasing and stabilization	CO 3, CO 4	DT
60	Junction field effect transistor	CO 1	DT
61	FET amplifiers	CO 5, CO 6	DT
DISCUSSION OF QUESTION BANK			
57	Diode applications	CO 1, CO 2	DT
58	Bipolar Junction Transistor (BJT)	CO 1	DT
59	Transistor biasing and stabilization	CO 3, CO 4	DT
60	Junction field effect transistor	CO 1	DT
61	FET amplifiers	CO 5, CO 6	DT

Signature of Course Coordinator **HOD, ECE**

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	**10**

PO 4.	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions **(Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice **(The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**

PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project. 6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	**12**

PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	Key Competencies Features (KCF)	No. of KCF's
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications 1. Analyze and solve real time problems in Robotics. 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications 3. Develop embedded systems modules using Real Time Operating System. 4. Undertake research and development projects in the field of Embedded Systems. 5. Adopt the engineering professional code and conduct.	**5**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs. 1.Inspect, survey and analyze types of ASIC chip designs. 2.Design ASIC prototypes using Verilog and VHDL languages. 3.Analyze microprocessor subsystems with memories and I/O interfacs for SOC designs 4.Explore hardware components for designig SOC 5.Adopt the engineering professional code and conduct 6.Designing prototypes of SOC using programming tools like MATLAB, LabVIEW. 7.Familiarize with the design flow of ASIC prototypes. 8.Realize SOC using Register-Transfer-Level designs 9.Analyse and develop models for system level descriptions for synthesis of SOC 10.Inspect and survey the abstractions and principles for the specification, simulation, verification, and synthesis of systems on chip (SoC) 11.Programming and hands-on skills to meet requirements of global environment.	**11**
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications. 1.Explicit software and programming tools for antenna design. 2.Adopt technical library resources and literature search. 3.Explore smart antennas. 4.Model, program for operation and control of smart antennas for wireless communication applications. 5.Interface automation tools. 6.Research, analysis, problem solving and presentation using software aids. 7.Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Electronics and Communication Engineering**				
Course Title	**Signals and Systems**				
Course Code	AECC02				
Program	B. Tech				
Semester	III				
Course Type	CORE				
Regulation	R-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Ms.V. Bindusree, Assistant Professor.				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSB11	III	Mathematical Transform Techniques

II COURSE OVERVIEW:

This course integrates the basic concepts of both continuous and discrete time signals and systems. It covers the linear time invariant systems and their analysis in time and frequency domain, mathematical tools, correlation and convolution of signals, sampling techniques. It provides the necessary background needed for understanding the signal processing and communications.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Signals and Systems	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could

be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
20%	Remember
50 %	Understand
30 %	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	-

VI COURSE OBJECTIVES:

The students will try to learn:

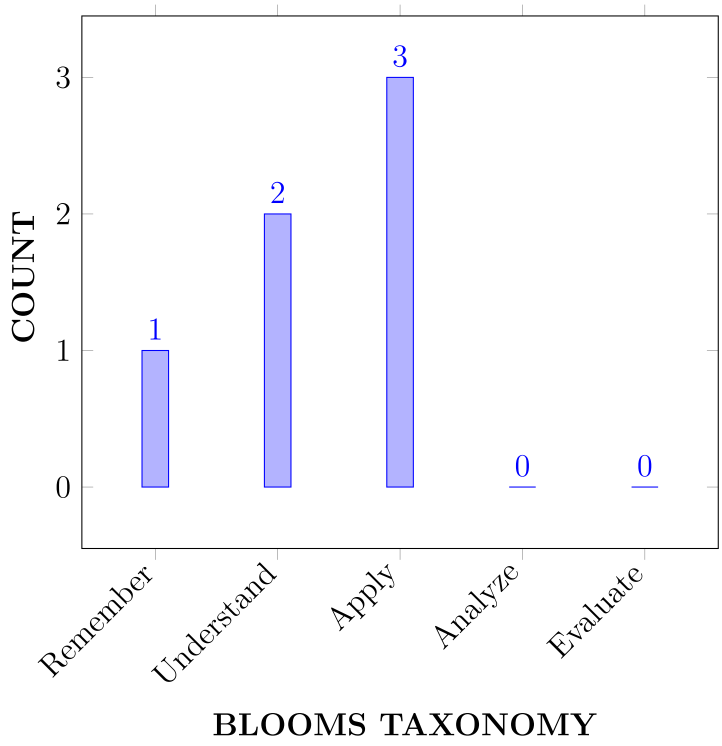
I	The representation, classification and analysis of continuous, discrete time signals in time and frequency domains.
II	The Fourier transform, Laplace and Z- transforms and their properties to analyze the signals and systems
III	The temporal and spectral characteristics of Random process and the extraction of Signal from noise by filtering.
IV	The sampling, quantization and reconstruction requirements for digital signal processing applications

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Describe** the concept of signals and signal properties for performing mathematical operations on signals.	Understand
CO 2	**Make use of** Fourier series and Fourier transforms for calculating spectral characteristics of periodic and aperiodic signals.	Apply
CO 3	**Utilize** the concept of convolution and correlation to determine the response of an LTI system.	Apply
CO 4	**Classify** the ideal lowpass,high pass,bandpass,ban stop filters for obtaining the behaviour of linear time invarinat system.	Remember
CO 5	**Apply** the Laplace and Z-transforms . for analysing the frequency domain representation of continuous and discrete time signals and systems respectively	Apply
CO 6	**Demonstrate** the procedure for sampling and reconstruction of bandlimited signals by using various sampling techniques.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO 3	**Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE / CIE / AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	SEE / CIE / AAT
PO 3	**Design/Development of Solutions:**Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	SEE / CIE / AAT
PO 5	**Conduct Investigations of Complex Problems:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	2	Lab related Exercises

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	2	Seminars

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	✓	-		-	-	-
CO 2	-	✓	-	-	✓	-	-	-	-	✓	-	-	✓	-	-
CO 3	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 4	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 5	-	✓	✓	-	✓	-	-	-	-	✓	-		✓	-	-
CO 6	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Classify (knowledge)** basic concepts of signals such as exponential, sinusoidal, impulse, unit step and signum for performing mathematical operations on signals **mathematical operations on signals** by applying the **principles of science for engineering problems.**	2
	PO 2	**Understand** the given **problem statement** and **formulate** the orthogonal signals from the vector algebra using **principles of mathematics and engineering science.**	4
	PO 10	Demonstrate the ablility to communicate effectively in **writing** design documentation and make effective presentation	1
CO 2	PO 2	**Understand** the given **problem statement** and **identification** of the Fourier transform and apply the **problem formulation**of spectral characteristics of continuous time aperiodic signals and **design** the frequency response of the given system.	4
	PO 5	**Develop** the Fourier transform of magnitude and phase using **Modern tools and analyze to complex engineering problems.**	1
	PO 10	Demonstrate the ablility to communicate effectively in **writing** design documentation and make effective presentation	1
	PSO 1	**Develop** the capability to **analyze** the Fourier transform properties of continuous time signals by **implementing** the frequency response.	2

Course Outcomes	**PO'S PSO'S**	**Justification for mapping (Students will be able to)**	**No. of Key competencies matched.**
CO 3	PO 1	**Extend** (knowledge, understand, apply) the linearity and time invariance concepts to linear time invariant system for **analyzing** the behavior of LTI system in both time and frequency domains by applying the **principles of mathematics** and **science for engineering problems.**	3
	PO 2	**Demonstrate** and **develop** the given problem statement, **identification** and **formulate** to **design** simple LTI system in both time and frequency domains. 5	2
	PO 10	Demonstrate the ablility to communicate effectively in **writing** design documentation and make effective presentation	1
CO 4	PO 2	**Understand** the given **problem statement and formulate** the (Complex) engineering problems of continuous time and discrete time systems such as Laplace and Z transform from the provided information and data.	2
	PO 5	**Design** various transform techniques like Laplace and Z transform using **modern tools** such as MATLAB software	1
	PO 10	Demonstrate the ablility to communicate effectively in **writing** design documentation and make effective presentation	1
	PSO 1	**Develop** the capability to **analyze** the continuous time and discrete signals by **implementing** the Region of convergence.	2
CO 5	PO 1	**Understand** the sampling theorem for band limited and bandpass signals and reconstruction of samples by filtering methods by applying the the **principles of mathematics** and science for **engineering problems**.	2
	PO 10	Demonstrate the ablility to communicate effectively in **writing** design documentation and make effective presentation	1
CO 6	PO 1	**Understand** the sampling theorem for band limited and bandpass signals and reconstruction of samples by filtering methods by applying the the **principles of mathematics** and science for **engineering problems**.	2
	PO 10	Demonstrate the ablility to communicate effectively in **writing** design documentation and make effective presentation	1

Note: For Key Attributes refer **Annexure - I**

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	Program Outcomes												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	2	4	-	-	-	-	-	-	-	1	-		-	-	-
CO 2	-	4	-	-	1	-	-	-	-	1	-	-	2	-	-
CO 3	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 5	-	2	2	-	1	-	-	-	-	1	-		2	-	-
CO 6	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	Program Outcomes												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	66.7	40	-	-	-	-	-	-	-	10	-		-	-	-
CO 2	-	40	-	-	20	-	-	-	-	10	-	-	100	-	-
CO 3	100	40	-	-	-	-	-	-	-	10	-	-	-	-	-
CO 4	66.7	-	-	-	-	-	-	-	-	10	-	-	-	-	-
CO 5	-	40	40	-	100	-	-	-	-	10	-		100	-	-
CO 6	40	-	-	-	-	-	-	-	-	10	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq$ C$\leq$ 5% – No correlation

1 -5 <C$\leq$ 40% – Low/ Slight

2 - 40 % <C < 60% –Moderate

3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	Program Outcomes												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	-	-	-	-	-	-	1	-	-	-	-	
CO 2	-	2	-	-	1	-	-	-	-	1	-	-	3	-	-
CO 3	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 5	-	2	2	-	3	-	-	-	-	1	-	-	3	-	-
CO 6	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-
TOTAL	8	8	2	-	4	-	-	-	-	6	-	-	6	-	-
AVERAGE	2.6	2	2	-	2	-	-	-	-	1	-	-	2	-	-

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	-	Tech - Talk	✓	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	✓	Open Ended Experiments	✓
Micro Projects	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**SIGNAL ANALYSIS**
	Signal Analysis: Analogy between Vectors and Signals, Orthogonal Signal Space, Signal approximation using Orthogonal functions, Mean Square Error, Closed or complete set of Orthogonal functions, Orthogonally in Complex functions, Exponential and Sinusoidal signals, Concepts of Impulse function, Unit Step function, Signum function.
MODULE II	**FOURIER SERIES**
	Representation of Fourier series, Continuous time periodic signals, Properties of Fourier Series, Dirichlet's conditions, Trigonometric Fourier Series and Exponential Fourier Series, Complex Fourier spectrum. **Fourier Transforms:** Deriving Fourier Transform from Fourier series, Fourier Transform of arbitrary signal, Fourier Transform of standard signals, Fourier Transform of Periodic Signals, Properties of Fourier Transform, Fourier Transform involving Impulse function and Signum function, Introduction to Hilbert Transforms.
MODULE III	**SIGNAL TRANSMISSION THROUGH LINEAR SYSTEMS**
	Linear System, Impulse response, Response of a Linear System, Linear Time Invariant (LTI) System, Linear Time Variant (LTV) System, Transfer function of a LTI System, Filter characteristic of Linear System, Distortion less transmission through a system, Signal bandwidth, System Bandwidth, Ideal LPF, HPF, and BPF characteristics. Causality and Paley-Wiener criterion for physical realization, Relationship between Bandwidth and rise time, Convolution and Correlation of Signals, Concept of convolution in Time domain and Frequency domain, Graphical representation of Convolution.

MODULE IV	**LAPLACE TRANSFORM AND Z-TRANSFORM**
	Laplace Transforms: Laplace Transforms (L.T), Inverse Laplace Transform, Concept of Region of Convergence (ROC) for Laplace Transforms, Properties of L.T, Relation between L.T and F.T of a signal, Laplace Transform of certain signals using waveform synthesis. Z–Transforms: Concept of Z-Transform of a Discrete Sequence, Distinction between Laplace, Fourier and Z Transforms, Region of Convergence in Z-Transform, Constraints on ROC for various classes of signals, Inverse Z-transform, Properties of Z-transforms
MODULE V	**SAMPLING THEOREM**
	Graphical and analytical proof for Band Limited Signals, Impulse Sampling, Natural and Flat top Sampling, Reconstruction of signal from its samples, Effect of under sampling – Aliasing, Introduction to Band Pass Sampling. Correlation: Cross Correlation and Auto Correlation of Functions, Properties of Correlation Functions, Energy Density Spectrum, Parseval's Theorem, Power Density Spectrum, Relation between Autocorrelation Function and Energy/Power Spectral Density Function, Relation between Convolution and Correlation, Detection of Periodic Signals in the presence of Noise by Correlation, Extraction of Signal from Noise by filtering

TEXTBOOKS

1. Signals, Systems Communications, B.P. Lathi, BS Publications, 2009.
2. Signals and Systems, A.V. Oppenheim, A.S. Willsky and S.H. Nawab ,PHI, 2nd Edition 2009.
3. Digital Signal Processing, Principles, Algorithms, and Applications, John G. Proakis, Dimitris G. Manolakis, Pearson Education / PHI. 2007.

REFERENCE BOOKS:

1. Signals and Systems, Simon Haykin and Van Veen, Wiley, 2nd Edition, 2009.
2. Signals and Signals, Iyer and K. Satya Prasad, Cengage Learning, 2 nd Edition, 2009.
3. Discrete Time Signal Processing, A. V. Oppenheim and R.W. Schaffer, PHI, 2009.
4. Fundamentals of Digital Signal Processing, Loney Ludeman. John Wiley, PHI, 2009.

WEB REFERENCES:

1. https://nptel.ac.in/courses/117/101/117101055/

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
0	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	CO 1	T1:4.1

CONTENT DELIVERY (THEORY)			
1	Introduction to signals and systems	CO 1	T1:4.2
2	Concepts of Impulse function, Unit Step function, Signum function, in continuous time	CO 1	T1: 5.1
3	Concepts of Impulse function, Unit Step function, Signum function, in continuous time	CO 1	R3: 1.7
4	Analogy between Vectors and Signals.	CO 2	T1: 6.1-6.6
5	Orthogonal Signal Space, Signal approximation using Orthogonal functions.	CO 2	T1: 6.1-6.6
6	Mean Square Error.	CO 2	T1: 6.1-6.6
7	Closed or complete set of Orthogonal functions.	CO 2	T1: 6.1-6.6
11	Orthogonally in Complex functions	CO 3	T1: 7.5
12	Continuous time periodic signals.	CO 3	T1: 7.7-7.12
13	Continuous time periodic signals.	CO 3	T1: 7.8
14	Dirichlet's conditions, Trigonometric Fourier Series	CO 4	T1: 10.2
15	Exponential Fourier Series, Complex Fourier spectrum.	CO 4	T1:7.7
16	Deriving Fourier Transform from Fourier series, Fourier Transform of arbitrary signal..	CO 5	T1: 7.8-7.10
17	Fourier Transform of Periodic Signals, Properties of Fourier Transform	CO 5	T1: 7.12
20	Linear System, Impulse response, Response of a Linear System, Linear Time Invariant (LTI) System, Linear Time Variant (LTV) System.	CO 7	R4: 4.2
21	Transfer function of a LTI System, Filter characteristic of Linear System, Distortion less transmission through a system .	CO 7	R4: 4.2
22	Signal bandwidth, System Bandwidth,	CO 8	T1: 10.4
23	Ideal LPF, HPF, and BPF characteristics.	CO 8	T1: 10.5
26	Causality and Paley-Wiener criterion for physical realization,	CO 9	T3: 1.5
27	Relationship between Bandwidth and rise time.	CO 9	T3: 1.6
28	Convolution and Correlation of Signals	CO 6	T3: 1.7
29	Concept of convolution in Time domain and Frequency domain, Graphical representation of Convolution	CO 9	T3:1.8
33	Laplace Transforms (L.T Inverse Laplace Transform,	CO 10	T3: 2.7 R3: 4.4
34	Concept of Region of Convergence (ROC) for Laplace Transforms.	CO 10	T3: 2.8 R3: 4.4
35	Properties of L.T, Relation between L.T and F.T of a signal	CO 10	T3: 2.7 R3: 4.4
36	Laplace Transform of certain signals using waveform synthesis.	CO 10	T3: 2.8 R3: 4.4
37	Concept of Z- Transform of a Discrete Sequence.	CO 11	T3: 8.9

38	Distinction between Laplace, Fourier and Z Transforms.	CO 10	T3: 2.7 R3: 4.4
39	Region of Convergence in Z-Transform,	CO 10	T3: 2.8 R3: 4.4
40	Constraints on ROC for various classes of signals, Inverse Z-transform.	CO 11	T3: 8.9
41	Properties of Z-transforms	CO 10	T3: 2.7 R3: 4.4
45	Graphical and analytical proof for Band Limited Signals, Impulse Sampling	CO 11	T3: 8.12-8.13
46	Natural and Flat top Sampling.	CO 11	T3: 9.1-9.2
47	Reconstruction of signal from its samples, Effect of under sampling – Aliasing, Introduction to Band Pass Sampling.	CO 11	T3: 9.3.
48	Cross Correlation and Auto Correlation of Functions, Properties of Correlation Functions	CO 11	T3: 8.12-8.13
49	Energy Density Spectrum, Parseval's Theorem, Power Density Spectrum	CO 11	T3: 9.1-9.2
50	Relation between Autocorrelation Function and Energy/Power Spectral Density Function,	CO 11	T3: 9.3.
51	Relation between Convolution and Correlation.	CO 11	T3: 8.12-8.13
52	Detection of Periodic Signals in the presence of Noise by Correlation, Extraction of Signal from Noise by filtering	CO 11	T3: 9.1-9.2
PROBLEM SOLVING/ CASE STUDIES			
9	Concepts of Impulse function, Unit Step function, Signum function, in continuous time	CO 1	T1: 5.1
10	Orthogonal Signal Space, Signal approximation using Orthogonal functions, Mean Square Error.	CO 1	R3: 1.7
18	Exponential Fourier Series, Complex Fourier spectrum.	CO 2	T1: 6.1-6.6
19	Fourier Transform of Periodic Signals, Properties of Fourier Transform	CO 2	T1: 6.1-6.6
30	Linear System, Impulse response, Response of a Linear System, Linear Time Invariant (LTI) System, Linear Time Variant (LTV) System.	CO 3	T1: 7.7-7.12
31	Signal bandwidth, System Bandwidth, Ideal LPF, HPF, and BPF characteristics.	CO 4	T1: 7.7-7.12
32	Convolution and Correlation of Signals, Concept of convolution in Time domain and Frequency domain, Graphical representation of Convolution	CO 5	T1: 7.7-7.12
42	Properties of L.T, Relation between L.T and F.T of a signal, Laplace Transform of certain signals using waveform synthesis.	CO 5	T1: 7.7-7.12
43	Laplace Transforms (L.T), Inverse Laplace Transform, Concept of Region of Convergence (ROC) for Laplace Transforms.	CO 6	T3: 1.7

44	Region of Convergence in Z-Transform, Constraints on ROC for various classes of signals, Inverse Z-transform, Properties of Z-transforms.	CO 6	T3: 1.7
51	Cross Correlation and Auto Correlation of Functions, Properties of Correlation Functions	CO 7	R4: 4.2
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Signal analysis	CO 1	T1:4.1
57	Fourier series and Fourier transform	CO 2	T2:4.1
58	signal transmission through linear systems	CO 3	T3:2.1
59	Laplace and Z transform	CO 4	R4: 4.2
60	sampling theorem and reconstruction of filters	CO 5	T2:6.1
DISCUSSION OF QUESTION BANK			
61	Derive the expression for component vector of approximating the function f1(t) over f2(t) and also prove that the component vector becomes zero if the f1(t) and f2(t) are orthogonal.	CO 1	T1:4.1
62	Find the Fourier transform of the signal x(t) = 5cos 5t+10 sin 15t and sketch its magnitude and phase spectra.	CO 2	T2:4.1
63	Compute the output y(t) for a continuous LTI system whose impulse response h(t) and the input x(t) are given by h(t)= e-at u(t) and x(t)= eat u(-t).	CO 3	T3:2.1
64	Determine the initial value and final value of Laplace transform of signal	CO 4	R4: 4.2
65	A filter has an input x(t)= u(t) and transfer function, H(w)=1/(1+jw). Find the ESD of the output?	CO 5	T2:6.1

Signature of Course Coordinator **HOD,ECE**
Ms.V.Bindusree,Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	**10**

PO 4.	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**

PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project. 6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	**12**
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**

PO11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Electronics and Communication Engineering**				
Course Title	**Digital System Design**				
Course Code	AECC03				
Program	B.Tech				
Semester	III				
Course Type	Core				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	S SUSHMA, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	**Course Code**	**Semester**	**Prerequisites**
B.Tech	AEE002	II	Electrical circuits

II COURSE OVERVIEW:

This course introduces the fundamental concepts and basic building blocks of digital circuits. It focuses on number sytems , designing of optimized combinational and sequential circuits, memories, programmable logic devices and the key concepts of hardware description language(VHDL). The applications includes in the area of VLSI design, microprocessors, microcontrollers and embedded systems.

III MARKS DISTRIBUTION:

Subject	**SEE Examination**	**CIE Examination**	**Total Marks**
Digital System Design	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentation	x	Chalk & Talk	X	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
50%	Understand
50%	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	-

VI COURSE OBJECTIVES:

The students will try to learn:

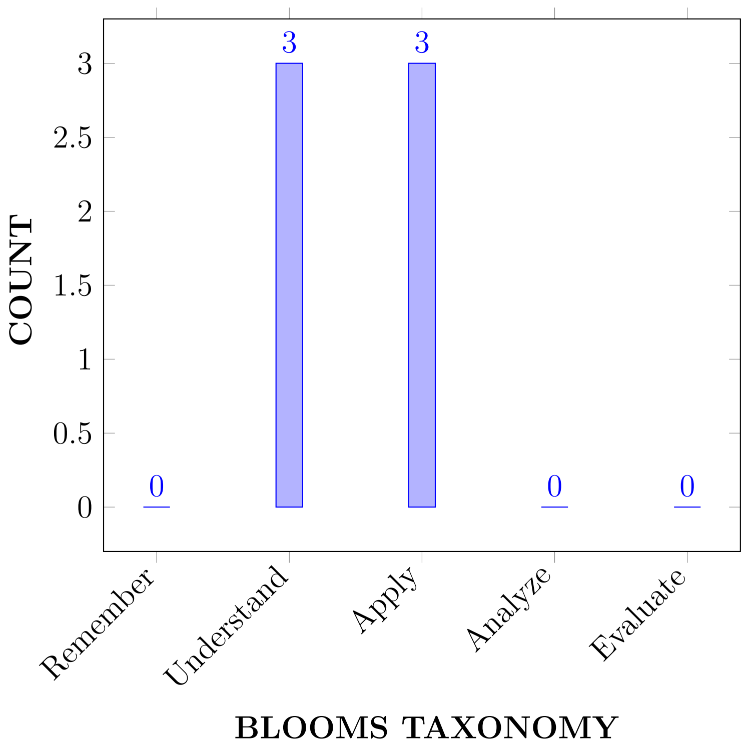
I	Simplification of the logic functions using boolean algebraic theorems and techniques.
II	Implementation of conventional combinational and sequential circuits.
III	The exploration of the logic families and semiconductor memories.
IV	The realization of the micro and macro circuits using VHDL programming.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Outline** binary arithmetic operations and optimize boolean functions using karnaugh and tabulation method.	Understand
CO 2	**Make use of** basic logic gates to realize the combinational logic circuits used in conventional electronic circuits	Apply
CO 3	**Interpret** the knowledge of flip-flops and latches in synchronous and asynchronous modules for memory storing applications.	Understand
CO 4	**Develop** Mealy/Moore models and state diagrams for the complex sequential circuit applications.	Apply
CO 5	**Identify** the different logic families, memories and programmable logic devices for understanding the architectural blocks of FPGA	Apply
CO 6	**Demonstrate** the different modelling styles and data types in VHDL for implementing combinational and sequential circuits.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO 3	**Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE / CIE / AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	3	SEE / CIE / AAT
PO 3	**Design / development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	SEE / CIE / AAT
PO 4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	SEE / CIE / AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions..	1	SEE / CIE / AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	-	-
PSO 2	Focus on the practical experience of ASIC prototype designs, virtual instrumentation and SoC designs.	2	SEE / CIE / AAT

PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	✓	-		-	-	-
CO 2	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-
CO 3	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-
CO 4	✓	✓	✓	✓	-	-	-	-	-	✓	-	-	-	✓	-
CO 5	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	✓	-
CO 6	✓	✓	✓	✓	-	-	-	-	-	✓	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Understand the number systems, Boolean operations, code conversion code by applying its **own engineering discipline, science principles and methodology.**	2
	PO 2	Understand the given **problem statement** and **formulate** the design (complex) engineering problems in detecting and correcting errors in the received data in **reaching substantiated conclusions by the interpretation of results.**	4
	PO 10	Understand the given **problem statement** and **communicate** the novel implementation to get it **published in the scientific community.**	1
CO 2	PO 1	Demonstrate the design procedures of various adder circuits with **own engineering discipline, science principles and methodology.**	2
	PO 2	Understand the given **problem statement** and **formulate** the (complex) engineering problems on adder circuit design **translate the information** into the model using type of adder from the provided **information and data, develop solutions** based on the functionality of the circuit, **validate** the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	7

	PO 3	**Understand the customer needs, use creativity and manage design process** in realization of combinational circuits using logic gates and **evaluate outcomes.**	3
	PO 10	Understand the given **problem statement** and **communicate** the novel implementation to get it **published in the scientific community.**	1
CO 3	PO 1	Apply the **knowledge** of flipflops and latches (**engineering fundamentals**) to understand synchronous and asynchrnous sequential circuits(**own engineering discipline, mathematical and science principles and methodology.**) to design registers,counters and memory applications.	3
	PO 2	Understand the given **problem statement** and **formulate** the (complex) engineering problems on adder circuit design **translate the information** into the model using type of adder from the provided **information and data**, develop solutions based on the functionality of the circuit, **validate** the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	6
	PO 3	**Understand the customer needs, investigate and define a problem, use creativity** and **establish innovative solutions** in designing the sequential circuits using flipflops and latches	4
	PO 10	Understand the given **problem statement** and **communicate** the novel implementation to get it **published in the scientific community.**	1
CO 4	PO 1	Understand the mealy and moore machines (**engineering knowledge**) for **complex sequential sircuits** used in pulse train generator, psuedo random binary sequence genrator and clock generation.(**own engineering discipline, mathematical and science principles and methodology.**)	3
	PO 2	Understand the given **problem statement** and **formulate** the (complex) engineering problems on adder circuit design **translate the information** into the model using type of FSM from the provided **information and data**, develop solutions based on the functionality of the sequential circuit, **validate** the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	7
	PO 3	Design the FSM using mealy/moore models (**understand the customer needs, investigate and define a problem, use creativity** and **establish innovative solutions**) for complex sequential circuits like clock generation, psuedo random generator etc	5

	PO 4	Implement (**complex sequential apllications** psuedo random generator, clock generator and pulse train generator **using mealy/moore FSMs**	2
	PO 10	Understand the given **problem statement** and **communicate** the novel implementation to get it **published in the scientific community.**	1
	PSO 2	**Design ASIC prototypes** by **adopting engineering professional code in VHDL** for the implementation of FSM to **familiarize with the ASIC design flow**, **realize RTL schematic** and **analyze the synthesis of SOC**	5
CO 5	PO 1	Explore the concept of logic families, memories, programmable logic devices for understanding architectural blocks of FPGA using the **own engineering discipline, science principles and methodology.**	2
	PO 2	Understand the given **problem statement** and **formulate** the (complex) engineering problems on PLDs and logic families **translate the information** into the model using type of PLDs from the provided **information and data**, develop solutions based on the functionality of the circuit, **validate** the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	7
	PO 3	**Understand the customer needs, investigate and define a problem, use creativity** and **establish innovative solutions** in designing PLDs and FPGA	3
	PO 10	Understand the given **problem statement** and **communicate** the novel implementation to get it **published in the scientific community.**	1
	PSO 2	**Design ASIC prototypes** by **adopting engineering professional code in VHDL** for the implementation of real time applications to **familiarize with the ASIC design flow**, **realize RTL schematic** and **analyze the synthesis of SOC**	5

CO 6	PO 1	Understand data types and objects, dataflow, behavioral and structural modeling for realizing the hardware modeling of the sequential, combinational blocks using the **own engineering discipline, Science principles and methodology.**	2
	PO 2	Understand the given **problem statement** and **formulate** the design (complex) engineering problems of digital logic design, **translate the information** into hardware circuit programming from provided **information and data, develop solutions** based on the simulation result, **validate** the results **reaching substantiated conclusions** by the **interpretation of results.**	7
	PO 3	**Develop** digital system design **based on customer needs for design of** combinational, sequential circuits to **establish innovative solutions**and **evaluate outcomes of the designs.**	5
	PO 4	Use the knowledge of VHDL design **laboratory skills**to combinational and sequential circuits and analyze the output to **synthesis of the information to provide valid conclusions** to design complex digital circuits.	2
	PO 10	Understand the given **problem statement** and **communicate** the novel implementation to get it **published in the scientific community.**	1

Note: For Key Attributes refer **Annexure - I**

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	2	4	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	2	7	3	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	3	6	4	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	2	7	5	2	-	-	-	-	-	1	-	-	-	5	-
CO 5	2	7	3	-	-	-	-	-	-	1	-	-	-	5	-
CO 6	2	7	5	2	-	-	-	-	-	1	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	67	40	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 2	67	70	30	-	-	-	-	-	-	20	-	-	-	-	-
CO 3	100	60	50	-	-	-	-	-	-	20	-	-	-	-	-
CO 4	67	70	50	18	-	-	-	-	-	20	-	-	-	45.5	-
CO 5	67	70	30	-	-	-	-	-	-	20	-	-	-	45.5	-
CO 6	67	70	50	18	-	-	-	-	-	20	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 - $0 \leq C \leq 5\%$ – No correlation
1 - $5 < C \leq 40\%$ – Low/ Slight
2 - $40\ \% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	3	1	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	3	3	2	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	3	2	1	-	-	-	-	-	1	-	-	-	2	-
CO 5	3	3	1	-	-	-	-	-	-	1	-	-	-	2	-
CO 6	3	2	2	1	-	-	-	-	-	1	-	-	-	-	-
TOTAL	18	16	8	2	0	0	0	0	0	6	0	0	0	4	0
AVERAGE	**3**	**2.7**	**1.6**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**2**	**0**

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	-
Quiz	-	Tech - Talk	-	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	✓	Open Ended Experiments	✓
Micro Projects	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**LOGIC SIMPLIFICATION AND COMBINATIONAL LOGICDESIGN**
	Review of boolean algebra and De Morgan's theorem, SOP & POS forms, canonical forms, karnaughmaps up to 6 variables, binary codes, code conversion.
MODULE II	**MSI DEVICES**
	MSI devices like comparators, multiplexers, encoder, decoder, driver & multiplexed display, half and full adders, subtractors, serial and parallel adders, BCD adder, barrel shifter and ALU
MODULE III	**SEQUENTIAL LOGIC DESIGN**
	Building blocks like S-R, JK and Master-Slave JK FF, edge triggered FF, ripple and synchronous counters, shift registers. Finite state machines, design of synchronous FSM, algorithmic state machines charts. Designing synchronous circuits like pulse train generator, pseudo random binary sequence generator, clock generation
MODULE IV	**LOGIC FAMILIES AND SEMICONDUCTOR MEMORIES**
	TTL NAND gate, specifications, noise margin, propagation delay, fan-in, fan-out, tristate TTL, ECL, CMOS families and their interfacing, memory elements, concept of programmable logic devices like FPGA. Logic implementation using programmable devices.
MODULE V	**VLSI DESIGN FLOW**
	Design entry: schematic, FSM & HDL, different modeling styles in VHDL, data types and objects, dataflow, behavioral and structural modeling, synthesis and simulation VHDL constructs and codes for combinational and sequential circuits.

TEXTBOOKS

1. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th Edition, 2009.
2. Douglas Perry, "VHDL", Tata McGraw Hill, 4th Edition, 2002.
3. W.H. Gothmann, "Digital Electronics- An introduction to theory and practice", PHI, 2nd Edition,2006.

REFERENCE BOOKS:

1. D.V. Hall, "Digital Circuits and Systems", Tata McGraw Hill, 1989.
2. Charles Roth, "Digital System Design using VHDL", Tata McGraw Hill 2nd Edition 2012.

WEB REFERENCES:

1. http://www.igniteengineers.com

2. http://www.ocw.nthu.edu.tw
3. http://www.uotechnology.edu.iq

COURSE WEB PAGE:

1. lms.iare.ac.in/index?route=course/details&course_id=406

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
0	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	-
CONTENT DELIVERY (THEORY)			
1	Introduction to number systems	CO 1	T1:1.1 to 1.5 R1:3.1 to 3.5
2	Base conversion methods	CO 1	T1:2.1 to 2.6 R2:2.8 to 3.5
CONTENT DELIVERY (THEORY)			
3	Complements of numbers	CO 1	T1:4.1 to 4.9 R2:2.1 to 2.4
4	Codes- binary codes	CO 1	T1:6.1 to 6.5 R2:7.1 to 7.7
5	BCD code and its properties	CO 1	T1:8.1 to 8.4 R2:4.1 to 4.8
6	Unit distance code	CO 1	T1:8.8 to 8.9 R2:3.3 to 3.7
7	Alphanumeric codes	CO 1	T2:3.1 to 3.2 R2: 2.7 to 2.9
8	Error detecting and correcting codes	CO 1	T2:4.1 to 4.9
9	Basic theorems and its properties	CO 1	T2:5.1 to 5.2 R1:3.1 to 3.5
10	Switching functions	CO 1	T2:5.3 to 5.5 R2:5.1 to 5.8
11	Canonical form	CO 1	T2:3.1 to 3.5 R1:2.1 to 2.5
12	Standard form	CO 1	T2:3.1 to 3.6 R2:2.8 to 3.5
13	Algebraic simplification of digital logic gates	CO 1	T2:4.1 to 4.9 R2:2.1 to 2.4
14	Properties of XOR gates	CO 1	T2:6.1 to 6.5 R2:7.1 to 7.7

15	Universal gates	CO 2	T2:7.1 to 7.4 R2:4.1 to 4.8
16	Multilevel NAND/NOR realizations	CO 2	T2:7.8 to 7.9 R2:3.3 to 3.7
17	Combinational design	CO 2	T3:3.1 to 3.2 R2: 2.7 to 2.9
18	Arithmetic circuits- adders	CO 2	T3:4.1 to 4.8
19	Subtractors	CO 2	T3:5.1 to 5.2 R1:3.1 to 3.5
20	Serial adder	CO 2	T3:5.3 to 5.5 R2:5.1 to 5.8
21	1's complement subtractor	CO 2	T3:6.1 to 6.5 R1:3.1 to 3.5
22	2's complement subtractor	CO 2	T3:6.6 to 6.8 R2:2.8 to 3.5
23	Combinational and sequential circuits	CO 2	T3:6.9 to 6.10 R2:2.1 to 2.4
24	The binary cell	CO 3	T3:7.1 to 7.5 R2:7.1 to 7.7
25	The fundamentals of sequential machine operation	CO 3	T3:7.6 to 7.7 R2:4.1 to 4.8
26	Flip-flop	CO 3	T3:7.8 to 7.10 R2:3.3 to 3.7
27	D-Latch Flip-flop	CO 3	T3:7.11 to 7.12 R2: 2.7 to 2.9
28	Clocked T Flip-flop	CO 3	T1:4.1 to 4.9
29	Clocked JK flip-flop	CO 4	T1:5.1 to 5.2 R1:3.1 to 3.5
30	Design of a clocked flip-flop conversion from one type of flip-flop to another	CO 4	T1:5.3 to 5.5 R2:5.1 to 5.8
31	Registers and counters	CO 4	T1:1.1 to 1.5 R1:3.1 to 3.5
32	Analyze TTL NAND gate, specifications	CO 4	T1:2.1 to 2.6 R2:2.8 to 3.5
33	Noise margin, propagation delay	CO 5	T1:4.1 to 4.9 R2:2.1 to 2.4
34	Fan-in, fan-out	CO 5	T1:6.1 to 6.5 R2:7.1 to 7.7
35	Implement tristate TTL, ECL.	CO 5	T2:5.1 to 5.4 R2:4.1 to 4.8
36	CMOS families and their interfacing, memory elements	CO 6	T1:2.8 R2:3.3 to 3.7
37	Understand concept of programmable logic devices like FPGA	CO 6	T3:3.7 to 3.8 R2: 2.7 to 2.9

38	Logic implementation using programmable devices	CO 6	T3:4.1 to 4.9
39	Design entry: Schematic, FSM & HDL, different modeling styles in VHDL	CO 6	T3:5.1 to 5.2 R1:3.1 to 3.5
40	Understand data types and objects, dataflow, behavioral and structural modeling	CO 6	T3:5.3 to 5.5 R2:5.1 to 5.8
PROBLEM SOLVING/ CASE STUDIES			
41	Multilevel NAND/NOR realizations	CO 1	T1:1.1 to 1.5 R1:3.1 to 3.5
42	Combinational design	CO 1	T1:2.1 to 2.6 R2:2.8 to 3.5
43	Arithmetic circuits-adders	CO 1	T1:4.1 to 4.9 R2:2.1 to 2.4
44	1's complement subtractor	CO 2	T1:6.1 to 6.5 R2:7.1 to 7.7
45	2's complement subtractor	CO 2	T2:5.1 to 5.4 R2:4.1 to 4.8
46	Combinational and sequential circuits	CO 3	T1:2.8 to 2.9 R2:3.3 to 3.7
47	Clocked T Flip-flop	CO 3	T3:3.7 to 3.8 R2: 2.7 to 2.9
48	Clocked JK flip-flop	CO 4	T1:4.1 to 4.9
49	Design of a clocked flip-flop conversion	CO 4	T1:5.1 to 5.2 R1:3.1 to 3.5
50	Registers and counters	CO 5	T1:5.3 to 5.5 R2:5.1 to 5.8
51	Analyze TTL NAND gate, specifications	CO 5	T1:1.1 to 1.5 R1:3.1 to 3.5
52	Implement tristate TTL, ECL	CO 5	T1:2.1 to 2.6 R2:2.8 to 3.5
53	CMOS families, memory elements	CO 6	T1:4.1 to 4.9 R2:2.1 to 2.4
54	Programmable logic devices.	CO 6	T1:6.1 to 6.5 R2:7.1 to 7.7
55	Schematic, FSM & HDL, different modeling styles in VHDL.	CO 6	T2:5.1 to 5.4 R2:4.1 to 4.8
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Universal gates	CO 1	T1:1.1 to 1.5 R1:3.1 to 3.5
57	Multilevel NAND/NOR realizations	CO 2	T1:2.1 to 2.6 R2:2.8 to 3.5
58	Combinational design	CO 4	T1:4.1 to 4.9 R2:2.1 to 2.4
59	Arithmetic circuits-adders	CO 5	T1:6.1 to 6.5 R2:7.1 to 7.7

60	Logic implementation using programmable devices	CO 6	T2:5.1 to 5.4 R2:4.1 to 4.8
DISCUSSION OF QUESTION BANK			
61	Design of a clocked flip-flop conversion	CO 1	T1:1.1 to 1.5 R1:3.1 to 3.5
62	Registers and counters	CO 2	T1:2.1 to 2.6 R2:2.8 to 3.5
63	Analyze TTL NAND gate, specifications	CO 3	T1:4.1 to 4.9 R2:2.1 to 2.4
64	Implement tristate TTL, ECL.	CO 4	T1:6.1 to 6.5 R2:7.1 to 7.7
65	CMOS families, memory elements	CO 5	T2:5.1 to 5.4 R2:4.1 to 4.8

Course Coordinator **HOD, ECE**
S SUSHMA, Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**

	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**

	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

ANNEXURE - II

Key Competencies for Assessing Program Specific Outcomes

PSO Number	NBA Statement / NBA statement / Vital features	No. of vitalfeatures
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications. 1. Analyze and solve real time problems in Robotics. 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications. 3. Develop embedded systems modules using Real Time Operating System. 4.Undertake research and development projects in the field of Embedded Systems. 5. Adopt the engineering professional code and conduct.	5

PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs. 1. Inspect, survey and analyze types of ASIC chip designs. 2. Design ASIC prototypes using Verilog and VHDL languages. 3. Analyze microprocessor subsystems with memories and I/O inter- facs for SOC designs 4. Explore hardware components for designig SOC 5.Adopt the engineering professional code and conduct 6. Designing prototypes of SOC using programming tools like MAT- LAB, LabVIEW. 7. Familiarize with the design flow of ASIC prototypes. 8. Realize SOC using Register-Transfer-Level designs 9. Analyse and develop models for system level descriptions for syn- thesis of SOC. 10.Inspect and survey the abstractions and principles for the specifi- cation, simulation, verification, and synthesis of systems on chip (SoC). 11.Programming and hands-on skills to meet requirements of global environment.	**11**
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications. 1. Explicit software and programming tools for antenna design. 2. Adopt technical library resources and literature search. 3.Explore smart antennas. 4. Model, program for operation and control of smart antennas for wireless communication applications. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Electronics and Communication Engineering**				
Course Title	**Probability Theory and Stochastic Process**				
Course Code	AECC04				
Program	B.Tech				
Semester	III				
Course Type	Foundation				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mrs G.Mary swarna latha, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSC07	II	Mathematical Transform Techniques

II COURSE OVERVIEW:

Stochastic processes are mathematical objects defined on probability space. The study of these processes is of primary importance in all science and engineering specializations. This course comprises two parts. The first part introduces the fundamental principles of probability theory and random variables necessary to understand the stochastic processes. The second part introduces the basic concepts of random processes, random signals, and their interaction with the electrical or electronic systems. The course forms the basis for the next level courses of an electronics engineer such as communications,digital signal processing, radar systems,machine learning and data science.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Probability Theory and Stochastic Process	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five modules and each module carries equal weightage

in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
58%	Understand
27%	Apply
15 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	-

VI COURSE OBJECTIVES:

The students will try to learn:

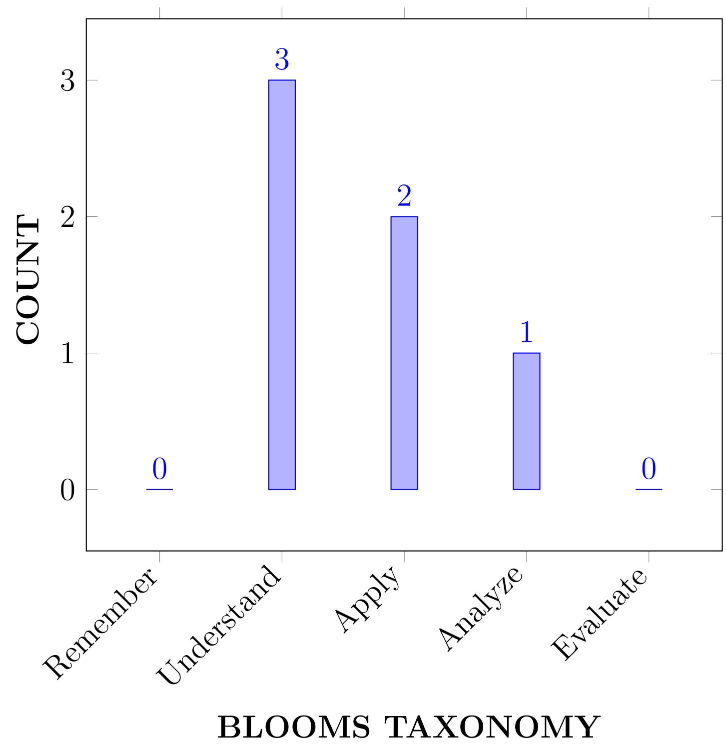
I	The fundamental concepts of the 1-dimensional and 2-dimensional random variables and their characterization in probability space.
II	The stationary random process, its framework and application for analyzing random signals and noises.
III	The characteristics of 1-dimensional stationary random signals in time and frequency domains.
IV	Analysis of the response of a linear time invariant (LTI) system driven by 1-dimensional stationary random signals useful for subsequent design and analysis of communication systems.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Infer** the concepts of the random experiment and probability for proving the Bayes theorem , computing complex event probabilities and independence of multiple events.	Understand
CO 2	**Interpret** the concept of random variable, the probability distribution function, probability density function and operations on single random variable to derive the moments.	Understand
CO 3	**Utilize** the joint distribution and density function for operations on multiple random variables.	Apply
CO 4	**Extend** the random variable concept to random process and its sample functions for demonstrating the time domain and frequency domain characteristics.	Understand
CO 5	**Develop** the auto-power and cross- power spectral densities to solve the related problems of random processes using correlation functions and the Fourier transform.	Apply
CO 6	**Analyze** the response of a linear time invariant (LTI) system driven by stationary random processes using the time domain and frequency domain description of random processes.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE/CIE/Quiz
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	SEE/CIE/Quiz
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	SEE/CIE/Quiz
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	SEE/CIE/Quiz

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	1	AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	✓
CO 2	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	✓
CO 3	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	✓
CO 4	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	✓

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 5	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	✓
CO 6	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	✓

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Make use of(knowledge) the concepts of the random experiment, sample space, and appreciate (understand) the meaning of event probability, joint event probability, and conditional event probability for (apply) proving the Bayes theorem and for demonstrating (understanding) the random variables using the **mathematical principles** and **scientific methodology** to support the study of next-level courses such as communications, digital signal processing, (**own engineering discipline**) etc.	3
	PO 2	Demonstrate(understand) the physical significance of the correlation and covariance functions, and **identify**, formulate,(apply)and **state a(complex) problem**, to **develop (apply)**solution using inversion of correlation/ covariance matrices in certain areas of communication (**problems)** and **interpret and document the results**.	6
	PO 3	Develop the solutions for **complex Engineering problems** and **design system components** using the Bayes theorem, understand **customer and user needs** and identify the **cost limitations** for the selection of parameters, **use creativity** in applying the methods of model analyses for **innovative solutions** for the use of Baye's theorem.	6
	PO 10	Demonstrate the ability to communicate effectively in **writing** design documentation and make effective presentations.	1
	PSO 3	Develop conditional event probability for the implementation of total probability and Bayes theorem in **research to model,analyze and problem solving in wired and wireless communication applications**.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 2	PO 1	Define (knowledge) a random variable using (knowledge) a real mapping function of outcomes of a random experiment into a random variable, define (knowledge) the probabilities and (understand) the continuous/discrete probability density function and distribution function for characterizing (knowledge, understand) various types of density functions such as Gaussian, Rayleigh, Poisson, etc. using the **mathematical principles** and **scientific methodology** to support(understand) their applications in next-level Courses of the program. (**own engineering discipline**).	3
	PO 2	Demonstrate(understand) the random variable as a statistical average operation to **identify, formulate,(apply)and state a(complex) problem**, to develop (apply)solution using appropriate expectation operations in certain areas of communication (problems).	3
	PO 3	Make use of distribution and density functions for **customer and user needs** and identify the **cost limitations** for the selection of parameters, **use creativity** in applying the methods of model analyses for **innovative solutions** for the analysis of noise in communications.	4
	PO 10	Demonstrate the ability to communicate effectively in **writing** design documentation and make effective presentations.	1
	PSO 3	Apply distribution and density functions of standard random variables in **research to model,analyze and problem solving in wired and wireless communication applications**.	2
CO 3	PO 1	Define (knowledge) the transformation and/or the expectation operation on random variables and their functions, to formulate the definition of moments of a random variable using **mathematical principles** and demonstrate (understand) the use of the characteristic and moment generating functions(knowledge) to analytically derive the standard moments(by means of **scientific principles and methodology**) useful for identifying (understand) various noises encountered in communication systems and electronic circuits to support the other courses of the program(**own engineering discipline**).	3
	PO 2	Demonstrate(understand) the physical significance of the characteristic and moment generating functions and develop (apply) the Nth order standard and central moments using the above functions to **identify, formulate and state a problem, and develop solution** that uses moments as features and **interpret and document the results**.	6

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 3	Develop the solutions for **complex Engineering problems** and **design system components** using the multiple random variables, understand **customer and user needs** and identify the **cost limitations** for the selection of parameters, **use creativity** in applying the methods of model analyses for the use of multiple random variables.	5
	PO 10	Demonstrate the ability to communicate effectively in **writing** design documentation and make effective presentations.	1
	PSO 3	Apply joint distribution and density functions of standard random variables in **research to model,analyze and problem solving in wired and wireless communication applications**.	2
CO 4	PO 1	Define (knowledge)the random process as the extension (understand) of scalar random variables using **mathematical principles** and explain (understand) the meaning of correlation and co variance using **scientific principles and methodology** and interpret (understand) them for supporting the study of interdisciplinary courses such as digital image processing (**own engineering discipline**) and data sciences (other engineering disciplines).	3
	PO 2	Demonstrate(understand) the physical significance of the random process and develop (apply) the Nth order distribution and density functions using the random variable concept to **identify, formulate and state a problem, and develop solution** that uses co-variance and correlation as features.	5
	PO 3	Develop the solutions for **complex Engineering problems** and **design system components** using the random process, understand **customer and user needs** and identify the **cost limitations** for the selection of parameters, **use creativity** in applying the methods of model analyses the use of random process.	5
	PO 10	Demonstrate the ability to communicate effectively in **writing** design documentation and make effective presentations.	1
	PSO 3	Apply random process for finding co variance and correlation in **research to model,analyze and problem solving in wired and wireless communication applications**.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 5	PO 1	Relate (understand) the correlation and co-variance (knowledge) of random process to the linear and time invariant systems using the **mathematical principles** and demonstrate (understand) the system response and its physical significance using **scientific methodology and integrate** these concepts into the study of communication systems **(own engineering discipline)** and (complex) signal processing systems.	3
	PO 2	Demonstrate(understand) the physical significance of the random process and develop (apply) the reponse of LTI system using the random process concept to **identify, formulate and state a problem, and develop solution** that uses co-variance and correlation as features.	5
	PO 3	Develop solutions for **complex Engineering problems** and **design system components** using random process for **customer and user needs** and identify the **cost limitations** for the selection of parameters, **use creativity** in applying the methods of model analyses for the analysis of linear time invariant systems in time domain.	5
	PO 10	Demonstrate the ability to communicate effectively in **writing** design documentation and make effective presentations.	1
	PSO 3	Apply random process for finding co variance and correlation for response of an LTI system in **research to model,analyze and problem solving in wired and wireless communication applications**.	2
CO 6	PO 1	Define (knowledge) the auto power spectral density and cross power spectral density functions, to formulate the response of LTI systems using **mathematical principles** and demonstrate (understand) the use of the joint characteristic and joint moment generating functions(knowledge) to analytically derive the power spectral densities of the LTI system (by means of **scientific principles and methodology** and for supporting(**own engineering discipline**) some image processing algorithms.	3
	PO 2	Demonstrate(understand) the physical significance of the random process and develop (apply) the response of LTI system in frequency domain using the random process concept to **identify and develop solution** that uses Fourier transform properties.	2
	PO 3	Develop the solutions for **complex Engineering problems** and **design system components** using the power spectral density functions, understand **customer and user needs**	3
	PO 10	Demonstrate the ability to communicate effectively in **writing** design documentation and make effective presentations.	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PSO 3	Apply random process for finding power spectral density functions for the response of LTI systems in **research to model,analyze and problem solving in wired and wireless communication applications**.	2

Note: For Key Attributes refer **Annexure - I**

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES/KEY COMPETENCIES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	3	6	6	-	-	-	-	-	-	1	-		-	-	2
CO 2	3	3	4	-	-	-	-	-	-	1	-	-	-	-	2
CO 3	3	6	5	-	-	-	-	-	-	1	-	-	-	-	2
CO 4	3	5	5	-	-	-	-	-	-	1	-		-	-	2
CO 5	3	5	5	-	-	-	-	-	-	1	-	-	-	-	2
CO 6	3	2	3	-	-	-	-	-	-	1	-		-	-	2

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	100	60	60	-	-	-	-	-	-	20	-	-	-	-	29
CO 2	67	30	40	-	-	-	-	-	-	20	-	-	-	-	29
CO 3	67	60	50	-	-	-	-	-	-	20	-	-	-	-	29
CO 4	67	50	50	-		-	-	-	-	20	-		-	-	29
CO 5	67	50	50	-	-	-	-	-	-	20	-	-	-	-	29
CO 6	67	20	30	-	-	-	-	-	-	20	-	-	-	-	29

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation
1 -$5 < C \leq 40\%$ – Low/ Slight
2 - $40\ \% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	-	-	-	-	-	-	1	-	-	-	-	1
CO 2	3	1	1	-	-	-	-	-	-	1	-	-	-	-	1
CO 3	3	3	2	-	-	-	-	-	-	1	-	-	-	-	1
CO 4	3	2	2	-	-	-	-	-	-	1	-	-	-	-	1
CO 5	3	2	2	-	-	-	-	-	-	1	-	-	-	-	1
CO 6	3	1	1	-	-	-	-	-	-	1	-	-	-	-	1
TOTAL	36	11	14	-	-	-	-	-	-	-	-	-	-	-	6
AVERAGE	3	2.75	2.33	-	-	-	-	-	-	-	-	-	-	-	1

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	-
Quiz	-	Tech - Talk	✓	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	✓	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY-INDIRECT:

X	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**PROBABILITY, RANDOM VARIABLES AND OPERATIONS ON RANDOM VARIABLES**
	Random Experiments, Sample Spaces, Events, Probability, Axioms, Joint, Conditional and Total Probabilities, Bay's Theorem, Independent Events. Random Variables: Definition, Conditions for mapping function of a Random Variable, Types of Random Variable, Distribution and Density functions: Definition and Properties, Binomial, Poisson, Uniform, Gaussian, Exponential, Rayleigh, random variables, Methods of defining Conditioning Event, Conditional Distribution, Conditional Density and their Properties, Expected Value of a Random Variable, Function of a Random Variable, Standard and Central Moments, Variance and Skew, Chebychev's Inequality
MODULE II	**SINGLE RANDOM VARIABLE TRANSFORMATIONS-MULTIPLE RANDOM VARIABLES**

	Characteristic Function, Moment Generating Function, Monotonic and Non-monotonic Transformations of Single Random Variables (Continuous and Discrete), Vector Random Variables, Joint Distribution Function and its Properties, Marginal Distribution Functions, Joint Density Function and its Properties, Marginal Density Functions, Conditional Distribution and Density – Point Conditioning, Conditional Distribution and Density – Interval conditioning, Statistical Independence, Sum of Two and more Random Variables, Central Limit Theorem: Equal and Unequal Distribution.
MODULE III	**OPERATIONS ON MULTIPLE RANDOM VARIABLES – EXPECTATIONS**
	PART:1 Expected value of a function of multiple random variables, Correlation and Covariance , Correlation Coefficient, Joint Moments about the origin, Joint Central moments, Joint characteristic function, Joint moment generating function. PART:2 Jointly Gaussian random variables: Two random variables case and N random variable case, Properties, Transformations of Multiple Random Variables, Jacobian Matrix, Linear Transformations of Gaussian Random Variables
MODULE IV	**RANDOM PROCESSES – TEMPORAL CHARACTERISTICS**
	Random Process: Definition and Classification, Distribution and Density Functions, Stationarity and Statistical Independence., First- Order, Second-Order , Wide-Sense Stationarities (N-Order) and Strict-Sense Stationarity, Time Averages andErgodicity, Mean-Ergodic and Correlation- Ergodic Processes, Autocorrelation Function and Its Properties, Cross-Correlation Function and Its Properties, Covariance Functions, Gaussian and Poisson Random Processes. Response of Linear Systems to Random Process input, Mean and MS value of System Response, Autocorrelation Function of Response, Cross- Correlation between Input and Output.
MODULE V	**RANDOM PROCESSES – SPECTRAL CHARACTERISTICS**
	Power Density Spectrum: Definition and Properties, Relationship between Power Density Spectrum and Autocorrelation Function, Cross Power Spectral Density: Definition and Properties, Relationship between Cross-Power Spectrum and Cross-Correlation Function, System Evaluation using Random Noise, Spectral Characteristics of System Response: Power Density Spectrum of Response, Cross-Power Density Spectra of Input and Output, Noise Bandwidth, White and Colored Noises.

TEXTBOOKS

1. Peyton Z. Peebles, "Probability, Random Variables and Random Signal Principles", Tata McGraw Hill, 4th Edition, 2001.

REFERENCE BOOKS:

1. Y. Mallikarjuna Reddy, "1. Probability Theory and Stochastic Processes ", University Press, 4thEdition, 2013.
2. Athanasios Papoulis and S. Unnikrishna Pillai, "2. Probability, Random Variables and Stochastic Processes ",PHI, 4th Edition,2002.
3. K .Murugesan, P. Guruswamy, "3. Probability, Statistics and Random Processes",, Anuradha Agencies, 3rd Edition,2003.
4. Bruce Hajck,"4. Random Processes for Engineers,Cambridge University Press,2015Signals, Systems & Communications - B.P. Lathi, B.S. Publications,2003.

WEB REFERENCES:

1. https://nptel.ac.in/courses/111/102/111102111/

2. https://lms.iare.ac.in/index?route=course/details&course_id=358

COURSE WEB PAGE:

https://www.iare.ac.in/?q=courses/r18-auto-ece/probability-theory-and-stochastic-process

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE), Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	-
CONTENT DELIVERY (THEORY)			
1	Probability, axioms, joint, conditional probabilities	CO 1	T1:1.1-1.5, R1:1.1-1.9
2	Total probabilities, Bay's theorem	CO 1	T1:1.1-1.5, R1:1.1-1.9
3	Random variables, types of random variable	CO 2	T1:2.0-2.1
4	Distribution and density functions: definition and properties	CO 2	T1:2.2-2.5, R1:2.3-2.4
5	Binomial, Poisson, Uniform random variables	CO 2	T1:2.2-2.5, R1:2.3-2.4
6	Gaussian, Exponential, Rayleigh, random variables	CO 2	T1:2.2-2.5, R1:2.3-2.4
7	Conditional distribution, conditional density and their properties	CO 2	T1:2.6, R1:2.7
8	Expected Value of a Random Variable	CO 2	T1:3.0-3.2, R1: 3.3-3.5
9	Standard and Central Moments, Variance and Skew	CO 2	T1:3.0-3.2, R1: 3.3-3.5
10	Chebychev's Inequality	CO 2	T1:3.0-3.2, R1: 3.3-3.5
11	Characteristic function, moment generating function properties	CO 2	T1:3.3, R1: 3.6

12	Monotonic transformations of Single random variables.	CO 2	T1:3.4, R1: 3.8
13	Non-monotonic transformations of single random variables (continuous and discrete)	CO 2	T1:3.4, R1: 3.8
14	Random Vector ,Joint distribution function and its properties, marginal distribution functions	CO 3	T1:4.0-4.4, R2: 4.2-4.3
15	Joint density function and its properties, marginal density functions	CO 3	T1:4.0-4.4, R2: 4.2-4.3
16	Conditional distribution and density – point conditioning, interval conditioning	CO 3	T1:4.5, R2: 4.4
17	Statistical independence, Sum of two and more random variables	CO 3	T1:4.5, R2: 4.4
18	Central limit theorem	CO 3	T1:4.6-4.7, R1: 4.6-4.7
19	Expected value of a function of multiple random variables ,Correlation and covariance , correlation coefficient	CO 3	T1:5.0-5.1, R1: 5.2-5.3
20	Joint moments about the origin, joint central moments	CO 3	T1:5.2, R1: 5.4-5.5
21	Joint characteristic function, Joint moment generating function	CO 3	T1:5.2, R1: 5.4-5.5
22	Jointly Gaussian random variables,2 and N random variable case	CO 3	T1:5.3, R1: 5.6
23	Transformations of multiple random variables	CO 3	T1:5.4-5.5, R1: 5.7-5.9
24	Linear transformations of Gaussian random variables	CO 3	T1:5.4-5.5, R1: 5.7-5.9
25	Random Process: Classification	CO 4	T1:5.4-5.6, R1: 6.2-6.6
26	Stationarity and statistical independence of random process	CO 4	T1:6.1-6.2, R1: 6.7-6.9
27	Wide-sense stationarities (N-Order) and Strict-sense stationarity	CO 4	T1:6.1-6.2, R1: 6.7-6.9
28	Time Averages and Ergodicity	CO 4	T1:6.1-6.2, R1: 6.7-6.9
29	Autocorrelation Function and Its Properties	CO 4	T1:6.3, R1: 6.10-6.12

30	Covariance Functions, Cross-correlation function and its Properties	CO 4	T1:6.4, R1: 6.10-6.12
31	Gaussian and Poisson random processes	CO 4	T1:6.5, R1: 6.10-6.12
32	Mean and mean square value of system Response	CO 4	T1:6.6, R1: 6.10-6.12
33	Autocorrelation Function of Response, Cross- Correlation between Input and Output	CO 6	T1:8.2 ,R1: 8.2-8.3
34	Power density spectrum and properties	CO 5	T1:7.1-7.2, R1: 7.2-7.5
35	Cross Power spectral density: definition and properties	CO 5	T1:7.3-7.4, R1: 7.5-7.6
36	Relationship between power density spectrum and autocorrelation function	CO 5	T1:7.1-7.2, R1: 7.2-7.5
37	Relationship between Cross-power Spectrum and Cross-correlation function	CO 5	T1:7.3-7.4, R1: 7.5-7.6
38	System evaluation using random noise	CO 6	T1:8.3-8.4, R1: 8.3-8.4
39	Power density spectrum of response, Cross-power density spectra of input and output	CO 6	T1:8.3-8.4, R1: 8.3-8.4
40	Noise Bandwidth, White and Colored Noises.	CO 6	T1:8.5-8.7, R1: 8.8, 8.17
PROBLEM SOLVING/ CASE STUDIES			
41	Numerical problems on Probability, Total probability, Posterior probability	CO 1	T1:1
42	Numerical problems on distribution and density function of random variable	CO 2	T1:2
43	Numerical problems on Mean ,variance and skew for the given random variable.	CO 2	T1:3
44	Numerical problems on characteristic function and moment generating function	CO 2	T1:3
45	Numerical problems on Transformation of random variables	CO 2	T1:3
46	Numerical problems on joint distribution and marginal distribution	CO 3	T1:4
47	Numerical problems on joint density and marginal density function	CO 3	T1:4
48	Numerical problems on density function of sum of 2 random variables	CO 3	T1:4

49	Numerical problems on joint characteristic function and joint moment generating function	CO 3	T1:5
50	Numerical problems on linear transformation of Gaussian random variables	CO 3	T1:5
51	Numerical problems on stationarity of random process	CO 4	T1:6
52	Numerical problems on Gaussian and Poisson random process	CO 4	T1:6
53	Numerical problems on correlation function and properties	CO 4	T1:6
54	Numerical problems on power spectral density calculation	CO 5	T1:7
55	Numerical problems on power spectral density of a system output	CO 6	T1:8
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Probability and random variable	CO 1, CO 2	T1:1,2,3
57	Multiple random variables	CO 3	T1:4,5
58	Characteristic function and moment generating function for single and multiple random variables.	CO 2,CO 3	T1:3,5
59	Random process and auto correlation function	CO 4,CO 6	T1:6
60	Power spectral density, output of linear system	CO 5,CO 6	T1:7,8
DISCUSSION OF QUESTION BANK			
61	Probability and random variable	CO 1, CO 2	T1:1,2,3
62	Multiple random variables	CO 3	T1:4,5
63	Transformation of random variables	CO 2,CO 3	T1:3,5
64	Stationarity and auto correlation function	CO 4,CO 6	T1:6
65	Power spectral density	CO 5,CO 6	T1:7,8

Signature of Course Coordinator **HOD,ECE**

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	**10**

PO 4.	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**

PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project. 6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	**12**

PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PSO1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications 1. Analyze and solve real time problems in Robotics 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications 3. Develop embedded systems modules using Real Time Operating System 4. Undertake research and development projects in the field of Embedded Systems 5. Adopt the engineering professional code and conduct	**5**
PSO2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs 1. Inspect, survey and analyze types of ASIC chip designs 2.Design ASIC prototypes using Verilog and VHDL languages 3. Analyze microprocessor subsystems with memories and I/O interfacs for SOC designs 4. Explore hardware components for designig SOC 5. Adopt the engineering professional code and conduct 6.Designing prototypes of SOC using programming tools like MATLAB, LabVIEW 7.Familiarize with the design flow of ASIC prototype 8.Realize SOC using Register-Transfer-Level designs 9. Analyse and develop models for system level descriptions for synthesis of SOC 10. Inspect and survey the abstractions and principles for the specification, simulation, verification, and synthesis of systems on chip (SoC) 11. Programming and hands-on skills to meet requirements of global environment	**11**
PSO3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications 1. Explicit software and programming tools for antenna design 2. Adopt technical library resources and literature search 3. Explore smart antennas 4. Model, program for operation and control of smart antennas for wireless communication applications 5. Interface automation tools 6. Research, analysis, problem solving and presentation using software aids 7.Programming and hands-on skills to meet requirements of global environment	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**ELECTRONICS AND COMMUNICATION ENGINEERING**				
Course Title	**DATA STRUCTURES**				
Course Code	ACSC08				
Program	B.Tech				
Semester	III				
Course Type	Core				
Regulation	UG.20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	3	1.5
Course Coordinator	Dr V Sitharamulu, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC01	I	Python Programming

II COURSE OVERVIEW:

The course covers some of the general-purpose data structures and algorithms, and software development. Topics covered include managing complexity, analysis, static data structures, dynamic data structures and hashing mechanisms. The main objective of the course is to teach the students how to select and design data structures and algorithms that are appropriate for problems that they might encounter in real life. This course reaches to student by power point presentations, lecture notes, and lab which involve the problem solving in mathematical and engineering areas.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Data Structures	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	whiteboard		Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIE examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Remember
60%	Understand
20%	Apply
10%	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 25 marks for Continuous Internal Examination (CIE) and 05 marks for Quiz \Alternative Assessment Tool (AAT).

Component	Theory		Total Marks
Type of Assessment	CIE Exam	Quiz \AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 17^{th} week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz - Online Examination
Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course

is given in table.

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

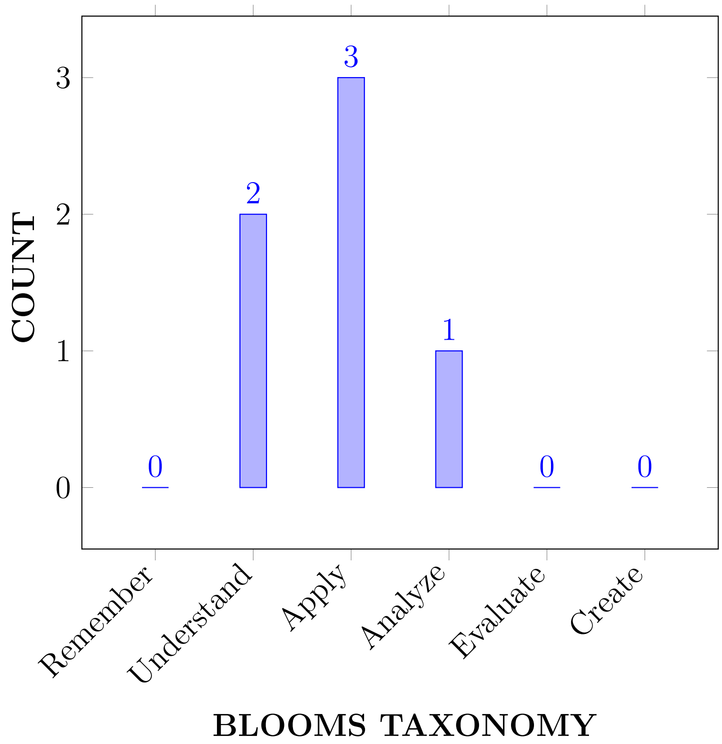
I	To provide students with skills needed to understand and analyze performance trade-offs of different algorithms / implementations and asymptotic analysis of their running time and memory usage.
II	To provide knowledge of basic abstract data types (ADT) and associated algorithms: stacks, queues, lists, tree, graphs, hashing and sorting, selection and searching.
III	The fundamentals of how to store, retrieve, and process data efficiently
IV	To provide practice by specifying and implementing these data structures and algorithms in Python.
V	Understand essential for future programming and software engineering courses.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Interpret** the complexity of algorithm using the asymptotic notations.	Understand
CO 2	**Select** appropriate searching and sorting technique for a given problem.	Apply
CO 3	**Construct** programs on performing operations on linear and nonlinear data structures for organization of a data	Apply
CO 4	**Make use of** linear data structures and nonlinear data structures solving real time applications.	Apply
CO 5	**Describe** hashing techniques and collision resolution methods for efficiently accessing data with respect to performance.	Understand
CO 6	**Compare** various types of data structures ; in terms of implementation, operations and performance.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Program Outcomes	
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	CIA/SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIA/SEE
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	1	CIA/SEE
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	CIA/SEE

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	3	CIA/SEE/Open ended Experiments
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	Tech Talk/Concept Videos/Open ended Experiments
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	1	Tech Talk/Concept Videos/Open ended Experiments

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	3	CIA/ SEE/ Tech Talk/ Concept Videos
PSO 2	FFocus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	2	CIA/ SEE/ Tech Talk/ Concept Videos
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	2	CIA/ SEE/ Tech Talk/ Concept Videos

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	✓
CO 2	✓	✓	✓	-	✓	-	-	-	-	✓	-	✓	✓	✓	✓
CO 3	✓	✓	✓	✓	✓	-	-	-	-	✓	-	✓	✓	✓	✓
CO 4	✓	✓	✓	✓	✓	-	-	-	-	✓	-	✓	✓	✓	✓
CO 5	✓	-	✓	-	✓	-	-	-	-	✓	-	-	✓	✓	✓
CO 6	✓	✓	✓	✓	✓	-	-	-	-	✓	-	✓	✓	✓	✓

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO1	PO 1	**Understand** (knowledge) the concept of conventional digital communication system and (understand) various types of pulse analog modulation techniques for signals analysis by applying the principles of **mathematics, science,** and **engineering fundamentals**.	3
	PO 2	**Problem Analysis** on different types of algorithms to analyze space and time complexities.	4
	PO 3	**Design the Solutions** for finding space and time complexities of a complex algorithm and representing it by asymptotic notations	2
	PO 10	**Subject matter and speaking style** assessed in explanation of various algorithms, algorithm complexity.	2
	PSO1	**Design and analyze** complex algorithms and specify its space and time complexities and representing it by asymptotic notations for faster processing of data.	3
	PSO3	**Make use of modern** computer tools for finding space and time complexities of a complex algorithm	1
CO 2	PO 1	**Make use** of broad knowledge of searching and sorting techniques for an efficient search from a data structure and optimize the efficiency of other algorithms by applying the knowledge of mathematics, science, Engineering fundamentals.	1
	PO 2	**Problem Analysis** on different types of search sort algorithms to analyze space and time complexities.	5

	PO 3	**Design/Development of Solutions** using appropriate searching and sorting techniques for designing a solution for complex Engineering problems.	2
	PO 5	**Implementation of** different sorting and searching techniques for given problem with the help of computer software	1
	PO 10	**Subject matter and speaking style** assessed in explanation of searching and sorting along with efficiency of searching and sorting techniques in terms of space and time complexity	2
	PO 12	**Keeping current in CSE and advanced engineering concepts** of various searching , sorting and respective time and space complexity by tech talk, concept videos and open ended experiments.	3
	PSO1	**Understand** complex problems and analyzing it and apply appropriate sorting and searching techniques for data processing.	4
	PSO2	**Applying** various selecting and sorting techniques while designing and developing information retrieval systems and its applications	2
	PSO3	**Make use of** various selecting and sorting techniques and extend the knowledge for advance frame works and platforms which are necessary for engineering practices and higher studies or become an entrepreneur.	1
CO 3	PO 1	**Make use of** linear and nonlinear data structures to organize the data in a particular way so to use them in the most effective way by applying the basic knowledge of mathematics, science, engineering fundamentals	2
	PO 2	**Problem analysis:** Organizing the given data in particular way by performing the operations on linear and nonlinear data structures to use the data in the most effective way.	7
	PO 3	**Recognize the** need of linear and nonlinear data structures such as linked list, array, stack and queue by Designing solutions for complex Engineering.	5
	PO 4	**Conduct Investigations** Conduct Investigations of Complex Problems: Ability to apply operations on linear and nonlinear data structures in order to organize the given data in a particular way	4
	PO 5	**Implementation of** Implementation of different operations on linear and nonlinear data structures for given problem with the help of computer software	1
	PO 10	**Subject matter and speaking style** assessed in explanation of linear and nonlinear data structures like linked lists, stacks and queues	2

	PO 12	**Keeping current in** CSE and advanced engineering concepts of linear and nonlinear data structures like linked lists, stacks and queues by tech talk, concept videos and open-ended experiments	3
	PSO1	**Understand** complex problems and analyzing it and apply appropriate operations on linear or nonlinear data structures for Developing the solution.	5
	PSO2	**Applying** various linear or nonlinear data structures while designing and developing information retrieval systems and its applications	2
	PSO3	**Make use of** various linear or nonlinear data structures and extend the knowledge for advance frame works and platforms which are necessary for engineering practices and higher studies or become an entrepreneur.	1
CO 4	PO 1	**Make use of** linear and nonlinear data structures for solving real time applications by applying the basic knowledge of mathematics, science, engineering fundamentals	3
	PO 2	**Problem analysis:**Solving real time applications by performing the operations on linear or nonlinear data structures.	7
	PO 3	**Recognize the** need of linear and nonlinear data structures such as linked list, array, stack and queue for Designing real time applications.	2
	PO 4	**Conduct Investigations of Complex Problems:** Ability to apply operations on linear or nonlinear data structures in order to solve real time applications.	4
	PO 5	**Implementation of** different operations on linear and nonlinear data structures for solving real time applications with the help of computer software	1
	PO 10	**Subject matter and speaking style** assessed in explanation of linear and nonlinear data structures like linked lists, stacks, queues, trees and graphs	2
	PO 12	**Keeping current** in CSE and advanced engineering concepts of linear and nonlinear data structures like linked lists, stacks, queues, trees and graphs by tech talk, concept videos and open-ended experiments for solving real time applications.	3
	PSO1	**Understand** complex problems and analyzing it and apply appropriate operations on linear or nonlinear data structures for solving real time applications.	5
	PSO2	**Applying** various linear or nonlinear data structures while designing and developing information retrieval systems and its applications	1

	PSO3	**Make use of** various linear or nonlinear data structures and extend the knowledge for advance frame works and platforms which are necessary for engineering practices and higher studies or become an entrepreneur.	1
CO 5	PO 1	**Understand** the knowledge of hashing techniques and collision resolution methods and implementing for specified problem domain using knowledge of mathematics, science and engineering fundamentals	1
	PO 3	**Design the Solution** for efficiently accessing data with respect to performance by using hashing techniques and collision resolution methods	2
	PO 5	**Implementation of** hashing techniques and collision resolution methods for efficiently accessing data with respect to performance with the help of computer software	1
	PO 10	**Subject matter and speaking style** assessed in explanation of Hashing, Collision techniques	2
	PSO1	**Understand** complex problems and analyzing it and apply appropriate hashing techniques and collision resolution methods for efficiently accessing data with respect to performance.	4
	PSO2	**Applying** various hashing techniques and collision resolution methods while designing and developing information retrieval systems and its applications	1
	PSO3	**Build** sufficient knowledge hashing techniques and collision resolution methods so that new product can be developed, which leads to become successful entrepreneur in the present market.	1
CO 6	PO 1	**Understand** various types of data structures in terms of implementations and choose appropriate data structure for specified problem domain using knowledge of mathematics, science and engineering fundamentals	3
	PO 2	**Problem Analysis:** Recognize the importance of suitable data structures in checking the efficiency of algorithms used for complex engineering problems.	7
	PO 3	**Design the Solution** complex problems or efficiently accessing data with respect to performance by using hashing techniques and collision resolution methods	5
	PO 4	**Conduct Investigations of Complex Problems:** Ability to apply operations on linear or nonlinear data structures in order to solve real time applications.	4
	PO 5	**Understand** the Implementation of various types of data structures with the help of computer software	1
	PO 10	**Subject matter and speaking** style assessed in explanation of Implementation of various types of data structures.	2

	PO 12	**Keeping current in CSE** and advanced engineering concepts of Implementation of various types of data structures by tech talk, concept videos and open ended experiments	3
	PSO 1	**Understand** complex problems and analyzing it and apply Implementation of various types of data structures.	5
	PSO 2	**Applying** Implementation of various types of data structures while designing and developing information retrieval systems and its applications	1
	PSO 3	**Build** sufficient knowledge Implementation of various types of data structures so that new product can be developed, which leads to become successful entrepreneur in the present market.	1

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	12	6	2	2
CO 1	1	4	2	-	-	-	-	-	-	2	-	-	3	-	1
CO 2	1	5	2	-	1	-	-	-	-	2	-	3	4	2	1
CO 3	2	7	5	4	1	-	-	-	-	2	-	3	5	2	1
CO 4	3	7	2	4	1	-	-	-	-	2	-	3	5	1	1
CO 5	1	-	2	-	1	-	-	-	-	2	-	-	4	1	1
CO 6	3	7	5	4	1	-	-	-	-	2	-	3	5	1	1

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	12	2	2	2
CO 1	33.3	40	20	-	-	-	-	-	-	40	-	-	50	-	50
CO 2	33.3	50	20	-	100	-	-	-	-	40	-	25	66.6	100	50
CO 3	66.6	70	50	36.3	100	-	-	-	-	40	-	25	83.3	100	50
CO 4	100	70	20	36.3	100	-	-	-	-	40	-	-	66.6	50	50
CO 5	33.3	-	20	-	100	-	-	-	-	40	-	-	66.6	50	50
CO 6	100	70	50	36.3	100	-	-	-	-	40	-	25	83.3	50	50

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 - $0 \leq$ C$\leq$ 5% – No correlation
1 -5 <C$\leq$ 40% – Low/ Slight
2 - 40 % <C < 60% –Moderate
3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	**PROGRAM OUTCOMES**												**PSO'S**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	1	1	-	-	-	-	-	-	1	-	-	2	-	2
CO 2	1	2	1	-	3	-	-	-	-	1	-	1	3	3	2
CO 3	3	3	2	1	3	-	-	-	-	1	-	1	3	3	2
CO 4	3	3	1	1	3	-	-	-	-	1	-	1	3	2	2
CO 5	1	-	1	-	3	-	-	-	-	1	-	-	3	2	2
CO 6	3	3	2	1	3	-	-	-	-	1	-	1	3	2	2
TOTAL	**12**	**12**	**8**	**3**	**15**	**-**	**-**	**-**	**-**	**6**	**-**	**4**	**17**	**12**	**12**
AVERAGE	**2.0**	**2.4**	**1.3**	**1.0**	**3.0**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**2.8**	**2.4**	**2.0**

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Seminars	-	Student Viva	-	Certification	-
Laboratory Practices	-	5 Minutes Video	✓	Open Ended Experiments	-
Term Paper	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION TO DATA STRUCTURES, SEARCHING AND SORTING**
	Basic concepts: Introduction to data structures, classification of data structures, operations on data structures; Algorithms Specification ,Recursive algorithms ,Data Abstraction, Performance analysis-time complexity and space complexity, Asymptotic Notation-Big O ,Omega and Theta notations. Introduction to Linear and Non Linear data structures, Searching techniques: Linear search, Binary search; Sorting techniques: Bubble, Selection, Insertion, Quick and Merge Sort and comparison of sorting algorithms
MODULE II	**LINEAR DATA STRUCTURES**
	Stacks: Stack ADT, definition and operations, Implementations of stacks using array, applications of stacks, Arithmetic expression conversion and evaluation; Queues: Primitive operations; Implementation of queues using Arrays, applications of linear queue, circular queue and double ended queue (deque).
MODULE III	**LINKED LISTS**
	Linked lists: Introduction, singly linked list, representation of a linked list in memory, operations on a single linked list; Applications of linked lists: Polynomial representation and sparse matrix manipulation. Types of linked lists: Circular linked lists, doubly linked lists; Linked list representation and operations of Stack, linked list representation and operations of queue
MODULE IV	**NON LINEAR DATA STRUCTURES**
	Trees: Basic concept, binary tree, binary tree representation, array and linked representations, binary tree traversal, binary tree variants, application of trees; Graphs: Basic concept, graph terminology, Graph representations-Adjacency matrix, Adjacency lists, graph implementation, Graph traversals-BFS,DFS, Application of graphs, Minimum spanning trees-Prims and Kruskal algorithms
MODULE V	**BINARY TREES AND HASHING**
	Binary search trees: Binary search trees, properties and operations; Balanced search trees: AVL trees; Introduction to M-Way search trees, B trees; Hashing and collision: Introduction, hash tables, hash functions, collisions, applications of hashing.

TEXTBOOKS

1. Rance D. Necaise, —Data Structures and Algorithms using Python, Wiley Student Edition.

2. Benjamin Baka, David Julian, —Python Data Structures and Algorithms, Packt Publishers, 2017.

REFERENCE BOOKS:

1. S. Lipschutz, —Data Structures , Tata McGraw Hill Education, 1st Edition, 2008.
2. D. Samanta, —Classic Data Structures, PHI Learning, 2nd Edition, 2004.

WEB REFERENCES:

1. http://www.tutorialspoint.com/data-structures-algorithms
2. https://www.geeksforgeeks.org/data-structures/
3. https://www.studytonight.com/data-structures/
4. https://www.coursera.org/specializations/data-structures-algorithms

COURSE WEB PAGE:

1. https://www.iare.ac.in/?q=courses/computer-science-and-engineering-autonomous/datastructures

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	https://www.iare.ac.in/?q=courses/computer-science-and-engineering-autonomous/datastructures
CONTENT DELIVERY (THEORY)			
1	Basic concepts: Introduction to Data Structures	CO 3	T1:1.1.3 R2 : 1.2
2	Classification of data structures	CO 3	T1:1.1.3 R2 : 1.4
3	Operations on data Structures	CO 3	T1:1.2
4	Recursive algorithm, Performance Analysis	CO 1	T1:1.2 T1:5.1
5	Searching techniques: Linear search and binary search	CO 2, CO 6	T1:5.1
6	Searching techniques: Fibonacci search and comparison	CO 2, CO 6	T1:5.1
8	Sorting techniques: Bubble sort, selection sort and companding	CO 2 CO 6	R1:14.5

9	Sorting techniques: Insertion sort, Quick sort	CO 2, CO 6,	T1:5.2 R2 : 10.2
10	Merge sort ,comparison of sorting algorithms	CO 4, CO 6	T1:5.2 R2 : 10.2
13	Stacks: Primitive operations, implementation of stacks using Arrays	CO 3, CO 4	T1:7.1
14	Applications of stacks arithmetic expression conversion and evaluation	CO 4, CO 6	T1:7.2
16	Queues: Primitive operations; Implementation of queues using Array	CO 3, CO 4	T1:8.1
17	Applications of linear queue, circular queue	CO 3, CO 4	T1:8.4
18	Double ended queue (deque)l	CO 3, CO 4	R2 : 5.4
19	Linked lists: Introduction, singly linked list, representation of a linked list in memory	CO 3, CO 4	T1:9.1
20	Operations on a single linked list :creation, insertion and deletion	CO 3, CO 4	T1:9.2
21	Applications of linked lists	CO 4,	T1:9.3
22	Operations on a double linked lists :creation, insertion and deletion	CO 3, CO 4	T1:9.4
23	Operations on a double linked lists : deletion ,traversal.	CO 3, CO 4	T1:9.4
24	single linked list :polynomial expression	CO 3, CO 4	T1:9.3
25	single linked list :Sparse matrix manipulation.	CO 3, CO 4	T1:9.3
26	Operations on a Circular linked lists: creation, insertion and deletion	CO 3, CO 4	T1:9
30	Operations on a Circular linked lists: deletion, traversal	CO 3, CO 4	T1:9
31	Linked list representation and operations of Stack	CO 3, CO 4	T1:9.7
32	Linked list representation and operations of queue	CO 3, CO 4	T1:9.8
37	Trees: Basic concept, Tree terminology	CO 3	T1:13.1

CONTENT DELIVERY (THEORY)			
38	Binary tree :Binary Tree properties	CO 3, CO 4	T1:13.1
39	Binary tree representation using array	CO 3, CO 4	T1:13.2
40	Binary tree representation using linked list	CO 3, CO 4	T1:13.2
41	Binary tree traversal, binary tree variants	CO 3, CO 4	T1:13.2
42	Application of trees	CO 4	T1:13.2.3
44	Graphs: Basic concept, graph terminology	CO 3	R2 : 8.2
45	Types of graphs, Representation of graph	CO 3	R2 : 8.2
46	Graph traversals :DFS and BFS, Application of graphs	CO 3	T2:6.2
48	Minimum Spanning Trees-Prims and Kruskal algorithms	CO 4	T1:6.1 T2:5.6
50	Binary search trees, properties	CO 3	T1:13.2.3
51	Binary search trees operations	CO 3	T1:13.2.3
52	AVL trees	CO 3	T1:14.3
53	M- Way search trees, B trees	CO 3	T1:14.3
54	Hashing, Collision	CO 5	R2 : 6.4
7	Problems on linear search, binary search and Fibonacci search.	CO 2	T1:5.1
11	Problems on bubble sort, selection and insertion sort	CO 3, CO 4	T1:5.2 R2 : 10.2
12	Problems on quick and merge sort	CO 3, CO 4	T1:5.2 R2 : 10.2
15	Problems on Arithmetic expression conversion and evaluation	CO 3, CO 4	T1:7.2
27	Problems on single linked list to add, delete element	CO 3, CO 4	T1:9.8
28	Problems on double linked list to add, delete element	CO 3, CO 4	T1:9.8
33	Problems on circular linked list to add, delete element	CO 3, CO 4	T1:9.4
34	Problems on double linked list to add, delete element	CO 3, CO 4	T1:9.3
35	Problems on stack using linked list	CO 3, CO 4	T1:9.7
36	Problems on queue using linked list	CO 3, CO 4	T1:9.8
43	Problems on Binary tree :creation ,insertion and deletion of a node	CO 3, CO 4	T1:13.2
47	Problems on Graph Traversal: DFS and BFS	CO 3, CO 4	T2:6.2

49	Problems on MST: Prim's and Kruskal's	CO 3, CO 4	T1:6.1 T2:5.6
55	Problems on Binary search tree	CO 4	T1:14.3
56	Problems oh hashing	CO 5	R2 : 6.4
DISCUSSION ON DEFINITION AND TERMINOLOGY			
57	Definitions on Data Structures, searching and sorting	CO 1,CO2,CO 3	T1:1 R1:14
58	Definitions on Linear Data Structures	CO 3	T1:7,.T1:8
59	Definitions on Linked Lists	CO 3	T1:9
60	Definitions on Non Linear data Structures	CO 3	T1:7.5
61	Definitions on Binary Trees and Hashing	CO 3 CO 5	T1:14
DISCUSSION ON QUESTION BANK			
62	Data Structures, searching and sorting	CO 1, CO2,CO6	T1:1 R1:14
63	Linear Data Structures	CO 3,CO 4,CO 6	T1:9
64	Linked Lists	CO 3,CO 4,CO 6	T1:2.5
65	Non Linear data Structures	CO 3,CO 4,CO 6	T1: 4.1
66	Binary Trees and Hashings	CO 3,CO 5,CO 6	T1: 5.1

Course Coordinator **HOD,ECE**
Dr V Sitharamulu, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043
ELECTRONICS AND COMMUNICATION ENGINEERING
COURSE DESCRIPTION

Course Title	**ELECTRONIC DEVICES AND CIRCUITS LABORATORY**				
Course Code	AECC05				
Program	B.Tech				
Semester	III	ECE			
Course Type	Core				
Regulation	IARE - UG 20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Mr. Seshagiri Rao V.R, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEE102	II	Electrical Circuits Laboratory

II COURSE OVERVIEW:
This course provides the hands-on experience on designing circuits using Diodes, Bipolar Junction Transistors, Field Effect Transistors, UJTs and SCRs. Determine the gain, bandwidth and input output impedences of BJT and FET amplifiers. Provides the capability to extract the characteristics of semiconductor devices with simulation tools.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Electonic Devices and Circuits Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	-
20 %	Analysis	-
20 %	Design	-
20 %	Conclusion	-
20 %	Viva	-

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
-	-	-	-	-	-

VI COURSE OBJECTIVES:

The students will try to learn:

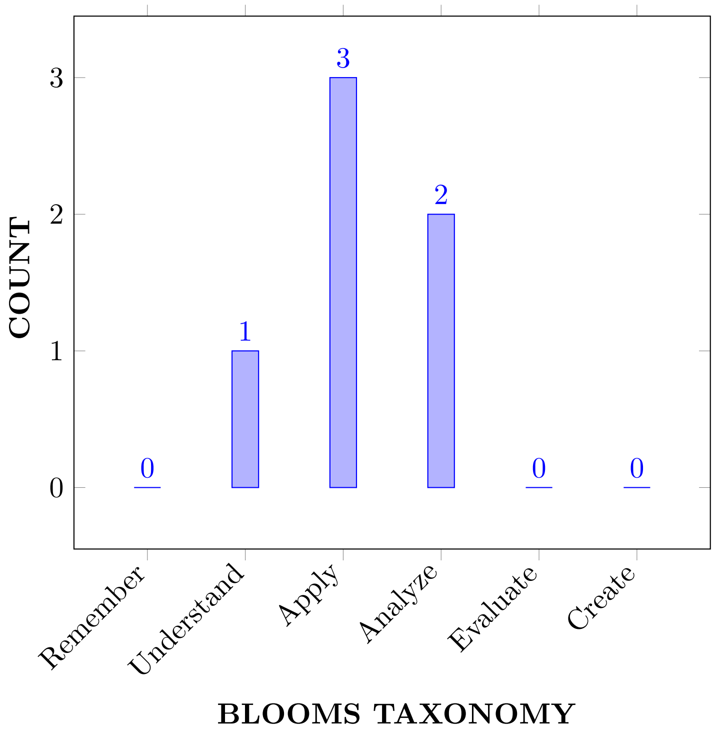
I	The behavior and characteristics of semiconductor devices for designing the semiconductor circuits such as amplifier and rectifiers.
II	Estimation of device characteristics like gain, bandwidth, input and output resistance of bipolar junction transistors and field effect transistors amplifiers to derive appropriate small-signal model analysis of basic amplifier circuits.
III	The analytical skills to model analog and digital integrated circuits at discrete and micro circuit level.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Demonstrate** the electronic instruments for measuring voltage, current and phase parameters.	Understand
CO 2	**Experiment** and determine the parameters of rectifiers and voltage regulators using the diode characteristics.	Apply
CO 3	**Examine** the input and output characteristics of transistor (BJT and FET) configurations for determining the input - output resistances.	Analyze
CO 4	**Characterize** BJT and FET amplifiers for estimating the voltage gain and Current gain.	Analyze
CO 5	**Calculate** the intrinsic stand-off ratio of the uni junction transistor using volt – ampere characteristics.	Apply
CO 6	**Build** and determine holding, latching current and break over voltage of silicon controlled rectifier using volt - ampere characteristics.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Program Outcomes	
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Lab Experiments / CIE / SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	Lab exercises/CIE/SEE
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	2	Lab exercises/CIE/SEE
PO 10	**Communication:** Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions	1	day-to-day evaluation

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs	1	Lab exercises/CIE/SEE

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 2	✓	-	-	-	-	-	-	-	-	✓	-	-	-	✓	-
CO 3	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 4	✓	✓	-	-	✓	-	-	-	-	✓	-	-	-	-	-
CO 5	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 6	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	✓	-

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Learn to use the Instruments **knowledge for measuring** the voltage, current and signal parameters with the information from other engineering disciplines, **mathematics, and scientific methodologies.**	2
	PO 10	Demonstrate the ability to **communicate effectively** by using the electronic instruments for measurement of signal properties..	1
CO 2	PO 1	**Determine the parameters** of rectifiers and voltage regulators using the diode characteristicswith support from other **engineering disciplines, mathematics, and scientific methodologies.**	2
	PO 10	Demonstrate the ability to analyze halfwave and full wave **rectifiers for higher efficiency** and voltage regulation	1
	PSO 2	**Formulate** and **Evaluate** the protection circuits applications in **the field of Intelligent** Embedded and Semiconductor technologies	3
CO 3	PO 1	Examine the input and output characteristics of transistor BJT and FET configurations knowledge with the support of **Elecronic Circuit theory.**	1

	PO 2	**Formulate** and **analyze Problem** for **complex Engineering problems** for power supplies knowledge **consisting of rectifiers using first principles** of **mathematics and Engineering sciences.**	5
	PO 10	Explain **forming half wave and full wave rectifiers** with necessary interconnections.	1
CO 4	PO 1	Design amplifiers knowledge consisting of BJTs and FETs with the support of **VLSI engineering tools such as stick diagrams and layouts.**	1
	PO 2	**Formulate** and analyze **Problem analysis** and **complex Engineering problems** for amplfiers **knowledge consisting of multiplexers** using first principles of **mathematics and Engineering sciences.**	5
	PO 5	Develop amplifiers knowledge of Electronic circuits **using modern Engineering and IT tools to high SNR.**	1
	PO 10	Explain **calculation of voltage and current gains** for BJT and FET amplifiers with clarity.	1
CO 5	PO 1	Understand the structure and operation of uni-junction transistor **knowledge by applying** the oscillation **fundamentals with support** from other engineering disciplines, **mathematics, and scientific methodologies.**	3
	PO 2	**Formulate** and analyze **Problem analysis** and **complex Engineering problems** of UJT circuits **knowledge using first principles** of **mathematics and Engineering sciences.**	5
	PO 10	Explain **calculation of intrinsic standoff ratio parameters** for UJT with clarity	1
CO 6	PO 1	Examine and **determine the holding, latching current** and break over voltage of silicon controlled rectifier using volt - ampere characteristics knowledge with data from **mathematics and engineering sciences.**	2
	PO 2	**Formulate** and analyze **Problem analysis** and **complex Engineering problems** for protection circuits using SCRs **knowledge using first principles** of **mathematics and Engineering sciences.**	5
	PO 10	**Focus on writing** the lab reports and work sheets with clarity	1
	PSO 2	**Formulate** and **Evaluate** the protection circuits applications in **the field of Intelligent Embedded** and Semiconductor technologies	3

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	2	-	-	-	-	-	-	-	-	1	-	-	-	3	-
CO 3	1	5	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	1	5	-	-	1	-	-	-	-	1	-	-	-	-	-
CO 5	3	5	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	2	5	-	-	-	-	-	-	-	1	-	-	-	3	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	66	-	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 2	66	-	-	-	-	-	-	-	-	20	-	-	-	27	-
CO 3	33	50	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 4	33	50	-	-	100	-	-	-	-	20	-	-	-	-	-
CO 5	100	50	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 6	66	50	-	-	-	-	-	-	-	20	-	-	-	27	-

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 - $0 \leq$ C$\leq$ 5% – No correlation
1 -5 <C$\leq$ 40% – Low/ Slight
2 - 40 % <C < 60% –Moderate
3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	-	-	-	-	-	-	-	-	1	-	-	-	1	-
CO 3	1	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	1	2	-	-	3	-	-	-	-	1	-	-	-	-	-
CO 5	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-

CO 6	3	2	-	-	-	-	-	-	-	1	-	-	-	1	-
TOTAL	**14**	**8**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**6**	**0**	**0**	**0**	**2**	**0**
AVERAGE	**2.3**	**2**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

WEEK I	**PN DIODE CHARACTERISTICS**
	(a) Plot volt-ampere characteristics of silicon and germanium p-n junction diodes. Find cut-in voltage, static and dynamic resistances in forward and reverse biased conditions using hardware. (b) Compare silicon and germanium diodes for cut-in voltage and magnitudes of diode currents from V-I characteristics using digital simulation.
WEEK II	**ZENER DIODE CHARACTERISTICS AND VOLTAGE REGULATOR**
	(a) With experimental set up, determine knee voltage, breakdown voltage and line & load regulation characteristics for zener diode. (b) Design zener voltage regulator circuit with 6V output voltage using digital simulation. Choose the current limiting resistor and load resistor considering minimum break down current.
WEEK III	**HALF WAVE RECTIFIER**
	(a) Draw input and output characteristics of half wave rectifier and observe the effect of cut in voltage on the peak output voltage using hardware. (b) With capacitor and inductor filters observe the variation in ripple voltage for small, medium & high load currents for half wave rectifier using digital simulation.
WEEK IV	**FULL WAVE RECTIFIER**
	(a) For full wave rectifier with centre tapped transformer draw the input and output waveforms using hardware. (b) Design full wave rectifier with appropriate filter so that ripple voltage is independent of load current using digital simulation.

WEEK V	**TRANSISTOR CB CHARACTERISTICS**
	(a) Determine the input and output characteristics of CB configuration and compute the following h – parameters. i) Input resistance (hib) Ohms ii) Reverse voltage transfer ratio (hrb) iii) Output admittance (hob) Mhos iv) Forward current gain (hfb) Also clearly identify active, cutoff and saturation regions on V-I characteristics using hardware. (b) Demonstrate the characteristics of pnp transistor in CB configuration, identifying active, cutoff and saturation regions with digital simulation. Mark the collector-emitter voltage (VCE) when transition from saturation to active region occurs.
WEEK VI	**TRANSISTOR CE CHARACTERISTICS**
	(a) For CE configuration, compare the h – parameters i) input resistance (hie) Ohms ii) reverse Voltage transfer Ratio (hre) iii)Output admittance (hoe) Mhos. iv) Forward current gain (hfe) with those of CB configuration using hardware. (b) Design an electronic switch using CE configuration using digital simulation.
WEEK VII	**FREQUENCY RESPONSE OF CE AMPLIFIER**
	(a) Assess the gain and bandwidth of CE amplifier using hardware. (b) Model CE amplifier with voltage gain of -24 and current gain -50 using digital simulation.
WEEK VIII	**FREQUENCY RESPONSE OF CC AMPLIFIER**
	(a) Construct CC amplifier and determine the gain and bandwidth using hardware. (b) Design a CC amplifier with current gain of 40 with suitable assumptions using digital simulation.
WEEK IX	**FREQUENCY RESPONSE OF CB AMPLIFIER**
	(a) Observe the frequency response of CB amplifier and determine the gain and bandwidth using hardware. (b) With appropriate selection of components, design a CB amplifier with voltage gain of 50 using digital simulation.
WEEK X	**UJT CHARACTERISTICS**
	(a) Verification of V-I Characteristics of uni- junction transistor and identify the negative resistance region using hardware. Also mark peak and valley points. (b) Design relaxation oscillator with uni -junction Transistor with digital simulation.
WEEK XI	**SCR CHARACTERISTICS**
	(a) Obtain the V-I Characteristics of SCR and determine the break down voltage and holding current using hardware. (b) Design battery charger circuit using silicon control rectifier using digital simulation.
WEEK XII	**FET CHARACTERISTICS**
	(a) From the observation table, draw the drain and transfer characteristics of field effect transistor using hardware. From the characteristics, calculate the values of dynamic resistance (rD) and trans-conductance (gm). (b) Demonstrate how FET can be used as voltage variable resistor (VVR) for small ac signals using digital simulation.

WEEK XIII	**FREQUENCY RESPONSE OF CS AMPLIFIER**
	(a) Observe frequency response of common source FET amplifier using hardware and determine the gain and bandwidth. (b) Design common source amplifier with voltage gain -10 and output impedance of 7 kΩ using digital simulation.
WEEK XIV	**FREQUENCY RESPONSE OF CD AMPLIFIER**
	(a) For common drain FET amplifier, draw the gain vs frequency graph using hardware and determine the bandwidth. (b) Construct common source follower amplifier with output impedance of 300 kΩ. Measure phase difference between input and output using digital simulation.

TEXTBOOKS

1. J. Millman, C.C.Halkias, Millman's, "Integrated Electronics", Tata McGraw Hill, 2nd Edition, 2001.
2. J.Millman, C.C.Halkias and satyabrata Jit, "Millman's Electronic Devices and circuits", Tata McGraw Hill, 2nd edition, 1998

REFERENCE BOOKS:

1. Mohammad Rashid, "Electronic Devices and Circuits", Cengage learning, 1st Edition, 2014.
2. David A. Bell, "Electronic Devices and Circuits", Oxford University Press, 5th Edition, 2009.

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	pn diode characteristics.	CO 2	T1: 3.1
2	Zener diode characteristics and voltage regulator	CO 2	T1: 3.11
3	Half wave rectifier	CO 3	T1: 4.6
4	Full wave rectifier.	CO 3	T1: 4.8
5	Transistor CB characteristics	CO 4	T1: 5.5
6	Transistor CE characteristics	CO 4	T1: 5.6
7	Frequency response of CE amplifier.	CO 5 CO 9	T1: 8.3
8	Frequency response of CC amplifier.	CO 5 CO 9	T1: 8.3
9	Frequency response of CB amplifier.	CO 5 CO 9	T1: 8.3
10	UJT characteristics.	CO 6	T1: 9.2
11	SCR characteristics	CO 7	T1:9.3
12	FET characteristics	CO 8	T1:10.6
13	Frequency response of CS amplifier	CO 5 CO 9	T1: 10.7
14	Frequency response of CD amplifier	CO 5 CO 9	T1: 10.7

XX EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Probing Further Experiments
1	Design high pass filter using bipolar junction transistor to produce the gain of 150.
2	Construct and verify the JFET's ability to behave as a voltage-controlled current regulator.
3	Design and verify the functionality of waveform clipper using Zener diode.
4	Construct and verify Battery Charger using SCR
5	Design the relaxation oscillator using Uni Junction Transistor.
6	Plot the V-I Characteristics of germanium diode and find the cut in voltage of diode.
7	Design diode acts as switch and plot the switching times of diode.
8	Design a zener voltage regulator circuit to drive a load of 6V, 100mW from an unregulated input supply of V_{min} = 8V, V_{max} = 12V using a 6V zener diode?
9	Design square wave generator using zener diode.
10	Design for a Zener Transistor series voltage regulator circuit to drive a load of 6V, 1W, from a supply of 10V with a ±3V ripple voltage
11	Design half wave rectifier with an applied input a.c. power is 100 watts, and it is to deliver an output power is 40 watts.
12	Design half wave rectifier with an a.c. supply of 230 V is applied through a transformer of turn ratio 10:1. Observe the output d.c. voltage, peak inverse voltage and identify dc output voltage if transformer turns ratio changed to 20:1.
13	Design a full wave rectifier with step down transformer and center tapped transformer. Justify the operation.
14	Design Full wave rectifier with capacitive filter using 10uF and 1uF. Observe the ripple factor.
15	Describe, based on your observations, the I-V curves of npn transistor. At approximately what collector-emitter voltage (V_{CE}) does the transition from saturation to active region occur?
16	Demonstrate the characteristics of Common base PNP transistor to determine the h parameters.
17	Design a Sustainable Relay Driving Circuit Using BJT.
18	Design an electronic switch using CE configuration.
19	Measure the DC voltages to make sure the BJT is in the forward active region. If it's not in forward active, adjust your resistor values to compensate.
20	Measure the voltage gain. Adjust the input signal from your wavetek to approximately 10mV amplitude, with a frequency of 100 kHz. What is the voltage swing?
21	Connect the common collector amplifier circuit you designed. Set the values of capacitors C1, C2, and C3 to 1uF each. Set R_L to be 1 kΩ and the supply voltage to 15V DC. Measure the DC bias voltages on the base, emitter and the collector. Calculate the collector current. Compare the measured voltages with the design intent and calculation. Tabulate the measured versus the calculated bias voltages and current.

22	Measure the frequency response of the amplifier starting from 100 Hz. change the test frequency to cover the upper cut-off frequency of the amplifier. Throughout the measurement of the frequency response, apply low input signal levels (in the order of few milli-Volts) to ensure that the output signal is not distorted. Monitor both input and output waveforms on the oscilloscope.
23	Design and observe the characteristics of relaxation oscillator using Uni-Junction Transistor.
24	Design Voltage sensing with a unijunction transistor and observe the characteristics.
25	Design battery charger circuit using silicon control rectifier.
26	Observe the characteristics of RC half wave and full wave Firing Circuit using silicon control rectifier.
27	Obtain the transistor drain characteristics in the saturated region, by applying the V_{MAX} is 40V, I_{MAX} is 20 mA and P_{MAX} is 0.4W.
28	Junction field-effect transistors (JFETs) are normally-on devices, the natural state of their channels being passable to electric currents. Thus, a state of cutoff will only occur on command from an external source. Explain what must be done to a JFET, specifically, to drive it into a state of cutoff.
29	Build the CS amplifier circuit using $V_{DD} = V_{SS} = 5$ V. Select 50 kΩ potentiometer and adjust it to obtain 250 µA bias current. Select $R_S = 10$ kΩ.
30	Obtain the frequency response of MOSFET amplifier in common source configuration.
31	Design and Plot the frequency response of single stage RC coupled amplifier using JFET.
32	Design a MOSFET amplifier and plot frequency response based on the given specifications. Both the input and the output should be AC coupled. Dual Supply Voltage = ±5V Load Resistance, R_L = 100Ω 0-to-Peak Output Swing is gtreaterthan or equal to 2V Voltage Gain= 50 Input Resistance= 10kΩ

Signature of Course Coordinator
Mr. Seshagiri Rao V.R, Associate Professor **HOD,ECE**

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**

PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	**10**
PO 4.	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**

PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**

PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project. 6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	**12**
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**

PO11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**
PSO1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications 1. Analyze and solve real time problems in Robotics 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications 3. Develop embedded systems modules using Real Time Operating System 4. Undertake research and development projects in the field of Embedded Systems 5. Adopt the engineering professional code and conduct	**5**

PSO2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs 1. Inspect, survey and analyze types of ASIC chip designs 2.Design ASIC prototypes using Verilog and VHDL languages 3. Analyze microprocessor subsystems with memories and I/O interfacs for SOC designs 4. Explore hardware components for designig SOC 5. Adopt the engineering professional code and conduct 6.Designing prototypes of SOC using programming tools like MATLAB, LabVIEW 7.Familiarize with the design flow of ASIC prototype 8.Realize SOC using Register-Transfer-Level designs 9. Analyse and develop models for system level descriptions for synthesis of SOC 10. Inspect and survey the abstractions and principles for the specification, simulation, verification, and synthesis of systems on chip (SoC) 11. Programming and hands-on skills to meet requirements of global environment	**11**
PSO3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications 1. Explicit software and programming tools for antenna design 2. Adopt technical library resources and literature search 3. Explore smart antennas 4. Model, program for operation and control of smart antennas for wireless communication applications 5. Interface automation tools 6. Research, analysis, problem solving and presentation using software aids 7.Programming and hands-on skills to meet requirements of global environment	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING
COURSE DESCRIPTION

Course Title	DIGITAL SYSTEM DESIGN LABORATORY				
Course Code	AECC06				
Program	B.Tech				
Semester	III				
Course Type	Laboratory				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	2	1
Course Coordinator	Mrs. S Swathi, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECC03	III	Digital System Design

II COURSE OVERVIEW:

The digital system design laboratory introduces the hardware description language for the design and development of digital integrated circuits and field programmable devices. It provides VHDL language elements, synthesizable register transfer logic models in structuaral, dataflow, behavioral modeling of combinational and sequential circuits. Includes applications in the area of VLSI system design.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Virtual Instrumentation Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	To test the preparedness for the experiment.	-
20 %	To test the performance in the laboratory.	-
20 %	To test the calculations and graphs related to the concern experiment.	-
20 %	To test the results and the error analysis of the experiment.	-
20 %	To test the subject knowledge through viva – voce.	-

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component	**Laboratory**		**Total Marks**
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
-	-	-	-	-	-

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

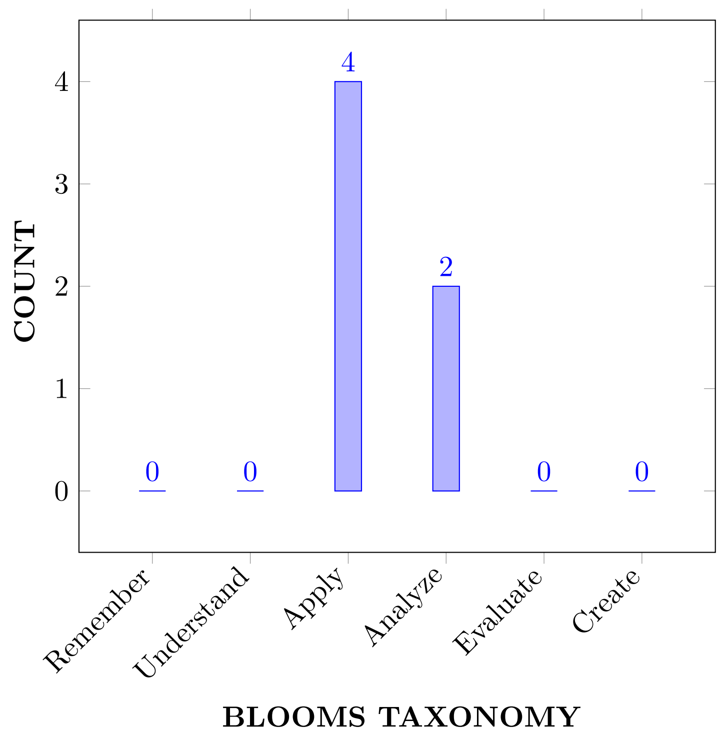
I	The fundamental principles of the VHDL and its constructs used in design implementation of digital logic systems.
II	The concepts of behavioral, dataflow and structural modeling of fundamental digital logic circuits using VHDL.
III	The exposure to various stages of a typical state of the art CAD VLSI tool for simulation, synthesis, place and route, layout and power and clock routing modules.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Utilize** the concept of Boolean algebra to verify the truth table of Boolean expressions using logic gates in Hardware Description Language.	Apply
CO 2	**Make use** of dataflow, structural and behavioral modelling styles of HDL for simulating the combinational logic circuits.	Apply
CO 3	**Analyze** the truth tables and characteristic equations of flip flops for the functional simulation and timing analysis of sequential circuits.	Analyze
CO 4	**Construct** the synchronous and asynchronous sequential circuits using the flip flops.	Apply
CO 5	**Model** a finite state machine with melay and moore machines for detecting a given sequence.	Apply
CO 6	**Examine** the functionality of real time traffic light controller, chess clock controller FSM, elevator operations using HDL code.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Lab Experiments / CIE / SEE

PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	Lab Experiments / CIE / SEE
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	Lab Experiments / CIE / SEE
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	3	Lab Experiments / CIE / SEE
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	2	Lab Experiments / CIE / SEE
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	Lab Experiments / CIE / SEE

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		**Strength**	**Proficiency Assessed by**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	1	Lab Experiments / CIE / SEE

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	**PROGRAM OUTCOMES**												**PSO'S**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	✓	-	-	-	-	✓	-	-	-	-	-
CO 2	✓	✓	✓	-	✓	-	-	-	-	✓	-	-	-	-	-
CO 3	-	✓	-	-	✓	-	-	-	-	✓	-	-	-	-	-
CO 4	✓	✓	-	-	✓	-	-	-	-	✓	-	-	-	-	-
CO 5	-	✓	✓	-	✓	-	-	-	-	✓	-	-	-	✓	-
CO 6	-	✓	✓	-	✓	-	-	-	✓	✓	-	-	-	✓	-

XII JUSTIFICATIONS FOR CO – PO / PSO) MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies matched.
CO 1	PO 1	Apply the **mathematical principles, scientific principles and methodology** of boolean algebra to understand the function of logic gates	2
	PO 2	Understand the given **problem statement** and **formulate** the engineering problems related to minimization of boolean functions, **translate the information** into the model and prototype systems from the provided **information and data, develop solutions** based on the functionality of the data translation, validate the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	5
	PO 5	Create a program for boolean expressions in VHDL and verify the outputs using **modern engineering tool.**	1
	PO 10	Describe the basic function of logic gates and implementation of boolean functions primitives by **giving effective presentations** and **take clear instructions**	2
CO 2	PO 1	Apply the **mathematical principles, scientific principles and methodology** of combinational circuits for simulating them in data flow,structural and behavioral modelling styles	2
	PO 2	Understand the given **problem statement** and **formulate** the engineering problems related to combinational logic circuits, **translate the information** into the model and prototype systems from the provided **information and data, develop** t the VHDL code and validate the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	5
	PO 3	**Understand the customer needs, investigate and define a problem, use creativity** and **manage design process** to model the complex combinational logic circuits making use of dataflow, behavioral and structural modeling styles in VHDL with the help of **modern engineering tools.**	5
	PO 5	Simulate the combinational circuits in VHDL using data flow or structural or behavioral models using **modern engineering tool**	1
	PO 10	Describe the implementation of combinational logic circuits using three modelling styles in VHDL by **giving effective presentations** and **take clear instructions**	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies matched.
CO 3	PO 2	Understand the given **problem statement** and **formulate** the engineering problems related to sequential logic circuits, **translate the information** into the model and prototype systems from the provided **information and data, develop** the VHDL code and validate the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	5
	PO 5	Verify the functional simulation and timing analysis sequential circuits using **modern engineering tool**.	1
	PO 10	Describe the implementation of sequential logic circuits using three modelling styles in VHDL by **giving effective presentations** and **take clear instructions**	2
CO 4	PO 1	**Apply the knowledge of mathematics, science, engineering fundamentals** to design universal shift registers	2
	PO 2	Understand the given **problem statement** and **formulate** the engineering problems in shift registers and counters, **translate the information** into the model and prototype systems from the provided **information and data, develop** the VHDL code and validate the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	5
	PO 5	Analyze the functional simulation and timing analysis of shift registers using **modern engineering tools**.	1
	PO 10	**Describe** the implementation of shift registers in VHDL by **giving effective presentations and take clear instructions**	2
CO 5	PO 2	Understand the given **problem statement** and **formulate** the engineering problems in the design and implementation of finite state machines, **translate the information** into the model and prototype systems from the provided **information and data, develop** t the VHDL code and validate the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	5
	PO 3	**Understand the customer needs, investigate and define a problem, use creativity** and **manage design process** and **establish innovative solutions** in designing the finite state machines using VHDL with the help of **modern engineering tools.**	6
	PO 5	Model the finite state machines and verify functional simulation using **modern engineering tool**	1
	PO 10	Describe the implementation of FSM in VHDL by **giving effective presentations** and **take clear instructions**	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies matched.
	PSO 2	**Design ASIC prototypes** by **adopting engineering professional code in VHDL** for the implementation of FSM to **familiarize with the ASIC design flow**, **realize RTL schematic** and **analyze the synthesis of SOC**	5
CO 6	PO 2	Understand the given **problem statement** and **formulate** the engineering problems in the design and implementation of basic real time applications of the digital circuits, **translate the information** into the model and prototype systems from the provided **information and data, develop** t the VHDL code and validate the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	5
	PO 3	**Understand the customer needs, investigate and define a problem, use creativity** and **manage design process** and **establish innovative solutions** in basic real time applications of the digital circuits like traffic light controller ,chess clock controller, elevator using **modern engineering tools.**	6
	PO 5	Build the real time applications of digital circuits and simulate in VHDL using **modern engineering tool.**	1
	PO 9	improves the **ability work with teams** includes **all levels of people, independently, maturely giving self directions** while performing the lab experiments	5
	PO 10	Describe the implementation of real time applications as traffic light controller, chess clock controller and elevator in VHDL by **giving effective presentations** and **take clear instructions**	2
	PSO 2	**Design ASIC prototypes** by **adopting engineering professional code in VHDL** for the implementation of real time applications to **familiarize with the ASIC design flow**, **realize RTL schematic** and **analyze the synthesis of SOC**	5

Note: For Key Attributes refer **Annexure - I**

XIII MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	**10**	**10**	**11**	**1**	**5**	**3**	**3**	**12**	**5**	**12**	**8**	**5**	**11**	**7**
CO 1	2	5	-	-	1	-	-	-	-	2	-	-	-	-	-
CO 2	2	5	5	-	1	-	-	-	-	2	-	-	-	-	-
CO 3	-	5	-	-	1	-	-	-	-	2	-	-	-	-	-
CO 4	2	5	-	-	1	-	-	-	-	2	-	-	-	-	-

CO 5	-	5	6	-	1	-	-	-	-	2	-	-	-	5	-
CO 6	-	5	6	-	1	-	-	-	5	2	-	-	-	5	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO–(PO / PSO):

COURSE OUTCOMES	**PROGRAM OUTCOMES**												**PSO'S**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	**10**	**10**	**11**	**1**	**5**	**3**	**3**	**12**	**5**	**12**	**8**	**5**	**11**	**7**
CO 1	66.6	50	-	-	100	-	-	-	-	40	-	-	-	-	-
CO 2	66.6	50	-	-	100	-	-	-	-	40	-	-	-	-	-
CO 3	-	50	50	-	100	-	-	-	-	40	-	-	-	-	-
CO 4	66.6	50	-	-	100	-	-	-	-	40	-	-	-	-	-
CO 5	-	50	60	-	100	-	-	-	-	40	-	-	-	45.5	-
CO 6	-	50	60	-	100	-	-	-	41.6	40	-	-	-	45.5	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 - $0 \leq$ C<5% – No correlation

1 -5 <C< 40% – Low/ Slight

2 - 40 % <C < 60% –Moderate

3 - 60% < C < 100% – Substantial /High

COURSE OUTCOMES	**PROGRAM OUTCOMES**												**PSO'S**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	-	3	-	-	-	-	2	-	-	-	-	-
CO 2	3	2	-	-	3	-	-	-	-	2	-	-	-	-	-
CO 3	-	2	2	-	3	-	-	-	-	2	-	-	-	-	-
CO 4	3	2	-	-	3	-	-	-	-	2	-	-	-	-	-
CO 5	-	2	3	-	3	-	-	-	-	2	-	-	-	2	-
CO 6	-	2	3	-	3	-	-	-	2	2	-	-	-	2	-
TOTAL	**18**	**14**	**6**	**6**	**9**	**0**	**0**	**0**	**0**	**6**	**0**	**0**	**0**	**3**	**0**
AVERAGE	**3**	**2.3**	**2**	**2**	**3**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

WEEK-I	**REALIZATION OF A BOOLEAN FUNCTION:**
	(a) Realize three and four variable Boolean functions using VHDL code, verify its functionality by Zybo FPGA board. (b) Make use of universal logic gates to realize 3 variable boolean function and develop the VHDL code using Vivado tool.
WEEK-II	**DESIGN OF DECODER AND ENCODER:**
	(a) With the VHDL code verify the functionality of 3 to 8 decoder and 8 to 3 encoder (With priority and without priority). (b) Construct the 8 to 3 encoder using 2 to 4 encoder and develop the VHDL code in structural modeling.
WEEK-III	**DESIGN OF MULTIPLEXER AND DE MULTIPLEXER:**
	(a) Observe the functionality of 8x1 multiplexer and 1x8 de-multiplexer using VHDL code. (b) Build the 16x1 multiplexer using 2x1 multiplexers and simulate the VHDL code.
WEEK-IV	**DESIGN OF CODE CONVERTERS:**
	(a) Simulate the VHDL code for the 4- bit binary to gray, gray to binary code converter and comparator circuits. (b) Develop the VHDL code for gray code to self complementing code converter.
WEEK-V	**FULL ADDER AND FULL SUBTRACTOR DESIGN MODELLING:**
	(a) Verify the functionality of a full Adder and full subtractor using VHDL code in three modeling styles. (b) Extend the full adder to design the 4-bit ripple carry adder circuit and simulate the VHDL code.
WEEK-VI	**DESIGN OF 8 BIT ALU:**
	(a) Build a VHDL model to implement 8-bit ALU functionality.
	(b) Extend the HDL code to verify 16-bit arithmetic and logical shift operations using structural modelling.
WEEK-VII	**HDL MODEL FOR FLIP FLOPS:**
	(a) Examine the operation of SR, D, JK, T Flip flops by using VHDL code. (b) Realize the D flip – flop using JK Flip-flop, T flip – flop using D flip-flop and simulate the VHDL code.

WEEK-VIII	**DESIGN OF COUNTERS:**
	(a) Write VHDL code for binary counter, BCD counter with synchronous and asynchronous reset. (b) Verify the states of 4-bit ring and Johnson counter using VHDL code.
WEEK-IX	**HDL CODE FOR UNIVERSAL SHIFT REGISTER:**
	(a) Design and simulate the VHDL code for universal shift register. (b) Develop the VHDL code to implement shift register, verify its operation in SISO, SIPO, PISO and PIPO modes.
WEEK-X	**HDL CODE FOR CARRY LOOK AHEAD ADDER:**
	(a) Design and simulate the VHDL code for carry-look-ahead adder. (b) Compare the functionality, speed of ripple carry adder and carry-look-ahead adder. Justify the carry-look-ahead adders are faster than ripple carry adder.
WEEK-XI	**HDL CODE TO DETECT A SEQUENCE:**
	(a) Choose melay FSM model to detect the sequence 1010101 and develop the VHDL code. (b) Make use of moore FSM model to detect the sequence 1010101 and write the VHDL code.
WEEK-XII	**CHESS CLOCK CONTROLLER FSM USING HDL:**
	(a) Make use of FSM to design a chess clock controller using VHDL code. (b) Develop the VHDL code for a simple functional clock generator.
WEEK-XIII	**TRAFFIC LIGHT CONTROLLER USING HDL:**
	(a) Model the traffic light controller using VHDL code and simulate. (b) Extend the VHDL code for a traffic light controller which changes the green light time depending on the traffic in that specific lane.
WEEK-XIV	**ELEVATOR DESIGN USING HDL CODE:**
	(a) Write VHDL code to simulate Elevator operations. (b) Simulate the HDL code for a five-story elevator controller.

TEXT BOOKS:

1. Douglas Perry, "VHDL", Tata McGraw Hill, 4th Edition, 2002.
2. W.H. Gothmann, "Digital Electronics- An introduction to theory and practice", PHI, 2nd Edition,2006.

REFERENCE BOOKS

1. D.V. Hall, "Digital Circuits and Systems", Tata McGraw Hill, 1989.
2. Charles Roth, "Digital System Design using VHDL", Tata McGraw Hill 2nd Edition 2012

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	(a) a. Realize three and four variable Boolean functions using VHDL code, verify its functionality by Zybo FPGA board. (b) Make use of universal logic gates to realize 3 variable boolean function and develop the VHDL code using Vivado tool.	CO 1	T1 13.2
2	(a) With the VHDL code verify the functionality of 3 to 8 decoder and 8 to 3 encoder (With priority and without priority). (b) Construct the 8 to 3 encoder using 2 to 4 encoder and develop the VHDL code in structural modeling.	CO 2	T1 14.5
3	(a) Observe the functionality of 8x1 multiplexer and 1x8 de-multiplexer using VHDL code. (b) Build the 16x1 multiplexer using 2x1 multiplexers and simulate the VHDL code.	CO 2	T1 14.8
4	(a) Simulate the VHDL code for the 4- bit binary to gray, gray to binary code converter and comparator circuits. (b) Develop the VHDL code for gray code to self complementing code converter.	CO 2	T1 15.5 -15.9
5	(a) Verify the functionality of a full Adder and full subtractor using VHDL code in three modeling styles. (b) Extend the full adder to design the 4-bit ripple carry adder circuit and simulate the VHDL code.	CO 2	T1 15.17
6	(a) Build a VHDL model to implement 8-bit ALU functionality. (b) Extend the HDL code to verify 16-bit arithmetic and logical shift operations using structural modelling.	CO 2	T1 15.16
7	(a) Examine the operation of SR, D, JK, T Flip flops by using VHDL code. (b) Realize the D flip – flop using JK Flip-flop, T flip – flop using D flip-flop and simulate the VHDL code.	CO 3	T1 16.1, T1 16.8
8	(a) Write VHDL code for binary counter, BCD counter with synchronous and asynchronous reset. (b) Verify the states of 4-bit ring and Johnson counter using VHDL code.	CO 4	R1 4.1
9	(a) a. Design and simulate the VHDL code for universal shift register. (b) Develop the VHDL code to implement shift register, verify its operation in SISO, SIPO, PISO and PIPO modes.	CO 4	R1 4.2
10	(a) Design and simulate the VHDL code for carry-look-ahead adder. (b) Compare the functionality, speed of ripple carry adder and carry-look-ahead adder. Justify the carry-look-ahead adders are faster than ripple carry adder.	CO 2	R1 4.3

11	(a) Choose melay FSM model to detect the sequence 1010101 and develop the VHDL code. (b) Make use of moore FSM model to detect the sequence 1010101 and write the VHDL code.	CO 5	R2 4.6
12	(a) Make use of FSM to design a chess clock controller using VHDL code. (b) Develop the VHDL code for a simple functional clock generator.	CO 6	R2 4.10
13	(a) Model the traffic light controller using VHDL code and simulate. (b) Extend the VHDL code for a traffic light controller which changes the green light time depending on the traffic in that specific lane.	CO 6	R2 5.6
14	(a) Write VHDL code to simulate Elevator operations. (b) Simulate the HDL code for a five-story elevator controller.	CO 6	R2 5.9

XX EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	**Design Oriented Experiments**
1	Implementation of binary multiplier and simulate using simulation tool
2	Design a stepper motor/lcd controller and implement
3	LabVIEW & Design and simulation of 8-bit Booth's multiplier.

Course Coordinator **HOD,ECE**
Mrs. S Swathi, Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**

	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**

	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PSO1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications 1. Analyze and solve real time problems in Robotics 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications 3. Develop embedded systems modules using Real Time Operating System 4. Undertake research and development projects in the field of Embedded Systems 5. Adopt the engineering professional code and conduct	**5**
PSO2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs 1. Inspect, survey and analyze types of ASIC chip designs 2.Design ASIC prototypes using Verilog and VHDL languages 3. Analyze microprocessor subsystems with memories and I/O interfacs for SOC designs 4. Explore hardware components for designig SOC 5. Adopt the engineering professional code and conduct 6.Designing prototypes of SOC using programming tools like MATLAB, LabVIEW 7.Familiarize with the design flow of ASIC prototype 8.Realize SOC using Register-Transfer-Level designs 9. Analyse and develop models for system level descriptions for synthesis of SOC 10. Inspect and survey the abstractions and principles for the specification, simulation, verification, and synthesis of systems on chip (SoC) 11. Programming and hands-on skills to meet requirements of global environment	**11**

PSO3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications 1. Explicit software and programming tools for antenna design 2. Adopt technical library resources and literature search 3. Explore smart antennas 4. Model, program for operation and control of smart antennas for wireless communication applications 5. Interface automation tools 6. Research, analysis, problem solving and presentation using software aids 7.Programming and hands-on skills to meet requirements of global environment	**7**

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INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043
ELECTRONICS AND COMMUNICATION ENGINEERING
COURSE DESCRIPTION

Course Title	DATA STRUCTURES LABORATORY				
Course Code	ACSC10				
Program	B.Tech				
Semester	III	ECE			
Course Type	Core				
Regulation	IARE - UG 20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Ms. K Laxminarayanamma, Assistant Professor				

I COURSE OVERVIEW:

The course covers some of the general-purpose data structures and algorithms, and software development. Topics covered include managing complexity, analysis, static data structures, dynamic data structures and hashing mechanisms. The main objective of the course is to teach the students how to select and design data structures and algorithms that are appropriate for problems that they might encounter in real life. This course reaches to student by power point presentations, lecture notes, and lab which involve the problem solving in mathematical and engineering areas

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC02	I	Python Programming Laboratory
B.Tech	ACSC08	III	Data Structures

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Data Structures Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

I	To provide students with skills needed to understand and analyze performance trade-offs of different algorithms / implementations and asymptotic analysis of their running time and memory usage.

II	To provide knowledge of basic abstract data types (ADT) and associated algorithms: stacks, queues, lists, tree, graphs, hashing and sorting, selection and searching. .
III	The fundamentals of how to store, retrieve, and process data efficiently.
IV	To provide practice by specifying and implementing these data structures and algorithms in Python.
V	Understand essential for future programming and software engineering courses.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Identify** appropriate searching technique for efficient retrieval of data stored location. .	Apply
CO 2	**choose** sorting technique to represent data in specified format to to optimize data searching.	Apply
CO 3	**Make use of** stacks and queues representation, operations and their applications to organize specified data	Understand
CO 4	**utilize** linked lists to implement and perform operations for for organizing specified data	Apply
CO 5	**Construct** tree to perform different traversal techniques	Apply
CO 6	**Select** Appropriate graph traversal techniques to visit the vertices of a graph	Remember

COURSE KNOWLEDGE COMPETENCY LEVEL

VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Lab Exercises
PO 2	**Problem Analysis:** Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences	3	Lab Exercises
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	Lab Exercises
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions	2	Lab Exercises
PO 5	**Modern Tool Usage:**Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	1	Lab Exercises
PO 6	**The Engineer and Society** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice	2	Lab Exercises
PO 8	**Ethics** Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice	3	Lab Exercises
PO 9	**Individual and Teamwork** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings	3	Lab Exercises
PO 10	**Communication:** Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions	4	Lab Exercises

PO 12	**Life - Long Learning:**Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	3	Lab Exercises

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		**Strength**	**Proficiency Assessed by**
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	2	Lab Exercises
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	2	Lab Exercises
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.	2	Lab Exercises

3 = High; 2 = Medium; 1 = Low

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	**Justification for mapping (Students will be able to)**	No. of Key Competencies
CO 1	PO 1	Identify appropriate searching technique for efficient retrieval of data stored location by applying the **principles of Mathematics and Engineering** , **Scientific principles and methodology**,**engineering disciplines to integrate / support study**	3
	PO 2	Identify appropriate searching technique for efficient retrieval of data stored location by applying Problem Analysis **Problem statement and system definition**,**Information and data collection**,**Solution development or experimentation / Implementation**	3
	PO 3	**Identify** appropriate searching technique for efficient retrieval of data stored location by applying **Design/Development of Solutions**	3
	PO 4	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by applying **Conduct Investigations of Complex Problems**	2
	PO 5	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by applying Computer software / simulation packages / diagnostic equipment / technical library resources / literature search toolsl	1

	PO 6	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by applying **reasoning informed by the contextual knowledge**	2
	PO 8	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by applying **ethical principles** and commit to professional **ethics and responsibilities** and norms of the Engineering practice	3
	PO 9	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by applying Function **effectively** as an individual, and as a member or leader to get Ability to work with all levels of people in an organization	3
	PO 10	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by **Communicate effectively** on **complex Engineering activities**	3
	PO 12	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by **Keeping current in CSE and advanced engineering concepts**	3
	PSO 1	Identify appropriate searching technique for efficient retrieval of data stored location in **search engines**	2
	PSO 2	Identify appropriate searching technique for efficient retrieval of data stored location in **mobile and web applications development**	2
	PSO 3	Identify appropriate searching technique for efficient retrieval of data stored location **in shipping real world software, using industry standard tools**	3
CO 2	PO 1	choose sorting technique to represent data in specified format to optimize data searching by applying the **principles of Mathematics and Engineering** , **Scientific principles and methodology**,**engineering disciplines to integrate / support study**	3
	PO 2	choose sorting technique to represent data in specified format to optimize data searching by applying Problem Analysis **Problem statement and system definition**,**Information and data collection**,**Solution development or experimentation / Implementation**	3
	PO 3	**Identify** choose sorting technique to represent data in specified format to optimize data searching by applying **Design/Development of Solutions**	3
	PO 4	**choose** sorting technique to represent data in specified format to optimize data searching by applying **Conduct Investigations of Complex Problems**	2
	PO 5	choose sorting technique to represent data in specified format to optimize data searching by applying Computer software / simulation packages / diagnostic equipment / technical library resources / **literature search toolsl**	1
	PO 6	choose sorting technique to **represent** data in specified format to optimize data searching by applying **reasoning informed by the contextual knowledge**	2

	PO 8	**choose** sorting technique to represent data in specified format to optimize data searching by applying **ethical principles** and commit to professional **ethics and responsibilities** and norms of the Engineering practice	3
	PO 9	choose sorting technique to **represent** data in specified format to optimize data searching by applying Function **effectively** as an individual, and as a member or leader to get Ability to work with all levels of people in an organization	3
	PO 10	choose**Apply** sorting technique to represent data in specified format to optimize data searching by **Communicate effectively** on **complex Engineering activities**	3
	PO 12	**choose** sorting technique to **represent** data in specified format to optimize data searching by **Keeping current in CSE and advanced engineering concepts**	3
	PSO 1	choose**Apply** sorting technique to represent data in specified format to optimize data searching in **search engines**	2
	PSO 2	choose**Apply** sorting technique to represent data in specified format to optimize data searching in **mobile and web applications development**	2
	PSO 3	choose**Apply** sorting technique to represent data in specified format to optimize data searching **in shipping real world software, using industry standard tools**	3
CO 3	PO 1	Make use of stacks and queues representation, operations and their applications to organize specified data by applying the **principles of Mathematics and Engineering** , **Scientific principles and methodology**,**engineering disciplines to integrate / support study**	3
	PO 2	Make use of stacks and queues representation, operations and their applications to organize specified data by applying Problem Analysis **Problem statement and system definition**,**Information and data collection**,**Solution development or experimentation / Implementation**	3
	PO 3	**Identify**, **Make use of** stacks and queues representation, operations and their applications to organize specified data by applying **Design/Development of Solutions**	3
	PO 4	Make use of **Apply**stacks and queues representation, operations and their applications to organize specified data by applying **Conduct Investigations of Complex Problems**	2
	PO 5	Make use of stacks and queues representation, operations and their applications to organize specified data by applying Computer software / simulation packages / diagnostic equipment / technical library resources / **literature search tools**	1

	PO 6	**Make use of** stacks and queues representation, operations and their applications to organize specified data by applying **reasoning informed by the contextual knowledge**	2
	PO 8	Make use of stacks and queues **representation**, operations and their applications to organize specified data by applying **ethical principles** and commit to professional **ethics and responsibilities** and norms of the Engineering practice	3
	PO 9	**Make use of** stacks and queues representation, operations and their applications to organize specified data by applying Function **effectively** as an individual, and as a member or leader to get Ability to work with all levels of people in an organization	3
	PO 10	Make use of stacks and queues representation, **operations and their applications** to organize specified data by **Communicate effectively** on **complex Engineering activities**	3
	PO 12	Make use of stacks and queues **representation**, operations and their applications to organize specified data by **Keeping current in CSE and advanced engineering concepts**	3
	PSO 1	Make use of stacks and queues **representation**, operations and their applications to organize specified data in **search engines**	2
	PSO 2	Make use of stacks and queues **representation**, operations and their applications to organize specified data **mobile and web applications development**	2
	PSO 3	Make use of stacks and queues **representation**, operations and their applications to organize specified data **in shipping real world software, using industry standard tools**	2
CO 4	PO 1	utilize linked lists to implement and perform operations for organizing specified data by applying the **principles of Mathematics and Engineering** , **Scientific principles and methodology**,**engineering disciplines to integrate / support study**	3
	PO 2	utilize linked lists to implement and perform operations for organizing specified data by applying Problem Analysis **Problem statement and system definition**,**Information and data collection**,**Solution development or experimentation / Implementation**	3
	PO 3	utilize**Apply** linked lists to **implement** and perform operations for organizing specified data by applying **Design/Development of Solutions**	3
	PO 4	utilize linked lists to **implement** and perform operations for organizing specified data by applying **Conduct Investigations of Complex Problems**	2

	PO 5	utilize linked lists to implement and perform operations for organizing specified data by applying Computer software / simulation packages / diagnostic equipment / technical library resources / **literature search toolsl**	1
	PO 6	utilize linked lists to implement and perform operations for organizing specified data by applying **reasoning informed by the contextual knowledge**	2
	PO 8	utilize linked lists to **implement** and perform operations for organizing specified data by applying **ethical principles** and commit to professional **ethics and responsibilities** and norms of the Engineering practice	3
	PO 9	utilize **Apply**linked lists to implement and perform operations for organizing specified data by applying Function **effectively** as an individual, and as a member or leader to get Ability to work with all levels of people in an organization	3
	PO 10	utilize linked lists to implement and **perform** operations for organizing specified data by **Communicate effectively** on **complex Engineering activities**	3
	PO 12	utilize**Apply** linked lists to implement and perform operations for organizing specified data by **Keeping current in CSE and advanced engineering concepts**	3
	PSO 1	utilize**Apply** linked lists to implement and perform operations for organizing specified in **search engines**	2
	PSO 2	utilize**Apply** linked lists to implement and perform operations for organizing specified in **mobile and web applications development**	2
	PSO 3	utilize**Apply** linked lists to implement and perform operations for organizing specified **in shipping real world software, using industry standard tools**	2
CO 5	PO 1	Construct tree to perform different traversal techniques by applying the **principles of Mathematics and Engineering** , **Scientific principles and methodology**,**engineering disciplines to integrate / support study**	3
	PO 2	Construct tree to perform different traversal techniques by applying Problem Analysis **Problem statement and system definition**,**Information and data collection**,**Solution development or experimentation / Implementation**	3
	PO 3	Construct**Apply** tree to **perform** different traversal techniques by applying **Design/Development of Solutions**	3
	PO 4	**Construct** tree to perform different traversal techniques by applying **Conduct Investigations of Complex Problems**	2

	PO 5	Construct tree to perform different traversal techniques by applying Computer software / simulation packages / diagnostic equipment / technical library resources / **literature search tools**	1
	PO 6	Construct tree to **perform** different traversal techniquesby applying **reasoning informed by the contextual knowledge**	2
	PO 8	ConstructApply tree to perform different traversal techniques by applying **ethical principles** and commit to professional **ethics and responsibilities** and norms of the Engineering practice	3
	PO 9	Construct tree to perform different traversal techniquesby applying Function **effectively** as an individual, and as a member or leader to get Ability to work with all levels of **people in an organization**	3
	PO 10	Construct tree to **perform** different traversal techniques by **Communicate effectively** on **complex Engineering activities**	3
	PO 12	**Construct** tree to perform different traversal techniques by **Keeping current in CSE and advanced engineering concepts**	3
	PSO 1	Construct tree to **perform** different traversal techniques in **search engines**	2
	PSO 2	Construct tree to **perform** different traversal techniques in **mobile and web applications development**	2
	PSO 3	Construct tree to **perform** different traversal techniques **in shipping real world software, using industry standard tools**	2
CO 6	PO 1	Select Appropriate graph traversal techniques to visit the vertices of a graph by applying the **principles of Mathematics and Engineering** , **Scientific principles and methodology**,**engineering disciplines to integrate / support study**	3
	PO 2	Select Appropriate graph traversal techniques to visit the vertices of a graph by applying Problem Analysis **Problem statement and system definition**,**Information and data collection**,**Solution development or experimentation / Implementation**	3
	PO 3	Select Appropriate graph traversal techniques to visit the vertices of a graph by applying **Design/Development of Solutions**	3
	PO 4	**Select** Appropriate graph traversal techniques to visit the vertices of a graph by applying **Conduct Investigations of Complex Problems**	2
	PO 5	Select Appropriate graph traversal techniques to visit the vertices of a graph by applying Computer software / simulation packages / diagnostic equipment / technical library resources / **literature search tools**	1

	PO 6	**Select** Appropriate graph traversal techniques to visit the vertices of a graph by applying **reasoning informed by the contextual knowledge**	2
	PO 8	**Select** Appropriate graph traversal techniques to visit the vertices of a graph by applying **ethical principles** and commit to professional **ethics and responsibilities** and norms of the Engineering practice	3
	PO 9	**Select** Appropriate graph traversal techniques to visit the vertices of a graph by applying Function **effectively** as an individual, and as a member or leader to get Ability to work with all levels of people in an organization	3
	PO 10	**Select** Appropriate graph traversal techniques to visit the vertices of a graph by **Communicate effectively** on **complex Engineering activities**	3
	PO 12	**Select** Appropriate graph traversal techniques to visit the vertices of a graph by **Keeping current in CSE and advanced engineering concepts**	3
	PSO 1	**Select** Appropriate graph traversal techniques to visit the vertices of a graph in **search engines**	2
	PSO 2	**Select** Appropriate graph traversal techniques to visit the vertices of a graph in **mobile and web applications development**	2
	PSO 3	**Select** Appropriate graph traversal techniques to visit the vertices of a graph **in shipping real world software, using industry standard tools**	2

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	**Program Outcomes/ No. of Key Competencies Matched**												**PSO'S**		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3	2	2	3	1	-	1	2	3	-	2	2	1	1
CO 2	1	2	2	2	3	1	-	2	3	3	-	2	1	1	1
CO 3	1	2	2	1	3	1	-	-	2	3	-	2	2	2	-
CO 4	1	2	1	1	3	1	-	-	2	3	-	2	2	1	1
CO 5	1	1	2	1	3	1	-	2	2	3	-	2	2	1	1
CO 6	1	1	2	1	3	1	-	1	3	3	-	2	2	1	1

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK I	**SEARCHING TECHNIQUES**
	Write Python programs for implementing the following searching techniques. a. Linear search. b. Binary search. c. Fibonacci search.
WEEK II	**SORTING TECHNIQUES**
	Write Python programs for implementing the following sorting techniques to arrange a list of integers in ascending order. a. Bubble sort. b. Insertion sort. c. Selection sort
WEEK III	**SORTING TECHNIQUES**
	Write Python programs for implementing the following sorting techniques to arrange a list of integers in ascending order. a. Quick sort. b. Merge sort.
WEEK IV	**IMPLEMENTATION OF STACK AND QUEUE**
	Write Python programs to a. Design and implementation Stack and its operations using Arrays. b. Design and implementation Queue and its operations using Arrays
WEEK V	**APPLICATIONS OF STACK**
	Write Python programs for the following: a. Uses Stack operations to convert infix expression into postfix expression. b. Uses Stack operations for evaluating the postfix expression.
WEEK VI	**IMPLEMENTATION OF SINGLE LINKED LIST**
	Write Python programs for the following: a. Uses functions to perform the following operations on single linked list. (i) Creation (ii) insertion (iii) deletion (iv) traversal b. To store a polynomial expression in memory using linked list.
WEEK VII	**IMPLEMENTATION OF CIRCULAR SINGLE LINKED LIST**
	Write Python programs for the following: Uses functions to perform the following operations on Circular linked list. (i) Creation (ii) insertion (iii) deletion (iv) traversal
WEEK VIII	**IMPLEMENTATION OF DOUBLE LINKED LIST**
	Write Python programs for the following: Uses functions to perform the following operations on double linked list. (i) Creation (ii) insertion (iii) deletion (iv) traversal in both ways.
WEEK IX	**IMPLEMENTATION OF STACK USING LINKED LIST**
	Write Python programs to implement stack using linked list.
WEEK X	**IMPLEMENTATION OF QUEUE USING LINKED LIST**
	Write Python programs to implement queue using linked list.
WEEK XI	**GRAPH TRAVERSAL TECHNIQUES**
	Write Python programs to implement the following graph traversal algorithms: a. Depth first search. b.Breadth first search.

WEEK XII	**IMPLEMENTATION OF BINARY SEARCH TREE**
	Write a Python program that uses functions to perform the following: a. Create a binary search tree. b.Traverse the above binary search tree recursively in pre-order, post-order and in-order. c. Count the number of nodes in the binary search tree.

TEXTBOOKS

1. Rance D. Necaise, "Data Structures and Algorithms using Python", Wiley Student Edition.
2. Benjamin Baka, David Julian, "Python Data Structures and Algorithms", Packt Publishers, 2017.

REFERENCE BOOKS:

1. Michael H Goldwasser, David Letscher, —Object Oriented Programming in Python‖, Prentice Hall, 1 st Edition, 2007.
2. Yashavant Kanetkar, Aditya Kanetkar, —Let us Python‖, BPB publication, 1st Edition, 2019.
3. Ashok Kamthane, Amit Kamthane, —Programming and Problem Solving with Python‖, McGraw Hill Education (India) Private Limited, 2018.
4. Taneja Sheetal, Kumar Naveen, —Python Programming – A modular approach‖, Pearson, 2017.
5. R Nageswara Rao, —Core Python Programming‖, Dreamtech Press, 2017 Edition.

WEB REFERENCES:

1. https://realpython.com/python3-object-oriented-programming
2. https://python.swaroopch.com/oop.html
3. https://python-textbok.readthedocs.io/en/1.0/Object-Oriented-Programming.html
4. https://www.programiz.com/python-programming/
5. . https://www.geeksforgeeks.org/python-programming-language

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Searching Techniques	CO 1	T1
2	Sorting Techniques.	CO 2	T1
3	Sorting Techniques	CO 2	T1,T2
4	Implementation of Stack and Queue	CO 3	T1,T2
5	Applications of Stack.	CO 3	T1, W1
6	Implementation of Single Linked List	CO 4	T1,W2
7	Implementation of Circular Single Linked List.	CO 4	T1,W3

8	Implementation of Double Linked List	CO 4	T2,W3
9	Implementation of Stack Using Linked List.	CO 3,CO 4	T2,W2
10	Implementation of Queue Using Linked List	CO 3,CO 4	T2,W5
11	Graph Traversal Techniques.	CO 6	T2,W2
12	Implementation of Binary Search Tree	CO 5	T1,W5

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	**Twin vortex formation:** Design a Data Structure SpecialStack that supports all the stack operations like push(), pop(), isEmpty(), isFull() and an additional operation getMin() which should return minimum element from the SpecialStack. All these operations of SpecialStack must be O(1). To implement SpecialStack, you should only use standard Stack data structure and no other data structure like arrays, list, . etc.
2	**Open channel:** In class, we studied binary search trees that do not allow us to insert duplicate elements. However, sometimes we do need to store duplicates. For example, a database of student marks might contain one record for every mark by every student; so if you've taken two courses, there will be two records with the same key (your student number) and different data (your two marks). To accomplish this, we might use a data structure called a "BST with duplicates", or BSTD
3	**Capillary action:** The variable tos in the Stack class is the index of the array element that would be filled the next time push() is called. Modify the code so that tos is the index of the top element actually in use. In other words, tos is to be the index of the top array element occupied by a value that has been "pushed" onto the stack. Write your changes on the code above. Don't forget to fix the comments. You do not need to add preconditions as in part-a.
4	**Buoyancy** Given an adjacency matrix representation of a graph, describe with pseudo code an algorithm that finds a single path, if one exists, between any two different vertices.
5	**Flow through pipes:** There is a garage where the access road can accommodate any number of trucks at one time. The garage is building such a way that only the last truck entered can be moved out. Each of the trucks is identified by a positive integer (a truck-id). Write a program to handle truck moves, allowing for the following commands: a) On-road (truck-id); b) Enter-garage (truck- id); c) Exit-garage (truck-id); d) Show-trucks (garage or road); If an attempt is made to get out a truck which is not the closest to the garage entry, the error message Truck x not near garage door

Signature of Course Coordinator **HOD,ECE**
Mrs. K LAXMINARAYANAMMA, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**ELECTRONICS AND COMMUNICATION ENGINEERING**				
Course Title	**COMPLEX ANALYSIS AND SPECIAL FUNCTIONS**				
Course Code	AHSC12				
Program	B. Tech				
Semester	IV				
Course Type	Foundation				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Ms. L Indira, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	Basic Principles of complex functions and probabilities

II COURSE OVERVIEW:

The course focuses on more advanced Engineering Mathematics topics which provide with the relevant mathematical tools required in the analysis of problems in engineering and scientific professions. The course includes complex functions and differentiation, complex integration, power series expansion of complex function and special functions. The mathematical skills derived from this course form a necessary base to analytical and design concepts encountered in the program.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Complex Analysis and probability distributions	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
25 %	Understand
75 %	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

I	The applications of complex variable and conformal mapping in two dimensional complex potential theories.
II	The fundamental calculus theorems and criteria for the independent path on contour integral used in problems of engineering
III	The concepts of special functions and its application for solving the partial differential equation in mathematical physics and engineering.

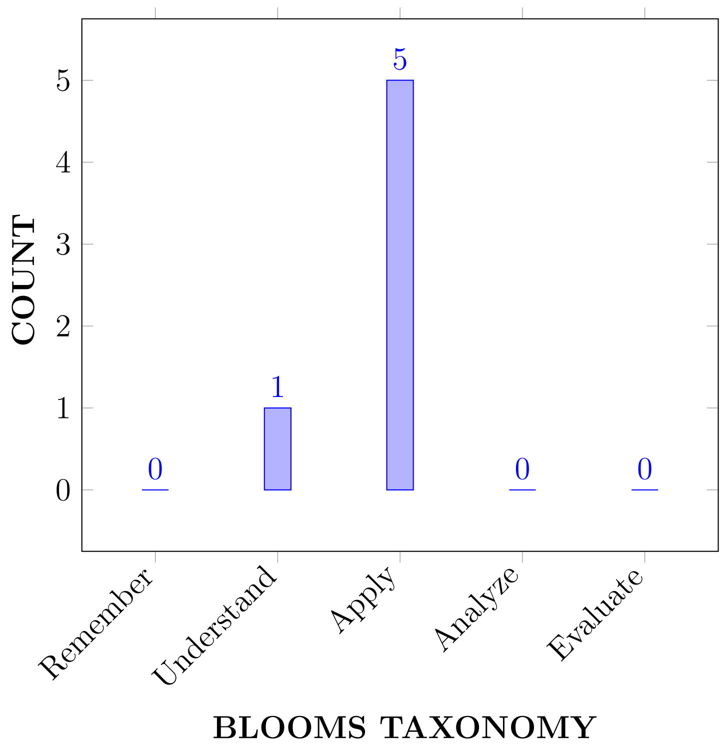
IV	The Mathematics of combinatorial enumeration by using generating functions and Complex analysis for understanding the numerical growth rates..

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Identify** the fundamental concepts of analyticity and differentiability for finding complex conjugates , conformal mapping of complex transformations.	Understand
CO 2	**Apply** integral theorems of complex analysis and its consequences for the analytic function with derivatives of all orders in simple connected region.	Apply
CO 3	**Extend** the Taylor and Laurent series for expressing the function in terms of complex power series.	Apply
CO 4	**Apply** Residue theorem for computing definite integrals by using the singularities and poles of real and complex analytic functions over closed curves.	Apply
CO 5	**Determine** the characteristics of special functions for obtaining the proper and improper integrals for obtaining the proper and improper integrals.	Apply
CO 6	**Apply** the role of Bessel functions in the process of obtaining the series solutions for second order differential equation	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/Quiz/AAT
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Formulate and evaluate the applications in the field of Intelligent Embedded and Semiconductor technologies.	-	-
PSO 2	Focus on the practical experience of ASIC prototype designs, Virtual instrumentation and SOC designs.	-	-
PSO 3	Build the Embedded hardware design and software programming skills for entry level job positions to meet the requirements of employers	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	-	-	-	-	-	-	-		-	-	-
CO 2	✓	✓	-	✓	-	-	-	-	-	-	-	-	-	-	-
CO 3	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	✓	-	-	✓		-	-	-	-	-	-		-	-	-
CO 5	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	✓	✓	-	-		-	-	-	-	-	-	-	-	-	

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUT COMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	**PO 1**	Identify the basic properties of analytic functions which are closed with respect to the fundamental operations of arithmetic (knowledge), algebra and applicability in solving majority of functions in various engineering problems by applying Mathematical principles.	2
CO 2	**PO 1**	Apply the integral theorem of complex analysis (knowledge) and its consequences to the analytic function for solving complex problems by applying the principal problems of mathematics.	2
	PO 2	Identify the problem statement to build extensions of Cauchy's theorem and application of necessary condition to vanish a contour integral around the simple connected regions from the provided information and data in reaching substantiated conclusions by using principles of mathematics.	4
	PO 4	Apply quantitative methods to simplify the calculation of certain contour integrals (knowledge) on simply connected regions in order to solve engineering problems.	2
CO 3	**PO 1**	Apply the knowledge of geometric series that enable us to use Cauchy's integral formula for understanding power series representations of analytic functions by applying the principles of mathematics.	2
	PO 2	IdeIdentify the problem formulation and abstraction of rational complex functions for expressing in negative or positive terms of power series (knowledge) using Laurent's series and Taylor's series by applying the principles of mathematics.	4
CO 4	**PO 1**	Apply the method of finding residues of given real or complex integrand (knowledge) the singular points and poles of complex functions and applicability of Residue theorem to solve definite and indefinite complex integrals by applying the principles of mathematics.	2
	PO 4	Make use of the quantitative methods of finding residues for evaluating line integrals (length of curve) of analytic functions over closed curves and applicability of Residue theorem by applying the principles of mathematics.	2

CO 5	**PO 1**	Identify the characteristics of beta and gamma functions as a generalization to the elementary factorial function (knowledge) and applicability for solving improper integrals by applying the principles of mathematics..	3
	PO 2	Identify the given problem and formulate relationship between beta and gamma functions (knowledge) and their applicability for solving improper integrals by transforming by applying the principles of mathematics.	1
CO 6	**PO 1**	Recognize the Bessel functions as series solution of second order differential equation (knowledge) and find its generating function and use it to prove some useful standard results and recurrence relations by applying the principles of mathematics.	3
	PO 2	Identify the given problem and formulate relationship between beta and gamma functions (knowledge) and their applicability for solving improper integrals by transforming by applying the principles of mathematics.	1

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	**PROGRAM OUTCOMES**												**PSO'S**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	-	-	-	-	-	-	-	-	-	-		-	2	-
CO 2	2	4	-	2	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	-	-	2		-	-	-	-	-	-		2	2	-
CO 5	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	2	4	-	-	-	-	-	-	-	-	-		-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	**PROGRAM OUTCOMES**												**PSO'S**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	66.7	-	-	-	-	-	-	-	-	-	-		-	-	-
CO 2	66.7	40.0	-	20	-	-	-	-	-	-	-	-	-	-	-
CO 3	66.7	40.0	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	66.7	-	-	20		-	-	-	-	-	-		-	-	-
CO 5	66.7	40.0	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	66.7	40.0	-	-		-	-	-	-	-	-		-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation
1 -$5 < C \leq 40\%$ – Low/ Slight
2 - $40\% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO 2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	18	4	-	3	-	-	-	-	-	-	-	-	-	-	-
AVERAGE	3	2	-	1	-	-	-	-	-	-	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	Tech-talk	✓	Concept video	✓
Assignments	-				

XVII ASSESSMENT METHODOLOGY-INDIRECT:

x	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**COMPLEX FUNCTIONS DIFFERENTIATION AND INTEGRATION**
	Complex functions and its representation on argand plane, concepts of limit, continuity, differentiability, analyticity, Cauchy-Riemann conditions and harmonic functions; Milne-Thomson method, Bilinear Transformation
MODULE II	**COMPLEX INTEGRATION**
	Line integral: Evaluation along a path and by indefinite integration; Cauchy's integral theorem; Cauchy's integral formula; Generalized integral formula; Power series expansions of complex functions And contour Integration: Radius of convergence.

MODULE III	**POWER SERIES EXPANSION OF COMPLEX FUNCTION**
	Expansion in Taylor's series, Maclaurin's series and Laurent series. Singular point; Isolated singular point; Pole of order m; Essential singularity; Residue: Cauchy Residue Theorem. Evaluation of Residue by Laurent Series and Residue Theorem. Evaluation of integrals of the type $\int_0^{2\pi} f(\cos\theta, \sin\theta)d\theta$ and $\int_0^{\infty} f(x)dx$
MODULE IV	**SPECIAL FUNCTIONS-I**
	Improper integrals; Beta and Gamma functions: Definitions; Properties of Beta and Gamma function; Standard forms of Beta functions; Relationship between Beta and Gamma functions
MODULE V	**SPECIAL FUNCTIONS-II**
	Bessel's Differential equation: Bessel function, properties of Bessel function, Recurrence relations of Bessel function, Generating function and Orthogonality of Bessel function, Trigonometric expansions involving Bessel function.

TEXTBOOKS

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons Publishers, 10th Edition,2010
2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2015.

REFERENCE BOOKS:

1. T.K.V Iyengar, B. Krishna Gandhi, "Engineering Mathematics - III", S. Chand and Co., 12th Edition, 2015.
2. Churchill, R.V. and Brown, J.W, "Complex Variables and Applications", Tata Mc Graw-Hill, 8th Edition, 2012.

WEB REFERENCES:

1. https://nptel.ac.in/courses/112105171/1

COURSE WEB PAGE:

1. https://www.youtube.com/watch?v=DUHEPRjezdE

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference T1: 4.1
OBE DISCUSSION			
1	In Out Come Based Education student should Identify curves and regions in the complex planedefined by simple expressions. Describe basic properties of complex integration and having the ability to compute such integrals. Decide when and where a given function is analytic and be able to find it series developement. Describe conformal mappings between various plane regions.Present the central ideas in the solution of Dirichlets problem. Able to Classify Singularities and Poles of Complex functions. Relate improper integrals with beta and gamma functions. Idenatify the role of Bessel functions for solving differential equations.	-	
CONTENT DELIVERY (THEORY)			
2	Understanding the complex function in Argand plane	CO 1	T1:12.4, R1:4.13
3	Apply the limit of a complex function	CO 1	T1:12.4, R1:4.13
4	Apply the continuity of a complex function	CO 1	T1:12.4, R1:4.13
5	Apply the differentiability and analyticity of a complex function	CO 1	T1:12.4, R1:4.13
6	Identify and Apply the of Cauchy-Riemann conditions in Cartesian and Polar forms	CO 1	T1:12.4, R1:4.13
7	Evaluate the Harmonic Conjugates	CO 1	T1:12.4, R1:4.13
8	Apply the Milne-Thomson method to find the Analytic function	CO 1	T1:12.4, R1:4.13
9	Apply the properties of Bilinear transformation for complex functions.	CO 1	T1:12.5, R1:8.8
10	Evaluate the Line Integral for a given path	CO 2	T1:13.1, R1:5.3
11	Apply the Cauchy's integral theorem in a given plane	CO 3	T1:13.1, R1:5.3
12	Apply the Cauchy's integral formula for evaluating contour integration	CO 3	T1:13.1, R1:5.3
. 13	Apply the Cauchy's general integral formula for evaluating contour integration.	CO 3	T1:13.1, R1:5.3
14	Define the Power series expansions of complex functions and contour Integration	CO 4	T1:14.1, R1:6.1
15	Evaluate the Radius of convergence of power series complex function	CO 4	T1:14.1, R1:6.1

16	Identify the types of power series expansions	CO 4	T1:14.1, R1:6.1
17	Define the types of Singularities and its nature	CO 4	T1:15.2 , R1:6.6
18	Define the concept of Residues	CO 4	T1:15.2 , R1:6.6
19	Evaluate the Residues of complex functions.	CO4	T1:15.2 , R1:6.6
20	Evaluate of contour integrals by Residue theorem.	CO4	T1:15.2 , R1:6.6
21	Definite integrals of the Type -I	CO 5	T2: 7.14, R1:1.6
22	Indefinite integrals of Type-II	CO5	T2: 7.14, R1:1.6
23	Improper integrals; Beta and Gamma functions	CO5	T2: 7.14, R1:1.6
24	Definitions; Properties of Beta	CO5	T2: 7.14, R1:1.6
25	Standard forms1,2,3 of Beta functions	CO 5	T2: 16.6, R1:7.36
26	Standard forms 4,5,6, ,of Beta functions;	CO 5	T2: 16.8, R1:7.41
27	Definitions; Properties Gamma function	CO 5	T2: 16.9, R1:7.42
28	Relationship between beta and gamma functions	CO 6	T2: 16.9, R1:7.42
29	Theorems of gamma functions	CO 6	T2: 16.9, R1:7.42
30	Complex functions differentiation and integration: Complex functions and its representation on argand plane	CO 2	T2: 16.9, R1:7.42
31	Concepts of limit, continuity	CO 1	T1:12.4, R1:4.13
32	Problems related to beta functions	CO5	T2: 7.14, R1:1.6
33	Problems related to gamma functions	CO5	T2: 7.15 , 1:16.5
34	Properties of Beta and Gamma function	CO 6	T2:11.3, R1:16.5
35	Bessel's Differential equation: Bessel function, properties of Bessel function	CO5	T2: 16.5, R1:7.32
36	Solutions of Bessel differential equation by power series method.	CO 6	T2: 16.6, R1:16.9
37	Generating function	CO 5	T2: 11.4, R1:16.18
38	Recurrence relations-I,II,III of Bessel function	CO6	T2: 16.8, R1:7.41

39	Recurrence relations IV,V,VI of Bessel function	CO 6	T1:17.5-17.6, R1:16.3.1
40	Generating function	CO 6	T2: 16.9, R1:7.422
41	Orthogonality of Bessel function	CO 4	T1:13.4, R1:5.10
PROBLEM SOLVING/ CASE STUDIES			
42	Problems on generalized integral formula	CO 2	T1:14.1, R1:6.1
43	Problems on generalized integral formula	CO 2	T1:14.1, R1:6.1
44	Problems on power series expansions of complex functions Expansion in Taylor's series	CO 3	T1:14.1, R1:6.1
45	Problems on Maclaurin's series	CO 3	T1:15.2 , R1:6.6
46	Problems on Laurent series	CO 3	T1:15.3, R1:7.9
47	Problems on types of singularities , pole of order m	CO 4	T1:15.3, R1:7.9
48	Problems on evaluation of residue by Laurent Series	CO 3	T1:15.3, R1:7.9
49	Problems on Residue Theorem.	CO 4	T1:14.1, R1:6.1
50	Problems on definite integrals of the type -I	CO 3	T1:15.3, R1:7.9
51	Problems on indefinite integrals of type-II	CO 4	T1:15.3, R1:7.9
52	PSolving problems on Cauchy's Residues Theorem	CO 5	T2: 16.9, R1:7.42
53	Solving problems on Definite integrals of the type -I,II	CO 5	T2: 16.9, R1:7.42
54	Solving problems on Trigonometric expansions involving Bessel function	CO 6	T2: 16.9, R1:7.42
55	Solving problems on beta and gamma functions	CO 5	T2: 16.7, R1:7.36
56	Definitions and terminology Cauchy-Riemann conditions in Cartesian and Polar forms	CO 1,CO2	T1:12.4, R1:4.13
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Definitions and terminology the differentiability and analyticity of a complex function	CO 1,CO2	T1:12.4, R1:4.13
58	Definitions and terminology Milne-Thomson method to find the Analytic function	CO 1,CO2	T1:12.4, R1:4.13
59	Definitions and terminology on Cauchy's general integral formula for evaluating contour integration, on types of singularities , pole of order m	CO 4	T1:13.4, R1:5.10
60	Definitions and Terminology on special functions-I module IV	CO 5	T1:15.2 , R1:6.6

61	Definitions and Terminology on special functions-II module V	CO 6	T1:12.4, R1:4.13
DISCUSSION OF QUESTION BANK			
62	Discussion of Question Bank of Module II Complex functions and differentiation	CO 1,2	T1:12.3, R1:4.4
63	Discussion of Question Bank of Module II complex integration	CO 3	T1:12.5, R1:8.8
64	Discussion of Question Bank of Module III power series expansion of complex function	CO4	T1:15.1, R1:7.4
65	Discussion of Question Bank of Module IV special functions-I	CO 5	T2: 7.15, R1:1.65
66	Discussion of Question Bank of Module V special functions-I	CO 6	T2: 16.9, R1:7.42

Signature of Course Coordinator **HOD,FE**
Ms. L Indira, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Electronics and Communication Engineering**				
Course Title	**Analog and Pulse Circuits**				
Course Code	AECC09				
Program	B.Tech				
Semester	IV				
Course Type	Core				
Regulation	UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	0	3	-	-
Course Coordinator	Mr. S Lakshmanachari, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEC02	II	Electrical Circuits
B.Tech	AECC01	III	Electronic Devices and Circuits

II COURSE OVERVIEW:

This course provides circuit analysis to design high frequency amplifiers and wave shaping circuits using discrete components. It covers on multistage amplifiers, power amplifiers, feedback concepts, sampling gates and multivibrators. Analog electronics are widely used in radio and audio equipment and in many applications where signals are derived from analog sensors and transducers.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Analog and Pulse Circuits	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
10 %	Remember
50 %	Understand
25 %	Apply
15 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table.

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

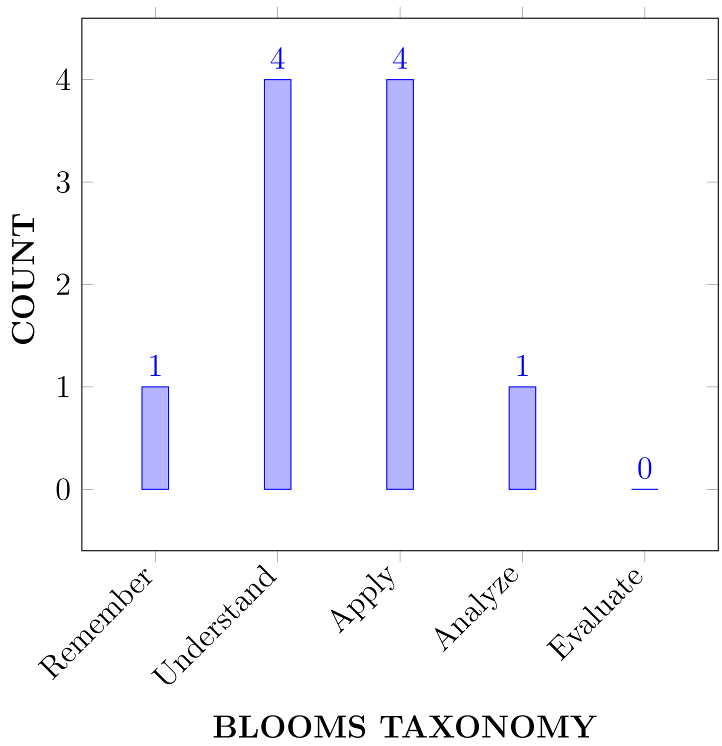
I	The design and analysis of transistor amplifiers using low frequency and high frequency signals.
II	The response for a linear wave shaping circuits of low pass filter and high pass filters.
III	The generation of non-linear oscillations by using regenerative feedback circuit for multivibrators.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Illustrate** Bipolar Junction Transistor (BJT) amplifier circuits and their frequency responses at low, mid and high frequencies for determining amplifier characteristics.	Understand
CO 2	**Summarize** the concept of feedback in amplifiers for the distinction between negative and positive feedback.	Understand
CO 3	**Obtain** the expression to find frequency of oscillations for RC and LC type oscillator circuits.	Understand
CO 4	**Identify** the suitable large signal amplifiers or power amplifiers for practical applications with given specifications.	Apply
CO 5	**Analyze** the response of linear and non-linear wave shaping circuits for impulse and pulse inputs with different time constants.	Analyze
CO 6	**Build** bistable, monostable and astable multivibrator circuits using transistors for real time applications.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Program Outcomes	
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE / CIE / AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	SEE / CIE / AAT

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 3	**Design / Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	1	SEE / CIE / AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	3	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s), PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	✓	-
CO 4	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	✓	✓	✓	-	-	-	-	-	-	-	-	-	-	✓	-

XII JUSTIFICATIONS FOR CO – PO / PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Illustrate** Bipolar Junction Transistor (BJT) amplifier circuits and their frequency responses at low, mid and high frequencies for determining amplifier characteristics by applying **engineering fundamentals** to the solution of complex engineering problems.	1
	PO 2	**Identify the problems** in Bipolar Junction Transistor (BJT) amplifier circuits then **formulate problem statement** based on the **Information provided** to analyze complex engineering problems using first principles of mathematics, natural sciences, and engineering sciences.	4

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 2	PO 1	**Describe** various types of feedback amplifiers like voltage series, voltage shunt, current series and current shunt by applying **knowledge of mathematics** and **engineering fundamentals** to the solution of complex engineering problems.	2
	PO 2	**Understand** the given **problem statement** and **formulate** the complex engineering problems of feedback amplifiers from the provided **information, develop solutions** based on the functionality of the circuit, **validate** the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	6
CO 3	PO 1	**Obtain** the expression to find frequency of oscillations for different oscillator circuits by applying **knowledge of mathematics** and **engineering fundamentals** to the solution of complex engineering problems.	2
	PO 2	**Understand** the **problem statement** of RC oscillators and **formulate** the complex engineering problems of RC oscillators from the provided **information, develop solutions** based on the functionality of the circuit, **validate** the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	6
	PO 3	**Design** solutions for complex engineering problems and design system components of oscillators that **meet the specified customer and user needs** with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	1
	PSO 2	Focus on the **Application Specific Integrated Circuit (ASIC) prototype designs** using analog and pulse circuits in the field of analog electronics.	1
CO 4	PO 1	**Identify** the suitable large signal amplifiers for practical applications with given specifications by applying the **knowledge of mathematics** and **engineering fundamentals** to the solution of complex engineering problems.	2
	PO 2	**Understand** the **problems of power amplifiers** and **formulate** the solutions of power amplifiers for practical applications with **given specifications** to analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and engineering sciences.	4
CO 5	PO 1	**Analyze** the response of linear and non-linear wave shaping circuits for impulse and pulse inputs with different time constants by applying the **knowledge of mathematics** and **engineering fundamentals**, and an engineering specialization to the solution of complex engineering problems.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	**Understand** the given **problem statement** and **formulate** the expression for percentage tilt from the response of high pass RC circuit for square input using **principles of mathematics** and **engineering science.**	4
	PO 3	**Design** solutions for **complex engineering problems** and **design system components** of **linear and non-linear wave shaping circuit's applications** that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	5
CO 6	PO 1	**Design** the basic electronic circuits using active transistors by applying **mathematics, science** and **engineering fundamentals.**	3
	PO 2	**Identifying the real time problems** in multivibrators then **analyze** the design process to **solve the real time problems** and to find the solution for various applications of multivibrators in real time using first **principles of mathematics, and engineering sciences.**	5
	PO 3	**Design** solutions for **complex engineering problems** and **design system components** of **multivibrators** that **meet the specified needs with appropriate consideration** for the public health and safety, and the cultural, societal, and environmental considerations.	5
	PSO 2	Focus on the **Application Specific Integrated Circuit (ASIC) prototype designs** and **System on Chip (SOC)** designs for multivibrator applications.	2

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO / PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	6	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	6	1	-	-	-	-	-	-	-	-	-	-	1	-
CO 4	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	2	4	5	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	5	5	-	-	-	-	-	-	-	-	-	-	2	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO / PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	33.3	40	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	66.7	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	66.7	60	10	-	-	-	-	-	-	-	-	-	-	50	-
CO 4	66.7	40	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	66.7	40	50	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	100	50	50	-	-	-	-	-	-	-	-	-	-	100	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -$5 < C \leq 40\%$ – Low/ Slight

2 - $40\% < C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	3	1	-	-	-	-	-	-	-	-	-	-	2	-
CO 4	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	1	2	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	2	2	-	-	-	-	-	-	-	-	-	-	3	-
TOTAL	**16**	**11**	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**0**
AVERAGE	**2.66**	**1.83**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	✓
Assignments	-				

XVII ASSESSMENT METHODOLOGY-INDIRECT:

✓	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**MULTISTAGE AMPLIFIERS**
	Classification of Amplifiers, Distortion in amplifiers, Different coupling schemes used in amplifiers, Frequency response and Analysis of multistage amplifiers, Cascade amplifier, Darlington pair. Transistor at High Frequency: Hybrid - model of Common Emitter transistor model, f_α, β and unity gain bandwidth, Gain band width product.
MODULE II	**FEEDBACK AMPLIFIERS**
	Concepts of feedback – Classification of feedback amplifiers – General characteristics of Negative feedback amplifiers – Effect of Feedback on Amplifier characteristics – Voltage series, Voltage shunt, Current series and Current shunt Feedback configurations .
MODULE III	**OSCILLATORS AND LARGE SIGNAL AMPLIFIERS**
	Condition for Oscillations, RC type Oscillators-RC phase shift and Wien-bridge Oscillators, LC type Oscillators –Generalized analysis of LC Oscillators, Hartley and Colpitts Oscillators, Frequency and amplitude stability of Oscillators, Crystal Oscillator. Class - A Power Amplifier- Series fed and Transformer coupled, Conversion Efficiency, Class - B Power Amplifier- Push Pull and Complimentary Symmetry configurations, Conversion Efficiency, Principle of operation of Class - AB and Class - C Amplifiers. Tuned Amplifiers: Single Tuned Amplifiers – Q-factor, frequency response of tuned amplifiers, Concept of stagger tuning and synchronous tuning.
MODULE IV	**LINEAR WAVE SHAPING AND SAMPLING GATES**
	Linear wave shaping circuits: High pass RC and low pass RC circuits, response to step and square inputs with different time constants, high pass RC circuit as a differentiator, low pass RC circuit as an integrator. Sampling gates: basic operating principle of sampling gate, uni and bi directional sampling gates. .
MODULE V	**MULTIVIBRATORS**
	Multivibrators: Bistable multivibrator, unsymmetrical triggering, symmetricaltriggering; Schmitt trigger; Monostable multivibrator, Astable multivibrator.

TEXT BOOKS

1. Jacob Millman, Christos C Halkias, "Integrated Electronics" McGraw Hill Education, 2ndEdition, 2010.
2. B.N.Yoganarasimhan, "Pulse and Digital Circuits", 2nd Edition, 2011.

REFERENCE BOOKS:

1. Robert L. Boylestead, Louis Nashelsky, "Electronic Devices and Circuits Theory", PearsonEducation, 11th Edition, 2009.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/108/108108111/

COURSE WEB PAGE:

1. https:://lms.iare.ac.in/index?route=course/details&course_id=192

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
	OBE DISCUSSION		
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	https://lms.iare.ac.in/index?route=course/details&course_id=456
	CONTENT DELIVERY (THEORY)		
2	Classification of amplifiers	CO 1	T1:1.1-1.4
3	Distortions in amplifiers	CO 1	T1:2.1
4	Different coupling schemes used in amplifiers	CO 1	T1:2.4
5	Frequency response of multistage amplifiers	CO 1	T1:2.4
6	Analysis of multistage amplifiers	CO 1	T1:2.2
7	Cascode amplifier	CO 1	T1:3.2
8	Darlington pair	CO 1	T1:3.3
9	Transistor at High Frequency: Hybrid - model of common emitter transistor model	CO 1	T1:4.1-4.3
10	f_α, β and unity gain bandwidth, Gain band width product	CO 1	T1:4.4-4.7
11	The CE current gain with Load, R_L	CO 1	T1:4.8-4.10
12	Classification of feedback amplifiers	CO 2	T1:4.11,5.1-5.3
13	General characteristics of negative feedback amplifiers	CO 2	T1:6.1-6.3
14	Effect of feedback on amplifier characteristics	CO 2	T1:6.4
15	Voltage series feedback amplifier	CO 2	T1:7.2
16	Voltage shunt feedback amplifier	CO 2	T1:7.2
17	Current series feedback amplifier	CO 2	T1:8.1-8.3
18	Current shunt feedback amplifier	CO 2	T1:8.4-8.5
19	Oscillations and condition for oscillations	CO 3	T1:9.1-9.3
20	RC phase shift and wien-bridge oscillators	CO 3	T1:9.4-9.7
21	LC type oscillators and generalized analysis of LC oscillators	CO 3	T1:10.1
22	Hartley and Colpits oscillators	CO 3	T1:10.2
23	Frequency and amplitude stability of oscillators	CO 3	T1:10.2
24	Class A power amplifier- series fed and transformer coupled, conversion efficiency	CO 4	T1:10.3
25	Class B power amplifier- push pull and complimentary symmetry configurations	CO 4	T1:10.3
26	Principle of operation of Class AB and Class C amplifiers.	CO 4	T1:10.4

S.No	Topics to be covered	CO's	Reference
27	Single tuned amplifiers – Q-factor, frequency response of tuned amplifiers	CO 4	T4:10.1
28	Concept of stagger tuning and synchronous tuning	CO 4	T4:10.2
29	Response of High pass RC circuit to step and square inputs with different time constants	CO 5	T4:10.4
30	Response of Low pass RC circuit to step and square inputs with different time constants	CO 5	T4:10.4
31	Sampling gates: basic operating principle of sampling gate.	CO 5	T4:10.5
32	High pass RC circuit as a differentiator and low pass RC circuit as an integrator	CO 5	T4:10.5
33	Uni and bi-directional sampling gates	CO 5	T4:10.6-10.7
34	Bistable multivibrator	CO 6	T4:10.8
35	Unsymmetrical triggering of Bistable multivibrator	CO 6	T4:10.8
36	Symmetrical triggering of Bistable multivibrator	CO 6	T3:3.12
37	Monostable multivibrator	CO 6	T3:3.12
38	Triggering of Monostable multivibrator	CO 6	T3:3.12
39	Astable multivibrator.	CO 6	T3:3.12
40	Schmitt trigger.	CO 6	T3:3.12
PROBLEM SOLVING/ CASE STUDIES			
41	Analysis of multistage amplifiers	CO 1	T1:2.2
42	Cascode amplifier and Darlington pair	CO 1	T2:1.12
43	Voltage series and voltage shunt feedback amplifiers	CO 2	T1:3.2
44	Current series and current shunt feedback amplifiers	CO 2	T1:3.6
45	Oscillators designing and condition for oscillations	CO 3	T1:3.6
46	Large signal amplifiers	CO 4	T1:4.1
47	Linear wave shaping circuits.	CO 4	T1:4.1-4.8
48	Sampling gates.	CO 5	T1:5.8
49	Designing of Bistable, Monostable and Astable multivibrators.	CO 6	T2:10.4 R2:7.2
50	Designing of Schmitt trigger circuit.	CO 6	T2:10.4 R2:7.2
DISCUSSION ON DEFINITION AND TERMINOLOGY			
51	Multistage amplifiers	CO 1	-
52	Feedback amplifiers	CO 2	-
53	Oscillators and large signal amplifiers	CO 3,CO 4	-
54	Linear wave shaping and sampling gates	CO 5	-
55	Multivibrators	CO 6	-
DISCUSSION ON QUESTION BANK			
56	Multistage amplifiers	CO 1	-

S.No	Topics to be covered	CO's	Reference
57	Feedback amplifiers	CO 2	-
58	Oscillators and large signal amplifiers	CO 3, CO 4	-
59	Linear wave shaping and sampling gates	CO 5	-
60	Multivibrators	CO 6	-

Signature of Course Coordinator **HOD,ECE**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	ELECTRONICS AND COMMUNICATION ENGINEERING				
Course Title	ANALOG AND DIGITAL COMMUNICATION				
Course Code	AECC10				
Program	B.Tech				
Semester	IV				
Course Type	Core				
Regulation	IARE - R20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mrs. G.Ajitha, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECC02	III	Signals and Systems
B.Tech	AECC01	III	Electronics Devices and Circuits

II COURSE OVERVIEW:

Communications emphasize on generation, transmission and reception of audio, video and telephony signals. The course is intended to understand various analog and pulse modulation schemes. Further, it emphasis the knowledge on various digital modulation techniques and linear block codes. Communication system principles are used for real world applications of radio and TV broadcasting systems. systems.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Analog and Digital Communication	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
50%	Understand
33%	Apply
17%	Analyze

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

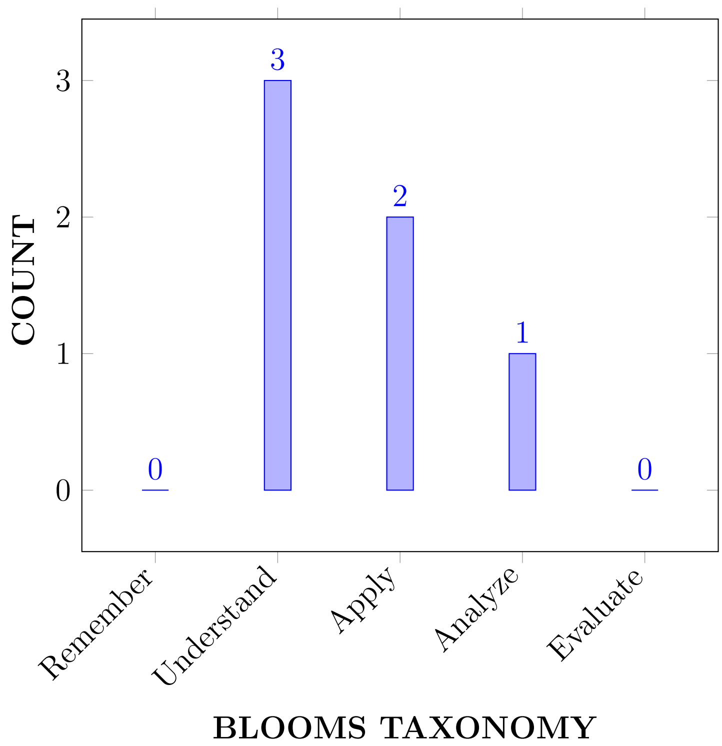
I	The need of modulation, generation and detection techniques of analog and pulse modulation systems.
II	Familiarize with digital systems like Pulse code modulation (PCM), Differential pulse code modulation (DPCM), Delta modulation (DM) and Adaptive DM.
III	The applications of spread spectrum techniques in secured digital communication systems.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Outline** the basic concepts of communication system, need of modulation and fundamental elements to realize amplitude modulation systems.	Understand
CO 2	**Interpret** the generation and detection techniques of frequency modulated waves used for audio signal transmission systems.	Understand
CO 3	**Illustrate** the concept of pulse modulation schemes, demodulation, sampling, quantization and coding for obtaining of digital data.	Understand
CO 4	**Analyze** digital pass band communication schemes (ASK, PSK, FSK) using modulation and demodulation process.	Analyze
CO 5	**Identify** the importance of spread spectrum techniques for secured digital communication systems	Apply
CO 6	**Build** the block codes for error detection and error correction in noisy environment.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

	Program Outcomes
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/Quiz/AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations .	2	CIE/Quiz/AAT
PO 10	**Communication:**Communicate effectively on complex engineering activitieswith the engineering community and with society at large, such as, being ableto comprehend and write effective reports and design documentation, makeeffective presentations, and give and receive clear instructions.	1	SEE/CIE/ Quiz/ AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 3	**Make use of** High frequency structure simulator (HFSS) for modeling and evaluating the patch and smart antennas for wired and wireless communication applications.	2	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	✓	-	-	-	-	-	-	✓	-		-	-	-
CO 2	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	✓
CO 3	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	✓
CO 4	✓	✓	✓	-	-	-	-	-	-	✓	-		-	-	✓

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 5	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	✓
CO 6	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Explain** the basic concepts, need of modulation and fundamental elements i.e transmitter,receiver,channel by applying **the mathematical principles,science and engineering fundamentals**	3
	PO 2	**Identify, formulate, review research** literature for generation and detection techniques of amplitude modulations and **translate** the **information** into the **graphical form** from the provided information and data, develop solutions for power,bandwidth requirements based on inputs of analog communication systems.	5
	PO 3	**Design** solutions for generation and detection of present generation modulation schemes for **complex Engineering** problems s by doing **innovative solution** and **implementing** them using modern tools such as cadence software, mentor graphics, synopsis with reduction in **cost constraints**.	3
	PO 10	Students to communicate effectively with the engineering community, **write** effective **reports** and documentation, make effective presentations, and give and receive clear instructions.	2
CO 2	PO 1	**Interpret** the generation and detection techniques of frequency modulated waves by using **mathematical,science principles and engineering problems**	3
	PO 2	**Identify, formulate, review research** literature for generation and detection techniques of frequency modulation techniques and **translate** the **information** into the **graphical form** from the provided information and data, develop solutions for power,bandwidth requirements based on inputs of analog communication systems.	5
	PO 3	**Design** modulations required for 5g,6g technologies for **complex Engineering problems** and **customer** needs **design** system components using **creativity** by **innovative solutions**,and implementing them with modern tools such as cadence software, mentor graphics, synopsis.	3
	PO 10	Students to communicate effectively with the engineering community, **write** effective **reports** and documentation, make effective presentations, and give and receive clear instructions.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PSO 3	**Develop** modulator and demodulator for Wired and **Wireless Communication** Applications.	2
CO 3	PO 1	**Interpret** the generation and detection techniques of frequency modulated waves by using **mathematical,science principles and engineering problems**	3
	PO 2	**Identify, formulate, review research** literature for generation and detection techniques of frequency modulation techniques and **translate** the **information** into the **graphical form** from the provided information and data, develop solutions based on inputs of analog communication systems.	5
	PO 3	**Design** solutions for generation and detection of present generation modulation schemes for **complex Engineering** problems s by doing **innovative solution** and **implementing** them using modern tools such as cadence software, mentor graphics, synopsis with reduction in **cost constraints**.	3
	PO 10	Students to communicate effectively with the engineering community, **write** effective **reports** and documentation, make effective presentations, and give and receive clear instructions.	2
	PSO 3	**Develop** modulator and demodulator for Wired and **Wireless Communication** Applications.	2
CO 4	PO 1	**Identify(knowledge)** pulse digital modulation and demodulation techniques and(understand) signal space diagrams analysis by applying the principles of **mathematics, science, engineering fundamentals**	3
	PO 2	**Understand** the given **problem statement** and **formulate** the (complex) engineering problems of power, bandwidth requirements of various modulated waves **translate** the **information** into the required form from the provided information and **data**, develop solutions based on inputs	5
	PO 3	**Develop** pulse digital modulation and demodulation system components, understand **customer and user needs** and identify the **cost limitations** for the selection of parameters, use **creativity** in applying the methods of model analyses for innovative solutions for the analysis of modulation techniques	3
	PO 10	Students to communicate effectively with the engineering community, **write** effective **reports** and documentation, make effective presentations, and give and receive clear instructions.	2
	PSO 3	Solve the transmitter and receiver design considerations for modeling and evaluating the patch and smart antennas for wired and wireless communication applications.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 5	PO 1	**Classify** knowledge various spread spectrum modulation techniques by applying the principles of **mathematics, science,** bandwidth spectrum in communication **engineering fundamentals.**	3
	PO 2	**Estimate** bandwidth requirements in communication **(problem statement)** and **formulate (complex)** spread spectrum techniques to implementation **(Solution development)** narrow band to wide band spectrum conversion from the provided **information** and substantiate with the **interpretation** of variations in the results	5
	PO 10	Students to communicate effectively with the engineering community, **write** effective **reports** and documentation, make effective presentations, and give and receive clear instructions.	2
CO 6	PO 1	**Determine** error detection and error correction capabilities of linear block codes by applying the principles of**mathematics, science**, matrix description of linear block codes **engineering fundamentals**.	3
	PO 2	Analyze **understand** generator matrix **problem statement)** and formulate **complex)** check bit vectors to implementation Solution **development** code vectors from the provided **information** and substantiate with the **interpretation** of variations in the results.	5
	PO 3	**Make use** of encoder **develop** code rate for **customer and user needs** and identify the **cost limitations** for the selection of parameters, use **creativity** in applying the methods of model analyses for **innovative solutions** for the analysis of entropy.	3
	PO 10	Students to communicate effectively with the engineering community, **write** effective **reports** and documentation, make effective presentations, and give and receive clear instructions.	2
	PSO 3	**Develop** modulator and demodulator for Wired and **Wireless Communication** Applications.	2

Note: For Key Attributes refer **Annexure - I**

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	5	3	-	-	-	-	-	-	2	-		-	-	-
CO 2	3	5	3	-	-	-	-	-	-	2	-	-	-	-	2
CO 3	3	5	3	-	-	-	-	-	-	2	-	-	-	-	2
CO 4	3	5	3	-	-	-	-	-	-	2	-		-	-	2

CO 5	3	5	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 6	3	5	3	-	-	-	-	-	-	2	-		-	-	2

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	50	30	-	-	-	-	-	-	40	-		-	-	-
CO 2	100	50	30	-	-	-	-	-	-	40	-	-	-	-	100
CO 3	100	50	30	-	-	-	-	-	-	40	-	-	-	-	100
CO 4	100	50	30	-	-	-	-	-	-	40	-		-	-	100
CO 5	100	50	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 6	100	50	30	-	-	-	-	-	-	40	-		-	-	100

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -5 $<C \leq 40\%$ – Low/ Slight

2 - 40 % $<C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	-	-	-	-	-	-	1	-	-	-	-	
CO 2	3	2	1	-	-	-	-	-	-	1	-	-	-	-	2
CO 3	3	2	1	-	-	-	-	-	-	1	-	-	-	-	2
CO 4	3	2	1	-	-	-	-	-	-	1	-	-	-	-	2
CO 5	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	3	2	1	-	-	-	-	-	-	1	-	-	-	-	2

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	✓	Tech - Talk	✓	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	✓	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY-INDIRECT:

	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**AMPLITUDE MODULATION**
	Introduction to communication system, need for modulation, Frequency division multiplexing, Amplitude modulation - time and frequency domain description, single tone modulation, power relations in AM waves, generation of AM waves - switching modulator, detection of AM Waves - envelope detector, DSBSC modulation - time and frequency domain description, generation of DSBSC Waves - Balanced modulators, coherent detection of DSB-SC modulated waves, SSB modulation - time and frequency domain description, frequency discrimination and phase discrimination methods for generating SSB, demodulation of SSB Waves, principle of Vestigial side band modulation
MODULE II	**ANGLE MODULATION**
	Basic concepts of phase modulation, Frequency modulation: Single tone frequency modulation, Narrow band FM, Wide band FM, constant average power, transmission bandwidth of FM wave -generation of FM signal direct method and Armstrong method, detection of FM Signal: balanced slope detector, phase locked loop, comparison of FM and AM., concept of pre-emphasis and de-emphasis.
MODULE III	**ANALOG AND DIGITAL PULSE MODULTAIONS**
	Pulse modulation: types of Pulse modulation- Pulse amplitude modulation (PAM), Pulse width modulation (PWM), Pulse position modulation (PPM), comparison of FDM and TDM. Elements of digital communications: Pulse code modulation, pulse code modulation (PCM) generation and reconstruction, quantization noise, uniform and non-uniform quantization and companding, Differential pulse code modulation (DPCM), Delta modulation (DM) and Adaptive DM, Noise in DM.
MODULE IV	**DIGITAL MODULATION TECHNIQUES**
	Amplitude shift keying (ASK)- modulator, coherent ASK detector, Frequency shift keying(FSK)- modulator, Non-coherent FSK detector, Binary phase shift keying(BPSK)- modulator, detector, principles of QPSK, Differential PSK, Probability of error for ASK,FSK, PSK.
MODULE V	**SPREAD SPECTRUM MODULATION AND ERROR CONTROL CODES**
	Spread spectrum modulation: Use of spread spectrum; Direct sequence spread spectrum (DSSS); Code division multiple access using DSSS, frequency hopping spread spectrum; PN-Sequences: Generation and characteristics. Linear Block Codes: Introduction to error control coding; Matrix description of linear block codes, error detection and error correction capabilities of linear block codes; Hamming code; Binary cyclic codes algebraic structure, encoding and decoding

TEXTBOOKS

1. Herbert Taub, Donald L. Schilling , "Principles of Communication Systems", TMH, 3rd edition,2008

2. K. Sam Shanmugam, "Digital and Analog Communication Systems", John Wiley and Sons, 2nd Edition, 2005.

3. Simon Haykin, "Digital communications", John Wiley, 3rd Edition, 2005.

REFERENCE BOOKS:

1. B.P.Lathi, “Modern Analog and Digital Communication”, Oxford reprint, 3rd Edition, 2004.
2. Singh, Sapre, “Communication Systems Analog and Digital”, TMH, 2nd Edition, 2004.
3. Principles of Communication Systems - Herbert Taub, Donald L Schilling, Goutam Saha, 3rd Edition, McGraw-Hill, 2008.

COURSE WEB PAGE:

1. https:://lms.iare.ac.in/index?route=course/details&course_id=467

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	https://lms.iare.ac.in/index?route=course/details$&$course_id=73
CONTENT DELIVERY (THEORY)			
2	Introduction to communication system and need for modulation	CO 1	T2 –2.1 to 2.2
3	Time domain and frequency domain description of amplitude modulation	CO 1	TI –1.1 to 2.5
4	Power relations in AM waves	CO 1	T3 –1.1 to 1.1.6
5	Generation of AM waves, square law Modulator, Switching modulator	CO 1	T3 –3.2 to 3.3.4
6	Detection of AM Waves; Square law detector, Envelope detector	CO 1	R1 –3.3, T3-8.3 to 8.4
7	DSBSC modulation and Generation of DSBSC Waves,Coherent detection of DSB-SC Modulated waves,	CO 1	T3 – 3.4
8	SSB modulation Mathematical Description, Generation and detection of SSBSC Waves	CO 1	T3 –3.4.1 to3.4.2, T3 –8.2.
9	Principles of Vestigial side band modulation	CO 1	T3 –3.5.1 to 3.5.2
10	Basic concepts of phase Modulation, frequency Modulation	CO 2	T3 – 4.1 to 4.3.4
11	Single tone frequency modulation	CO 2	T3 -4.4 to 4.4.5, T2 – 2.14
12	Narrow band FM, Wide band FM	CO 2	T3 –9.1 to 9.5.2

13	Constant Average Power, Transmission bandwidth of FM Wave	CO 2	R3 –6.1
14	Generation of FM Signal	CO 2	R3 –6.2 to 6.4.6
15	Detection of FM Signal	CO 2	T2 -6.2 to 6.3
16	Phase locked loop	CO 2	T3 – 1.2 to 1.2.3
17	Pre-emphasis and de-emphasis	CO 2	T3 –1.2.4 to 1.4.8
18	Pulse amplitude modulation (PAM)	CO 3	TI –1.1 to 2.5
19	Pulse width modulation (PWM)	CO 3	T3 –1.1 to 1.1.6
20	Pulse position modulation (PPM)	CO 3	T3 –3.2 to 3.3.4
21	comparison of FDM and TDM.	CO 3	R1 –3.3, T3-8.3 to 8.4
22	Elements of digital communications: Pulse code modulation	CO 3	T3 – 3.4
23	pulse code modulation (PCM) generation	CO 3	T3 –3.4.1 to3.4.2, T3 –8.2.
24	pulse code modulation (PCM) reconstruction, quantization noise	CO 3	T3 –3.5.1 to 3.5.2
25	uniform and non-uniform quantization and companding Phase locked loop,	CO 3	T3 – 4.1 to 4.3.4
26	Differential pulse code modulation (DPCM)	CO 3	T3 -4.4 to 4.4.5, T2 – 2.14
27	Delta modulation (DM),Adaptive DM, Noise in DM.	CO 3	T3 –9.1 to 9.5.2
28	Amplitude shift keying (ASK)- modulator, coherent ASK detector	CO 4	R3 –6.1
29	Frequency shift keying(FSK)- modulator, Non-coherent FSK detector	CO 4	R3 –6.2 to 6.4.6
30	Binary phase shift keying(BPSK)- modulator, detector	CO 4	T2 -6.2 to 6.3
31	principles of QPSK	CO 4	T3 – 1.2 to 1.2.3
32	Differential PSK	CO 4	T3 –1.2.4 to 1.4.8
33	Probability of error for ASK,FSK.	CO 4	TI –1.1 to 2.5
34	Probability of error for PSK.	CO 4	T3 –1.1 to 1.1.6
35	Spread spectrum modulation: Use of spread spectrum; Direct sequence spreadspectrum (DSSS).	CO 5	TI –1.1 to 2.5
36	Code division multiple access using DSSS	CO 5	T3 –1.1 to 1.1.6
37	Frequency hopping spread spectrum	CO 5	TI –1.1 to 2.5

38	PN-Sequences: Generation and characteristics	CO 5	T3 –1.1 to 1.1.6
39	Linear Block Codes: Introduction to error control coding; Matrix description of linear block codes	CO 6	T3 –3.5.1 to 3.5.2
40	Error detection and error correction capabilities of linear block codes	CO 6	T3 – 4.1 to 4.3.4
41	Hamming code; encoding and decoding	CO 6	T3 – 4.1 to 4.3.4
42	Binary cyclic codes encoding and decoding	CO 6	T3 – 4.1 to 4.3.4
PROBLEM SOLVING/ CASE STUDIES			
43	Time domain and frequency domain equations of AM wave .	CO 1	TI –1.1 to 2.5
44	Design of envelope detector circuit Problem solving on Power, current, voltage relations in AM wave	CO 1	TI –1.1 to 2.5
45	Time domain and frequency domain equations of DSBSC	CO 1	T3 – 3.4
46	Time domain and frequency domain equations of SSBSC	CO 1	T3 -4.4 to 4.4.5, T2 – 2.14
47	Frequency modulation	CO 2	R3 –6.2 to 6.4.6
48	Frequency modulation	CO 3	T2 -6.2 to 6.3
49	TDMA.	CO 2	T2 -6.2 to 6.3
50	Pulse Code Modulation	CO 3	T3 –9.1 to 9.5.2
51	Delta Modulation.	CO 3	R3 –6.1
52	Digital modulation Schemes.	CO 4	TI –1.1 to 2.5
53	Digital modulation Schemes.	CO 4	T3 –3.5.1 to 3.5.2
54	linear block codes.	CO 6	T3 – 4.1 to 4.3.4
55	linear block codes.	CO 6	T3 – 4.1 to 4.3.4
56	Problem solving on Hamming codes	CO 6	T3 – 4.1 to 4.3.4
57	Hamming codes	CO 6	T3 – 4.1 to 4.3.4
DISCUSSION OF DEFINITION AND TERMINOLOGY			
58	Amplitude modulation	CO 1	T3 –9.1 to 9.5.2
59	Angle Modulation	CO 2	R3 –6.2 to 6.4.6
60	Digital pulse modulation	CO 3	T3 –3.5.1 to3.5.2
61	Digital modulation techniques	CO 4	T3 – 4.1 to 4.3.4

62	Error control codes	CO 6	T3 – 4.1 to 4.3.4
DISCUSSION OF QUESTION BANK			
63	Amplitude modulation generation and detection	CO 1	R4:2.1
64	Angle Modulation	CO 2	T4:7.3
65	Digital pulse modulation	CO 3	R4:5.1
66	Digital modulation techniques	CO 4	T1:7.5
67	Error control codes	CO 6	T3 – 4.1 to 4.3.4

Signature of Course Coordinator **HOD, ECE**

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	**3**
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences **(Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations **(Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**

	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**

	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**ELECTRONICS AND COMMUNICATION ENGINEERING**				
Course Title	**IC APPLICATIONS**				
Course Code	AECC12				
Program	B.Tech				
Semester	IV				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mr. J Siva Ramakrishna, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	**Course Code**	**Semester**	**Prerequisites**
B.Tech	AECC01	III	Electronic Devices and Circuits
B.Tech	AECC03	III	Digital System Design

II COURSE OVERVIEW:

This course deals with the fundamental concepts of operational amplifier, linear & non linear application of op-amp and digital Integrated circuits. It covers design and analysis of frequency selective and tuning circuits like oscillators, active filters, phase locked loops and its use for communication applications. Along with switching applications like that of comparators, learn IC based design of voltage regulators, digital IC's for combination and sequential circuit designs. This course forms the basis for the next level of course VLSI Design.

III MARKS DISTRIBUTION:

Subject	**SEE Examination**	**CIE Examination**	**Total Marks**
IC Applications	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	PPT	✓	Chalk & Talk	x	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
%	Remember
%	Understand
%	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

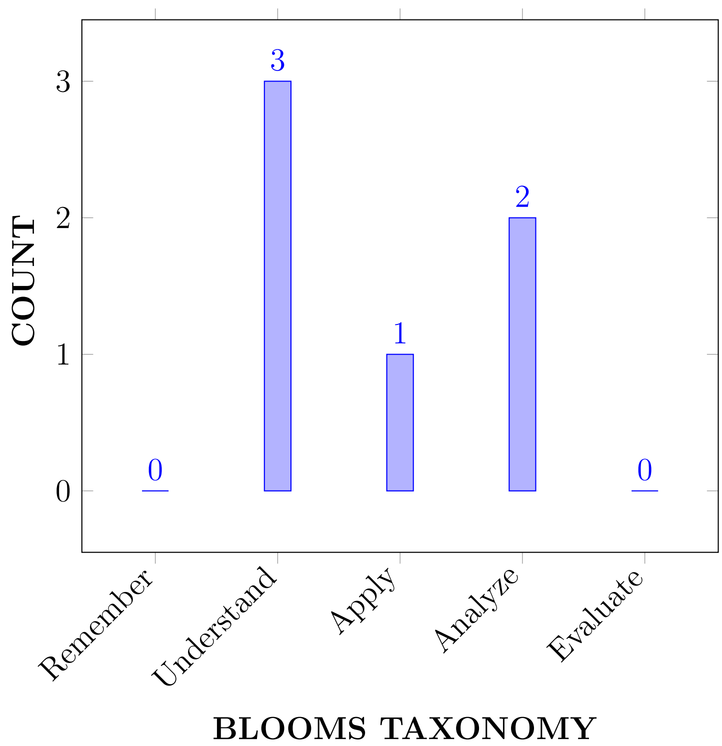
I	The basic building blocks, characteristics and applications of operational amplifier.
II	The functional details of logic families, combinational and sequential digital circuits (ICs) used in digital design.
III	Different IC models which are basic for mixed signal integrated circuits in future.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Describe** the principles and characteristics of op-amp circuits to perform arithmetic operations	Understand
CO 2	**Distinguish**linear and non-linear applications of op-amp circuits to measure the output characteristics	Understand
CO 3	**Design** frequency selective circuitsusing OPAMP for audio and radio frequency ranges.	Analyze
CO 4	**Demonstrate**the characteristics, operation and applicationsof Multi-vibrators using IC555 timer	Understand
CO 5	**Choose**an appropriate A/D and D/A converterfor signal processing applications	Apply
CO 6	**Analyze** the characteristics of sequential and combinational digital integrated circuitsfor digital circuit design	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE / CIE / AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	SEE / CIE / AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	1	SEE / CIE / AAT
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	SEE /CIE/ AAT/ QUIZ
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	SEE /CIE/ AAT/ QUIZ

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	2	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 2	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 3	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-
CO 4	✓	✓	✓	✓	-	-	-	-	-	✓	-	-	-	✓	-
CO 5	✓	-	✓	✓	-	-	-	-	-	✓	-	-	-	✓	-
CO 6	✓	✓	✓	-	-	-	-	-	-	✓			-	✓	-

XII JUSTIFICATIONS FOR CO – PO / PSO) MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies matched.
CO1	PO 1	**Recall** the basic function of transistor and to an extent appreciate the importance of differential amplifier and the characteristics **by applying the own Engineering discipline, Science principles and methodology.**	2
	PO 2	**Understand** the given **problem statement** and **formulate** the of improving DC, AC characteristics of an operational, **translate the information** into the model from the provided **information and data, develop solutions** as compensation techniques, **validate** the arithmetic operations by the **interpretation of results**	7
	PO 10	**Design** the differential amplifier circuit in different forms to **Communicate effectively on complex engineering activities** with engineering community	1
CO2	PO 1	**Recall** Discuss the drawback of using discrete components for design of circuit and appreciate the importance of Op-Amp IC ,its characteristics ,application of open loop Op-Amp **by applying the own Engineering discipline , Science principles and methodology.**	3
	PO 2	**Understand** the given **problem statement** and **formulate** the of improving DC, AC characteristics of an operational, **translate the information** into the model from the provided **information and data, develop solutions** as compensation techniques, **validate** the frequency response, stability of the circuit by the **interpretation of results**	7

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies matched.
	PO 10	**Realize** the DC and AC characteristic circuits of operational amplifier to **Communicate effectively on complex engineering activities** with engineering community	1
CO3	PO 1	**Explain** the importance of frequency selective circuits using op-amp and the application of frequency selective models **using own Engineering discipline, scientific principles and methodology.**	3
	PO 2	**Understand** the given **problem statement** and **formulate** the (complex) engineering problems frequency selective op-amp models, **translate the information** into the model using IC741 from the provided **information and data, develop solutions** based on the functionality of the circuit, **validate** the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	6
	PO3	**Understand** the **customer needs, use creativity and manage design process** in realization of audio and radio frequency range circuits using IC 741 op-amp and **evaluate outcomes.**	4
	PO10	**Design** frequency elective circuits using operational amplifier to **Communicate effectively on complex engineering activities** with engineering community	1
CO4	PO 1	**Develop** various multivibrator circuits; Astable, monostable, bi-stable multivibrators circuits using IC 555 timer **by applying own Engineering discipline, Science principles and methodology.**	3
	PO 2	**Understand** the given **problem statement** and **formulate** the (complex) engineering problems on operation and applications of multivibrator using op-amp, **translate the information** into the model using IC 555 timer from the provided **information and data, develop solutions** based on the functionality of the circuit, **validate** the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	7
	PO 3	**Understand** the **customer needs, use creativity and manage design process** in realization of multivibrator circuits using IC 555 timer and **evaluate outcomes.**	4
	PO 4	**Distinguish** different types multivibrator circuits such as mono stable, astable, and bi-stable multivibrators **using design of experiments, analysis and interpretation of data.**	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies matched.
	PO 10	**Design** different multivibrators using IC 555 timer to **Communicate effectively on complex engineering activities** with engineering community	1
	PSO 2	**Make use of** the basic concepts of nonlinear circuits of op-amp to apply them to various areas, **like Communications, Signal processing, VLSI in the design and implementation of complex systems.**	2
CO5	PO 1	**Model** different data converters such as A/D and D/A **using the own Engineering discipline, Science principles and methodology.**	3
	PO 2	**Interpret** the differen data converter using accuracy, time delay and error in the data conversion based on **information and data collection, model translation and validate using experimental design**	6
	PO 4	**Examine** different data converters such as A/D and D/A using **design of experiments, analysis and interpretation of data.**	5
	PO 10	**Realize** different data converters such as A/D and D/A to **Communicate effectively on complex engineering activities** with engineering community	1
CO6	PO 1	**Outline** the characteristics of different digital logic circuits by using **own engineering discipline, science principles and methodology.**	3
	PO 2	**Determine** response of sequential and combinational logic circuits using **information, data collection and document** the characteristics of filters using **experimental design, validation and interpret the results.**	6
	PO 3	**Understand customer needs, use creativity, manage the design** of digital logic circuits and **evaluate outcomes of the circuit.**	5
	PO 10	**Design** sequential and combinational logic circuits using transistor-transistor logic to **Communicate effectively on complex engineering activities with engineering community**	1
	PSO 2	**Apply** digital logic circuits in various field such as **Application Specific Integrated Circuit (ASIC) Prototype designs, System on Chip (SOC) designs.**	2

Note: For Key Attributes refer **Annexure - I**

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO / PSO) MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	**10**	**10**	**11**	**1**	**5**	**3**	**3**	**12**	**5**	**12**	**8**	**2**	**2**	**2**
CO 1	2	7	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 2	2	7	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 3	2	6	4	-	-	-	-	-	-	2	-	-	-	-	-
CO 4	2	7	4	3	-	-	-	-	-	2	-	-	-	2	-
CO 5	2	6	-	5	-	-	-	-	-	2	-	-	-	2	-
CO 6	2	6	5	-	-	-	-	-	-	2	-	-	-	2	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO–(PO / PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	**10**	**10**	**11**	**1**	**5**	**3**	**3**	**12**	**5**	**12**	**8**	**2**	**2**	**2**
CO 1	66.7	70	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 2	66.7	70	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 3	66.7	60	40	-	-	-	-	-	-	40	-	-	-	-	-
CO 4	66.7	70	40	27.2	-	-	-	-	-	40	-	-	-	50	-
CO 5	66.7	60	-	45.5	-	-	-	-	-	40	-	-	-	50	-
CO 6	66.7	60	50	-	-	-	-	-	-	40	-	-	-	50	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 - 0$\leq$ C$\leq$ 5% – No correlation

1 -5 <C$\leq$ 40% – Low/ Slight

2 - 40 % <C < 60% –Moderate

3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	3	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	3	3	1	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	3	1	1	-	-	-	-	-	1	-	-	-	2	-
CO 5	3	3	-	2	-	-	-	-	-	1	-	-	-	2	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 6	3	3	2	-	-	-	-	-	-	1	-	-	-	2	-
TOTAL	**18**	**18**	**4**	**3**	**0**	**0**	**0**	**0**	**0**	**6**	**0**	**0**	**0**	**6**	**0**
AVERAGE	**3**	**2.6**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	-
Quiz	-	Tech - Talk	✓	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	✓	Open Ended Experiments	✓
Micro Projects	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**OPERATIONAL AMPLIFIER**
	Operational Amplifier: Differential Amplifier, DC and AC analysis of dual input balanced output configuration, dual input unbalanced output. Characteristics of Op-amps, Op-amp block diagram, ideal and practical Op-amp specifications. DC characteristics: Input & output offset voltages & currents, drift. AC characteristics: Frequency response, slew rate, CMRR and PSRR.
MODULE II	**APPLICATIONS OF OPERATIONAL AMPLIFIERS**
	Linear applications of Op-amps: Inverting and non-inverting amplifier, integrator, differentiator, instrumentation amplifier, AC amplifier. Non-linear applications of Op-Amps: Comparators, multi vibrators, triangular, saw tooth, square wave generators, log and anti-log amplifiers. Introduction to voltage regulators, features of 723 Regulator, three terminal voltage regulators.

MODULE III	**ACTIVE FILTERS AND TIMERS**
	Active Filters: Classification of filters, 1st order low pass and high pass filters, 2nd order low pass, high pass, band pass, band reject and all pass filters. Timers: Introduction to 555 timer, functional diagram, mono-stable, astable operations and applications, schmitt trigger. PLL: Introduction, block schematic, principles and description of individual blocks,565 PLL.
MODULE IV	**DATA CONVERTERS**
	Data converters: Introduction, classification, need of data converters. DAC techniques: weighted resistor DAC, R2R ladder DAC, inverted R-2R DAC, and IC 1408 DAC. ADC techniques: Flash converters, successive approximation, integrating ADC. DAC/ADC characteristics.
MODULE V	**DIGITAL IC APPLICATIONS**
	Study of digital logic families such as Resistor Transistor Logic (RTL), Diode Transistor Logic (DTL), Transistor Logic (TTL), Emitter Coupled Logic and CMOS. Characteristics of digital logic families containing fan-in, fan-out, power dissipation, propagation delay and noise margin, Familiarity with commonly available 74XX & CMOS 40XX series ICs-Flip Flops (IC 7474, IC 7473), Shift Registers, Universal Shift Register(IC 74194), Synchronous counters (74LS93,74HC163), Decade Counters, (74HC190).

TEXTBOOKS

1. D.RoyChowdhury,"Linear Integrated Circuits", New age international (p) Ltd, 2nd Edition, 2003, Third Edition, Prentice Hall of India, 2007.

2. Ramakanth A. Gayakwad, "Op-amps & linear ICs", PHI, 3rd Edition, 2003.

3. John F.Wakerly, "Digital Design Principles and Practices", Prentice Hall, 3rd Edition, 2005.

4. M. Morris Mano, Michael D. Ciletti, "Digital Design, Pearson Education/PHI, 3rd Edition, 2008.

REFERENCE BOOKS:

1. Salivahanan, "Linear Integrated Circuits and Applications", TMH, 1st Edition, 2008.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/108/108108111/

COURSE WEB PAGE:

1. https:://lms.iare.ac.in/index?route=course/details&course_id=192

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	https://lms.iare.ac.in/index?route=course/details&course_id=192
CONTENT DELIVERY (THEORY)			
2	Introduction to integrated circuits (ICs)	CO 1	T1:1.1-1.4
3	Basics of operational amplifier	CO 1	T1:2.1
4	Differential amplifier	CO 1	T1:2.4
7	Analysis of differential amplifier-1	CO 1	T1:2.4
8	Operational amplifier	CO 1	T1:2.2
9	Dc characteristics of op-amps	CO 1	T1:3.2
10	Ac characteristics of op-amps	CO 1	T1:3.3
11	Linear applications of op-amps:1	CO 2	T1:4.1-4.3
12	Linear applications of op-amps:2	CO 2	T1:4.4-4.7
13	Non-linear applications of op-amps:1	CO 2	T1:4.8-4.10
14	Non-linear applications of op-amps:2	CO 2	T1:4.11,5.1-5.3
20	Voltage regulators	CO 2	T1:6.1-6.3
21	Voltage regulators	CO 2	T1:6.4
22	Active filters-1	CO 3	T1:7.2
25	Active filters-2	CO 3	T1:7.2
26	555 Timers	CO 4	T1:8.1-8.3
27	555 Timer applications	CO 4	T1:8.4-8.5
28	Phase locked loops(565 PLL)	CO 4	T1:9.1-9.3
29	Phase locked loops(565 PLL) applications	CO 4	T1:9.4-9.7
32	Data converters	CO 5	T1:10.1
33	DAC techniques	CO 5	T1:10.2
34	DAC techniques	CO 5	T1:10.2
35	ADC techniques	CO 5	T1:10.3
36	ADC techniques	CO 5	T1:10.3
37	Data converter characteristics.	CO 5	T1:10.4
40	Logic families	CO 6	T4:10.1
41	Logic families characteristics	CO 6	T4:10.2

42	Resistor transistor logic (RTL), diode transistor logic (DTL)	CO 6	T4:10.4
43	High threshold logic (HTL) family, transistor logic tristate logic (TTL).	CO 6	T4:10.5
44	Emitter coupled logic family, CMOS logic family	CO 6	T4:10.6-10.7
45	CMOS NAND and NOR gates	CO 6	T4:10.8
46	CMOS sequential circuits	CO 6	T4:10.8
47	CMOS combinational circuits	CO 6	T3:3.12
48	CMOS 40XX series IC	CO 6	T3:3.12
49	IC 7473, IC 7474.	CO 6	T3:3.12
50	IC 74194.	CO 6	T3:3.12
51	IC 74LS93, IC 74HC163.	CO 6	T3:3.12 R2:12.7
52	IC74HC190	CO 6	T3:3.12 R2:12.7
51	Asynchronous up / down counter	CO 6	T3:7.2
52	3 bit & 4 bit up / down ripple counter	CO 6	T3:8.4
PROBLEM SOLVING/ CASE STUDIES			
5	Differential amplifier	CO 1	T1:2.2
6	Ac, dc analysis of differential amplifier	CO 1	T2:1.12
15	Operational amplifier	CO 1	T1:3.2
16	Linear applications of op-amps	CO 2	T1:3.6
17	Linear applications of op-amps	CO 2	T1:3.6
18	Non-linear applications of op-amps	CO 2	T1:4.1
19	Non-linear applications of op-amps	CO 2	T1:4.1-4.8
23	Active filters-1	CO 3	T1:5.8
24	Active filters-2	CO 3	T1:5.8
29	Phase locked loop	CO 4	T1:8.2-8.5
30	555 Timer	CO 4	T2:10.4 R2:7.2
31	555 Timer	CO 4	T2:10.4 R2:7.2
38	Data converters	CO 5	T1:10.1-10.2
39	Data converters	CO 5	T1:10.7-10.8
33	Voltage regulators	CO 3	T1:12.1
DISCUSSION ON DEFINITION AND TERMINOLOGY			
56	Fundamental on op-amp	CO 1	-
57	Linear and non-linear operations and application of op-amps	CO 2	-
58	Active filters,timers and their IC's	CO 2,CO 3	-
59	Analog to digital and digital to analog converters.	CO 5	-
60	Logic families and digital IC's .	CO 6	-
DISCUSSION ON QUESTION BANK			
61	Basics of op-amps	CO 1	-
62	Applications of op-amps	CO 2	-

63	Timers,PLL,voltage regulators	CO 3	-
64	Data converters.	CO 5	-
65	Digital IC.	CO 6	-

Signature of Course Coordinator **HOD,ECE**
Mr J. Siva Ramakrishna, Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**

	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**

	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	Electronics and Communication Engineering				
Course Title	Electromagnetic Waves and Transmission Lines				
Course Code	AECC11				
Program	B.Tech				
Semester	IV				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Ms M Sreevani, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSC02	1	Linear Algebra and Calculus
B.Tech	AHSC03	1	Engineering Physics

II COURSE OVERVIEW:

Electromagnetic Waves and Transmission Lines gives the necessary information about the formation of magnetic fields when electric current flows and structures to conduct electromagnetic waves. It covers the fundamental concepts of electro-magnetic wave theory and introduces the basic laws of electromagnetic fields, time varying Maxwell's equations, wave propagation and transmission lines. It provides a platform for advanced courses such as antennas and wave propagation, microwave engineering, transmission via wired links and optical fiber networks.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Electromagnetic Waves and Transmission Lines	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIE examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Remember
50%	Understand
25%	Apply
15%	Analyze
0%	Evaluate
0%	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 25 marks for Continuous Internal Examination (CIE) and 05 marks for Quiz \Alternative Assessment Tool (AAT).

<table>
<tr><th colspan="2">Component</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td rowspan="4">CIA</td><td>Continuous Internal Examination – 1 (Mid-term)</td><td>10</td><td rowspan="4">30</td></tr>
<tr><td>Continuous Internal Examination – 2 (Mid-term)</td><td>10</td></tr>
<tr><td>AAT-1</td><td>5</td></tr>
<tr><td>AAT-2</td><td>5</td></tr>
<tr><td>SEE</td><td>Semester End Examination (SEE)</td><td>70</td><td>70</td></tr>
<tr><td colspan="3">Total Marks</td><td>100</td></tr>
</table>

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table.

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

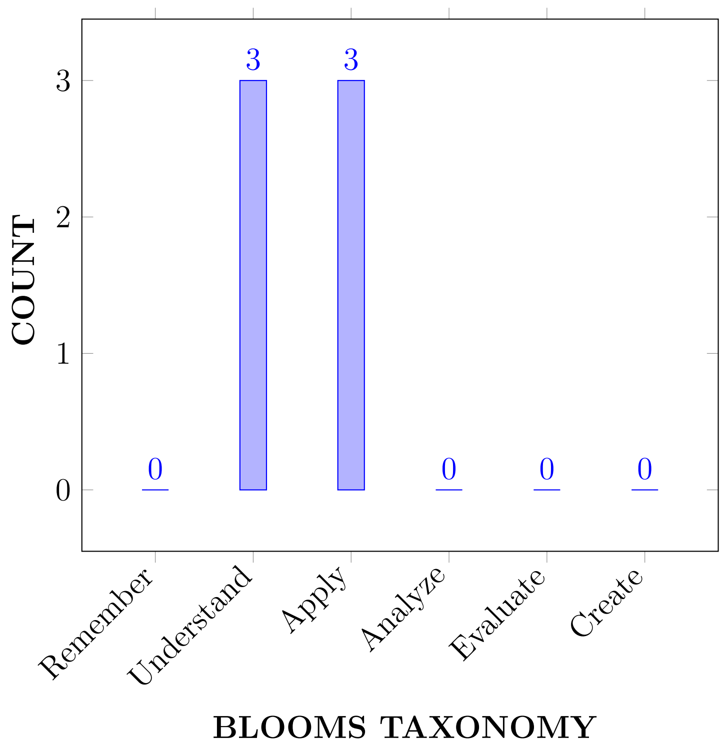
I	The basic concepts required to understand various engineering applications involving electromagnetic fields.
II	The wave propagation characteristics of electromagnetic wave in bounded and unbounded media.
III	The basic theory of transmission lines, appropriate tools (smith chart) to analyze transmission lines.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Describe** fundamental laws (Coulomb's and Gauss's) of electrostatic fields to evaluate the field intensity and flux density of continuous charge distributions.	Understand
CO 2	**Demonstrate** Biot-Savart's law and Ampere's circuit law to determine forces due to magnetic fields.	Understand
CO 3	**Apply** Maxwell's equations and their applications to time varying fields and boundary conditions.	Apply
CO 4	**Construct** the wave equations for both conducting and dielectric media to derive the relation between electric and magnetic field intensities.	Apply
CO 5	**Understand** the propagation of electromagnetic waves through different media using the concept of uniform plane waves.	Understand
CO 6	**Make use of** the smith chart as a graphical tool to solve impedance matching issues in transmission lines.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE/CIE/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	SEE/CIE/AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	SEE/CIE/AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.	1	SEE/CIE/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 3	Make use of high frequency structure simulator (HFSS) for modeling and evaluating the patch and smart antennas for wired and wireless communication applications.	2	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s), PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 2	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 3	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	✓
CO 4	✓	✓	✓	-	-	-	-	-	-	✓	-		-	-	-
CO 5	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	✓
CO 6	✓	✓	-	-	-	-	-	-	-	✓	-		-	-	✓

XII JUSTIFICATIONS FOR CO – PO / PSO MAPPING - DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Demonstrate** the fundamental laws of static electric fields to evaluate the Field intensity and Flux density of various charge distributions by applying **the knowledge of mathematics, Science and engineering fundamentals.**	3
	PO 2	**Identify and formulate** the fundamental laws of static electric fields to evaluate the field intensity and flux density of various charge distributions **by using principles of mathematics and engineering sciences.**	4
	PO 10	**Describe** fundamental laws of electrostatic fields by **giving effective presentations and take clear instructions** to evaluate the field intensity and flux density of continuous charge distributions.	2
CO 2	PO 1	**Apply** the **knowledge of mathematics, Science and engineering fundamentals** to develop Biot-Savart's law and ampere's circuit law to determine forces due to magnetic fields.	3
	PO 2	**Formulate and review** Biot-Savart's law and Ampere's circuit law to determine forces due to magnetic fields **by using the principles of mathematics and engineering sciences.**	4
	PO 10	**Describe** fundamental laws of magnetostatic fields by **giving effective presentations and take clear instructions** to evaluate the forces due to magnetic fields.	2
CO 3	PO 1	**Apply** Maxwell's equations and their application to time varying fields and boundary conditions to solve complex engineering problems uing **the knowledge of mathematics, Science and engineering fundamentals.**	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	**Identify and formulate** the complex engineering problems to apply Maxwell's equations by using **the principles of mathematics and engineering sciences.**	4
	PO 3	**Investigate and identify** the **knowlegde** of **complex engineering problems** using Maxwell's equations to time varying fields and boundary conditions.	4
	PO 10	**Analyze** Maxwell's equations by **giving effective presentations and take clear instructions** to time varying fields and boundary conditions.	2
	PSO 3	**Make use of** high frequency structure simulator (HFSS) for **modeling and evaluating** the time varying fields and boundary conditions in **wireless communication applications.**	3
CO 4	PO 1	**Construct** the wave equations for both conducting and dielectric media to derive the relation between electric and magnetic field intensities by using **knowledge of mathematics, Science and engineering fundamentals.**	3
	PO 2	**Identify and formulate** the wave equations for both conducting and dielectric media to derive the relation between electric and magnetic field intensities by using **the principles of mathematics and engineering sciences.**	4
	PO 3	**Investigate and identify** the **knowlegde** of **complex engineering problems** the wave equations for both conducting and dielectric media to derive the relation between electric and magnetic field intensities	4
	PO 10	**Relate** the wave equations for both conducting and dielectric media **by giving effective presentations and take clear instructions** to derive the relation between electric and magnetic field intensities.	2
CO 5	PO 1	**Examine** the phenomena of wave propagation in different media and its interfaces by applying **the knowledge of mathematics, science and engineering fundamentals.**	3
	PO 2	**Identify and review** the phenomena of wave propagation in different media and its interfaces by using **the principles of mathematics and engineering sciences.**	4
	PO 10	**Study** the phenomena of wave propagation in different media and its interfaces **by giving effective presentations and take clear instructions** using the concept of uniform plane waves.	2
	PSO 3	**Make use of** high frequency structure simulator (HFSS) for **modeling and evaluating** wave propagation in different media and its interfaces in **wireless communication applications.**	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 6	PO 1	**Make use of** Smith chart to calculate the characteristic parameters of transmission lines to solve complex engineering problems using the **knowledge of mathematics, science and engineering fundamentals.**	3
	PO 2	**Identify and formulate** to calculate the characteristic parameters of transmission lines by using **the principles of mathematics and engineering sciences.**	4
	PO 10	**Use** the Smith chart to calculate the characteristic parameters of transmission lines **by giving effective presentations and take clear instructions** to solve impedance matching in transmission lines.	2
	PSO 3	**Make use of** high frequency structure simulator (HFSS) for **modeling and evaluating** the characteristic parameters of transmission lines in **wired communication applications.**	3

Note: For Key Attributes refer **Annexure - I**

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO / PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	3	4	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 2	3	4	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 3	3	4	4	-	-	-	-	-	-	2	-	-	-	-	2
CO 4	3	4	4	-	-	-	-	-	-	2	-	-	-	-	-
CO 5	3	4	-	-	-	-	-	-	-	2	-	-	-	-	2
CO 6	3	4	-	-	-	-	-	-	-	2	-	-	-	-	2

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	100	40	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 2	100	40	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 3	100	40	40	-	-	-	-	-	-	40	-	-	-	-	100
CO 4	100	40	40	-	-	-	-	-	-	40	-	-	-	-	-
CO 5	100	40	-	-	-	-	-	-	-	40	-	-	-	-	100
CO 6	100	40	-	-	-	-	-	-	-	40	-	-	-	-	100

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.
0 - $0 \leq C \leq 5\%$ – No correlation
1 -$5 < C \leq 40\%$ – Low/ Slight
2 - $40\% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	3	2	2	-	-	-	-	-	-	1	-	-	-	-	2
CO 4	3	2	1	-	-	-	-	-	-	1	-	-	-	-	-
CO 5	3	2	-	-	-	-	-	-	-	1	-	-	-	-	2
CO 6	3	2	-	-	-	-	-	-	-	1	-	-	-	-	2
TOTAL	**18**	**12**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**0**	**0**	**0**	**0**	**6**
AVERAGE	**3**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**2**

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	✓	Tech - Talk	-	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	-	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	ELECTROSTATICS
	Electrostatic fields: Coulomb's law, electric field intensity, fields due to different charge distributions; Electric flux density, gauss law and its applications; Scalar electric potential; Energy density, illustrative problems; Convection and conduction currents; Dielectric constant, isotropic and homogeneous dielectrics; Continuity equation and relaxation time, conductivity, power absorbed in conductor, Poisson's and laplace's equations; Capacitance; Method of images; Illustrative problems.

MODULE II	**MAGNETOSTATICS**
	Magneto statics: Biot-savart law; Ampere's circuital law and applications; Magnetic flux density; Magnetic scalar and vector potentials; Forces due to magnetic fields; Ampere's force law; Magnetic boundary conditions; Inductances and magnetic energy; Illustrative problems. **Maxwell's Equations (Time Varying Fields):** Faraday's law; Inconsistency of ampere's law for Time Varying Fields and definition for Displacement Current density; Maxwell's equations in differential form, integral form and word Statements; Conductors and dielectrics-characterization; Loss Tangent.
MODULE III	**UNIFORM PLANE WAVES**
	Uniform plane waves: Wave equations for conducting and perfect dielectric media; Relation between E and H; Wave propagation in lossless and conducting media; Intrinsic Impedance; Skin Depth; Polarization, Illustrative Problems. **Reflection/refraction of plane waves:** Reflection and refraction at normal incidence, reflection and refraction at oblique incidence; Standing waves; Brewster angle, critical Angle, total internal reflection, surface impedance; Poynting vector & poynting theorem-applications; Power Loss in plane conductor; Illustrative problems.
MODULE IV	**TRANSMISSION LINES CHARACTERISTICS**
	Transmission lines characteristics: Types; Transmission line Parameters; Transmission line Equations; Characteristic Impedance, propagation constant; Phase and group velocities; Infinite line concepts, Loss less /low loss transmission line characterization; condition for distortion less and minimum attenuation in transmission lines; Loading- types of loading; Illustrative problems.
MODULE V	**UHF TRANSMISSION LINES AND APPLICATIONS**
	UHF Transmission Lines & Applications: Input impedance relations; SC and OC Lines; Reflection coefficient, VSWR; UHF Lines as Circuit Elements, $\lambda/4$, $\lambda/2$ and $\lambda/8$ Lines- impedance transformations, significance of Zmin and Zmax ; Smith chart-configuration and applications; Single and double stub matching; Illustrative problems.

TEXTBOOKS

1. Matthew N.O. Sadiku, "Elements of Electromagnetic", Oxford University Press, 4th Edition,2009.

2. E.C. Jordan, K.G. Balmain, "Electromagnetic waves and Radiating Systems", PHIlearning, 2nd Edition, 2000.

3. Umesh Sinha, Satya Prakashan, "Transmission lines and Networks", Tech IndiaPublications, 1st Edition, 2010.

REFERENCE BOOKS:

1. Nathan Ida, "Engineering Electromagnetic", Springer (India) Pvt. Ltd, 2nd Edition,2005

2. William H. Hayt Jr., John A. Buck, "Engineering electromagnetic", Tata McGraw Hill, 7th Edition, 2006.

3. G. Sashibushana Rao, "Electromagnetic Field theory and Transmission Lines, Wiley India,2013.

WEB REFERENCES:

1. https://nptel.ac.in/courses/112105171/1

COURSE WEB PAGE:

1. https://lms.iare.ac.in/index?route=course/details&course_id=75

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	https://lms.iare.ac.in /in-dex?route=course /details & course _id=75
CONTENT DELIVERY (THEORY)			
2	Introduction to vector algebra and calculus.	CO 1	T1: 3.1 to 3.8
3	Introduction to coordinate systems.	CO 1	T1: 3.1 to 3.8
4	Introduction to electrostatics-Coulomb's law.	CO 1	T1: 3.1 to 3.8,
5	Electric field intensity due to line charge.	CO 1	T1: 4.3 to 4.4,4.6,4.7
6	Electric field intensity due to surface and volume charges.	CO 1	T1: 4.3 to 4.4,4.6,4.7
7	Electric flux density-Gauss law.	CO 1	T1: 3.1 to 3.8
8	Gauss law for volume charge.	CO 1	T1: 3.1 to 3.8
9	Energy density in electric fields.	CO 1	T1: 3.1 to 3.8
10	Boundary conditions in electric fields	CO 1	T1: 3.1 to 3.8
11	Convection and conduction currents.	CO 1	T1: 3.1 to 3.8 R2: 1.8 to 1.9
12	Resistance and capacitance-parallel plate capacitor.	CO 1	T1: 3.1 to 3.8 R2: 1.8 to 1.9
13	Cylindrical and spherical capacitors.	CO 1	T1: 4.3 to 4.4,4.6,4.7
14	Introduction to magnetostatics- Biot-Savart's law.	CO 1	T1: 3.1 to 3.8, R2: 1.8 to 1.9
15	Ampere's circuit law.	CO 1	T1: 4.3 to 4.7, R2: 7.1
16	Applications of ampere's law.	CO 1	T1: 4.3 to 4.4,4.6,4.7, R2-7.1
17	Forces due to magnetic fields.	CO 1	T1: 4.3 to 4.4,4.6,4.7
18	Maxwell's equations for magnetic fields.	CO 1	T1: 4.3 to 4.4,4.6,4.7
19	Magnetci boundary conditions.	CO 2	T1: 4.3 to 4.4,4.6,4.7 R2: 7.1

20	Inductors and magnetic energy.	CO 2	T1: 4.3 to 4.4,4.6,4.7 R2: 7.1
21	Introduction to time varying fields-Faraday's law.	CO 2	T1: 4.3 to 4.4,4.6,4.7 R2: 7.1
22	Inconsistancy of ampere's law.	CO 2	T1: 4.3 to 4.7 R2:7.1
23	Introduction to wave characteristics.	CO 3	T1: 7.1 to 7.2,4.8,7.6,7.8
24	Relation between E and H.	CO 2	T1: 7.1 to 7.2,4.8,7.6,7.8
25	Wave propagation in dielectrics.	CO 3	T1: 7.1 to 7.2,4.8,7.6,7.8
26	Wave propagation in lossy dielectrics.	CO 3	T1: 7.1 to 7.2,4.8,7.6,7.8
27	Wave propagation in good conductors.	CO 3	T1: 7.1 to 7.2,4.8,7.6,7.8
28	Reflection and refraction of uniform plane waves.	CO 3	T1: 8.2 to 8.5
29	Poynting vector and poynting theorem.	CO 4	T1: 9.2 to 9.3
30	Normal incidence at a plane dielectric boundary.	CO 4	T1: 9.3 to 9.4
31	Surface impedance and polarization.	CO 4	T1: 9.4 to 9.5
32	Oblique incidence at a plane dielectric boundary.	CO 5	T1: 9.5 to 9.6
33	Perpendicular polarization.	CO 5	T1: 9.6 to 9.7
34	Parallel polarization.	CO 5	T1: 9.7 to 9.8
35	Brewster angle.	CO 5	T1: 9.8 to 9.9
36	Introduction to transmission lines-types and parameters.	CO 5	T1: 9.9 to 9.10
37	Transmission line equation.	CO 6	T3: 1.9 to1.12
38	Reflection coefficient and standing wave ratio.	CO 6	T3: 1.9 to1.15
39	Attenuation and phase constants.	CO 6	T3: 1.9 to1.17
40	Condition for minimum attenuation.	CO 6	T3: 5.4 to 5.5
41	UHF lines as circuit elements.	CO 6	T3: 5.4 to 5.7
42	Single stub matching.	CO 1	T1: 4.2-4.13.
43	Double stub matching.	CO 1	T1: 4.2-4.13.
44	Smith chart configuration-1.	CO 1	T1: 7.1-7.13 R2: 4.1- 4.3
45	Smith chart configuration-2.	CO 1	T1: 7.1-7.13 R2: 4.1- 4.3
PROBLEM SOLVING/ CASE STUDIES			
46	Problems on gauss law	CO 1	T1: 4.2-4.13.
47	Problems on coulombs' law and E	CO 1	T1: 4.2-4.13.
48	Problems on line charge	CO 1	T1: 7.1-7.13 R2: 4.1- 4.3
49	Problems on surface, volume charge	CO 1	T1: 7.1-7.13 R2: 4.1- 4.3
50	Problems on magnetic energy	CO 2	T1: 9.1-9.8, R2: 7.1-7.6

51	Problems on H and B	CO 2	T1: 11.2 R2: 10.4
52	Problems on displacement current density	CO 3	T1: 11.3 R2: 10.5
53	Problems on wave equations	CO 4	T1: 11.11-11.12
54	Problems on dielectrics	CO 3	T1: 11.13-11.14
55	Problems on intrinsic impedance	CO 4	T1: 11.18, R2: 10.13
56	Problems on reflection and refraction	CO 5	T1: 11.2 R2: 10.4
DISCUSSION ON DEFINITION AND TERMINOLOGY			
57	Electostatics	CO 1, CO 3	T1: 1.1-19, 2.1-2.8, 3.1-3.8, 4.1-4.25
58	Magnetostatics	CO 2, CO 3	T1: 7.1-7.32
59	Uniform plane waves characteristics	CO 4, CO 5	T1: 8.1-8.10, 9.1-9.6
60	Transmission line characteristics	CO 6	T1: 11.1-11.18
61	UHF Transmission line and applications	CO 6	T1: 13.1-13.25
DISCUSSION ON QUESTION BANK			
62	Electrostatics	CO 1, CO 3	T1:1.1-19, 2.1-2.8, 3.1-3.8, 4.1-4.25
63	Magnetostatics	CO 2, CO 3	T1: 7.1-7.32
64	Uniform plane waves	CO 4, CO 5	T1: 8.1-8.10, 9.1-9.6
65	Transmission line characteristics	CO 6	T1: 11.1-11.18
66	UHF Transmission line and applications	CO 6	T1: 13.1-13.25

Course Coordinator **HOD,ECE**
Ms M Sreevani, Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**

	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**

	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

COURSE DESCRIPTION

Course Title	**ANALOG AND DIGITAL COMMUNICATIONS LABORATORY**				
Course Code	AECC14				
Program	B.Tech				
Semester	IV	ECE			
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Dr.V Siva Nagaraju, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECB17	IV	Signals and systems laboratory

II COURSE OVERVIEW:

Communication engineering is the field of study concerned with the transmission of information either in analog or digital form. The objective of this course provides a platform to the students to understand the basics of analog and digital communication systems, modulation techniques, data transmission and multiplexing etc.The applications include digital signal processors in secured communication systems, multimedia and data storage applications.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Analog and Digital Communications Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External

Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

I	The elements of analog communication system, modulation and demodulation.
II	The pulse analog modulation techniques, generation and detection of digital modulation techniques
III	The time and frequency domain analysis of the signals in communication system by using MATLAB tools

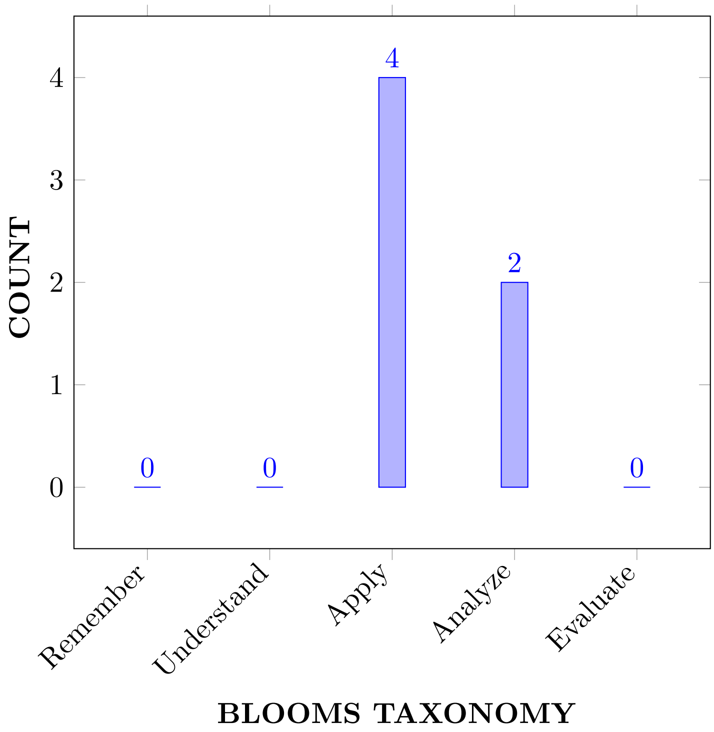
VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Discriminate** the generation and detection of amplitude modulated and frequency modulated signals to calculate the modulation index and frequency deviation	Analyze

CO 2	**Make use of** the balance modulator and synchronous detector for generating and detecting DSBSC modulated wave.	Apply
CO 3	**Analyze** the analog pulse modulation and demodulation methods for transmitting the information by pulses	Analyze
CO 4	**Apply** the concept of pulse code modulation and demodulation for encoded data in analog to digital conversion	Apply
CO 5	**Select** the time division or frequency division multiplexing techniques for transmitting multiple signals at a time in the communication system.	Apply
CO 6	**Examine** the digital modulation techniques for convey more information, high quality and security	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		**Strength**	**Proficiency Assessed by**
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	Lab Exercises/ CIE/ SEE

PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	3	Lab Exercises/ CIE/ SEE
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	2	Lab Exercises/ Projects
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	Lab Exercises/ Projects

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		**Strength**	**Proficiency Assessed by**
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications	2	Lab Exercises/ CIE/ SEE

3 = High; 2 = Medium; 1 = Low

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	**PO'S PSO'S**	**Justification for mapping (Students will be able to)**	**No. of Key Competencies**
CO 1	PO 2	**Formulate** the given problem of the modulation index and frequency deviation from the amplitude modulated and frequency modulated waveforms using **principles of mathematics and engineering science**	2
	PO 5	Use MATLAB tool to model the basic amplitude and frequency modulation techniques .	1
	PO 9	Team work and as individual which will enable the student to become a productive member of a design team for completion of assignments, achieving of goals to drive their performance in the hands-on labs	6
	PO 10	Communicate **orally** on modulation and **write** effective reports on modulation index and frequency deviation.	2

	PSO 3	Make use of **High Frequency Structure Simulator**(HFSS) for modeling and evaluating the radio frequency communications for Wired and Wireless Communication Applications	1
CO 2	PO 2	**Identify the problem** and make use of balance modulator and synchronous detector to generate and detect DSBSC modulated waveforms and **interpret the results** for providing solution to the **complex engineering problems**	4
	PO 5	Make use of MATLAB software for writing, simulating the code to generate and detect SSBSC waveform to solve complex engineering activities.	1
	PO 10	Communicate **orally** on DSBSC and **write** effective reports on sideband suppression	2
CO 3	PO 2	**Identify** (Problem analysis) three different types of pulse width variations and **analyse** trailing edge , leading edge centre of the pulse using **principles of mathematics, natural sciences, and engineering sciences**	3
	PO 5	Make use of **MATLAB** software for writing, simulating the code to generate and detect pulse width variations to solve complex engineering activities.	1
	PO 9	**Team work and as individual** which will enable the student to become a **productive member of a design team** for completion of **assignments, achieving of goals** to drive their performance in the **hands-on labs**	6
	PO 10	**Communicate effectively** on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation	1
CO 4	PO 2	**Identify** (Problem analysis) sampling rate and sampling time interval in analog to digital signal conversion using **principles of mathematics, natural sciences, and engineering sciences**	3
	PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction filter and modelling the pulse code modulation and demodulation using serial to parallel and parallel to serial data transmission **(Modern Tool Usage)** to complex Engineering activities with an understanding of the limitations in PCM.	1
	PO 10	**Communicate effectively** on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports on delta modulation	1

CO 5	PO 2	**Identify and formulate** the principle of multiplexing and de multiplexing **analyze complex engineering problems** in the design of transmitter and receiver of a communication system by **applying principles of mathematics, natural sciences, and engineering sciences**.	2
	PO 5	Make use of **MATLAB** software to simulate the code to identify the differences between TDM and FDM.	1
	PO 10	**Communicate** effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and **write** effective reports on delta modulation	2
CO 6	PO 2	**Identify** the importance of digital modulation techniques and calculating the error probability (solution implementation) by using **principles of mathematics, natural sciences, and engineering sciences**	2
	PO 10	**Communicate** effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and **write** effective reports on probability of error	2
	PSO 3	Make use of High Frequency Structure Simulator(HFSS) for modeling and evaluating the radio frequency communications for Wired and Wireless Communication Applications	1

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES				PSO'S
	PO 2	PO 5	PO 9	PO 10	PSO 3
CO 1	1	3	2	1	-
CO 2	2	3	-	1	2
CO 3	1	3	2	1	-
CO 4	1	3	-	1	-
CO 5	1	3	-	1	-
CO 6	1	-	-	1	2

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK I	**AMPLITUDE MODULATION AND DEMODULATION**
	Generation of amplitude modulation and demodulation using hardware and MATLAB
WEEK II	**DSB-SC MODULATOR and DETECTOR**
	Generation of AM-Double Side Band Suppressed Carrier (DSB-SC) signal using Balanced Modulator
WEEK III	**FREQUENCY MODULATION AND DEMODULATION**
	Generation of frequency modulation and demodulation sing hardware and MATLAB
WEEK IV	**SAMPLING THEOREM VERIFICATION**
	Verification of sampling theorem for under, perfect, over sampling cases using hardware and MATLAB
WEEK V	**PULSE WIDTH MODULATION AND DEMODULATION**
	Generation of Pulse width modulation and demodulation using hardware and MATLAB
WEEK VI	**PULSE POSITION MODULATION AND DEMODULATION**
	Generation of pulse position modulation and demodulation using hardware and MATLAB
WEEK VII	**PULSE CODE MODULATION GENERATION AND DETECTION**
	Generation of pulse code modulation and demodulation using hardware and understanding the concept analog to digital conversion
WEEK VIII	**DIFFERENTIAL PULSE CODE MODULATION**
	Generation of differential pulse code modulation and demodulation using hardware
WEEK IX	**DELTA MODULATION**
	Generation of delta modulation and demodulation using hardware
WEEK X	**TIME DIVISION MULTIPLEXING**
	To study the operation of Time-Division multiplexing and demultiplexing
WEEK XI	**FREQUENCY SHIFT KEYING GENERATION AND DETECTION**
	Generation of Frequency shift keying modulation and demodulation using hardware
WEEK XII	**BINARY PHASE SHIFT KEYING GENERATION AND DETECTION**
	Generation of Phase shift keying modulation and demodulation using hardware
WEEK XIII	**DIFFERENTIAL PHASE SHIFT KEYING GENERATION AND DETECTION**
	Generation of Differential Phase shift keying modulation and demodulation using hardware
WEEK XIV	**AMPLITUDE SHIFT KEYING GENERATION AND DETECTION**
	Generation of Amplitude Shift Key modulation and demodulation using hardware

TEXTBOOKS

1. S. S. Haykin, "Communication Systems", Wiley Eastern, 3rd Edition, 2006.
2. Taub, Schilling, "Principles of Communication Systems", Tata McGraw-Hill, 4th Edition, 2013.

REFERENCE BOOKS:

1. B.P. Lathi, "Communication Systems, BS Publication", 2nd Edition, 2006.
2. John G. Proakis, Masond, Salehi, "Fundamentals of Communication Systems", PEA, 1st Edition,2006
3. George Kennedy, Bernard Davis, "Electronics and Communication System", Tata McGraw Hill, 5th Edition, 2011.

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Amplitude Modulation and Demodulation	CO 1	T1: 3.2
2	DSB-SC Modulator and Synchronous Detector	CO 2	T1: 3.4
3	Frequency modulation and demodulation	CO 1	T1: 3.11
4	Sampling Theorem verification	CO 3	T1: 6.2
5	Pulse width modulation and demodulation	CO 3	T1: 6.3
6	Pulse position modulation and demodulation	CO 3	T1: 6.5
7	Pulse code modulation generation and detection	CO 4	T1: 6.8
8	Differential Pulse code modulation	CO 4	T1: 6.12
9	Delta modulation	CO 4	T1: 6.11
10	Time division multiplexing and demultiplexing	CO 5	T1: 6.4
11	Frequency shift keying generation and detection	CO 6	T1 8.12
12	Binary phase shift keying generation and detection	CO 6	T1: 8.11
13	Differential phase shift keying generation and detection	CO 6	T1 8.17
14	Amplitude shift keying generation and detection	CO 6	T2: 5.9

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Implement the modulation and demodulation of Quadrature Amplitude Modulation (QAM).
2	Perform simple processes on speech signals (filtering, frequency translation), and examine their effect on the sound using MATLAB.
3	Design of FM receiver (90.4 MHz)
4	Design a sampling circuit with 5 V p-p amplitude and 100 Hz sine wave and remove aliasing effect
5	Design PAM transmission of voice signal with W = 3kHZ. Calculate transmission bandwidth if fs = 8Khz

6	Design adaptive delta modulator and find the maximum amplitude of a 1 KHz sinusoidal signal input to a delta modulator that will prevent slope overload, when the sampling rate is 10,000 samples/sec and the step size is = 0.1 .
7	Design differential phase shift keying modulator using XOR gate with bit stream 11011100101. Draw the encoded sequence and the transmitted phase sequence

Signature of Course Coordinator **HOD,ECE**
Dr.V Siva Nagaraju, Associate Professor of ECE

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING
COURSE DESCRIPTION

Course Title	**IC APPLICATIONS LABORATORY**				
Course Code	AECC15				
Program	B.Tech				
Semester	IV	ECE			
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	2	1
Chief Coordinator	Ms S Swathi, Assistant Professor				

I COURSE OVERVIEW:

Linear and digital IC applications lab enables to learn design, testing and describing of circuit performance with digital and analog integrated circuits. It focuses on applications of special ICs and apply the techniques for the design of 741 ICs, applications of 555 timers, data converters and digital IC's for combination and sequential circuits design. This course provides practical hands-on experiments to analyze characteristics of commercially available digital integrated circuits.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
B.Tech	AECC12	IV	IC Applications	3

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Linear and Digital IC Applications Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing Further Experiments

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks for internal assessment and 70 marks for semester end lab examination. Out of 30 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end lab examination for 70 marks shall be conducted by two examiners, one of them being Internal Examiner and the other being External Examiner, both nominated by the Principal from the panel of experts recommended by Chairman, BOS.
The emphasis on the experiments is broadly based on the following criteria:

20 %	To test the preparedness for the experiment.
20 %	To test the performance in the laboratory.
20 %	To test the calculations and graphs related to the concern experiment.
20 %	To test the results and the error analysis of the experiment.
20 %	To test the subject knowledge through viva – voce.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Table 1: Assessment pattern for CIA

Component	Laboratory		
Type of Assessment	**Day to day Performance**	**Final Internal Lab Assessment**	**Total Marks**
CIA Marks	20 Marks	10 Marks	30

Continuous Internal Examination (CIE):
One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

A. Experiment Based:

Preparation	Performance	Calculations and Graph	Results and Error Analysis	Viva	Total
2	2	2	2	2	10

VI HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Lab Experiments / CIE / SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	Lab Experiments / CIE / SEE

PO 4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Lab Experiments / CIE / SEE
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations.	3	Lab Experiments / CIE / SEE
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	3	Lab Experiments / CIE / SEE

3 = High; 2 = Medium; 1 = Low

VII HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		**Strength**	**Proficiency Assessed by**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	1	Lab Experiments / CIE / SEE

3 = High; 2 = Medium; 1 = Low

VIII COURSE OBJECTIVES:

The students will try to perform:

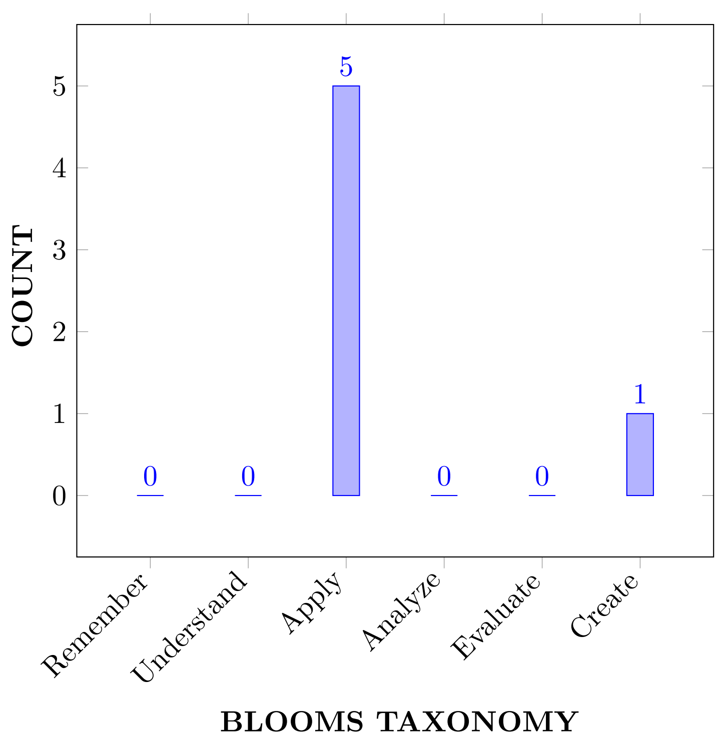
I	The experiments on design of Linear and Digital Integrated circuits using operational amplifier and digital ICs.
II	The design and implementation of analog circuits and gain the hands-on experience on the various building blocks of digital circuits.
III	The IC based real-time applications in the fields of communication systems and home-based automation systems.

IX COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO No	Course Outcomes	Knowledge Level (Bloom's Taxonomy)
CO 1	**Design** linear Integrated circuits to perform mathematical operations and voltage gain calculations using IC741.	Create
CO 2	**Plot** the frequency response of second order active filters using IC 741	Apply
CO 3	**Determine** the frequency of oscillations of multi-vibrators using IC741 and IC555 timer.	Apply
CO 4	**Obtain** the capture range and lock-in range of phase locked loop circuit using IC565.	Apply
CO 5	**Construct** the low and high voltage regulators to find the percentage of regulation using IC723.	Apply
CO 6	**Implement** combinational and sequential circuits using digital ICs to verify their functionality.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



X MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	✓	✓	-	✓	✓	-	-	-	✓	-	-	-	-	-	-
CO 2	✓	✓	-	✓	✓	-	-	-	✓	-	-	-	-	✓	-
CO 3	✓	✓	-	✓	✓	-	-	-	✓	-	-	-	-	✓	-
CO 4	✓	✓	-	✓	✓	-	-	-	✓	-	-	-	-	✓	-
CO 5	✓	✓	-	✓	✓	-	-	-	✓	-	-	-	-	-	-
CO 6	✓	✓	-	-	✓	-	-	-	✓	-	-	-	-	✓	-

XI JUSTIFICATIONS FOR CO – PO / PSO) MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies matched.
CO 1	PO 1	**(Recall)** the basic function of transistor , importance of differential amplifier and the characteristics by applying the **own engineering discipline, science principles and methodology.**	2
	PO 2	Understand the given **problem statement** and **formulate** the (complex) engineering problems of improving dc, ac characteristics of an operational, **translate the information** into the model from the **provided information and data, develop solutions** as compensation techniques ,**validate** the frequency response , stability of the circuit by the **interpretation of results.**	7
	PO 4	**Analyze and interpret** the design of linear Integrated circuits to perform mathematical operations and voltage gain calculations.	2
	PO5	**Create, select and apply appropriate techniques** to design the linear Integrated circuits to perform mathematical operations and voltage gain calculations.	3
	PO9	To improve the performance of team effectively in the classroom periods, in the hands-on labs and in the design projects to design linear integrated circuits .	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies matched.
CO 2	PO 1	**Explain** the importance of feedback and realize linear and non linear circuits using op-amp and the application of that model using **own engineering discipline, scientific principles and methodology.**	2
	PO 2	Understand the given **problem statement** and **formulate** the (complex) engineering problems of applications of op-amp, **translate the information** into the model using IC741 from the provided **information and data, develop solutions**based on the functionality of the circuit,**validate** the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	7
	PO 4	**Analyze and interpret** the frequency response of active filter circuits to calculate different time constants.	2
	PO5	**Create, select and apply appropriate techniques** to find the frequency response of active filter circuits to calculate different time constants.	3
	PO9	To improve the performance of team effectively in the classroom periods, in the hands-on labs and in the design projects by Analyzing the frequency selective circuits.	2
	PSO 2	**Speaks fluently** about the importance of feeback and applications of operational amplifier**(Subject matter)**.	2
CO 3	PO 1	**Explain** the importance of IC 555 timer,voltage regulators and realize multivibrator circuits using IC 555 and the application of that model using **own engineering discipline, scientific principles and methodology.**	2
	PO 2	**Interpret**frequency of oscillations, pulse width and able to change these parameters based on **information and data collection , model translation and validate using experimental design.**	4
	PO 4	**Analyze and interpret** the frequency of oscillations of multi-vibrators using IC741 and IC555 timer circuits.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies matched.
CO 3	PO5	**Create, select and apply appropriate techniques** to calculate the frequency of oscillations of multi-vibrators using IC741 and IC555 timer circuits.	3
	PO9	To improve the performance of team effectively in the classroom periods, in the hands-on labs and in the design projects to calculate the frequency of oscillations of multi-vibrators using IC741 and IC555 timer circuits.	2
	PSO 2	**Apply** data converters in the field of application specific integrated circuit (ASIC) prototype designs and system on chip (SOC) designs.	1
CO 4	PO 1	**Demonstrate** different data converters for converting analog data to digital data and vice versa **applying basic knowledge of science and engineering fundamentals.**	2
	PO 2	Understand the given **problem statement** and **formulate** the (complex) engineering problems of data converters, **translate the information** into the model and prototype systems from the provided **information and data, develop solutions** based on the functionality of the data translation, **validate** the data converters in reaching substantiated conclusions by the **interpretation of results**.	7
	PO 4	**Analyze ans interpret** the capture range and lock-in range of phase locked loop circuit using IC565.	2
	PO5	**Create, select and apply appropriate techniques** to find the capture range and lock-in range of phase locked loop circuit using IC565.	3
	PO9	To improve the performance of team effectively in the classroom periods, in the hands-on labs and in the design projects to find the capture range and lock-in range of phase locked loop circuit using IC565.	2
	PSO 2	**Apply** data converters in the field of application specific integrated circuit (ASIC) prototype designs and system on chip (SOC) designs.	1
CO 5	PO 1	**Build** digital logical design using digital ICs with the **knowledge of mathematics, science and engineering fundamentals.**	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies matched.
CO 5	PO 2	Understand the given **problem statement** and **formulate** the (complex) engineering problems of digital system design , **translate the information** into the model and prototype systems from the provided **information and data, develop solutions** digital design using equipment, **validate** the design in reaching substantiated conclusions by the **interpretation of results**.	7
	PO 4	**Analyze and interpret** the low and high voltage regulators to find the percentage of regulation using IC723.	2
	PO5	**Create, select and apply appropriate techniques** to design the low and high voltage regulators to find the percentage of regulation using IC723.	3
	PO9	To improve the performance of team effectively in the classroom periods, in the hands-on labs and in the design projects to design the low and high voltage regulators to find the percentage of regulation using IC723.	3
CO 6	PO 1	**Build** digital logical design using digital ICs with the **knowledge of mathematics, science and engineering fundamentals.**	2
	PO 2	Understand the given **problem statement** and **formulate** the (complex) engineering problems of digital system design , **translate the information** into the model and prototype systems from the provided **information and data, develop solutions** digital design using equipment, **validate** the design in reaching substantiated conclusions by the **interpretation of results**.	7
	PO5	**Create, select and apply appropriate techniques** to verify the functionality of digital logic circuits.	3
	PO9	To improve the performance of team effectively in the classroom periods, in the hands-on labs and in the design projects to verify the functionality of digital logic circuits.	3
	PSO 2	**Design**, various digital circuits in application secific integrated circuit (ASIC) and system on chip (SOC) designs.	1

XII MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	7	-	2	3	-	-	-	2	-	-	-	-	-	-
CO 2	2	7	-	3	3	-	-	-	2	-	-	-	-	2	-
CO 3	2	4	-	2	5	-	-	-	2	-	-	-	-	1	-
CO 4	2	7	-	2	3	-	-	-	2	-	-	-	-	1	-
CO 5	2	7	-	2	3	-	-	-	3	-	-	-	-	-	-
CO 6	2	7	-	-	3	-	-	-	3	-	-	-	-	-	-

XIII PERCENTAGE OF KEY COMPETENCIES FOR CO–(PO / PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	**10**	**10**	**11**	**1**	**5**	**3**	**3**	**12**	**5**	**12**	**8**	**2**	**2**	**2**
CO 1	66.6	70	-	18.2	100	-	-	-	16.7	-	-	-	-	-	-
CO 2	66.6	70	-	27.3	100	-	-	-	16.7	-	-	-	-	100	-
CO 3	66.6	70	-	18.2	100	-	-	-	16.7	-	-	-	-	50	-
CO 4	66.6	70	-	18.2	100	-	-	-	16.7	-	-	-	-	50	-
CO 5	66.6	70	-	18.2	100	-	-	-	25	-	-	-	-	-	-
CO 6	66.6	70	-	-	100	-	-	-	25	-	-	-	-	-	-

XIV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 - $0 \leq$ C$\leq$ 5% – No correlation

1 -5 <C$\leq$ 40% – Low/ Slight

2 - 40 % <C < 60% –Moderate

3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	-	1	3	-	-	-	1	-	-	-	-	-	-
CO 2	3	3	-	1	3	-	-	-	1	-	-	-	-	3	-
CO 3	3	3	-	1	3	-	-	-	1	-	-	-	-	2	-
CO 4	3	3	-	1	3	-	-	-	1	-	-	-	-	2	-
CO 5	3	3	-	1	3	-	-	-	1	-	-	-	-	-	-
CO 6	3	3	-	-	-	-	-	-	1	-	-	-	-	-	-
TOTAL	**18**	**18**	**0**	**5**	**15**	**0**	**0**	**0**	**6**	**0**	**0**	**0**	**0**	**7**	**0**
AVERAGE	**3**	**3**	**0**	**1**	**3**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**0**

XV ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	✓	Assignments	-
Laboratory Practices	✓	Student Viva		Mini Project	-	Certification	
Term Paper	-	5 Minutes Video	-	Open Ended Experiments	-	-	-

XVI ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVII SYLLABUS:

Week-1	**INVERTING, NON-INVERTING AND DIFFERENTIAL AMPLIFIERS**
	To construct and test the performance of an Inverting, Non-inverting amplifier and Differential amplifier using IC 741.
Week-2	**INTEGRATOR AND DIFFERENTIATOR**
	To construct and test the performance of an Integrator and Differentiator using IC 741.
Week-3	**SECOND ORDER ACTIVE LOWPASS, HIGHPASS AND BANDPASS FILTERS**
	To design and verify the operation of the Active low pass and High pass using IC 741.
Week-4	**SECOND ORDER ACTIVE BAND PASS AND BANDREJECT FILTERS**
	To design and verify the operation of the Band pass and Band reject filters using IC 741.
Week-5	**ASTABLE MULTIVIBRATORS USING 555**
	To design and construct an astablemultivibrator using IC 555.
Week-6	**MONOSTABLE MULTIVIBRATORS 555**
	To design and construct Monostable multivibrators using IC 555.
Week-7	**SCHMITT TRIGGER USING 555**
	To design and construct Schmitt trigger using NE555 Timer
Week-8	**PLL USING IC 565**
	Verifying characteristics of PLL.
Week-9	**INSTRUMENTATION AMPLIFIER**
	To design and verify the operation of instrumentation amplifier using IC 741.
Week-10	**DIGITAL TO ANALOG CONVERTER**
	To design and verify the operation of R-2R and Inverted R-2R DAC Converter using IC 741.
Week-11	**IC 723**
	To design and implement voltage regulator using IC 723.
Week-12	**RTL LOGIC**
	Verify Functionality of NOR and NAND gate using RTL Logic.
Week-13	**DTL LOGIC**
	Verify Functionality of NOR and NAND gate using DTL Logic

TEXTBOOKS

1. D. Roy Chowdhury, "Linear Integrated Circuits", New age international (p) Ltd, 2nd Edition,2003
2. Ramakanth A. Gayakwad, "Op-Amps linear ICs", PHI, 3rdEdition,2003.
3. John F. Wakerly, "Digital Design Principles and Practices", Prentice Hall, 3rdEdition,2005.

REFERENCE BOOKS:

1. Salivahanan, “Linear Integrated Circuits and Applications”, TMH, 1st Edition, 2008

XVIII COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Week No	**Topics to be covered**	**CO’s**	**Reference**
1	To find voltage gain of inverting, Non-inverting and Differential Amplifiers using IC 741.	CO 1	T1:11.1-11.5
2	To find the frequency response of integrator and differentiator for different inputs using IC741.	CO 1	T1:11.1-11.5
3	To find the frequency response of second order Active Lowpass, High-pass And Bandpass Filters using IC 741.	CO 2	T1:4.8 , T1:7.2
4	To find the frequency response of Second Order Active Band Pass and Band-reject Filters using IC 741.	CO 2	T1:4.8 , T1:7.2
5	To find the frequency of oscillations of Astable Multivibrators Using 555timer.	CO 3	T2:10.4 , R2:7.2
6	To find the frequency of oscillations of Monostable Multivibrators Using 555timer.	CO 3	T2:10.4 , R1:7.2
7	To find the hysteresis voltage of Schmitt Trigger Using 555 timer.	CO 7	T2:10.4 , R1:7.2
8	To find the capture range and lock-in range of PLL Using IC 565.	CO 4	T1:8.2-8.5
9	To find the voltage gain of Instrumentation Amplifier using IC 741.	CO 1	T1:11.1-11.5
10	To find the different analog outputs using Digital to Analog Converter.	CO 5	T1:10.1 , T1:10.2
11	To find the voltage regulation of small voltage regulator using IC 723.	CO 4	T1:11.1-11.5
12	To verify the truth tables of RTL Logic using NAND and NOR implementations.	CO 6	T3:3.12 , R1:12.7
13	To verify the truth tables of DTL Logic using NAND and NOR implementations.	CO 6	T3:3.12 , R1:12.7

XIX EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Design an automatic Street Light using 555 timer and LDR.
2	Design an analog Temperature Sensor detector using IC 741.
3	Design an Electronic Eye controlled security system using LDR.
4	Design PWM Based DC Fan Controller using IC 555 timer.
5	Design an automatic Washroom Light Switch using IC741.

Signature of Course Coordinator **HOD,ECE**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING
COURSE DESCRIPTION

Course Title	**ANALOG AND PULSE CIRCUITS LABORATORY**				
Course Code	AECC13				
Program	B.Tech				
Semester	IV	ECE			
Course Type	Core				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	2
Course Coordinator	Dr. V. Vijay, Associate Professor				

I COURSE OVERVIEW:

The objective of this course is to meet the requirements of practical work meant for circuit designing, analysis and provides hands-on experience by examining the pulse circuits and measuring instruments. This lab covers the analysis of the linear, non-linear wave shaping circuits, oscillators and multivibrators. Students will proficiency with the capability to use simulation tools for performing analysis of various amplifier circuits, wave shaping circuits and multivibrator applications.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
B.Tech	AEC001	III	Electronic Devices and Circuits	3

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Electronic Circuits and Pulse Circuits Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing Further Experiments

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks for internal assessment and 70 marks for semester end lab examination. Out of 30 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end lab examination for 70 marks shall be conducted by two examiners, one of them being Internal Examiner and the other being External Examiner, both nominated by the Principal from the panel of experts recommended by Chairman, BOS.
The emphasis on the experiments is broadly based on the following criteria:

20 %	To test the preparedness for the experiment.
20 %	To test the performance in the laboratory.
20 %	To test the calculations and graphs related to the concern experiment.
20 %	To test the results and the error analysis of the experiment.
20 %	To test the subject knowledge through viva – voce.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Table 1: Assessment pattern for CIA

Component	Laboratory		
Type of Assessment	**Day to day Performance**	**Final Internal Lab Assessment**	**Total Marks**
CIA Marks	20 Marks	10 Marks	30

Continuous Internal Examination (CIE):
One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

A. Experiment Based:

Preparation	Performance	Calculations and Graph	Results and Error Analysis	Viva	Total
2	2	2	2	2	10

VI HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	2	Lab Experiments / CIE / SEE
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	Lab Experiments / CIE / SEE
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Lab Experiments / CIE / SEE
PO 4	**Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Lab Experiments / CIE / SEE

PO 5	**Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.	2	Lab Experiments / CIE / SEE
PO 9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	1	Lab Experiments / CIE / SEE
PO 10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	Lab Experiments / CIE / SEE

3 = High; 2 = Medium; 1 = Low

VII HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		**Strength**	**Proficiency Assessed by**
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	1	Lab Experiments / CIE / SEE

3 = High; 2 = Medium; 1 = Low

VIII COURSE OBJECTIVES:

The students will try to learn:

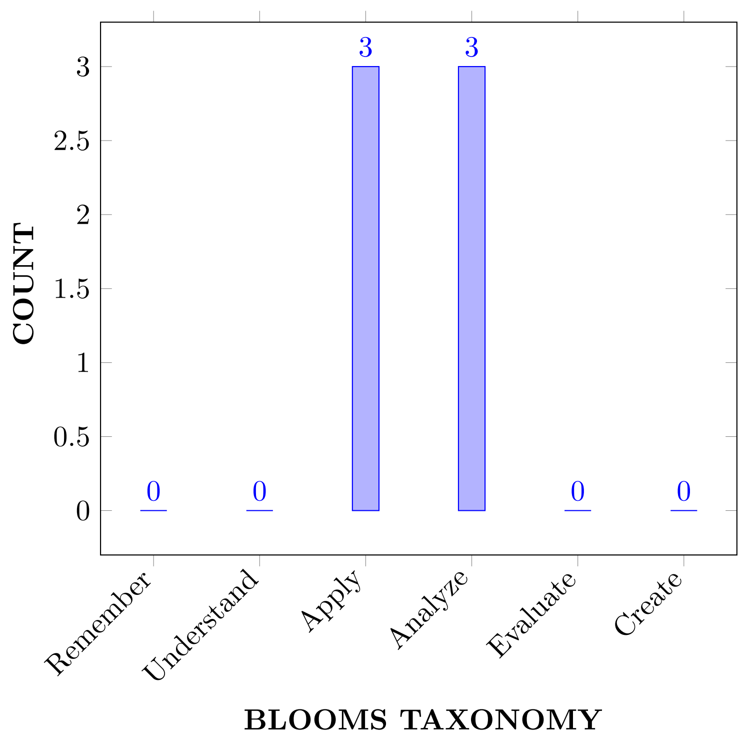
I	The basic amplifier circuits using common emitter and common base configurations.
II	The multivibrator circuits using transistors for real time applications.
III	The principle of oscillation and design of oscillators.
IV	The response of linear and non linear wave shaping circuits for sinusoidal, pulse and ramp inputs.

IX COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Analyze** the single stage and multistage Bipolar Junction Transistor (BJT) amplifiers for determining the voltage gain and bandwidth. .	Analyze
CO 2	**Build** linear and non-linear wave shaping circuits to obtain the response for sine and square wave inputs.	Apply
CO 3	**Analyze** Make use of voltage series and current shunt feedback amplifier circuits for determining amplifier characteristics.	Analyze
CO 4	**Apply** the barkhausen criteria to oscillators for generating sine wave.	Apply
CO 5	**Examine** Identify the suitable multivibrator to generate non-sinusoidal waveforms for real time applications.	Apply
CO 6	**Examine** the frequency response of class-A power amplifiers and single tuned voltage amplifier circuits using Bipolar Junction Transistor (BJT).	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



X MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO 1	✓	-	-	✓	✓	-	-	-	-	✓	-	-	✓	-	-
CO 2	✓	✓	✓	✓	-	-	-	-	-	✓	-	-	-	-	-
CO 3	✓	-	-	✓	✓	-	-	-	✓	✓	-	-	-	-	-
CO 4	✓	-	-	✓	✓	-	-	-	-	✓	-	-	-	-	-
CO 5	✓	-	✓	✓	-	-	-	-	✓	✓	-	-	-	-	-
CO 6	✓	✓	-	✓	✓	-	-	-	-	✓	-	-	-	-	-

XI JUSTIFICATIONS FOR CO – PO / PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Analyze** the single stage and multistage Bipolar Junction Transistor (BJT) amplifiers for determining the voltage gain and bandwidth by applying knowledge of **mathematics** and **engineering fundamentals**.	2
	PO 4	**Understand** the single stage and multistage Bipolar Junction Transistor (BJT) amplifiers for analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	4
	PO 5	**Create**, select, and apply appropriate techniques to obtain the frequency response of single and multi stage amplifier circuits using **NI Multisim software** and calculate gain bandwidth.	1
	PO 10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and **write effective reports** and design documentation, make **effective presentations**, and give and receive clear instructions.	2
	PSO 1	**Formulate** and Evaluate the amplifier applications in the field of Intelligent Embedded and Semiconductor technologies.	1
CO 2	PO 1	**Build** wave shaping circuits to obtain the response for sine and square wave inputs by applying knowledge of **mathematics** and **engineering fundamentals**.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	**Understand** the given the wave shaping circuit application **problem statement** and finding the **solution implementation** of wave shaping circuits by **analyzing complex engineering problems**.	4
	PO 3	**Design** solutions for linear and non-linear wave shaping circuits to complex engineering problems and design system components or processes that **meet the specified needs** with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	4
	PO 4	Use research-based **knowledge** and **research methods** including design of experiments, analysis and interpretation of data, and synthesis of the information of the basic embedded modules using different electronic circuits to provide valid conclusions.	3
	PO 10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and **write effective reports** and design documentation, make **effective presentations**, and give and receive clear instructions.	2
CO 3	PO 1	**Make use of** voltage series and current shunt feedback amplifier circuits for determining amplifier characteristics by applying knowledge of **mathematics** and **engineering fundamentals**.	2
	PO 4	Use research-based **knowledge** and **research methods** including design of experiments, analysis and interpretation of data, and synthesis of the information of the basic embedded modules using different electronic circuits to provide valid conclusions.	4
	PO 5	**Create**, select, and apply appropriate techniques to obtain the frequency response of single and multi stage amplifier circuits using **NI Multisim software** and calculate gain bandwidth.	1
	PO 9	**Individual and team work**: Function effectively as an individual, and as a member to obtain the readings.	3
	PO 10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and **write effective reports** and design documentation, make **effective presentations**, and give and receive clear instructions.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 4	PO 1	**Apply** the barkhausen criteria to oscillators for generating sine wave by applying knowledge of science, **mathematics** and **engineering fundamentals**.	3
	PO 4	Use research-based **knowledge** and **research methods** including design of experiments, analysis and interpretation of data, and synthesis of the information of the basic embedded modules using different electronic circuits to provide valid conclusions.	4
	PO 5	**Create**, select, and apply appropriate techniques to obtain the frequency response of single and multi stage amplifier circuits using **NI Multisim software** and calculate gain bandwidth.	1
	PO 10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and **write effective reports** and design documentation, make **effective presentations**, and give and receive clear instructions.	2
CO 5	PO 1	**Identify** the suitable multivibrator to generate non-sinusoidal waveforms for real time applications by applying knowledge of **mathematics** and **engineering fundamentals.**	2
	PO 3	**Design** solutions for multivibrator circuits to complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	4
	PO 4	Use research-based **knowledge** and **research methods** including design of experiments, analysis and interpretation of data, and synthesis of the information of the basic embedded modules using different electronic circuits to provide valid conclusions.	4
	PO 9	**Individual and team work**: Function effectively as an individual, and as a member to obtain the readings.	4
	PO 10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and **write effective reports** and design documentation, make **effective presentations**, and give and receive clear instructions.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 6	PO 1	**Examine** the frequency response of class-A power amplifiers and single tuned voltage amplifier circuits using Bipolar Junction Transistor (BJT) by applying knowledge of **mathematics** and **engineering fundamentals**.	2
	PO 2	**Identify**, formulate and analyze complex engineering problems of power amplifiers reaching substantiated conclusions using **first principles of mathematics, natural sciences,** and **engineering sciences.**	4
	PO 4	Use research-based **knowledge** and **research methods** including design of experiments, analysis and interpretation of data, and **synthesis of the information** of the basic embedded modules using different electronic circuits to provide valid conclusions.	3
	PO 5	**Create**, select, and apply appropriate techniques to obtain the frequency response of single and multi stage amplifier circuits using **NI Multisim software** and calculate gain bandwidth.	1
	PO 10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and **write effective reports** and design documentation, make **effective presentations**, and give and receive clear instructions.	2

XII MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO 1	3	-	-	1	3	-	-	-	-	1	-	-	3	-	-
CO 2	3	2	2	1	-	-	-	-	-	1	-	-	-	-	-
CO 3	3	-	-	1	3	-	-	-	1	1	-	-	-	-	-
CO 4	3	-	-	1	3	-	-	-	-	1	-	-	-	-	-
CO 5	3	-	2	1	-	-	-	-	1	1	-	-	-	-	-
CO 6	3	2	-	1	3	-	-	-	-	1	-	-	-	-	-

XIII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	✓	Assignments	-
Laboratory Practices	✓	Student Viva		Mini Project	-	Certification	
Term Paper	-	5 Minutes Video	-	Open Ended Experiments	-	-	-

XIV ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	-	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Mini Project	✓	Certification	-

XV ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVI SYLLABUS:

WEEK - 1	**BASIC AMPLIFIERS/ LINEAR WAVESHAPING**
	a. Simulate frequency response of common emitter amplifier and common base amplifier. b. Design RC low pass and high pass circuit for different time constants.
WEEK - 2	**BASIC AMPLIFIERS/ LINEAR WAVESHAPING**
	a. Design RC low pass and high pass circuit for different time constants. b. Simulate frequency response of common emitter amplifier and common base amplifier.
WEEK - 3	**TWO STAGE RC COUPLED AMPLIFIER / NON-LINEAR WAVESHAPING**
	a. Simulate frequency response of two stage RC coupled amplifier. b. Design transfer characteristics of clippers and clampers.
WEEK - 4	**TWO STAGE RC COUPLED AMPLIFIER / NON-LINEAR WAVESHAPING**
	a. Design transfer characteristics of clippers and clampers. b. Simulate frequency response of two stage RC coupled amplifier.
WEEK - 5	**SINGLE TUNED AMPLIFIERS / TRANSISTOR AS A SWITCH**

	a. Simulate a single tuned amplifier. b. Design of transistor as a switch.
WEEK - 6	**SINGLE TUNED AMPLIFIERS / TRANSISTOR AS A SWITCH**
	a. Design of transistor as a switch. b. Simulate a single tuned amplifier.
WEEK - 7	**FEEDBACK AMPLIFIERS / COMPARATOR**
	a. Simulate voltage series feedback amplifier and current shunt feedback amplifier. b. Design of comparator circuit.
WEEK - 8	**FEEDBACK AMPLIFIERS / COMPARATOR**
	a. Design of comparator circuit. b. Simulate voltage series feedback amplifier and current shunt feedback amplifier.
WEEK - 9	**RC PHASE SHIFT OSCILLATOR USING TRANSISTOR / MULTIVIBRATORS**
	a. Simulate sine wave generated for a particular frequency by an RC phase shift oscillator. b. Design different types of multivibrators and plot its waveforms.
WEEK - 10	**RC PHASE SHIFT OSCILLATOR USING TRANSISTOR / MULTIVIBRATORS**
	a. Design different types of multivibrators and plot its waveforms. b. Simulate sine wave generated for a particular frequency by an RC phase shift oscillator.
WEEK - 11	**OSCILLATORS / SCHMIT TRIGGER**
	a. Simulate sine wave generated for a particular frequency by Colpitts and Hartley oscillator. b. Design a Schmitt trigger circuit.
WEEK - 12	**OSCILLATORS / SCHMIT TRIGGER**
	a. Design a Schmitt trigger circuit. b. Simulate sine wave generated for a particular frequency by Colpitts and Hartley oscillator.
WEEK - 13	**POWER AMPLIFIERS/ UJT AS A RELAXATION OSCILLATOR**
	a. Simulate class A power amplifier (transformer less) and class B power amplifier. b. Design of UJT as a relaxation oscillator.
WEEK - 14	**POWER AMPLIFIERS/ UJT AS A RELAXATION OSCILLATOR**
	a. Design of UJT as a relaxation oscillator. b. Simulate class A power amplifier (transformer less) and class B power amplifier.

TEXT BOOKS

1. Douglas Perry, “VHDL”, Tata McGraw Hill, 4th Edition, 2002.
2. W.H. Gothmann, “Digital Electronics- An introduction to theory and practice”, PHI, 2nd Edition,2006.

REFERENCE BOOKS

1. D.V. Hall, “Digital Circuits and Systems”, Tata McGraw Hill, 1989.
2. Charles Roth, “Digital System Design using VHDL”, Tata McGraw Hill 2nd Edition 2012.

XVII COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Week No	Topics to be covered	CO’s	Reference
1	Simulate frequency response of common emitter amplifier and common base amplifier.	CO 1	T1-2.1 to 2.7
2	Design RC low pass and high pass circuit for different time constants.	CO 2	T1-20.1 to 20.2
3	Simulate frequency response of two stage RC coupled amplifier.	CO 1	T1-8.1 to 8.2
4	Design transfer characteristics of clippers and clampers.	CO 2	T1–8.3 to 8.7
5	Simulate a single tuned amplifier.	CO 6	T1-10.1 to 10.10
6	Design of transistor as a switch.	CO 5	T1-10.11 to 10.13
7	Simulate voltage series feedback amplifier and current shunt feedback amplifier.	CO 3	T1-11.1 to 11.5
8	Design of comparator circuit.	CO 5	T1 –11.12
9	Simulate sine wave generated for a particular frequency by an RC phase shift oscillator.	CO 4	T1–17.1 to 17.6
10	Design different types of multivibrators and plot its waveforms.	CO 5	T1–14.1 to 4.3
11	Simulate sine wave generated for a particular frequency by Colpitts and Hartley oscillator.	CO 4	T1-14.9
12	Design a Schmitt trigger circuit.	CO 5	T1-19.1 to 19.3
13	Simulate class A power amplifier (transformer less) and class B power amplifier.	CO 6	T1–6.1 to 6.5
14	Design of UJT as a relaxation oscillator.	CO 4	T1–7.1 to 7.3

XVIII EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Design a Bootstrap sweep circuit
2	Design a schmitt trigger circuit.
3	Design a UJT relaxation oscillator.

Signature of Course Coordinator **HOD,ECE**
Dr. V. Vijay, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Electronics and Communication Engineering**				
Course Title	**Antennas and wave propagation**				
Course Code	AECC18				
Program	B.Tech				
Semester	V				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4		
Course Coordinator	Dr. V.Kishen Ajay Kumar, Associate Professor				

I COURSE OVERVIEW:

Antennas are devices used to transform an RF signal, travelling on a conductor, into electromagnetic waves in free space.This course will cover the fundamentals of antenna, radiation phenomenon, types of antennas, antenna arrays, antenna measurements and wave propagation (influence of earth's atmosphere on radio waves). Antennas had wide range of application in government and commercial fields and able to design the antennas like wire antennas, aperture antennas, reflector antennas, lens antennas, micro strip antennas, and smart antennas.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECC11	IV	Electromagnetic waves and transmission lines

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Antennas and Wave Propagation	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	×	Assignments	×	MOOCs
×	Open Ended Experiments	×	Tech talk	×	Mini Project	×	Videos
×	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in below table.

Percentage of Cognitive Level	**Blooms Taxonomy Level**
0 %	Remember
33.33 %	Understand
33.33 %	Apply
33.33 %	Analyze
0%	Evaluate
0%	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE) and 10 marks for Quiz / Alternative Assessment Tool (AAT).

Component	Theory		Total Marks
Type of Assessment	CIE Exam	AAT	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams

Alternative Assessment Tool (AAT):
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table 3.

Table 3: Assessment pattern for AAT

Concept Video	Tech-talk	Open Ended Experiment
50%	50%	0%

VI COURSE OBJECTIVES:

The students will try to learn:

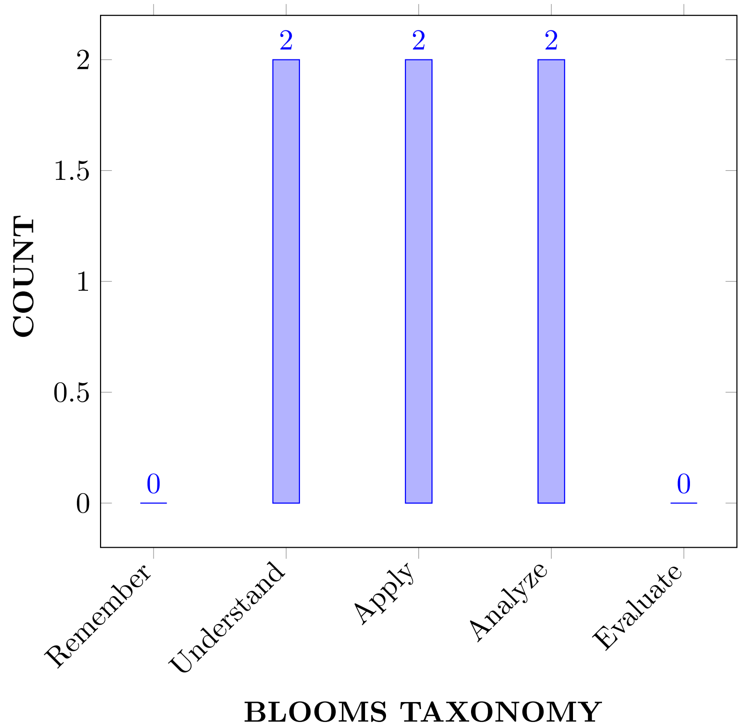
I	Principles of radiation, antenna parameters and working principle of VHF, UHF and microwave antennas used in communications, broad casting, radar, navigation and similar systems.
II	Antenna types and common structures, measurement of antenna characteristics and application of antennas over the radio frequency (RF) to micro wave (MW) frequency range.
III	The applications of smart, wideband and ultra wideband antennas for wireless communications, satellite communication, and radar systems.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Illustrate** the radiation mechanism in wire antennas and retarded potentials using Maxwell's equations.	Understand
CO 2	**Interpret** the radiation characteristics of yagi-uda, horn and helical antennas using radiation pattern in far field region.	Understand
CO3	**Analyze** the radiation characteristics of micro strip and micro wave antennas using electric and magnetic field distribution.	Analyze
CO 4	**Identify** the radiation patterns of arrays using principle of multiplication pattern.	Apply
CO 5	**Examine** the performance of antennas using the radiation pattern, directivity and gain.	Analyze
CO 6	**Select** the modes of wave propagation in the atmosphere at micro wave frequencies using refraction and reflection concepts.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

Program Outcomes	
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Strength	Proficiency Assessed by
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE / CIE / AAT
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	3	SEE / CIE / AAT
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	SEE / CIE / AAT

PO 10	**Communicate** effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. .	1	AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Strength	Proficiency Assessed by
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the patch and smart antennas for wired and wireless communication applications.	2	–

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 2	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-
CO 3	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	✓
CO 4	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	✓
CO 5	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-
CO 6	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	**Understand** the basic parameters of an antenna by **applying** the **mathematical principles** and **own engineering discipline**.	3
	PO 2	**Identify** and **formulate** the retarded potentials in radiation fields and **analyze** the (potentials) **complex engineering problems** using **principles of mathematics and engineering science**.	5
	PO 10	**Communicate effectively** and **write effective reports** on radiation fields for public health, safety and environment conditions	2

CO 2	PO 1	**Understand** the radiation pattern of Yagi-uda, horn and helical antennas in far field region by **scientific principles and methodology**	2
	PO 2	**Identify** the given problem in direction finding and **formulate** field components of wire antennas using **experimental design** from the provided **information and data collection** in reaching **substantiated conclusions** by the **interpretation of results** into a new **model translation and validation**	7
	PO 3	**Investigate constraints** of VHF antennas and **design solutions** for **complex engineering problems** in Yagi-uda and helical antenna, **understand customer needs** that meet the specified needs for the **public health to promote sustainable development**	5
	PO 10	**Communicate effectively** and **write effective reports** on antenna design for public health, safety and environment conditions	2
CO 3	PO 1	**Analyze** the radiation properties of micro strip antennas using **mathematical principles and own engineering discipline**. .	2
	PO 2	**Identify** the given problem in direction finding and **formulate** field components of wire antennas using **experimental design** from the provided **information and data collection** in reaching **substantiated conclusions** by the **interpretation of results** into a new **model translation and validation**	7
	PO 3	**Investigate and define radiation problems** in parabolic antennas and **identify** constraints including **environmental, health and safety** understand **customer and user needs** and the importance of considerations, use **creativity** to establish **innovative solutions** in dipole antennas design, manage the **design process of dipole antennas and evaluate outcomes**.	5
	PO 10	**Communicate orally** on radiation properties of micro strip antennas and **write** effective reports on smart antennas	2
	PSO 3	**Explore** and **control** VHF, UHF antennas using High Frequency Structure Simulator (HFSS) and **explicit** software tools for antenna design to **meet requirements of global environment**.	4

CO 4	PO 1	**Illustrate** the multiplication of radiation patterns by understanding the knowledge in solving (complex) engineering problems related to antenna arrays by **applying scientific, mathematical principles and own engineering discipline**.	3
	PO 2	**Identify** the problems in antenna measurements and **formulate** field components of arrays using **experimental design** from the provided **information and data collection** in reaching **substantiated conclusions** by the **interpretation of results** into a new **model translation and validation**	7
	PO 3	**Investigate and define radiation problems** in parabolic antennas and **identify** constraints including **environmental, health and safety** understand **customer and user needs** and the importance of considerations, use **creativity** to establish **innovative solutions** in dipole antennas design, manage the **design process of dipole antennas and evaluate outcomes**.	5
	PO 10	**Communicate orally** on radiation properties of micro strip antennas and **write** effective reports on smart antennas	2
	PSO 3	**Explore** and **control** smart antennas using High Frequency Structure Simulator (HFSS) and **explicit** software tools for antenna design to **meet requirements of global environment**.	4
CO 5	PO 1	**Understand engineering fundamentals** of antennas and **apply the knowledge** to find the performance of antennas by measuring the parameters	2
	PO 2	**Identify** the problems in antenna measurements and **formulate** field components of arrays using **experimental design** from the provided **information and data collection** in reaching **substantiated conclusions** by the **interpretation of results** into a new **model translation and validation**	7
	PO 3	**Understand** the user needs of antennas for working,**identify** the cost limitations for the selection of parameters, use **creativity** in producing new antenna designs for **innovative solutions** and manage the **design process of antennas and evaluate outcomes**	5
	PO 10	**Communicate orally** on the performance of antennas and **write** effective reports on characteristics of antennas	2

CO 6	PO 1	**Understand** the modes of wave propagation through the earth's atmosphere by **applying** the **scientific, mathematical principles and own engineering discipline**	3
	PO 2	**Identify** the problems in atmospheric layers and **formulate** VHF antennas using **experimental design** from the provided **information and data collection** in reaching **substantiated conclusions** by the **interpretation of results** into a new **model translation and validation**	7
	PO 10	**Communicate effectively** on the modes of wave propagation and **write** effective reports on parameters of wave propagation.	2

Note: For Key Attributes refer **Annexure - I**

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	3	5	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 2	2	7	5	-	-	-	-	-	-	2	-	-	-	-	-
CO 3	2	7	5	-	-	-	-	-	-	2	-	-	-	-	4
CO 4	2	7	5	-	-	-	-	-	-	2	-	-	-	-	4
CO 5	2	7	5	-	-	-	-	-	-	2	-	-	-	-	-
CO 6	3	5	-	-	-	-	-	-	-	2	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	100	50	-	-	-	-	-	-	-	40	-		-	-	-
CO 2	66.6	70	50	-	-	-	-	-	-	40	-	-	-	-	-
CO 3	66.6	70	50	-	-	-	-	-	-	40	-	-	-	-	57
CO 4	66.6	70	50	-	-	-	-	-	-	40	-		-	-	57

CO 5	66.6	70	50	-	-	-	-	-	-	40	-	-	-	-	-
CO 6	100	50	-	-	-	-	-	-	-	40	-		-	-	-

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.
0 - $0 \leq C \leq 5\%$ – No correlation
1 - $5\% < C \leq 40\%$ – Low/ Slight
2 - $40\% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	3	2	-	-	-	-	-	-	-	1	-		-	-	-
CO 2	3	3	2	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	3	3	2	-	-	-	-	-	-	1	-	-	-	-	2
CO 4	3	3	2	-	-	-	-	-	-	1	-		-	-	2
CO 5	3	3	2	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
TOTAL	18	16	8	-	-	-	-	-	-	6	-	-	-	-	4
AVERAGE	3.0	2.6	2.0	-	-	-	-	-	-	1.0	-	-	-	-	2.0

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	-
Quiz	-	Tech - Talk	✓	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	✓	Open Ended Experiments	✓
Micro Projects	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**ANTENNA BASICS**
	Antenna fundamentals: Introduction, basic antenna parameters-patterns, beam area, radiation intensity, beam efficiency, directivity-gain-resolution, antenna apertures, effective height, illustrative problems, fields from oscillating dipole, field zones, front-to-back ratio, antenna theorems, radiation, retarded potentials, radiation from small electric dipole, quarter wave monopole and half wave dipole, current distributions, field components, radiated power, radiation resistance, loop antennas- introduction, small circular loop, comparison of far fields of small loop and short dipole.
MODULE II	**VHF,UHF AND MICROWAVE ANTENNAS-I**
	Arrays with parasitic elements, Yagi-uda array, folded dipoles and their characteristics, helical antennas-helical geometry, helix modes, practical design considerations for monofilar helical antenna in axial and normal modes, horn antennas- types, Fermat's principle, optimum horns, design considerations of pyramidal horns, illustrative problems.
MODULE III	**VHF,UHF AND MICROWAVE ANTENNAS-II**
	Micro strip Antennas-Introduction, basic characteristics of micro strip antennas, feeding methods, method of analysis, rectangular and circular micro strip antennas, basic concepts of Smart antennas, concepts and benefits of smart antennas, fixed weight beam forming, adaptive beam forming. **Reflector Antennas**- Introduction, paraboloidal reflectors- geometry, pattern characteristics, feed methods lens antennas: introduction, geometry of non-metallic dielectric lenses, zoning, tolerances, applications, slot antenna, Babinet's principle, applications.
MODULE IV	**ANTENNA ARRAYS AND MEASUREMENTS**
	Antenna Arrays: Point sources- definition, patterns, arrays of 2 isotropic sources – different cases, principle of pattern multiplication, uniform linear arrays- broadside arrays, end-fire arrays, EFA with increased directivity, derivation of their characteristics and comparison, BSAs with Non-uniform amplitude distributions, general considerations and binomial arrays, illustrative problems **Antenna Measurements**: Introduction, concepts – Reciprocity, near and far fields, coordinate system, sources of errors patterns to be measured, pattern measurement arrangement directivity measurement, gain measurements (by Comparison, Absolute and 3-Antenna methods)

MODULE V	**RADIO WAVE PROPAGATION**
	Wave Propagation - I: Introduction, definitions, categorizations ,different Modes of Wave Propagation; Ground wave propagation: Introduction, plane earth reflections, , wave tilt, curved earth reflections; Space wave propagation: Introduction, field strength variation with distance and height, effect of earth's curvature, absorption, super refraction, M-curves, duct propagation, scattering phenomena, tropospheric propagation, fading and path loss calculations; Wave propagation – II: Sky wave propagation: Introduction, structure of ionosphere, refraction and reflection of sky waves by ionosphere; ray path, critical frequency, MUF, LUF, OF, virtual height and skip distance; relation between MUF and skip distance; multi-hop propagation

TEXTBOOKS

1. John D. Kraus, Ronald J. Marhefka, Ahmad S. Khan, "Antennas and Wave Propagation", TMH, 4th Edition, 2010.

2. C.A. Balanis, "Antenna Theory", John Wiley and Sons, 2nd Edition, 2001.

REFERENCE BOOKS:

1. E.C. Jordan, K.G. Balmain, "Electromagnetic Waves and Radiating Systems", PHI, 2nd Edition, 2000.

2. E.V.D. Glazier, H.R.L. Lamont, "Transmission and Propagation", Her Majesty's Stationery Office, 1958.

3. F.E. Terman, "Electronic and Radio Engineering", McGraw-Hill, 4th Edition, 1955.

4. K.D. Prasad, SatyaPrakashan, "Antennas and Wave Propagation", Tech India Publications, 1st Edition, 2001.

WEB REFERENCES:

1. https://nptel.ac.in/courses/117/107/117107035/

COURSE WEB PAGE:

1. https://lms.iare.ac.in/index?route=course/details &course_ id=181

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping.	-	https://lms.iare.ac.in/index?route=course/details&course_id=181
CONTENT DELIVERY (THEORY)			
2	Antenna fundamentals: introduction	CO 1	T1: 2.1
3	Basic antenna parameters-patterns, beam area, radiation intensity, beam efficiency, directivity-gain-resolution	CO 1	T1: 2.2-2.8
4	Antenna apertures, effective height, fields from oscillating dipole	CO 1	T1: 2.9-2.10, 2.12
6	Field zones, front-to-back ratio, antenna theorems	CO 1	T1:2.13,21,22
7	Radiation, retarded potentials	CO 1	T1: 4.1-4.2
8	Radiation from small electric dipole	CO 1	T1: 4.3
9	Quarter wave monopole and half wave dipole, current distributions, field components	CO 1	T1: 6.5
11	Radiated power, radiation resistance	CO 1	T1: 6.6 R2-8.1
13	Loop Antennas- introduction, small circular loop, comparison of far fields of small loop and short dipole	CO 1	T1: 7.1-7.3
14	Arrays with parasitic elements, Yagi -uda array	CO 2	T1: 8.6
16	Folded dipoles and their characteristics	CO 2	T1: 8.7
17	Helical antennas-helical geometry, helix modes	CO 2	T1: 8.1-8.4
18	Practical design considerations for mono-filar helical antenna in axial and normal modes, horn antennas-types	CO 2	T1: 8.5-8.9
20	Fermat's principle, optimum horns, design considerations of pyramidal horns	CO 2	T1: 8.9-8.12
22	Micro strip antennas-introduction, basic characteristics of micro strip antennas	CO 3	T1: 14.1-14.4
23	Feeding methods, methods of analysis, rectangular and circular micro strip antennas	CO 3	T1: 14.5-14.6

24	Basic concepts of smart antennas, concepts and benefits of smart antennas, fixed weight beam forming, adaptive beam forming	CO 3	T1: 14.8
25	Reflector Antennas- introduction	CO 3	T1: 9.1-9.3
26	Paraboloidal reflectors- geometry, pattern characteristics, feed methods	CO 3	T1: 9.4-9.10
28	Lens antennas: introduction, geometry of non-metallic dielectric lenses, zoning, tolerances, applications	CO 3	T1: 10.1-10.3
30	Slot antenna, Babinet's principle, applications.	CO 3	T1: 10.4-10.6
31	Antenna arrays: point sources- definition, patterns	CO 4	R3: 7.1
32	Arrays of 2 isotropic sources – different cases	CO 4	R3: 7.2-7.3
33	Principle of pattern multiplication, uniform linear arrays- broadside arrays	CO 4	T1: 5.10-5.11
36	End-fire arrays, EFA with increased directivity, derivation of their characteristics and comparison	CO 4	T1: 5.13
38	BSAs with non-uniform amplitude distributions, general considerations and binomial arrays	CO 4	T1: 5.15
39	Antenna measurements: introduction, concepts –Reciprocity, near and far fields, coordinate system, sources of errors	CO 5	T1: 21.1-21.2
40	Errors patterns to be measured, pattern measurement arrangement, directivity measurement	CO 5	T1: 21.3, 21.5
41	Gain measurements (by comparison, absolute and 3-antenna methods)	CO 5	T1: 21.5
42	Wave propagation - I: introduction, definitions, categorizations, different modes of wave propagation	CO 6	R3:11.1-11.3
43	Ground wave propagation: Introduction, plane earth reflections	CO 6	R3:11.4
44	Wave tilt, curved earth reflections	CO 6	R3:11.5
45	Space wave propagation: introduction	CO 6	R3:11.19
46	Field strength variation with distance and height	CO 6	R3:11.19
48	Effect of earth's curvature, absorption, super refraction, M-curves	CO 6	R4:11.41
49	Duct propagation, scattering phenomena	CO 6	R4:11.31
50	Tropospheric propagation, fading and path loss calculations	CO 6	R4:11.32-33
51	Wave propagation – II: sky wave propagation: introduction, structure of ionosphere	CO 6	R4:11.34
52	Refraction and reflection of sky waves by ionosphere	CO 6	R4:11.34

53	Ray path, critical frequency	CO 6	R4:11.35
55	MUF, virtual height and skip distance	CO 6	R4:11.36
58	Relation between MUF and skip distance	CO 6	R4:11.37
59	LUF, OF, multi-hop propagation	CO 6	R4:11.38
PROBLEM SOLVING/ CASE STUDIES			
5	Problems on effective aperture	CO 1	T1: 2.9-2.10
10	Problems on power radiated by half wave dipole	CO 1	T1:6.5
12	Problems on radiation resistance and radiated power	CO 1	T1:6.6
15	Problems on Yagi- uda antenna	CO 2	T1: 8.6
19	Problems on helical antenna	CO 2	T1:8.1-8.4
21	Problems on horn antenna	CO 2	T1: 9.4-9.10
27	Problems on parabolic reflector	CO 3	T1: 9.4-9.10
29	Problems on lens antenna	CO 3	T1: 10.1-10.3
34	Problems on multiplication pattern	CO 4	T1: 5.10-5.11
35	Problems on broadside array	CO 4	T1: 5.12
37	Problems on end fire array	CO 4	T1: 5.13
47	Problems on field strength	CO 6	R4:11.36
54	Problems on critical frequency	CO 6	R4:11.36
56	Problems on maximum usable frequency	CO 6	R4:11.36
57	Problems on skip distance	CO 6	R4:11.36
DISCUSSION ON DEFINITION AND TERMINOLOGY			
60	Definitions on antenna parameters	CO 1	T1: 2.2-2.8
61	Definitions on basic antennas	CO 2	T1: 7.1-7.3
62	Definitions on array antennas	CO 4	R4:11.1-11.3
63	Definitions on measurements of antenna	CO 5	T1: 2.9-2.10
64	Definitions on modes of radio wave propagation	CO 6	R4:11.7
DISCUSSION ON QUESTION BANK			
65	Radiation intensity and half wave dipole antenna	CO 1	T1: 2.1-2.22, T1:4.1-4.3, T1:6.5-7.3
66	Helical and horn antenna	CO 2	T1:8.1 - 8.12
67	Microstrip and smart antennas	CO 3	T1: 14.1-14.6, T1:14.8, T1:9.1-9.10

68	Array and measurements	CO 4	T1:10.1-10.6, R3:7.1-7.3, T1:21.1-21.6
69	Space wave and ionospheric propagations	CO 5, CO 6	R3:11.1-11.38

Signature of Course Coordinator **HOD,ECE**
Dr.V.Kishen Ajay Kumar, Associate Professor.

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences **(Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations **(Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**

	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**

PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**

PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**
	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**

PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

ANNEXURE

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	NBA Statement / NBA statement / Vital features	No. of vitalfeatures
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications. 1. Analyze and solve real time problems in Robotics. 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications. 3. Develop embedded systems modules using Real Time Operating System. 4.Undertake research and development projects in the field of Embedded Systems. 5. Adopt the engineering professional code and conduct.	5
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs. 1. Inspect, survey and analyze types of ASIC chip designs. 2. Design ASIC prototypes using Verilog and VHDL languages. 3. Analyze microprocessor subsystems with memories and I/O interfacs for SOC designs 4. Explore hardware components for designig SOC 5.Adopt the engineering professional code and conduct 6. Designing prototypes of SOC using programming tools like MATLAB, LabVIEW. 7. Familiarize with the design flow of ASIC prototypes. 8. Realize SOC using Register-Transfer-Level designs 9. Analyse and develop models for system level descriptions for synthesis of SOC. 10.Inspect and survey the abstractions and principles for the specification, simulation, verification, and synthesis of systems on chip (SoC). 11.Programming and hands-on skills to meet requirements of global environment.	**11**

PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications. 1. Explicit software and programming tools for antenna design. 2. Adopt technical library resources and literature search. 3.Explore smart antennas. 4. Model, program for operation and control of smart antennas for wireless communication applications. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Electronics and Communication Engineering**				
Course Title	**Microprocessors and Microcontrollers**				
Course Code	AECC19				
Program	B.Tech				
Semester	V				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Dr S.China Venkateswarlu, Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECB07	III	Digital System Design
B.Tech	AECB32	V	Computer Architecture

II COURSE OVERVIEW:

Processor and controller cores are the key components in most of the modern embedded and system-on-chip designs. This course outlines the architecture and signal description of Intel microprocessor and microcontrollers. The instruction set and assembly language programming along with I/O and memory interfacing techniques are covered. The knowledge acquired from this course will enable the students in development of embedded hardware projects and models for engineering and scientific applications.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Microprocessors and Microcontrollers	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
✓	Open Ended Experiments	✓	Tech talk	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with either or choice will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
50 %	Understand
50 %	Apply
0 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), 10 marks for Alternative Assessment Tool (AAT).

Component	Theory		Total Marks
Type of Assessment	CIE Exam	AAT	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours / classes, techtalk, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), concept video, MOOCs etc. The AAT chosen for this course is given in table .

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	—

VI COURSE OBJECTIVES:

The students will try to learn:

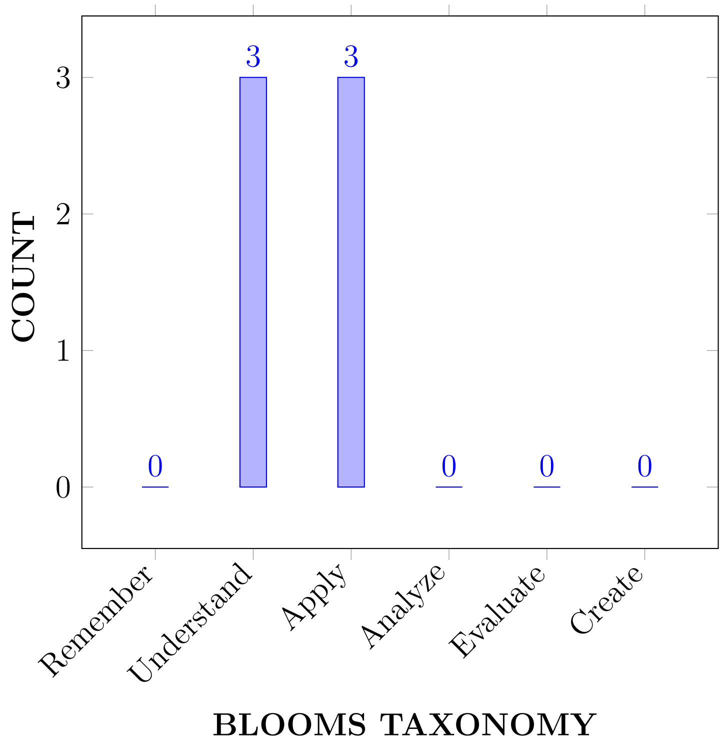
I	The signal descriptions along with functional architecture and hardware interfacing skills using microprocessors and micro controllers.
II	The instruction set and logic to build assembly language programs for arithmetic, logic and automated electronic systems.
III	The essential concepts of development through a practical hands-on approach on advanced ARM processors and Internet of Things based systems.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Describe** the features of intel processors and micro controllers for signal description and architecture.	Understand
CO 2	**Make use of** addressing modes and instruction set of target microprocessors and micro controllers for writing efficient assembly language programs.	Apply
CO 3	**Demonstrate** the internal architecture and modes of operation of peripheral devices for interfacing memory and I/O devices.	Understand
CO 4	**Illustrate** the interrupt handling mechanism in microprocessors and micro controllers using interrupt controller.	Understand
CO 5	**Choose** an appropriate data transfer scheme and hardware for data transfer between the devices.	Apply
CO 6	**Develop** microprocessor and micro controller based applications using appropriate input and output devices.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Program Outcomes	
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE, CIE, AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	SEE, CIE, AAT

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	SEE, CIE, AAT
PO 10	**Communication:** Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	SEE, CIE, AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build embedded software and digital circuit development platform for robotics, embedded systems and signal processing applications.	3	AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	✓	-	-	-	-	-	-	-	-	✓	-		-	-	-
CO 2	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 3	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-
CO 4	-	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-
CO 5	-	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-
CO 6	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Describe the features and architectures of Intel 8086 processor and Intel 8051 microcontroller (knowledge) by applying the knowledge of **mathematics, Engineering fundamentals,**and electronics **engineering specialization** for understanding the operation.	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 10	Explain the functional components of microprocessors and microcontrollers by **giving effective presentations and clear instructions** for understanding the operation of architectures.	1
CO 2	PO 1	Illustrate instructions from the set library (knowledge) for efficient assembly level programming by applying the knowledge of **science, engineering fundamentals and mathematics.**	3
	PO 2	Select proper instructions from the instruction set by **Information and data collection** for **Solution development** by writing assembly language level programming efficient and **Interpretation of results**	3
	PO 3	**Manage the design process** and make use of **creativity to establish solutions** by selecting proper mnemonics to write the assembly language level programming by **Understanding of the requirement for engineering activities to promote sustainable development.**	3
	PO 10	Utilize addressing modes and instruction set of target microprocessors and micro controllers micro controllers by **with clarity.**	1
	PSO 1	Develop software program skills to write efficient programs by **understanding the performance parameters** of software/ Hardware systems for **robotics, embedded systems and signal processing applications**	2
CO 3	PO 1	Illustrate the internal architecture and modes of operation of peripheral devices like PPI, DMA controller, PIC, USART by applying the principles of **mathematics, engineering fundamentals, electronics engineering specialization** for the solution of complex engineering problems.	3
	PO 2	Explain the **Problem statement and system definition** for interfacing devices with microprocessor and microcontroller by **Information and data collection** using peripheral devices like PPI, DMA controller, PIC, USART for **Solution development** and **Interpret the results**	4
	PO 3	**Manage the design process and evaluate outcomes** by interfacing devices with microprocessor and microcontroller using Programmable Peripheral Interface (PPI) and Interrupt Controllers **to establish innovative solutions** by**Understanding of the requirement for engineering activities to promote sustainable development**	3
	PO 10	Describe the internal architecture and modes of operation of peripheral devices by **giving effective presentations.** for interfacing memory and I/O devices.	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 4	PO 2	Explain the functionality of various types of interrupts and their structure with **Information and data collection** for controlling the processor or controller with program execution flow and**Interpret the results** for **solution development** using interrupt controller.	3
	PO 3	**Understand the requirement for engineering activities to promote sustainable development** in Interrupt handling and **use creativity to establish innovative solutions** using interrupt controller by **Managing the design process and evaluate outcomes**	3
	PO 10	Explain the interrupt handling mechanism in microprocessors and micro controllers with **clarity.**	1
CO 5	PO 2	Formulate and analyze (Problem analysis) **complex Engineering problems** by differentiating synchronous & asynchronous communication with **Information and data collection** for data transfer between the devices using first principles of **mathematics and Engineering sciences** and then **Interpret the results**	4
	PO 3	**understand the customer and user needs** and select an appropriate data transfer scheme and hardware by **Managing the design process and evaluate outcomes** to **promote sustainable development** for data transfer between the devices **using creativity to establish innovative solutions**	4
	PO 10	Select an appropriate data transfer scheme and hardware by **giving effective presentations and receive clear instructions** for data transfer between the devices.	1
CO 6	PO 1	Build (Apply)necessary hardware and software interface using microcomputer based systems to provide solution for real world problems by applying **knowledge of mathematics, engineering fundamentals, engineering specialization.**	3
	PO 2	**Identify problem** and Choose necessary hardware and software interface **(information and data collection)** and conduct **experimental design** with **model translation** to provide **solution development** for real world problems **by interpreting results.**	6

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 3	Organize necessary hardware and software interface **based on user needs and importance of considerations** for **innovative solutions, of the problem including all aspects to manage design process** , in microcomputer based systems **by applying different techniques, to achieve required sustained development, with legal requirements governing engineering activities, including personnel, health, safety, and risk issues.**	6
	PO 10	Build micro processor and micro controller based applications using necessary input and output devices and **give effective oral presentations and instructions.**	1
	PSO 1	Develop microprocessor and microcontroller based applications in the fields of r**obotics and embedded systems** using **embedded software** and necessary input output devices.	2

Note: For Key Attributes refer **Annexure - I**

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	3	3	-	-	-	-	-	-	1		-	2	-	-
CO 3	3	4	3	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	-	3	3	-	-	-	-	-	-	1	-	-	-	-	-
CO 5	-	4	4	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	3	6	6	-	-	-	-	-	-	1	-	-	2	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	100	-	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 2	100	30	30	-	-	-	-	-	-	20	-	-	40	-	-
CO 3	100	40	30	-	-	-	-	-	-	20	-	-	-	-	-
CO 4	-	30	30	-	-	-	-	-	-	20	-	-	-	-	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 5	-	40	40	-	-	-	-	-	-	20	-	-	-	-	-
CO 6	40	60	60	-	-	-	-	-	-	20	-	-	40	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - 0 $\leq$ C$\leq$ 5% – No correlation
1 -5 <C$\leq$ 40% – Low/ Slight
2 - 40 % <C < 60% –Moderate
3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	1	1	-	-	-	-	-	-	1	-	-	3	-	-
CO 3	3	2	1	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	-	1	1	-	-	-	-	-	-	1	-	-	-	-	-
CO 5	-	2	2	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	3	3	3	-	-	-	-	-	-	1	-	-	3	-	-
TOTAL	**12**	**9**	**8**	-	-	-	-	-	-	6	-	-	**6**	-	-
AVERAGE	**3**	**1.8**	**1.6**	-	-	-	-	-	-	1	-	-	**3**	-	-

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	-
Quiz	-	Tech - Talk	✓	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	✓	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**8086 MICROPROCESSORS**
	8086 Architecture, Register Organization, Memory Segmentation, Signal descriptions of 8086, modes of operation with timing diagrams, interrupts Addressing modes and Instruction Set of 8086. Simple Programs involving arithmetical, Logical, Branch and Call Instructions, Sorting, String Manipulations..
MODULE II	**INTERFACING DEVICES**
	PIO 8255 modes of operation of 8255, stepper motor interfacing, interfacing to D/A and A/D converters, Semiconductor memory interfacing, dynamic RAM interfacing, USART.
MODULE III	**8051 MICROCONTROLLER**
	8051 Microcontroller – Internal architecture and pin configuration, 8051 addressing modes, instruction set, Bit addressable features. I/O Port structures, assembly language programming using data transfer, arithmetic, logical and branch instructions.
MODULE IV	**SYSTEM DESIGN USING MICROCONTROLLER**
	8051 Timers/Counters, Serial data communication and its programming, 8051 interrupts, Interrupt programming. Real world interfacing of 8051 with external memory, expansion of I/O ports, stepper motor, ADC, DAC, LCD..
MODULE V	**ARM ARCHITECTURE**
	ARM Processor fundamentals, ARM Architecture – Register, CPSR, Pipeline, exceptions and interrupts interrupt vector table, ARM instruction set – Data processing, Branch instructions, load store instructions, Software interrupt instructions, Program status register instructions, loading constants, Conditional execution, Introduction to Thumb instructions.

TEXTBOOKS

1. A.K Ray, K. M. Bhurchandani, "Advanced Microprocessors and Peripherals" Tata McGraw-Hill Education, 2nd Edition, 2006..
2. Kenneth. J. Ayala, "The 8051 Microcontroller", Cengage Learning, 3rd Edition, 2004..
3. Andrew N SLOSS, Dominic SYMES, Chris WRIGHT, "ARM System Developers guide", Elsevier, 1st Edition, 2012. .

REFERENCE BOOKS:

1. N. Senthil Kumar, M. Saravanan, S. Jeevanathan, S. K. Shah, "Microprocessors and Interfacing", Oxford University, 1st Edition, 2012.
2. Lyla B. Das, "The x86 Microprocessors", Pearson India, 2nd Edition, 2014.
3. D. V. Hall, "Microprocessors and Interfacing", Tata McGraw-Hill Education, 3rd Edition 2013.

WEB REFERENCES:

1. http://www.daenotes.com/electronics/digital-electronics/Intel-80858bitmicroprocessoraxzz2I9yUSe7I
2. https://www.smartzworld.com/notes/microprocessors-and-microcontrollers-mpmc/
3. http://www.iare.ac.in

COURSE WEB PAGE:

1. http://engineersevanigam.blogspot.in/2013/07/microprocessors-and-interfacing-by.html
2. https://www.scribd.com/doc/153593067/Microprocessor-by-A-P-Godse-D-A-Godse

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	https://lms.iare.ac.in/index?route=course/details&course_id=135
CONTENT DELIVERY (THEORY)			
2	Register organization of 8086 microprocessor and Flag Register of 8086 Microprocessor	CO 1	T1:1.1 R2:1.3
3	Architecture and signal description of 8086 microprocessor and Physical memory organization of 8086 microprocessor	CO 1	T1:1.2 R2:1.1,6.1
4	General bus operation, I/O addressing capability and special purpose activities	CO 1	T1:1.5,1.6,1.7
5	Operation of 8086 microprocessor in minimum mode with read nd write timing diagrams and Operation of 8086 microprocessor in maximum mode with read nd write timing diagrams	CO 1	T1:1.8 R2:6.3
7	Machine language instruction formats and Addressing modes of 8086 Microprocessor	CO 2	T1:2.1 R2:3.1
8	Instruction Set Of 8086 Microprocessor: Data transfer instructions	CO 2	T1:2.3 R2:3.2
9	Instruction Set Of 8086 Microprocessor: Arithmetic and Logical instructions , Program control transfer instructions	CO 2	T1: 2.3 R2:3.4,3.5
10	Instruction Set Of 8086 Microprocessor: Machine Control Instructions and Flag manipulation instructions	CO 2	T1: 2.3 R2:3.7
11	Instruction Set Of 8086 Microprocessor: Shift and rotate instructions	CO 2	T1: 2.3 R2:3.6
12	Instruction Set Of 8086 Microprocessor: String instructions, Assembler Directives and operators and Machine level programs, programming with an assembler	CO 2	T1: 2.3 R2:4.1
13	Introduction to stack and stack structure of 8086/8088 microprocessor	CO 1	T1:4.1,4.2
14	Interfacing I/O ports, Pin diagram and Architecture 8255 PPI and Operating modes of 8255 PPI	CO 3	T1:5.3
15	Interrupts and Interrupt service routines , Interrupt cycle of 8086 microprocessor, non- mask able interrupt and mask able interrupt and Interrupt programming	CO 4	T1:4.3 R2:8.1

16	A/D and D/A converters	CO 6	T1:5.6,5.7 R2:9.8,9.9
17	Control of high power devices using 8255 PPI	CO 6	T1:5.9
18	Pin configuration of 8259 PIC and Architecture of 8259 PIC	CO 4	T1:6.2 R2:10.3
19	Keyboard /display controller 8279	CO 6	T1:6.3 R2:10.2
24	Programmable communication interface 8251 USART	CO 5	T1:6.4 R2:11.3
25	DMA Controller 8257	CO 3	T1:7.1 R2:11.6
26	Internal architecture and pin configuration of 8051 microcontroller	CO 1	T1:17.2 R2:20.1
27	Addressing modes of 8051 microcontroller and Instruction set of 8051 microcontroller	CO 2	T1:17.3
28	Bit addressable features and I/O Port structures and 8051 Timers/Counters	CO 1	T1:17.4 R2:19.10
29	Serial data communication and its programming	CO 5	T1:17.6 R2:20.6
30	8051 interrupts, Interrupt vector table	CO 4	T1:17.7 R2:20.5
31	Introduction to ARM Embedded Systems,ARM Processor fundamentals and ARM Architecture – Register	CO 1	T3:1.1 to 1.4
33	CPSR, Pipeline, exceptions	CO 1	T3:2.1 to 2.4
34	Interrupts interrupt vector table	CO 1	T3:2.1 to 2.4
35	ARM instruction set – Data processing, Branch instructions	CO 1	T3:2.1 to 2.2
36	load store instructions and Software interrupt instructions,	CO 1	T3:2.3 R2:10.3
38	load store instructions ,Software interrupt instructions and Conditional execution	CO 1	T3:2.4 to T3:2.8
40	Introduction to Thumb instructions-data processing instructions	CO 1	T3:3.1 to T3:3.2
42	branch and load store instructions	CO 1	T3:3.1 to T3:3.3
43	software interrupt and program status register instructions	CO 1	T3:3.4 to T3:3.5
44	loading constant ARMv5E Extensions	CO 1	T3:3.6 to T3:3.7
45	ARMv5E Extensions and conditional executions	CO 1	T3:3.7 to T3:3.8
46	Software abstract layers executing on hardware.	CO 1	T3:1.3 to 1.4
48	ARM Core dataflow and complete ARM register set	CO 1	T3: 2.1 to 2.2
49	ARM 7 Three stage pipeline and Pipeline Execution Characteristics	CO 1	T3: 2.3 to 2.3.1

50	Single register load store addressing, word or unsigned byte	CO 1	T3:3.3 to 3.5
PROBLEM SOLVING/ CASE STUDIES			
6	Physical address calculation	CO 1	T1:1.1 R2:1.1
20	Assembly language programs For Sorting of numbers using 8086 microprocessor	CO 2	T1:3.4 R2:4.7
21	Assembly language programs for multibyte addition and subtraction, sum of squares using 8086 microprocessor	CO 2	T1:3.4 R2:4.7
22	Assembly language programs for String manipulations using 8086 microprocessor	CO 2	T1:3.4 R2:4.1
23	Assembly language programs for Code conversions using 8086 microprocessor	CO 2	T1:3.4 R2:4.4,4.5
28	Memory interfacing to 8086 microprocessor (Static RAM)	CO 3	T1:5.1 R2:12.2,12.3
29	Memory interfacing to 8086 microprocessor (EPROM)	CO 3	T1:5.2 R2:12.4
32	Interfacing A/D and D/A converters with 8086 microprocessor	CO 6	T1:5.6,5.7 R2:9.8,9.9
34	Assembly language programs to rotate stepper motor in clockwise and anticlock wise direction	CO 2	T1:5.8 R2:9.11
37	Cascading of Interrupt Controller and its importance, interfacing 8259 PIC with 8086 microprocessor	CO 4	T1:6.2 R2:10.3,10.4
39	Interfacing keyboard /display controller 8279 to 8086 microprocessor	CO 6	T1:6.3 R2:10.2
41	Interfacing programmable communication interface 8251 USART to 8086 microprocessor	CO 5	T1:6.4 R2:11.3
47	Assembly language programming using data transfer, arithmetic, logical and branch instructions	CO 2	T1:17.8 R2:19.3
51	Real world interfacing of 8051 microcontroller with external memory	CO 6	T1:17.6 R2:20.2
52	Interfacing 8051 microcontroller with LCD	CO 6	T1:17.9 R2:21.3
53	Interfacing 8051 microcontroller with ADC and DAC	CO 6	T1:17.9 R2:21.1
DISCUSSION OF DEFINITION AND TERMINOLOGY			
54	8086 Microprocessor	CO 1, CO 2	T1, R2
55	INTERFACING DEVICES	CO 1, CO 2, CO 4	T1, R2
56	8051 MICROCONTROLLER	CO 2, CO 3, CO 4, CO 5, CO 6	T1, R2
57	SYSTEM DESIGN USING MICROCONTROLLER	CO 1, CO 2,	T1, R2

58	ARM ARCHITECTURE	CO 3, CO 4, CO 5, CO 6	T1, R2
DISCUSSION OF QUESTION BANK			
59	8086 Microprocessor	CO 1, CO 2	T1, R2
60	INTERFACING DEVICES	CO 1, CO 2, CO 4	T1, R2
61	8051 MICROCONTROLLER	CO 2, CO 3, CO 4, CO 5	T1, R2
62	SYSTEM DESIGNUSING MICROCONTROLLER	CO 1, CO 2	T1, R2
63	ARM ARCHITECTURE	CO 1, CO 4, CO 5	T1, R2

Signature of Course Coordinator
Dr. S.China Venkateswarlu, Professor **HOD, ECE**

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences **(Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations **(Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**

	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**

	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications 1. Analyze and solve real time problems in Robotics. 2. . Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications 3. Develop embedded systems modules using Real Time Operating System 4. Undertake research and development projects in the field of Embedded Systems. 5. Adopt the engineering professional code and conduct	**5**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs 1. Inspect, survey and analyze types of ASIC chip designs. 2. Design ASIC prototypes using Verilog and VHDL languages. 3. Analyze microprocessor subsystems with memories and I/O interfaces for SOC designs 4. Explore hardware components for designig SOC 5. Adopt the engineering professional code and conduct/ new technology 6. Designing prototypes of SOC using programming tools like MATLAB, LabVIEW 7. Familiarize with the design flow of ASIC prototypes. 8. Realize SOC using Register-Transfer-Level designs. 9. Analyse and develop models for system level descriptions for synthesis of SOC. 10. Inspect and survey the abstractions and principles for the specification, simulation, verification, and synthesis of systems on chip (SoC) 11. Programming and hands-on skills to meet requirements of global environment.	**11**

PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications 1. Explicit software and programming tools for antenna design. 2. Adopt technical library resources and literature search. 3. Explore smart antennas. 4. Model, program for operation and control of smart antennas for wireless communication applications. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	Electronics and Communication Engineering				
Course Title	Electronic Measurements and Instrumentation				
Course Code	AECC20				
Program	B.Tech				
Semester	V				
Course Type	Core				
Regulation	UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Ms.Ajitha G, Assistant Prfoessor,ECE				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEC02	II	Electrical Circuits
B.Tech	AECC01	III	Electronic Devices and Circuits

II COURSE OVERVIEW:

The purpose of this course is to design, realization and use of Electronic Systems for the measurement of electrical and non-electrical quantities. It gives an emphasis on analog and digital instruments, oscilloscopes, signal generators, signal analyzers, AC / DC bridges and transducers. The knowledge of measurements and instrumentation is used to test and analyze the performance of measuring instruments in the field of science, engineering and technology.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Electronic Measurements and Instrumentation	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
33%	Understand
50 %	Apply
17 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	-

VI COURSE OBJECTIVES:

The students will try to learn:

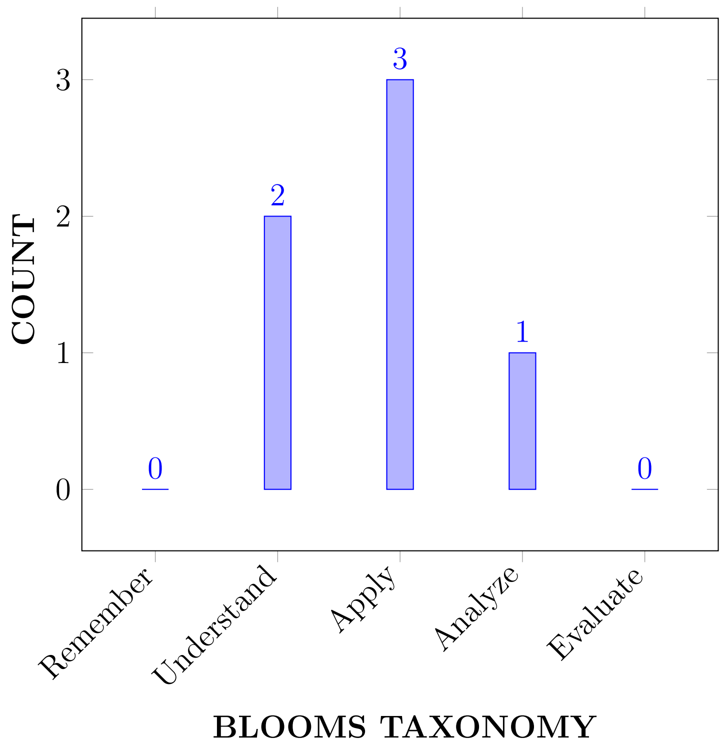
I	The performance characteristics and working principle of analog and digital instruments for measuring electrical quantities.
II	The analysis of different signals by using oscilloscopes and signal analyzers which are generated by built in signal generators
III	The measurement of unknown resistive and reactive components by using AC and DC bridge circuits.
IV	The construction and working of transducers for the conversion of physical quantities into electrical quantities

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Illustrate** the fundamentals and working principle of analog and digital instruments for measuring of electrical parameters.	Understand
CO 2	**Demonstrate** the building blocks and functionality of oscilloscopes to display and measure the parameters of the signals.	Understand
CO 3	**Utilize** the signal generators to produce various signals for design and test the signal processing applications.	Apply
CO 4	**Analyze** the relative amplitude of the signal and its harmonic components in frequency domain by using Signal Analyzers	Analyze
CO 5	**Identify** appropriate bridge circuits for the measurement of unknown electrical parameters.	Apply
CO 6	**Select** the suitable transducers for measuring electrical and non-electrical parameters to resolve the real-world problem.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE / CIE / AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	SEE / CIE / AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	SEE / CIE / AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	SEE / CIE / AAT

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications	2	SEE/ CIE / AAT
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs	2	AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 2	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 3	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 4	✓	✓	-	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 5	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 6	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	✓	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT :

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO1	PO 1	**Examine** the schematics of measuring systems and performance characteristics **(knowledge)** of an instrument using the **principles of science and mathematics** for the solution of **complex engineering problems.**	3
	PO 2	Understand the given **problem statement** and **formulate** the measurement of electrical parameters and **translate the information** into the model.	3
	PO 3	**Understand the customer needs, use creativity and manage design process** in realization of measuring instruments for measuring analog and digital values to **establish innovative solutions**	3
	PO 10	**Effective presentation and speaking style** on building blocks of an instrument and **write subject matter effectively** on working principle of D' Arsonvalmovement.	2
	PSO 1	**Design and provide optimal solutions for signal processing** using the concept analog and digital meters to measure voltage, current and resistance by using virtual instrumentation to solve **real time applications** by **adopting the engineering professional code.**	2
CO2	PO 1	**Understand** different blocks present in Oscilloscopes **(knowledge)** and combine all the blocks to get the appropriate output an **engineering specialization to the solution of complex engineering problems.**	3
	PO 2	Understand the given **problem statement** and **formulate** for the measurement using principles of electrostatic deflection sensitivity in Oscilloscopes **translate the information** into the model from the **provided information** and data to develop a solution and **validate the output by the interpretation of results**.	6
	PO 3	**Understand customer needs, manage the design** various Oscilloscopes for in realization of measuring signal parameters and **establish innovative solutions**	4

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 10	**Effective presentation and speaking style** on building blocks of Oscilloscopes and **write subject matter effectively** on working functionality of Digital Oscilloscopes.	2
	PSO 1	**Develop and design optimal solutions for signal processing applications** using oscilloscopes to **analyze** the real time signals by adopt the engineering professional code	2
CO 3	PO 1	**Understand** concept of multi-function signal generators **analyze** the different blocks present in generator **an engineering specialization to the solution of complex engineering problems.**	3
	PO 2	Understand the given **problem statement** and **formulate** for the measurement using principles of electrostatic deflection sensitivity in Oscilloscopes **translate the information** into the model	4
	PO 3	**Develop** signal generator circuit **based on customer needs for designg** of multi-function signal generators and **establish innovative solutions**	2
	PO 10	**Effective presentation and speaking style** on working of AF, RFSignal Generator and **write subject matter effectively** on working functionality of different blocks present in Signal Generators.	2
	PSO 1	**Develop the model** of signal generators to perform the **real time** signals and **design** and provide **optimal solutions for signal processing** by adopting the engineering professional code	2
CO4	PO 1	**Understand(knowledge)** the concepts of analyzers such as spectrum and wave analyzers and **analyze** the blocks of wave analyzers an engineering specialization to **the solution of complex engineering problems.**	3
	PO 2	Understand the given **problem statement** and **formulate** for the working functionality of analyzers **translate the information** into the model from the **provided information** and data to develop a solution and **validate the output by the interpretation of results**.	6
	PO 10	**Effective presentation and speaking style** on concept of wave analyzer and **write subject matter effectively** on on analysis of various signal analyzers.	2
	PSO 1	**Develop** the model of signal analyzers to the **real time signals** with the harmonic components and to **design** and provide **optimal solutions** for signal processing applications by adopting the engineering **professional code.**	2
CO5	PO 1	**Understand (knowledge)** the concept of bridges in electronic measuring instruments **an engineering specialization to the solution of complex engineering problems**	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	Understand the given **problem statement** and **formulate** for AC and DC bridge circuits and compare them **translate the information** into the model from the **provided information** and data to develop a solution and **validate the output by the interpretation of results**.	6
	PO 3	**Understand customer needs, manage the design** AC and DC bridge circuits on requirement and **establish innovative solutions**	3
	PO 10	**Effective presentation and speaking style** on concept of AC and DC bridges and **write subject matter effectively** on measurement of unknown parameter using bridges.	2
	PSO 1	**Understand** the performance of a bridge using practical experience to **analyze Virtual Instrumentation** by adopting the engineering professional code	2
CO 6	PO 1	**Apply (understand) the knowledge of engineering fundamentals to** define transducer and Understand the concepts of different types of Transducers **(Engineering knowledge)**	3
	PO 2	Understand the given **problem statement** and **formulate** for to convert physical quantities into electrical using transducers and classify them according to their application and **translate the information** into the model from the **provided information** and data to develop a solution and **validate the output by the interpretation of results**.	6
	PO 3	**Develop (Design/development of solutions)** an transducers like strain gauges, LVDT **(in the design of system components to establish innovative solutions)**to measure different electrical and non-electrical parameters.	3
	PO 10	**Effective presentation and speaking style** on working principles of all various types of Transducers and **write subject matter effectively** to measure different electrical and non-electrical parameters.	2
	PSO 1	**Understand** the concepts of measuring instrument systems to measure different electrical parameters using **embedded hardware design** by adopting the engineering professional code.	2
	PSO 2	**Design** sensors for measuring different physical quantities with the **survey , analyze** and **design flow** of **ASIC prototypes**, hardware components to **design SOC** using **programming tools** and **hands-on skills.**	5

Note:For Key Competencies refer Annexure - I

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	3	3	3	-	-	-	-	-	-	2	-	-	2	-	-
CO 2	3	6	4	-	-	-	-	-	-	2	-	-	2	-	-
CO 3	3	4	3	-	-	-	-	-	-	2	-	-	2	-	-
CO 4	3	6	-	-		-	-	-	-	2	-		2	-	-
CO 5	3	6	3	-	-	-	-	-	-	2	-	-	2	-	-
CO 6	3	6	3	-	-	-	-	-	-	2	-	-	2	5	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	30	30	-	-	-	-	-	-	40	-		40	-	-
CO 2	100	60	40	-	-	-	-	-	-	40	-	-	40	-	-
CO 3	100	40	30	-	-	-	-	-	-	40	-	-	40	-	-
CO 4	100	60	-	-		-	-	-	-	40	-		40	-	-
CO 5	100	60	30	-	-	-	-	-	-	40	-	-	40	-	-
CO 6	100	60	30	-	-	-	-	-	-	40	-		40	45	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq$ C$\leq$ 5% – No correlation

1 -5 <C$\leq$ 40% – Low/ Slight

2 - 40 % <C < 60% –Moderate

3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	1	1	0	0	0	0	0	0	2	0	0	2	0	0
CO 2	3	3	2	0	0	0	0	0	0	2	0	0	2	0	0
CO 3	3	2	1	0	0	0	0	0	0	2	0	0	2	0	0
CO 4	3	3	0	0	0	0	0	0	0	2	0	0	2	0	0
CO 5	3	3	1	0	0	0	0	0	0	2	0	0	2	0	0
CO 6	3	3	1	0	0	0	0	0	0	2	0	0	2	2	0
TOTAL	18	15	6	0	0	0	0	0	0	2	0	0	12	2	0
AVERAGE	3	2.5	1	0	0	0	0	0	0	2	0	0	2	2	0

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	-
Quiz	-	Tech - Talk	✓	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	✓	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

-	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION TO MEASURING INSTRUMENTS**
	Block schematics of measuring systems, performance characteristics, Static characteristics: Accuracy, resolution, precision, gross error, types of errors, Dynamic characteristics : Repeatability, reproducibility, fidelity, lag; Analog measuring instruments: D' Arsonval movement, DC voltmeters and ammeter, AC voltmeters and current meters, ohmmeters, multimeters, meter protection, extension of range, digital voltmeters: Ramp type, staircase, dual slope integrating type, successive approximation type, specifications of instruments.
MODULE II	**OSCILLOSCOPE**
	Oscilloscopes: CRT, block schematic of CRO, time base circuits, delay lines, high frequency CRO considerations, applications, specifications, special purpose oscilloscopes: Dual trace, dual beam CROs, sampling oscilloscopes, storage oscilloscopes, digital storage CROs, Lissajous figures, frequency measurement, phase measurement, CRO probes.
MODULE III	**SIGNAL GENERATOR AND SIGNAL ANALYZERS**
	Signal Generators: AF and RF signal generators, sine and square wave generators, function generators arbitrary waveform generator, sweep frequency generators, video signal generators, and specifications. Signal Analyzers: AF, HF wave analyzers, heterodyne wave analyzers, harmonic distortion, spectrum analyzers, power analyzers
MODULE IV	**AC AND DC BRIDGES**
	Measurements using DC and AC bridges: Wheat stone bridge, Kelvin bridge, AC bridges, Maxwell, Hay, Schering, Wien, Anderson bridges, Wagner & ground connection.
MODULE V	**TRANSDUCERS**

	Transducers: Classification, strain gauges, force and displacement, transducers, resistance thermometers, hotwire anemometers, LVDT, thermocouples, synchros; Piezoelectric transducers, variable capacitance transducers; Magneto strictive transducers, measurement of physical parameters: Flow measurement, displacement meters, liquid level measurement, measurement of humidity and moisture, velocity, force, pressure, high pressure, vacuum level, temperature measurements.

TEXTBOOKS

1. A.K.Sawhney,"Electrical and electronics measurements and instrumentation", 19th Edition,2011.
2. H.S.Kalsi, "Electronic Instrumentation", TMH, 2nd Edition,2004.
3. K. Lal Kishore, "Electronic Measurements and Instrumentation", Pearson Education,2nd Edition,2010

REFERENCE BOOKS:

1. David A. Bell, "Electronic Instrumentation and Measurements", Oxford University Press, 1st Edition, 2007
2. A.D. Helbincs, W.D. Cooper, "Modern Electronic Instrumentation and Measurement Techniques", PHI, 56th Edition, 2003.

WEB REFERENCES:

1. https://nptel.ac.in/courses/112105171/1

COURSE WEB PAGE:

1. https://lms.iare.ac.in/index?route=course/details course id=356

XIX COURSE PLAN

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping		W 1
CONTENT DELIVERY (THEORY)			
2	Block schematics of measuring systems, performance characteristics	CO 1	T1:1.1, 1.2. T2:1.2-1.7 R2:2.10
3	Static and Dynamic characteristics, types of errors	CO 1	T1:1.2.,T2:1.2-1.7 R2:2.10
4	D' Arsonval movement	CO 1	T1: 2.2., T2:2.3-2.7 R2:3.3
5	DC voltmeters	CO 1	T1: 4.2,4.3. ,T2:4.3-4.7
6	DC ammeters	CO 1	T1: 3.2,3.3. T2:3.3-3.4
7	AC voltmeters	CO 1	T1: 4.7-4.17, T2:4.7-4.17

8	AC current meters (Ammeters)	CO 1	T1: 3.5, 3.6.,T2:3.5-3.7
9	Ohmmeters ,Multimeters, meter protection, extension of range	CO 1	T1: 4.4,4.6,T2:4.7-4.17
10	Digital voltmeters, Ramp type, staircase	CO 1	T1:5.1-5.10, R2:5.1
11	Digital voltmeters dual slope integrating type, successive approximation type, specifications of instruments.	CO 1	T1:5.1-5.10, R2:5.3
12	Oscilloscopes: CRT, block schematic of CRO	CO 2	T1:7.1-7.13,R2:4.1-4.3
13	Time base circuits, delay lines	CO 2	T1:7.1-7.13,R2:4.1-4.3
14	high frequency CRO considerations, applications, specifications	CO 2	T1:7.1-7.13,R2:4.1-4.3
15	special purpose oscilloscopes: Dual trace, dual beam CROs	CO 2	T1:7.14-7.18,R2:4.7-4.13
16	sampling oscilloscopes, storage oscilloscopes	CO 2	T1:7.19-7.28,R2:4.7-4.13
17	Digital Storage CROs	CO 2	T1:7.19-7.28,R2:4.7-4.13
18	Lissajous figures, frequency measurement, phase measurement	CO 2	T1:7.19-7.28,R2:4.7-4.13
19	CRO probes	CO 3	T1:7.19-7.28,R2:4.7-4.13
20	Signal Generators: standard signal generators	CO 3	T1:8.1-8.2,R2:6.1-6.13
21	AF sine and square wave generators	CO 3	T1:8.1-8.18,R2:6.1-6.13
22	function generators, arbitrary waveform generator	CO 3	T1:8.1-8.18,R2:6.1-6.13
23	sweep frequency generators, video signal generators	CO 3	T1:8.1-8.18,R2:6.1-6.13
24	Signal Analyzers: AF, HF wave analyzers	CO 4	T1:9.1-9.8, R2:7.1-7.6
25	heterodyne wave analyzers, harmonic distortion wave analyzers	CO 4	T1:9.1-9.8, R2:7.1-7.6
26	spectrum analyzers, power analyzers	CO 4	T1:9.1-9.8, R2:7.1-7.6
27	Measurements using DC bridges: Wheat stone bridge	CO 5	T1:11.2 R2:10.4
28	Measurements using DC bridges: Kelvin bridge	CO 5	T1:11.3 R2:10.5
29	AC bridges: Maxwell bridge, Hay bridge	CO 5	T1:11.11-11.12 R2:10.8
30	AC bridges: Schering bridge, Wien bridge	CO 5	T1:11.13-11.14 R2:10.9-10.10
31	AC bridges: Anderson bridge	CO 5	T1:11.18,R2:10.13
32	Wagner & ground connection	CO 5	T1:11.15,R2:10.16
33	Transducers: Classification	CO 6	T1:13.1,R2:12.1
34	strain gauges	CO 6	T1:13.6,R2:12.6
S.No	**Topics to be covered**	**CO's**	**Reference**
35	resistance thermometers	CO 6	T1:13.7,R2:12.7
36	hotwire anemometers, thermocouples	CO 6	T1:13.8,R2:12.9
37	LVDT	CO 6	T1:13.11,R2:12.10
38	Piezoelectric transducers	CO 6	T1:13.15,R2:12.17

39	Magneto strictive transducers	CO 6	T1:13.16,R2:12.18
40	measurement of physical parameters: force and displacement	CO 6	T1:13.23-13.27, R2:12.24-12.28
41	measurement of physical parameters: Pressure, vacuum level, temperature measurements	CO 6	T1:13.23-13.27, R2:12.24-12.28
42	Problem solving on Voltmeters and ammeters	CO 1	T1: 4.2-4.13.
43	Problem solving on series and shunt ohmmeters, digital multimeters	CO 1	T1: 4.2-4.13.R2:4.13
44	Problem solving on electrostatic deflection sensitivity, Velocity of electron beam	CO 2	T1:7.1-7.13,R2:4.1-4.3
45	Problem solving on frequency and phase measurement	CO 2	T1:7.1-7.13,R2:4.1-4.3
46	Problem solving on minimum detectable signal of spectrum analyzer	CO 4	T1:9.1-9.8, R2:7.1-7.6
47	Problem solving on whetstone bridge	CO 5	T1:11.2 R2:10.4
48	Problem solving on Kelvin bridge	CO 5	T1:11.3 R2:10.5
49	Problem solving on wien bridge	CO 5	T1:11.11-11.12 R2:10.8
50	Problem solving on Maxwell bridge	CO 5	T1:11.13-11.14 R2:10.9-10.10
51	Problem solving on Schering bridge	CO 5	T1:11.18,R2:10.13
52	Problem solving on Anderson bridge	CO 5	T1:11.2 R2:10.4
53	Problem solving on hay's bridge	CO 5	T1:11.3 R2:10.5
54	Problem solving on strain gauges	CO 6	T1:13.6,R2:12.6
55	Problem solving on LVDT	CO 6	T1:13.11,R2:12.10
56	Problem solving on Thermistor	CO 6	T1:13.15,R2:12.17
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Module-I: Introduction to Measuring Instruments	CO 1	T1:1.1-19,2.1-2.8,3.1-3.8,4.1-4.25,5.1-5.10
58	Module-II: Oscilloscopes	CO 2	T1:7.1-7.32
59	Module-III: Signal Generators and Wave Analyzers	CO 3,4	T1:8.1-8.10,9.1-9.6
60	Module-IV: AC and DC Bridges	CO 5	T1:11.1.-11.18
61	Module-V: Transducers	CO 6	T1:13.1-13.25
DISCUSSION OF QUESTION BANK			
62	Module-I: Introduction to Measuring Instruments	CO 1	T1:1.1-19,2.1-2.8,3.1-3.8,4.1-4.25,5.1-5.10
63	Module-II: Oscilloscopes	CO 2	T1:7.1-7.32
64	Module-III: Signal Generators and Wave Analyzers	CO 3,4	T1:8.1-8.10,9.1-9.6
65	Module-IV: AC and DC Bridges	CO 5	T1:11.1.-11.18
66	Module-V: Transducers	CO 6	T1:13.1-13.25

Course Coordinator **HOD,ECE**
Ms.Ajitha G, Assistant Prfoessor

ANNEXURE - I

KEY COMPETENCIES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	**10**

PO 4.	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**

PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project. 6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	**12**

PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

KEY COMPETENCIES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications 1. Analyze and solve real time problems in Robotics. 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications 3. Develop embedded systems modules using Real Time Operating System. 4. Undertake research and development projects in the field of Embedded Systems. 5. Adopt the engineering professional code and conduct	5
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs. 1. Inspect, survey and analyze types of ASIC chip designs. 2. Design ASIC prototypes using Verilog and VHDL languages. 3. Analyze microprocessor subsystems with memories and I/O interfacs for SOC designs 4. Explore hardware components for designig SOC. 5. Adopt the engineering professional code and conduct 6. Designing prototypes of SOC using programming tools like MATLAB, LabVIEW. 7. Familiarize with the design flow of ASIC prototypes. 8. Realize SOC using Register-Transfer-Level designs 9. Analyse and develop models for system level descriptions for synthesis of SOC 10. Inspect and survey the abstractions and principles for the specification, simulation, verification, and synthesis of systems on chip (SoC) 11. Programming and hands-on skills to meet requirements of global environment.	**11**
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications. 1. Explicit software and programming tools for antenna design. 2. Adopt technical library resources and literature search. 3. Explore smart antennas. 4. Model, program for operation and control of smart antennas for wireless communication applications. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**ELECTRONICS AND COMMUNICATION ENGINEERING**				
Course Title	**CONTROL SYSTEMS**				
Course Code	AECC21				
Program	B.Tech				
Semester	V				
Course Type	CORE				
Regulation	UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	J. Siva Ramakrishna, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSC07	II	Mathematical Transform Techniques
B.Tech	AECC02	II	Electrical Circuits

II COURSE OVERVIEW:

This course deals with the basic concepts of block diagram reduction technique, time response analysis of first order and second order systems. It deals with time and frequency domain analysis. It elaborates the concept of stability and its assessment for linear time invariant systems. This course address the real time issues and control strategies, which are used in automation areas, associates with several engineering streams.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Control Systems	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	x	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
50 %	Understand
33.3%	Apply
16.6 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	-

VI COURSE OBJECTIVES:

The students will try to learn:

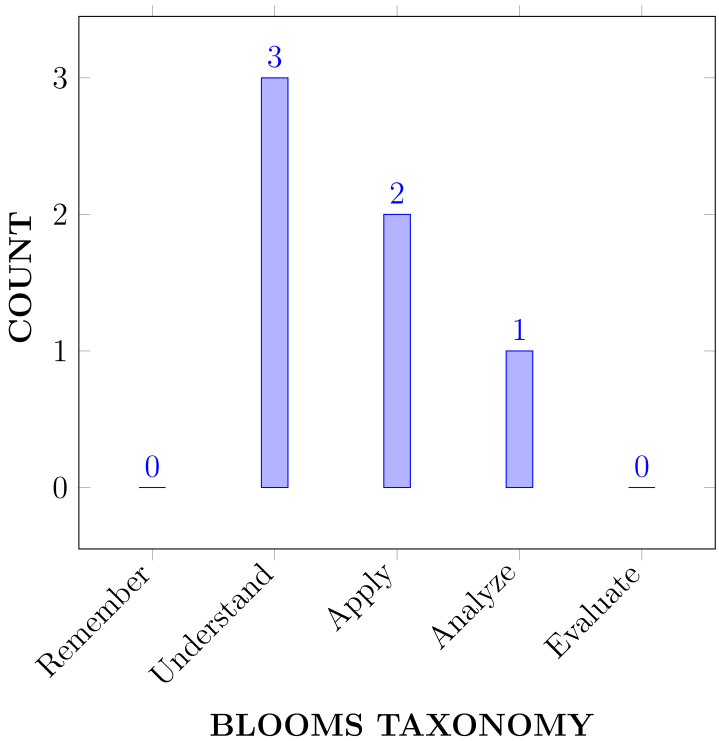
I	The mathematical models of dynamic systems using the concepts of basic sciences.
II	The system performance using time domain and frequency domain analysis for standard inputs.
III	Classification of controllers and compensators as per the desired dynamic response of the system.
IV	The system representation techniques such as transfer function and state space.

VII COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Relate** the physical and mechanical systems into equivalent electrical analogies using the mathematical form of physical systems.	Understand
CO 2	**Utilize** various reduction techniques for developing the transfer function, transient and steady state error with the standard input signals.	Apply
CO 3	**Make use of** the ROUTH-HOURITZ criterion to determine the stability of a system	Apply
CO 4	**Demonstrate** the stability of a system using root locus technique for analysing the system performance	Understand
CO 5	**Illustrate** the system using polar plot, Nyquist plot, and Bode plot for determining the stability of the system.	Analyze
CO 6	**Interpret** linear system equations in state space form for the analysis of LTI system	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Program Outcomes	
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	CIE/Quiz/AAT

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	CIE/Quiz/AAT
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	1	CIE/Quiz/AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	**Professional Skills:** Build embedded software and digital circuit development platform for robotics, embedded systems and signal processing applications.	1	Research Paper / Quiz / AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	✓	-		✓	-	
CO 2	✓	✓	-	-	-	-	-	-	-	✓	-	✓		-	-
CO 3	✓	✓	✓	-	-	✓	-	-	-	✓	-	-	-	-	-
CO 4	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-
CO 5	✓	✓	✓	-	-	✓	-	-	-	✓	-	✓	-	-	-
CO 6	✓	✓	✓	-	-	✓	-	-	-	✓	-	-	✓	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	**PO 1**	Understands the concept of control systems and its types with the knowledge of **mathematics, science** and **engineering fundamentals**.	3
	PO 2	**Identify** the **mathematical models** of **complex systems** by **analyzing complex engineering problems** using **principles** of **mathematics** and **engineering sciences**.	7
	PO 10	Understands the basics of control systems and should be able to **communicate effectively on complex engineering activities**	2
	PSO 1	Understands the operation of open and closed loop control systems to find the optimal solution for **signal processing applications**	1
CO 2	**PO 1**	Explain the different complex physical systems with the knowledge of **mathematics, science** and **engineering fundamentals**.	3
	PO 2	**Identify** the **mathematical models** for developing transfer function and steady state error analysis by **analyzing complex engineering problems** using **principles of mathematics** and **engineering sciences**.	6
	PO 10	Understands the basics of reduction techniques for developing the transfer function and steady state error analysis techniques, which are able to **communicate effectively on engineering activities**.	2
CO 3	**PO 1**	Understand the concept of stability of the system from the characteristic equation using **principles of mathematics, science** and **engineering fundamentals**.	3
	PO 2	**Formulate the mathematical equations** for a system's stability framed using basics of **mathematics** and **engineering sciences**.	5
	PO 3	**Design the solution** for a system of unity feedback by analyzing **complex engineering problems and design system components** using principles of **mathematics** and **engineering sciences**.	5
	PO 6	Understands the concept of stability of open and closed loop system and type of feedback from the **contextual knowledge to assess societal engineering practice**.	3
	PO 10	Understands the basics of time domain analysis and should be able to **communicate effectively on engineering activities**.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 4	**PO 1**	Understand the concept of stability analysis of a system by **applying principles of mathematics, science, and engineering fundamentals**.	3
	PO 2	Determine the stability of **complex systems** using **first principles of mathematics and engineering sciences**.	4
	PO 3	**Design solutions for complex engineering** system performance and **design system components using principles of mathematics and engineering sciences**.	7
	PO 10	Understands the basics of requency domain analysis and various types of system should be able to **communicate effectively on engineering activities**.	2
CO 5	**PO 1**	Determine the stability of a system in frequency domain using the **fundamentals of mathematics, science, and engineering fundamentals**.	3
	PO 2	**Identify, formulate** appropriate frequency domain technique for analyzing **complex system** stability using **basics of mathematics and engineering sciences**.	5
	PO 3	**Design the solutions** for stability analysis of **complex engineering** systems using Nyquist plot, and Bode plot, **that meet the societal needs**.	6
	PO 6	Understands the concept of stability analysis techniques such as Nyquist plot, and Bode plot and their applicability to the **contextual knowledge to assess societal engineering practice**.	2
	PO 10	Understands the basics of stability analysis of a system in frequency domain, which should be able to **communicate effectively on engineering activities**.	2
CO 6	**PO 1**	Understands state space models of control system using its block diagram using basic knowledge of **mathematics, science and engineering fundamentals**.	3
	PO 2	**Identify and formulate** the state space models for the analysis of LTI system using **first principles of mathematics and engineering sciences**.	4
	PO 3	Determine the linear system equations in state space form for **analyzing complex engineering problems that meet the specified needs with appropriate consideration for societal needs**.	7
	PO 6	Understand the concept of state space models for LTI system analysis by the **contextual knowledge to assess the societal issues**.	2
	PO 10	Understands the basics of state space analysis, which are **able to communicate effectively on engineering activities**.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PSO 1	Understands the basics of state space analysis techniques for **signal processing applications**.	1

Note:Refer annexure to check the mapping of program outcomes.

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	**10**	**10**	**11**	**1**	**5**	**3**	**3**	**12**	**5**	**12**	**8**	**5**	**11**	**7**
CO 1	3	7	-	-	-	-	-	-	-	2	-	-	1	-	-
CO 2	3	3	-	-	-	-	-	-	-	1	-	3	-	-	-
CO 3	3	5	5	-	-	3	-	-	-	1	-	-	-	-	-
CO 4	3	4	7	-	-	-	-	-	-	1	-	-	-	-	-
CO 5	3	5	7	-	-	2	-	-	-	1	-	2	-	-	-
CO 6	3	4	7	-	-	2	-	-	-	1	-	-	1	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	**10**	**10**	**11**	**1**	**5**	**3**	**3**	**12**	**5**	**12**	**8**	**5**	**11**	**7**
CO 1	100	100	-	-	-	-	-	-	-	20	-	-	20	-	-
CO 2	100	100	-	-	-	-	-	-	-	20	-	37	-	-	-
CO 3	100	100	50	-	-	60	-	-	-	20	-	-	-	-	-
CO 4	100	66	66	-	-	-	-	-	-	20	-	-	-	-	-
CO 5	100	66	66	-	-	40	-	-	-	20	-	25	-	-	-
CO 6	100	66	66	-	-	-	-	-	-	20	-	-	20	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -5 $< C \leq 40\%$ – Low/ Slight

2 - 40 % $< C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	-	-	-	-	-	-	-	1	-	-	1	-	-
CO 2	3	3	-	-	-	-	-	-	-	1	-	1	-	-	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 3	3	3	3	-	-	3	-	-	-	1	-	-	-	-	-
CO 4	3	2	2	-	-	-	-	-	-	1	-	-	-	-	-
CO 5	3	2	2	-	-	1	-	-	-	1	-	1	-	-	-
CO 6	3	2	2	-	-	-	-	-	-	1	-	-	1	-	-
TOTAL	18	15	9	-	-	4	-	-	-	6	-	2	2	-	-
AVERAGE	3	2.5	2.0	-	-	2	-	-	-	1	-	1	1	-	-

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	-
Quiz	-	Tech - Talk	✓	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	✓	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

-	Early Semester Feedback	✓	End Semester OBE Feedback
-	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION AND MODELING OF PHYSICAL SYSTEMS**
	Control systems: Introduction, open loop and closed loop systems, examples, comparison, mathematical modelling and differential equations of physical systems, concept of transfer function, translational and rotational mechanical systems, electrical systems, force-voltage and force-current analogy.
MODULE II	**BLOCK DIAGRAM REDUCTION AND TIME RESPONSE ANALYSIS**
	Block Diagrams: Block diagram representation of various systems, block diagram algebra, characteristics of feedback systems, signal flow graph, time response analysis: standard test signals, impulse response, unit step response of second order systems, time response specifications, steady state errors and error constants, PID controllers.
MODULE III	**CONCEPT OF STABILITY AND ROOT LOCUS TECHNIQUE**
	Concept of stability: Necessary and sufficient conditions for stability, Routh Hurwitz stability criterions and limitations. Root locus technique: Introduction, root locus concept, construction of root loci, graphical determination of 'k' for specified damping ratio, effect of adding zeros and poles on stability.

MODULE IV	**FREQUENCY DOMAIN ANALYSIS**
	Frequency domain analysis: Introduction, frequency domain specifications, stability analysis from Bode plot, Nyquist plot, relative stability, calculation of gain margin and phase margin, determination of transfer function from Bode a plot, correlation between time and frequency responses.
MODULE V	**STATE SPACE ANALYSIS AND COMPENSATORS**
	State Space Analysis: Concept of state, state variables and state model, derivation of state models from block diagrams, solving the time invariant state equations, state transition matrix and properties, concept of controllability and observability; Compensators: Lag, lead, lag-lead networks.

TEXTBOOKS

1. I J Nagrath, M Gopal, "Control Systems Engineering", New Age International Publications, 3rd Edition, 2007.
2. K Ogata, "Modern Control Engineering", Prentice Hall, 4th Edition, 2003
3. N C Jagan, "Control Systems", BS Publications, 1st Edition, 2007.

REFERENCE BOOKS:

1. Anand Kumar, "Control Systems", PHI Learning, 1st Edition, 2007.
2. S Palani, "Control Systems Engineering", Tata McGraw-Hill Publications, 1st Edition, 2001.
3. N K Sinha, "Control Systems", New Age International Publishers, 1st Edition, 2002.

WEB REFERENCES:

1. https://nptel.ac.in/courses/112105171/1

COURSE WEB PAGE:

https://nptel.ac.in/courses/112105171/1

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	-
CONTENT DELIVERY (THEORY)			
1	Introduction to Control systems	CO 1	T1:1.1
2	Types of Control systems Open loop and Closed loop systems	CO 1	T1:1.1
3	Examples of closed control system and open loop system	CO 1	T1:1.4-1.6
4	Concept of transfer function	CO 1	T1: 2.4
5	Mechanical translational system, Force balance equations.	CO 1	T1:2.2
6	Mechanical rotational system, Torque balance equations.	CO 1	T1:2.2
7	Transfer function of Armature controlled and Field controlled of DC Motor.	CO 1	T1:2.4

8	Force -Voltage and Force-Current Analogy	CO 1	T1:2.2
9	Block Diagrams: Block diagram representation of various control systems	CO 2	T1:2.5
10	Block diagram reduction and Rules of block diagram	CO 2	T1:2.5
11	Characteristics of feedback systems	CO 2	T1: 3.1-3.2
12	AC Servomotor working and characteristics	CO 2	T1: 1..2
13	Signal Flow Graph, properties and rules of signal flow graph	CO 2	T1 :2.6
14	Step by step procedure of transfer function from signal flow graph using Mason's Gain Formula	CO 2	T1 :2.6
15	Time response analysis, Standard test signals	CO 2	T1 :5.1-5.2
16	Impulse response	CO 2	T1 :5.1-5.2
17	Response of first order system for step input	CO 2	T1: 5.3
18	Response of Un damped second order system for step input	CO 2	T1: 5.3
19	Response of Under damped and Over damped second order system for step input	CO 2	T1: 5.3
20	Time Domain specifications of second order system	CO 2	T1: 5.4
21	Steady state errors and error constants	CO 2	T1: 5.5
22	Error constants for various inputs and for different Types of system	CO 2	T1: 5.5
23	PID Controllers	CO 2	T1:5.8
24	Concept of stability Necessary and sufficient conditions for stability	CO 3	T1: 6.1 -6.2
25	Conditions and special cases for stability using Routh's Hurwitz method.	CO 3	T1: 6.3 -6.5
26	Introduction to Root locus concept.	CO 3	T1: 7.1 -7.2
27	Step by step procedure for construction of root locus	CO 3	T1: 7.3
28	Effect of adding zeros and poles on stability.	CO 3	T1: 5.6
29	Frequency domain analysis Introduction	CO 4	T1: 8.1 -8.2
30	Frequency domain specifications, stability analysis	CO 4	T1: 8.2
31	Procedure of Bode Plot for magnitude and phase plot.	CO 4	T1: 8.4
32	Procedure for gain margin and phase margin	CO 4	T1: 8.4
33	Procedure of Nyquist plot for magnitude and phase plot.	CO 4	T1: 9.1-9.4
34	Determination of transfer function, correlation between time and frequency responses	CO 4	T1: 8.1 -8.2
35	State Space Analysis: Concept of state, state variables and state model	CO 6	T1: 12.1-12.2
36	Derivation of state models from block diagrams	CO 6	T1: 12.3-12.4
37	State transition matrix and properties,	CO 6	T1: 12.4
38	Canonical Form of state variables	CO 6	T1: 12.6

39	Concept of controllability and observability	CO 6	T1:12.7
40	Compensators: Lag, lead, lead - lag networks.	CO 5	T1:10.3
PROBLEM SOLVING/ CASE STUDIES			
41	Determine transfer function from mechanical systems	CO 1	R1: 2.6
42	Determine transfer function from electrical systems	CO 1	R1: 2.6
43	Transfer function from Block diagram using reduction technique	CO 2	R1: 3.2
44	Transfer function from Signal Flow Graph using masons gain formula	CO 2	R1: 3.2
45	Problems on Error constants	CO 2	R1: 4.4 Pg No 195-198
46	Problems on time domain specifications	CO 2	R1: 4.4 Pg No 198-209
47	Stability using Routh's Hurwitz method	CO 3	R1:5.3 Pg No 285-292
48	Problems on Root Locus for a given transfer function	CO 3	R1:6.4 Pg No 339-347
47	Problems on Routh's Hurwitz method to find K	CO 3	R1:5.6 Pg No 298-307
48	Problems on Frequency domain specifications	CO 4	R1:7.2 Pg No 413-416
49	Sketch Bode Plot for stability	CO 4	R1:7.3 Pg No 417-427
50	Sketch Bode Plot for gain and phase margin	CO 4	R1:7.4 Pg No 452-465
51	Sketch Polar Plot for gain and phase margin	CO 4	R1:7.3 Pg No 417-427
52	Problems on state model to the canonical form	CO 6	R1:10.3 Pg No 594-597
53	State controllability and observability of a system	CO 6	R1: 10.4 Pg No 661-671
54	Problems on Compensators	CO 5	R1: 9.2
55	Problems on State Transition Matrix	CO 6	R1: 10.7 Pg No 630-639
DISCUSSION OF DEFINITION AND TERMINOLOGY			

56	Transfer function, components of feedback control system, Automatic Controllers.	CO 1	T1: 2.4
57	Basic elements in Block Diagram, signal flow graph, transient response, transmittance, Masons Gain formula	CO 2	T1: 3.1-3.2
58	Stability, Routh stability criterion, Auxiliary polynomial, Relative stability	CO 3	T1: 6.3 -6.5
59	Frequency response, Resonant frequency, Corner frequency, Polar plot.	CO 4	T1: 8.1 -8.2
60	State variable, Controllability, Compensator, sampling theorem	CO 5, CO 6	T1: 12.3-12.4
DISCUSSION OF QUESTION BANK			
61	Mechanical Rotational System	CO 1	T1: 2.4
62	Block Diagram, Signal flow graph	CO 2	T1: 3.1-3.2
63	Root Locus and Routh's Hurwitz method	CO 3	T1: 6.3 -6.5
64	Bode plots, polar plot and Nyquist plot	CO 4	T1: 8.1 -8.2
65	State Transmission matrix and compensators	CO 5, CO 6	T1: 12.3-12.4

Signature of Course Coordinator **HOD,ECE**

ANNEXURE

KEY ATTRIBUTES FOR ASSESSING POS AND PSOS

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis**). 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions**). 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	**10**

PO 4.	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**

PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project. 6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	**12**

PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions **(Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments **(Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change **(Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications 1. Analyze and solve real time problems in Robotics. . 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications. 3. Develop embedded systems modules using Real Time Operating System. 4. Undertake research and development projects in the field of Embedded Systems. 5. Adopt the engineering professional code and conduct.	5

PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs. 1. Inspect, survey and analyze types of ASIC chip designs. 2. Design ASIC prototypes using Verilog and VHDL languages. 3. Analyze microprocessor subsystems with memories and I/O interfaces for SOC designs 4. Explore hardware components for designig SOC 5. Adopt the engineering professional code and conduct 6. Designing prototypes of SOC using programming tools like MATLAB, LabVIEW. 7. Familiarize with the design flow of ASIC prototypes. 8. Realize SOC using Register-Transfer-Level designs 9. Analyse and develop models for system level descriptions for synthesis of SOC 10. Inspect and survey the abstractions and principles for the specification, simulation, verification, and synthesis of systems on chip (SoC) 11. Programming and hands-on skills to meet requirements of global environment.	**11**
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications. 1. Explicit software and programming tools for antenna design. 2. Adopt technical library resources and literature search. 3. Explore smart antennas. 4. Model, program for operation and control of smart antennas for wireless communication applications. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Electronics and Communication Engineering**				
Course Title	**Cellular and Mobile Communications**				
Course Code	AECC22				
Program	B.Tech				
Semester	V				
Course Type	Professional Elective				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3		
Course Coordinator	Dr V Siva Nagaraju, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECC10	IV	Analog and Digital Communications

II COURSE OVERVIEW:

The cellular mobile communication allows the users to communicate with others in different locations without the use of any physical connection. It covers the operation, performance criteria, handoff mechanism and channel assignments of the cellular system. The applications include Wi-Fi, Bluetooth, cell phones and wireless power transfer.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Cellular and Mobile Communications	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	x	Tech talk	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
%	Remember
50%	Understand
33%	Apply
17 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

<table>
<tr><th colspan="2">Component</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td rowspan="4">CIA</td><td>Continuous Internal Examination – 1 (Mid-term)</td><td>10</td><td rowspan="4">30</td></tr>
<tr><td>Continuous Internal Examination – 2 (Mid-term)</td><td>10</td></tr>
<tr><td>AAT-1</td><td>5</td></tr>
<tr><td>AAT-2</td><td>5</td></tr>
<tr><td>SEE</td><td>Semester End Examination (SEE)</td><td>70</td><td>70</td></tr>
<tr><td colspan="3">Total Marks</td><td>100</td></tr>
</table>

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	0%

VI COURSE OBJECTIVES:

The students will try to learn:

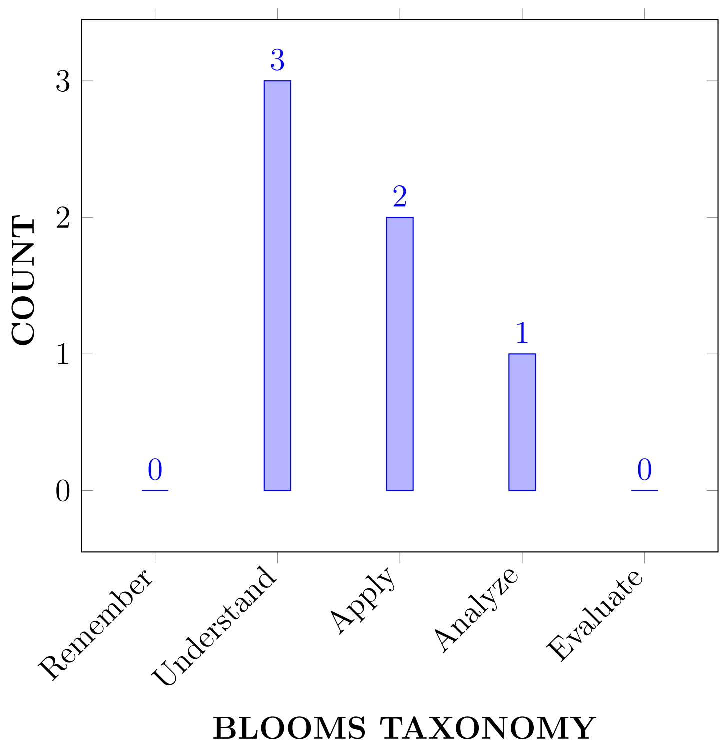
I	The cellular mobile system, cell coverage, cell site and mobile antennas system for interference reduction.
II	The wireless system standard applications for the Global System for Mobile Communications, Code Division Multiple Access and Time Division Multiple Access technologies.
III	The advanced intelligent network for wireless communications and future public land mobile telecommunications.

VII COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Summarize** the cellular mobile system concepts to improve the Signal to noise ratio and cell coverage.	Understand
CO 2	**Outline** the co-channel and non co-channel interferences and their parameters to improve the system capacity.	Understand
CO 3	**Utilize** the omni directional and directional antenna patterns to improve the channel capacity and interference reduction.	Apply
CO 4	**Identify** the importance of Hand-off mechanism for preventing loss of interruption of services to a caller.	Apply
CO 5	**Analyze** the wireless systems and its standards for the implementation of multiple access schemes.	Analyze
CO 6	**Infer** the Intelligent cell concept and advanced intelligent network for advanced land mobile telecommunication system.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/Quiz/AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	1	CIE/Quiz/AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	**Build** Embedded software and digital circuit development platform for robotics, embedded systems and digital signal processing applications	–	–
PSO 2	**Focus** on the Application specific Integrated circuits (ASIC) prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	–	–
PSO 3	**Make use of** High frequency structure simulator (HFSS) for modeling and evaluating the patch and smart antennas for wired and wireless communication applications.	1	Research papers /Project

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	✓	-		-	-	-
CO 2	✓	-	✓	-	-	-	-	-	-	✓	-	-	-	-	-
CO 3	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	✓
CO 4	✓	-	-	-		-	-	-	-	✓	-		-	-	-
CO 5	✓	-	✓	-	-	-	-	-	-	✓	-	-	-	-	✓
CO 6	✓	✓	-	-		-	-	-	-	✓	-	-	-	-	✓

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO1	**Identify** the basic mobile telephone Systems by applying the **mathematics, science and engineering fundamentals** to solve the limitations of the conventional system.	3
	PO2	**Understand** the cellular mobile system design concepts (**problem statement**) and **implementation** (solution development) of the information and general description and **interpretation** of the problem.	4
	PO10	Communicate **orally** on cellular mobile systems and **write** effective reports on the telephone systems and limitations of the conventional system.	2
CO 2	PO1	**Review** the concept of frequency reuse channels, **formulate** the co-channel interference reduction factor and **validate** the results with the basics of engineering science.	3
	PO3	**Investigate** the signal reflections in flat and hilly terrain, **identify** constraints including fading effects and Co-Channel Interference	2
	PO10	Communicate **orally** on cellular mobile systems and **write** effective reports on the telephone systems and limitations of the conventional system.	2
CO 3	PO1	**Understand** the user needs of cell coverage for signal and space diversity antennas for working, identify the cost limitations for the selection of parameters, use creativity in producing new antenna designs for **innovative solutions**	2
	PO2	**Identify** the importance of omni-directional and directional antennas **formulate** their parameters by **reviewing research literature, analyze complex engineering problems, interpret** and **validate** the results with the **basics of engineering science**	5

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO10	Communicate **orally** on cellular mobile systems and **write** effective reports on the telephone systems and limitations of the conventional system.	2
	PSO3	**Explore** smart antennas to improve the channel capacity and reduction in interference	1
CO 4	PO1	**Analyze** the hand-off mechanism using **mathematical principles and own engineering discipline**.	2
	PO10	Communicate **orally** on cellular mobile systems and **write** effective reports on the telephone systems and limitations of the conventional system.	2
CO 5	PO1	**Illustrate** the concepts of wireless systems and standards by understanding the knowledge in solving (complex) engineering problems related to antenna arrays by **applying scientific, mathematical principles and own engineering discipline**	2
	PO3	**Analyze** various methodologies for sharing the channel to multiple users, **innovative solutions** and manage the **design process of wireless standards**	2
	PO10	Communicate **orally** on cellular mobile systems and **write** effective reports on the telephone systems and limitations of the conventional system.	2
	PSO3	**Interface** automation tools to analyze the wireless systems	1
CO 6	PO1	**Model** the public land mobile telecommunication system by **applying** the **scientific, mathematical principles and own engineering discipline**	3
	PO2	**Review** the advanced intelligent network by **research literature, analyze complex engineering problems, interpret** and **validate the results with the basics of engineering science**	5
	PO10	Communicate **orally** on cellular mobile systems and **write** effective reports on the telephone systems and limitations of the conventional system.	2
	PSO3	**Adopt** technical library resources and literature search in advanced research wireless and mobile cellular networks.	1

Note: For Key Attributes refer **Annexure - I**

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	-	2	-	-	-	-	-	-	2	-	-	-	-	-

CO 3	2	5	-	-	-	-	-	-	-	2	-	-	-	-	1
CO 4	2	-	-	-	-	-	-	-	-	2	-		-	-	-
CO 5	2	-	2	-	-	-	-	-	-	2	-	-	-	-	1
CO 6	3	5	-	-	-	-	-	-	-	2	-		-	-	1

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	100	40	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 2	100	-	20	-	-	-	-	-	-	40	-	-	-	-	-
CO 3	67	50	-	-	-	-	-	-	-	40	-	-	-	-	14
CO 4	67	-	-	-	-	-	-	-	-	40	-		-	-	-
CO 5	67	-	20	-	-	-	-	-	-	40	-	-	-	-	14
CO 6	100	50	-	-	-	-	-	-	-	40	-	-	-	-	14

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -5 $< C \leq 40\%$ – Low/ Slight

2 - 40 % $< C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	3	2	-	-	-	-	-	-	-	2	-	-	-	-	
CO 2	3	-	1	-	-	-	-	-	-	2	-	-	-	-	-
CO 3	3	2	-	-	-	-	-	-	-	2	-	-	-	-	1
CO 4	3	-	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 5	3	-	1	-	-	-	-	-	-	2	-	-	-	-	1
CO 6	3	2	-	-	-	-	-	-	-	2	-	-	-	-	1
TOTAL	18	6	2	-	-	-	-	-	-	12	-	-	-	-	3
AVERAGE	3.0	2.0	1.0	-	-	-	-	-	-	2.0	-	-	-	-	1.0

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	✓
Assignments	-				

XVII ASSESSMENT METHODOLOGY-INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**CELLULAR MOBILE RADIO SYSTEMS**
	Introduction to cellular mobile System, performance criteria, uniqueness of mobile radio environment, operation of cellular systems, hexagonal shaped cells, analog and digital Cellular systems, General description of the problem, concept of frequency channels, Co-channel Interference Reduction Factor, desired C/I from a normal case in a omni directional Antenna system, Cell splitting, consideration of the components of Cellular system.
MODULE II	**INTERFERENCE AND CELL COVERAGE FOR SIGNAL AND TRAFFIC**
	Introduction to Co-Channel Interference, real time Co-Channel interference, Co-Channel measurement, design of Antenna system, Antenna parameters and their effects, diversity receiver, non-cochannel interference-different types, Signal reflections in flat and hilly terrain, effect of human made structures, phase difference between direct and reflected paths, constant standard deviation, straight line path loss slope, general formula for mobile propagation over water and flat open area, near and long distance propagation antenna height gain, form of point to point model. Small-scale fading and multipath: Small scale multipath propagation, types of small - Scale fading; Fading effects due to multipath time delay spread, flat fading, frequency selective fading.
MODULE III	**CELL SITE AND MOBILE ANTENNAS**
	Sum and difference patterns and their synthesis, omni directional antennas, directional antennas for interference reduction, space diversity antennas, umbrella pattern antennas, minimum separation of cell site antennas, high gain antennas, Numbering and grouping, setup access and paging channels channel assignments to cell sites and mobile units, channel sharing and borrowing, sectorization, overlaid cells, non-fixed channel assignment, Handoff, dropped calls and cell splitting, types of handoff, handoff invitation, delaying handoff, forced handoff, mobile assigned handoff. Intersystem handoff, cell splitting, micro cells, vehicle locating methods, dropped call rates and their evaluation.channel planning for wireless systems, Indoor propagation models-partition losses (Same Floor), partition losses between floors, log- distance path loss model
MODULE IV	**WIRELESS SYSTEMS AND STANDARDS**
	Second generation and Third generation Wireless Networks and Standards, WLL, Bluetooth, GSM, IS95, DECT, GSM architecture, GSM channels, multiplex access scheme, TDMA, CDMA.
MODULE V	**INTELLIGENT NETWORK FOR WIRELESS COMMUNICATIONS**
	Intelligent cell concept, advanced intelligent network, SS7 network and ISDN for AIN, AIN for mobile communication, asynchronous transfer mode technology, future public land mobile telecommunication system, wireless information superhighway Gateway, TCP/IP Model and the OSI Network Model.

TEXTBOOKS

1. W.C.Y. Lee, "Mobile Cellular Telecommunications", Tata McGraw-Hill, 2nd Edition, 2006.
2. Gordon L. Stuber, "Principles of Mobile Communications", Springer International, 2nd Edition, 2007.
3. Yi-Bing Lin and Imrich chlantae, "Wireless and Mobile Network Architecture", John Wiley, 1st Edition, 2006.

REFERENCE BOOKS:

1. Theodore. S. Rapport, "Wireless Communications", 3rd Edition, Pearson Education, 2003.
2. Lee, "Wireless and Mobile Communications", McGraw Hill, 3rd Edition, 2006.
3. Jon W. Mark and Weihua Zhqung, "Wireless Communication and Networking", PHI, 1st Edition, 2005.
4. R. Blake, "Wireless Communication Technology", Thompson Asia Pvt. Ltd., 1st Edition 2004.

COURSE WEB PAGE:

https://lms.iare.ac.in/index?route=course/detailscourse id_127

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	https://lms.iare.ac.in/ index? route=course/details& course id_127
CONTENT DELIVERY (THEORY)			
2	Introduction to cellular mobile System	CO 1	T1-3.2-3.3
3	performance criteria, uniqueness of mobile radio environment	CO 1	T1-3.3-3.4
4	operation of cellular systems, hexagonal shaped cells	CO 1	T1-3.3-3.4
5	analog and digital Cellular systems, General description of the problem	CO 1	T1-3.5
6	concept of frequency channels	CO 1	T1-4.2
7	Frequency reuse, Co-channel Interference Reduction Factor	CO1	T1-4.4
8	Cell splitting, consideration of the components of Cellular system	CO 1	T1-4.2
9	Introduction to Co-Channel Interference, real time Co-Channel interference	CO 2	T1-4.6
10	Co-Channel measurement, design of Antenna system,	CO 2	T1-4.7
11	Antenna parameters and their effects, diversity receiver, non-co channel interference-different types	CO 2	T1-4.10

12	Signal reflections in flat and hilly terrain, effect of human made structures, phase difference between direct and reflected paths	CO 2	T1-4.10.6
13	constant standard deviation, straight line path loss slope, general formula for mobile propagation over water and flat open area,	CO 2	T1-4.11
14	near and long distance propagation antenna height gain, form of point to point model.	CO 2	T1-4.2
15	Small-scale fading and multipath: Small scale multipath propagation	CO 2	T1-5.1.1
16	Types of small - Scale fading; Fading effects due to multipath time delay spread	CO 2	T1-5.1.1
17	Flat fading, frequency selective fading	CO 2	T1-5.1.1
18	Sum and difference patterns and their synthesis, omni directional antennas	CO 3	T1-5.2
19	Directional antennas for interference reduction, space diversity antennas	CO 3	T1-5.3
20	Umbrella pattern antennas, minimum separation of cell site antennas, high gain antennas	CO 3	T1-5.3.2
21	Numbering and grouping, setup access	CO 3	T1-5.3.3,5.4
21	paging channels channel assignments to cell sites and mobile units	CO 3	T1-5.4.2
22	channel sharing and borrowing, sectorization, overlaid cells, non-fixed channel assignment	CO 3	T1-5.5
23	Handoff, dropped calls and cell splitting	CO 4	T1-5.11
24	Types of handoff, handoff invitation, delaying handoff, forced handoff, mobile assigned handoff. Intersystem handoff,	CO 4	T1-5.11
25	cell splitting, micro cells, vehicle locating methods	CO 4	T1-5.11
26	dropped call rates and their evaluation	CO 4	T1-5.11
27	channel planning for wireless systems, Indoor propagation models-partition losses (Same Floor)	CO 4	T1-7.1,7.2
28	partition losses between floors, log- distance path loss model	CO 4	T1-7.3,7.4
29	Second generation and Third generation Wireless Networks and Standards	CO 5	T1-7.6,7.7
30	WLL, Bluetooth	CO 5	T1-7.7.2
31	GSM, IS95,	CO 5	T1-7.8
32	DECT, GSM architecture	CO 5	T1-7.8.1,8.2
33	GSM channels	CO 5	T1-7.10,11
34	Multiplex access scheme: TDMA	CO 5	T1-7.10.2-3
35	Multiplex access scheme: CDMA	CO 5	T1-7.10.3
36	Intelligent cell concept, advanced intelligent network	CO 6	R3-P184
37	SS7 network and ISDN for AIN, AIN for mobile communication	CO 6	R3-P185
38	Common channel signaling, asynchronous transfer mode technology	CO 6	R3-P191

39	future public land mobile telecommunication system, wireless information superhighway	CO 6	R3-P190
40	Gateway, TCP/IP Model and the OSI Network Model	CO 6	R3-P191
PROBLEM SOLVING/ CASE STUDIES			
41	Problems on Signal reflections in flat and hilly terrain	CO 2	T1-3.1-3.2
42	Problems on probability of cell system	CO 3	T1-3.3-3.4
43	Problems on effective aperture	CO 4	T1-4.6
44	Problems on diffraction loss	CO 3	T1-4.7
45	Problems on received power	CO 4	T1-5.1.1
46	Problems on grade of service	CO 6	T1-4.6
47	Problems on phase difference between direct and reflected paths	CO 4	T1-5.3.2
48	Problems on path loss slope	CO 5	T1-5.1.1
DISCUSSION ON DEFINITION AND TERMINOLOGY			
49	The cellular concept system design fundamentals	CO 1	T1-3.1-3.24
50	Mobile radio propagation	CO 3	T1-4.1 to 4.9
51	Cellular system design fundamentals	CO 5	T1-5.1 to 5.16
52	Equalization and diversity	CO 4	T1-7.1 to 7.17
53	Asynchronous transfer mode technology	CO 3	R3 7.4-7.8
DISCUSSION ON QUESTION BANK			
54	The cellular concept system design fundamentals	CO 2	T1-3.1-3.24
55	Mobile radio propagation	CO 3	T1-4.1 to 4.9
56	Channel sharing, borrowing, sectorization and overlaid cells	CO 5	T1-5.1 to 5.16
57	WLL, Bluetooth, GSM, IS95, DECT	CO 4	T1-7.1 to 7.14
58	Wireless networks and standards	CO 5	R3-8.6-8.9
59	SS7 network and ISDN for AIN, AIN for mobile communication	CO 6	T2-9.9 to 9.12
60	Intelligent cell concept, advanced intelligent network	CO 6	T2-9.3 to 9.7

Signature of Course Coordinator **HOD**
Dr. V Siva Nagaraju, Associate Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES and PROGRAM SPECIFIC OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**

	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**

	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications 1. Analyze and solve real time problems in Robotics. 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications 3. Develop embedded systems modules using Real Time Operating System 4. Undertake research and development projects in the field of Embedded Systems. 5. Adopt the engineering professional code and conduct	**5**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs. 1. Inspect, survey and analyze types of ASIC chip designs. 2. Design ASIC prototypes using Verilog and VHDL languages. 3. Analyze microprocessor subsystems with memories and I/O interfaces for SOC designs 4. Explore hardware components for designig SOC 5. Adopt the engineering professional code and conduct. 6. Designing prototypes of SOC using programming tools like MATLAB, LabVIEW. 7. Familiarize with the design flow of ASIC prototypes. 8. Realize SOC using Register-Transfer-Level designs. 9. Analyse and develop models for system level descriptions for synthesis of SOC. 10. Inspect and survey the abstractions and principles for the specification, simulation, verification, and synthesis of systems on chip (SoC). 11. Programming and hands-on skills to meet requirements of global environment.	**11**

PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications. 1. Explicit software and programming tools for antenna design. 2.Adopt technical library resources and literature search. 3. Explore smart antennas. 4. Model, program for operation and control of smart antennas for wireless communication applications. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043
COURSE DESCRIPTION

Department	**Electronics and Communication Engineering**					
Course Title	**Wireless Communications and Networks**					
Course Code	AECC25					
Program	B.Tech					
Semester	V					
Course Type	Professional Elective					
Regulation	UG-20					
Course Structure	Theory			Practical		
	Lecture	Tutorials	Credits	Laboratory	Credits	
	3	-	3	-	-	
Course Coordinator	Mr A.Karthik, Assistant Professor					

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECC10	IV	Analog and Digital Communiations

II COURSE OVERVIEW:
This course is intended to provide an overview of transmitting information from one point to another without using any connection like wires, cables or any physical medium.It covers the fundamentals of cellular communications, radio propagation, equalization, diversity and wireless networks.It focuses on performance analysis and design of a wireless communication system such as mobile telephone, satellite communication, TV and radio transmissions.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Wireless Communications and Networks	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	x	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
50%	Understand
33%	Apply
17 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	-

VI COURSE OBJECTIVES:

The students will try to learn:

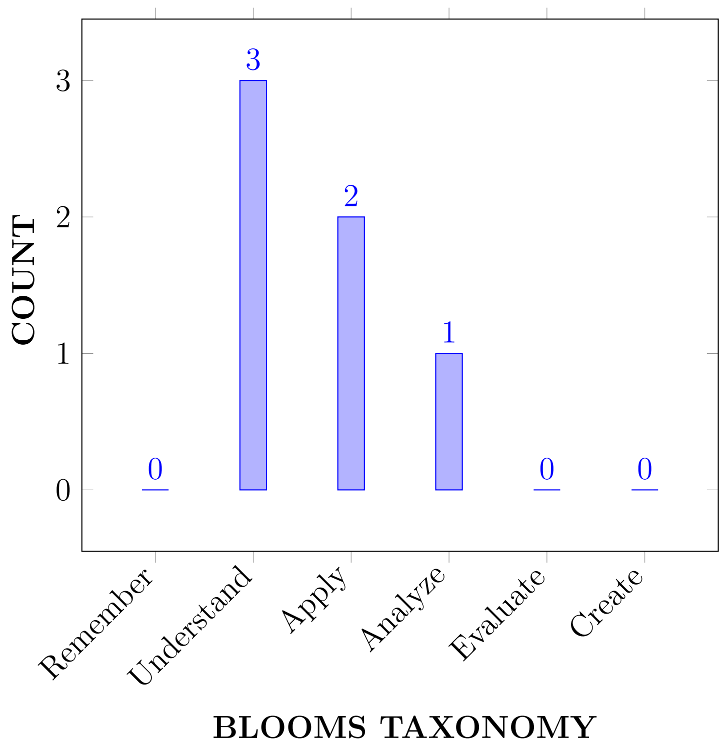
I	The concepts of frequency reuse, handoff, multipath channels and multiple access techniques used in wireless communication systems.
II	The process of fading mechanism, types of equalizers and diversity techniques.
III	The wireless network standards together with network protocols.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Demonstrate** the functioning of a cellular system for implementing technical challenges.	Understand
CO 2	**Summarize** the propagation mechanisms and radio wave propagation to know the behavior of radio waves..	Understand
CO 3	**Apply** the channel path loss models for the reduction in power density (attenuation) of an electromagnetic wave.	Apply
CO 4	**Identify** the multiple access schemes and techniques for providing multiple users on a single channel.	Apply
CO 5	**Analyze** the process of equalization and diversity schemes carried out in mobile devices for reduced distortion of received signals. .	Analyze
CO 6	**Classify** the types of wireless local area networks and networking standards for implementing the network of computing devices.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Program Outcomes	
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	SEE / CIE / QUIZ / AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	1	SEE / CIE / QUIZ / AAT
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	SEE / CIE / QUIZ / AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	SEE / CIE / QUIZ / AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	**Build** Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications	–	—
PSO 2	**Focus** on the Application Specific Integrated Circuits (ASIC) prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	–	–
PSO 3	**Make use of** High Frequency Structure Simulator (HFSS) for modeling and evaluating the patch and smart antennas for wired and wireless communication applications.	2	Research papers /Project

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	✓	-	-	-	-	-	-	-	-	✓	-		-	-	-
CO 2	✓	✓	-	✓	-	-	-	-	-	✓	-	-	-	-	✓
CO 3	✓	✓	-	✓	-	-	-	-	-	✓	-	-	-	-	✓
CO 4	✓	✓	-	✓	-	-	-	-	-	✓	-		-	-	-
CO 5	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 6	✓	✓	-	-	-	-	-	-	-	✓	-		-	-	-

XII JUSTIFICATIONS FOR CO – PO / PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Understand the cell structure and handoff (knowledge) for wireless system by applying the **mathematical principles .**	1
	PO 10	**Communicate orally** on basics of cellualr communication	1
CO 2	PO 1	Understand the concept of channel capacity and co-channel interference for **mathematical and scientific principles** parameters.	2
	PO 2	The channel interfernce **problem formulation** and **solution development** the fading operations by analyzing **interpretation of results**	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 4	**Knowledge** of the channel interfernce **characteristics** and **ability to apply modeling techniques** of fading operations by analyzing **engineering problems**	5
	PO 10	**Efficitive presentation and speaking sytle** on propagation mechanisms.	1
	PSO 3	**Problem soving** of channel capacity for **wireless communication applications** to **meet requirements** of global environment	3
CO 3	PO 1	The radio wave propagation **scientific principles** used in propagation mechanisms by applying the **mathematics principles**	2
	PO 2	Understand the radio wave propagation of **problem formulation** to the propagation mechanisms using principles of **scientific methodology** for **Implementation**	3
	PO 4	**Knowledge** of the wave propagation **characteristics** and **ability to apply modeling techniques** of fading operations by analyzing **engineering problems**	5
	PO 10	**Effective presentation and speaking style** on channel path loss models.	
	PSO 3	**Research analysis** of radio wave propagation for **wireless communication applications** to **meet requirements** of global environment	3
CO 4	PO 1	Analyze (knowledge) the channel path loss models and transmission operations by **mathematical principles** using the principles of **scientific methodology**	2
	PO 2	Understand the channel path loss models **problem statement** and finding the **solution implementation** of fading operations by analyzing **experimental design**	3
CO 5	PO 10	**Effective presentation and speaking style** on multiple ccess schems and techniques	1
	PO 1	Identify parameters of equalization of **scientific methodology** by using **mathematical principles** for **engineering disipline**	3
	PO 4	**Knowledge** of the multipath **characteristics** and **ability to apply modeling techniques** of fading operations by analyzing **engineering problems**	5
	PO 10	**Effective presentation and speaking style** on process of equalization and diversity schems.	1
CO 6	PO 1	Different types of wirelss local area networks for **scientific methodlogy** to specify multiple users over a single channel by analyze the **engineering disipline**	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	Identify the parameters of wireless area networks **problem statements** using **mathematics principles.**	2
	PO 10	**Communicate orally** on the performance of wireless local area network characteristics	1

Note: For Key Competencies Refer Annexure

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	2	3	-	5	-	-	-	-	-	1	-	-	-	-	3
CO 3	2	3	-	5	-	-	-	-	-	1	-	-	-	-	3
CO 4	2	3	-	5	-	-	-	-	-	1	-	-	-	-	-
CO 5	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	2	2	-	-	-	-	-	-	-	1	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	33.3	-	-	-	-	-	-	-	-	20	-		-	-	-
CO 2	66.6	30.0	-	45.5	-	-	-	-	-	20	-	-	-	-	42
CO 3	66.6	30.0	-	45.5	-	-	-	-	-	20	-	-	-	-	42
CO 4	66.6	30.0	-	45.5	-	-	-	-	-	20	-		-	-	
CO 5	100	-	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 6	66.6	20.0	-	-	-	-	-	-	-	20	-		-	-	-

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.
0 - $0 \leq C \leq 5\%$ – No correlation
2 - $40\ \% < C < 60\%$ –Moderate
1-5 $< C \leq 40\%$ – Low/ Slight
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	1	-	-	-	-	-	-	-	-	1	-		-	-	-
CO 2	2	1	-	2	-	-	-	-	-	1	-	-	-	-	2
CO 3	2	1	-	2	-	-	-	-	-	1	-	-	-	-	2
CO 4	2	1	-	2	-	-	-	-	-	1	-		-	-	-
CO 5	3		-	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	2	1	-	-	-	-	-	-	-	1	-		-	-	-
TOTAL	**19**	**4**	-	**6**	-	-	-	-	-	**6**	-	-	-	-	**4**
AVERAGE	**1.9**	**1**	-	**2**	-	-	-	-	-	**1**	-	-	- -	-	**2**

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	✓	Tech - Talk	-	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	-	Open Ended Experiments	-
Micro Projects	-				

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**THE CELLULAR CONCEPT SYSTEM DESIGN FUNDAMENTALS**
	Introduction, frequency reuse, channel assignment strategies, handoff strategies; Prioritizing handoffs, practical handoff considerations, interference and system capacity; Co-channel interference and system capacity, channel planning for wireless systems, adjacent channel interference, power control for reducing interference, trunking and grade of service, improving coverage and capacity in cellular systems; Cellsplitting, sectoring.

MODULE II	**MOBILE RADIO PROPAGATION- LARGE SCALE**
	Large-Scale Path Loss: Introduction to radio wave propagation, free space propagation model, relating power to electric field, the three basic propagation mechanisms; Reflection: Reflection from dielectrics, Brewster angle, reflection from prefect conductors, ground reflection (Two-Ray) mode; Diffraction Fresnel zone geometry, knife-edge diffraction model, multiple knife-edge diffraction, scattering, outdoor propagation models; Longley-Ryce model, Okumura Model, HataModel, PCS extension to hata Model, Walfisch and Bertoni model, wideband PCS microcell model, indoor propagation models-partition losses (Same Floor), partition losses between floors, log-distance path loss model, ericsson multiple breakpointmodel, attenuation factor model, signal penetration into buildings, ray tracing and site specific modeling.
MODULE III	**MOBILE RADIO PROPAGATION- SMALL SCALE**
	Small-scale fading and multipath: Small scale multipath propagation; Factors influencing small scale fading, Doppler shift, impulse response model of a multipath channel; Relationship between bandwidth and received power, small; Scale multipath measurements; Direct RF pulse system, spread spectrum sliding correlator channel sounding, frequency domain channels sounding, parameters of mobile multipath channels; Time dispersion parameters. Coherence Bandwidth, Doppler spread and coherence time, types of small - Scale fading; Fading effects due to multipath time delay spread, flat fading, frequency selective fading, fading effects due to Doppler Spread-Fast fading, slow fading, statistical models for multipath fading channels; Clarkes model for flatfading, spectral shape due to Doppler spread in Clarkes model, simulation of Clarke and Gans Fading model, level crossing and fading statistics, two-ray Rayleigh fading model.
MODULE IV	**EQUALIZATION AND DIVERSITY**
	Introduction, fundamentals of equalization, training a generic adaptive equalizer, equalizers in a communication receiver, linear equalizers, non-linear equalization; Decision feedback equalization (DFE), maximum likelihood sequence estimation (MLSE) equalizer, algorithms for adaptive equalization; Zero forcing algorithm, least mean square algorithm, recursive least squares algorithm; Diversity techniques; Derivation of selection diversity improvement, derivation of maximal ratio combining improvement, practical space diversity consideration; Selection diversity, feedback or scanning diversity, maximal ratio combining, equal gain combining, polarization diversity, frequencydiversity, time diversity, RAKE receiver.
MODULE V	**WIRELESS NETWORKS**
	Introduction to wireless networks, advantages and disadvantages of wireless local area networks, WLAN topologies, WLAN standard IEEE 802.11, IEEE 802.11 medium access control, comparison of IEEE802.11 a,b,g and n standards, IEEE 802.16 and its enhancements, wireless PANs, Hipper LAN, WLL.

TEXTBOOKS

1. Theodore.S. Rapport, —Wireless Communications‖, Pearson Education, 2nd Edition, 2010.
2. UpenDalal, "Wireless communication", oxford University press.
3. KavehPahlvan, Prashant Krishnamurthy, "Principle of wireless networks", A United Approach‖, Pearson Education, 2004.
4. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005.

REFERENCE BOOKS:

1. P.Nicopolitidis, M.S. Obaidat, G.I.Papadimitria, A.S. Pomportsis,"Wireless Networks" John Wiley and sons, 1st Edition, 2003.
2. Vijay K Garg,"Wireless Communications and Networks", Morgan Kaufmann Publishers an Imprint of Elsevier, USA 2009 (Indian Reprint).
3. Mark Ciampa Jorge Olenewa, "wireless communication and Networking", IE, 2009.
4. X.Wang, H.V.Poor ,Wireless communication system, Pearson Education, 2004.
5. JochenSchiller,"Mobile Communication", Pearson Education, 2nd Edition, 2003.

COURSE WEB PAGE:

https://lms.iare.ac.in/index ?route=course/details& course id=137

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	https://lms.iare.ac.in/index ?route=course/details& course id_137
CONTENT DELIVERY (THEORY)			
2	Frequency reuse and channel assignment strategies.	CO 1	T1-3.1-3.2
3	Handoff strategies: Prioritizing handoffs, practical handoff considerations.	CO 1	T1-3.3-3.4
4	Co-channel interference and system capacity	CO 1	T1-3.3-3.4
5	Trunking and grade of service	CO 1	T1-3.5
6	Improving coverage and capacity in cellular systems: Cell splitting, sectoring.	CO 1	T1-4.2
9	Introduction to radio wave propagation	CO2	T1-4.4
10	Free space propagation model and relating power to electric field	CO 2	T1-.5.1,4.5.2

11	Reflection: Reflection from dielectrics	CO 2	T1-4.6
12	Diffraction Fresnel zone geometry and knife-edge diffraction	CO 3	T1-4.7
13	Scattering and outdoor propagation models	CO 3	T1-4.10
15	Longley-Ryce model and okumura Model,	CO 3	T1-4.10.6
16	Indoor propagation models-partition losses (Same Floor) and partition losses between floors	CO 3	T1-4.11
18	Ericsson multiple break point model and attenuation factor model,	CO 3	T1-4.2
19	Small-scale fading and multipath	CO 3	T1-5.1.1
20	Factors influencing small scale fading	CO 4	T1-5.1.1
21	Relationship between bandwidth and received power	CO 4	T1-5.1.1
22	Spread spectrum sliding correlator channel sounding and parameters of mobile multipath channels	CO 3	T1-5.2
23	Coherence bandwidth and doppler spread and coherence time, types of small - Scale fading.	CO 3	T1-5.3
25	Fading effects due to multipath time delay spread	CO 4	T1-5.3.2
26	Slow fading, statistical models for multipath fading channels	CO 4	T1-5.3.3,5.4
27	Clarkes model for flat fading	CO 4	T1-5.4.2
28	Simulation of clarke and gans fading model	CO 4	T1-5.5
29	Level crossing and fading statistics, two-ray Rayleigh fading model.	CO 7	T1-5.11
30	Small scale multipath measurements	CO 3	T1-5.11
32	Fading effects due to Doppler Spread-Fast fading	CO 6	T1-5.11
33	Two-ray Rayleigh fading model	CO 3	T1-5.11
34	Fundamentals of equalization	CO 5	T1-7.1,7.2
37	Training a generic adaptive equalizer	CO 5	T1-7.3,7.4
39	Non-linear equalization	CO 5	T1-7.6,7.7
40	Decision feedback equalization (DFE) and maximum likelihood sequence estimation equalizer (MLSE)	CO 5	T1-7.7.2
41	Algorithms for adaptive equalization	CO 5	T1-7.8
42	Derivation of selection diversity improvement	CO 5	T1-7.8.1,8.2
43	Derivation of maximal ratio combining improvement, practical space diversity consideration	CO 5	T1-7.10,11

44	Diversity techniques	CO 5	T1-7.10.2-3
45	Polarization diversity and RAKE receiver.	CO 5	T1-7.10.3
46	Introduction to wireless networks	CO 6	R3-P184
47	WLAN topologies and WLAN standard IEEE 802.11	CO6	R3-P185
48	Comparison of IEEE802.11 a,b,g and n standards	CO 6	R3-P191
49	IEEE 802.16 and its enhancements	CO 6	R3-P190
50	Wireless PANs, Hipper LAN, WLL.	CO 6	R3-P191
PROBLEM SOLVING/ CASE STUDIES			
7	Problems on grade of service	CO 1	T1-3.1-3.2
8	Problems on probability of cell system	CO 1	T1-3.3-3.4
14	Problems on effective aperture	CO 2	T1-4.6
17	Problems on diffraction loss	CO 2	T1-4.7
24	Problems on received power	CO 2	T1-5.1.1
31	Problems on Brewster angle	CO 2	T1-4.6
35	Problems on computation of rms delay	CO 2	T1-5.3.2
36	Problems on total power in the carrier	CO 2	T1-5.1.1
DISCUSSION ON DEFINITION AND TERMINOLOGY			
51	The cellular concept system design fundamentals	CO 1	T1-3.1-3.24
52	Mobile radio propagation	CO 2	T1-4.1 to 4.9
53	Mobile radio propagtion-small scale	CO 3	T1-5.1 to 5.16
54	Equalization and diversity	CO 5	T1-7.1 to 7.17
55	Wireless networks	CO 6	R3
DISCUSSION ON QUESTION BANK			
56	The cellular concept system design fundamentals	CO 1	T1-3.1-3.24
57	Mobile radio propagation	CO 2	T1-4.1 to 4.9
58	Mobile radio propagtion-small scale	CO3	T1-5.1 to 5.16
59	Equalization and diversity	CO 5	T1-7.1 to 7.14
60	Wireless networks	CO 6	R3

Signature of Course Coordinator **HOD,ECE**

ANNEXURE

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**

	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**

	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	Key Competencies Features (KCF)	No. of KCF's
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications 1. Analyze and solve real time problems in Robotics. 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications 3. Develop embedded systems modules using Real Time Operating System. 4. Undertake research and development projects in the field of Embedded Systems. 5. Adopt the engineering professional code and conduct.	**5**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs. 1.Inspect, survey and analyze types of ASIC chip designs. 2.Design ASIC prototypes using Verilog and VHDL languages. 3.Analyze microprocessor subsystems with memories and I/O interfacs for SOC designs 4.Explore hardware components for designig SOC 5.Adopt the engineering professional code and conduct 6.Designing prototypes of SOC using programming tools like MATLAB, LabVIEW. 7.Familiarize with the design flow of ASIC prototypes. 8.Realize SOC using Register-Transfer-Level designs 9.Analyse and develop models for system level descriptions for synthesis of SOC 10.Inspect and survey the abstractions and principles for the specification, simulation, verification, and synthesis of systems on chip (SoC) 11.Programming and hands-on skills to meet requirements of global environment.	**11**
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications. 1.Explicit software and programming tools for antenna design. 2.Adopt technical library resources and literature search. 3.Explore smart antennas. 4.Model, program for operation and control of smart antennas for wireless communication applications. 5.Interface automation tools. 6.Research, analysis, problem solving and presentation using software aids. 7.Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTION

Course Title	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY				
Course Code	AECC31				
Program	B.Tech				
Semester	V	ECE			
Course Type	Core				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	2
Course Coordinator	Mr.Mohd Khadir, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEC002	III	Digital System Design

II COURSE OVERVIEW:

This laboratory course will facilitates the students to program 8086 microprocessor and 8051 microcontroller. Win862 software will be used for writing and debugging assembly language programs. The course includes performing arithmetic and logical operations, string manipulations, code conversions and interfacing of I/O devices to processor/controller. The hands-on experience acquired by the student's during the course makes them to carry out processor/controller based projects and extend their knowledge on the latest trends and technologies in the field of embedded system.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Microprocessors and Microcontrollers Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks for internal assessment and 70 marks for semester end lab examination. Out of 30 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end lab examination for 70 marks shall be conducted by two examiners, one of them being Internal Examiner and the other being External Examiner, both nominated by the Principal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
1	1	1	1	1	05

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
1	1	1	1	1	05

VI COURSE OBJECTIVES:

The students will try to learn:

I	Assembly language programming skills ranging from simple arithmetic operations to interfacing real time systems.
II	The usage of software tools to design, debug and test microprocessor/microcontroller based projects using assembly language programming.
III	The design of microcomputer and microcontroller based real-time applications in the fields of communication systems, home based automation systems, automobiles and unmanned applications.

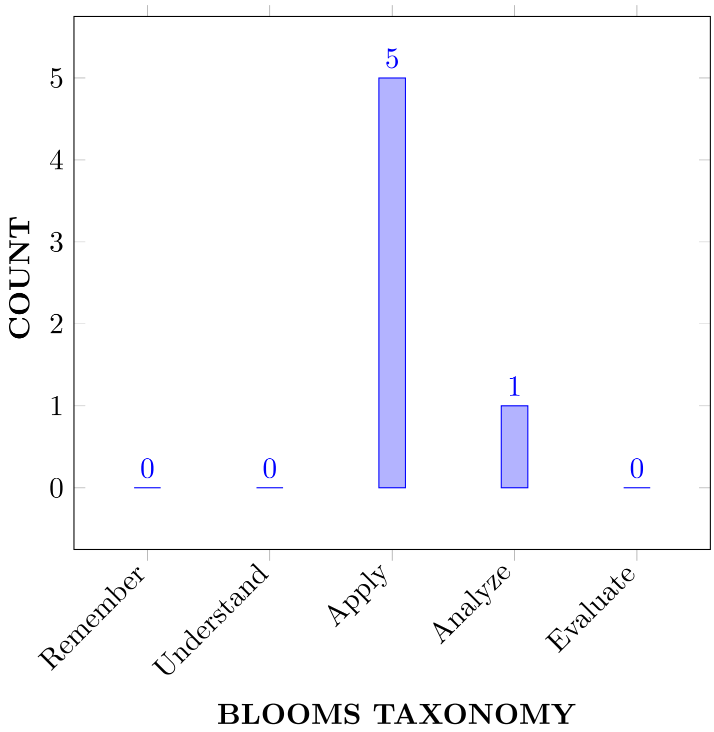
VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Make use of** emulators and assemblers for writing, compiling and running an assembly language programs on training boards.	Apply
CO 2	**Develop** Assembly language programs for accomplishing code conversions, string manipulations and sorting of numbers.	Apply

CO 3	**Choose** serial or parallel communication for transmitting the data between microprocessor or microcontroller and peripherals.	Apply
CO 4	**Utilize** Analog to Digital and Digital to Analog converters with processor or controller for data conversion.	Apply
CO 5	**Select** suitable registers of microcontroller and write assembly language program to verify timer or counter operations.	Apply
CO 6	**Build** an interface between processor or controller and peripherals to provide solutions to the real world problems.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Program Outcomes	
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems.	3	Day to Day Evaluation/ CIE/SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	Day to Day Evaluation/ CIE/SEE
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	Day to Day Evaluation/ CIE/SEE
PO 5	**Modern Tool Usage:**Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	3	Day to Day Evaluation/ CIE/SEE

PO 9	**Individual and Teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings	2	Day to Day Evaluation/ CIE/SEE
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	Day to Day Evaluation/ CIE/SEE

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Build embedded software and digital circuit development platform for robotics, embedded systems and signal processing applications.	3	Day to Day Evaluation/ CIE/SEE

3 = High; 2 = Medium; 1 = Low

XI JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Make use of emulators and assemblers for writing, compiling and running an assembly language programs with the **knowledge of science, Engineering fundamentals, and an Engineering specialization** on training boards to the solution of complex Engineering problems.	3
	PO 2	Make use of emulators and assemblers for writing, compiling and running an assembly language programs with **information and data collection** for **developing solutions** on training boards and **interpret the results**.	3
	PO 3	**Understand customer needs** and make use of emulators and assemblers for **managing design process** and **use creativity to establish innovative solutions** by writing, compiling and running an assembly language programs on training boards	3
	PO 5	Make use of emulators and assemblers for writing, compiling and running an assembly language program on training boards using **Computer software**.	1
	PO 9	Make use of emulators and assemblers for writing, compiling and running an assembly language programs by **referring textbooks** on training boards in **hands-on labs** and **build an ability to work with all levels of people in an organization**	3

	PO 10	Make use of emulators and assemblers for writing, compiling and running an assembly language programs on training boards and **write effective reports** .	1
	PSO 1	Make use of emulators and assemblers**(embedded system modules)** for writing, compiling and running an assembly language programs on training boards for **research and development projects in the field of embedded system.**	2
CO 2	PO 1	write Assembly language programs for accomplishing code conversions, string manipulations and sorting of numbers by **applying the knowledge of mathematics, Engineering fundamentals, and an Engineering specialization** to the solution of complex Engineering problems	3
	PO 2	Understand the given **problem statement and develop** assembly language program for accomplishing sorting of numbers, code conversions and string manipulation to provide processor/controller based **solution** and **validate** the **obtained results.**	4
	PO 3	Develop **design process** for accomplishing code conversions, string manipulations and sorting of numbers and establish **innovative solutions** to meet the **requirements of user**.	3
	PO 5	Use **computer software** and write Assembly language programs for accomplishing code conversions, string manipulations and sorting of numbers to provide solutions for complex Engineering activities with an understanding of the limitations.	1
	PO 9	**Take a defined problem** and **refer appropriate textbook, use hands-on labs** and develop **the solutions** for code conversions, string manipulations and sorting of numbers.	4
	PO 10	Develop Assembly language program for accomplishing code conversions, string manipulations and sorting of numbers **and write effective reports and design documentation.**	1
	PSO 1	Develop **embedded system modules** perform code conversions which are commonly used for **research and development projects in the field of embedded system.**	2
CO 3	PO 1	Perform serial or parallel communication by applying the **knowledge of mathematics, Engineering fundamentals, and an Engineering specialization** for transmitting the data between microprocessor or microcontroller and peripherals.	3
	PO 2	Understand the given data transfer schemes **(problem statement)**and interface microprocessor with serial I/O ports and develop**experimental design** to establish data transfer **(solution)** and**validate** the obtained **results.**	5

	PO 3	Develop processor or controller based systems by **managing the designing process** to establish serial/ parallel communication based on **customer needs** with appropriate consideration for **the public health and safety,**and Environmental considerations and provide the **innovative solutions**	4
	PO 5	Make use of **software and hardware tools** to perform data transfer between processor and I/O devices.	1
	PO 9	Focus on working as a **member or leader** in designing the processor based data transfer schemes in **hands-on labs** by **referring appropriate textbooks** and **evaluate their performance.**	4
	PO 10	Recognize the role of microprocessors and controllers in performing the data transfer by **communicating effectively and write effective reports.**	1
	PSO 1	choose peripherals and interfacing devices **embedded system modules** to perform serial and parallel communication for data transmitting which are commonly used in **research and development projects in the field of embedded system.**	2
CO 4	PO 1	Utilize Analog to Digital and Digital to Analog converters by the **knowledge of mathematics,Engineering fundamentals, and an Engineering specialization** with processor or controller for data conversion.	3
	PO 2	**Identify the problem** and **conduct experimental design** using Analog to Digital and Digital to Analog converters with processor or controller with **Information and data collection** for data conversion**(Solution development)** and **Interpretation of results**.	5
	PO 3	Design processor or controller based systems to perform analog to digital conversion or digital to analog conversion based on **customer needs** and use **creativity** in designing solution with appropriate consideration for the**public health and safety, and Environmental considerations.**	4
	PO 5	Utilize **software and hardware tools** to perform data conversion between processor and ADC/DAC.	1
	PO 9	Focus on working as a **member or leader** in designing the processor based data conversion techniques in **hands-on labs** by **referring appropriate textbooks** and**evaluate their performance**	4
	PO 10	Identify the role of microprocessors, ADC and DAC devices in performing the data conversion and **write effective reports.**	1
	PSO 1	Develop A/D and D/A **embedded system modules** to perform data conversions for **development of projects in the field of embedded systems.**	2

CO 5	PO 1	Make use of suitable registers of microcontroller and write assembly language program to verify timer or counter operations **by applying the knowledge of mathematics,Engineering fundamentals, and an Engineering specialization**.	3
	PO 2	Understand the requirements **(opportunity)** of timer/counters in industrial applications**(problem statement)** and design controller based solution**(solution)** to perform given job and **validate** the obtained **results** in real time environment.	5
	PO 3	Design microcontroller based systems to perform timer/counter operations which is necessary in automated industries based on **customer needs** and use**creativity** in designing solution with appropriate consideration for the**public health and safety, and Environmental considerations**	4
	PO 5	Make use of **software and hardware tools** for effective implementation of timer/counter applications.	1
	PO 9	Work effectively as a **member or leader** in designing the controller based timer/ counter operations in **hands-on labs** by**referring appropriate textbooks** and**evaluate their performance**	4
	PO 10	Identify the role of microcontrollers in performing the timer/ counter operations by **writing effective reports.**	1
	PSO 1	make use of registers and interfacing devices **embedded system modules** to solve the **real time problems in robotics** where timer/counter operations are required.	2
CO 6	PO 1	Develop an interface between processor or controller and peripherals by applying **the knowledge of mathematics,Engineering fundamentals, and an Engineering specialization** to provide solutions to the real world problems.	3
	PO 2	Understand the requirements **(opportunity)** of industrial applications **(problem statement)** and design processor or controller based solution **(solution)** to perform given job and **validate** the **obtained results** in real time environment.	5
	PO 3	Develop processor or controller based systems by **managing the designing process** to establish **innovative solutions** based on**customer needs** with appropriate consideration for **the public health and safety,** and Environmental considerations.	4
	PO 5	Make use of **software and hardware tools** for effective design of processor or controller based applications.	1
	PO 9	Focus on working as a **member or leader** in designing the processor and controller based solutions in**hands-on labs** by **referring appropriate textbooks** and**evaluate their performance**	4

	PO 10	Recognize the role microprocessors and controllers in providing the solutions to real-time systems by **writing effective reports.**	1
	PSO 1	Utilize **embedded system modules** to interface processor or controller to analyze and solve the **real time problems in robotics** .	2

XII MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES						PSO'S
	PO 1	PO 2	PO 3	PO 5	PO 9	PO 10	PSO 1
CO 1	3	3	3	1	3	1	2
CO 2	3	4	3	1	4	1	2
CO 3	3	5	4	1	4	1	2
CO 4	3	5	4	1	4	1	2
CO 5	3	5	4	1	4	1	2
CO 6	3	5	4	1	4	1	2

XIII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIV ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XV SYLLABUS:

WEEK I	**DESIGN A PROGRAM USING WIN862(ORIENTATION LAB)**
	(a) Design and develop an Assembly language program using 8086 microprocessor and to show the following aspects. (i)Programming (ii)Execution (iii)Debugging To Demonstrate the win 862 software and Trainer kit for 8086 Microprocessor. (b) Programs to the students in order to practice building, downloading and running such as memory allocations, push and pop operations.

WEEK II	**BASIC PROGRAMS USING 8086 MICROPROCESSOR**
	(a) Examine the output of 16 Bit arithmetic and logical operations using WIN862 software. (b) Examine the output of multi byte addition and subtraction using WIN862 software (c) Convert BCD to ASCII of given number using WIN862 software (d) Convert Hexadecimal to ASCII using WIN862 software
WEEK III	**PROGRAMS TO SORT NUMBERS 8086 MICROPROCESSOR**
	((a) Develop a program and examine the results of sorting of given numbers in ascending order using WIN862 software (b) Develop a program and examine the results of sorting of given numbers in descending order using WIN862 software (c) Develop a program and examine the results of counting number of vowels in a given array using WIN862 software
WEEK IV	**PROGRAMS FOR STRING MANIPULATIONS OPERATIONS 8086 MICROPROCESSOR**
	Students develop assembly language program for following string manipulations, then build examine the results which are stored in segment memory of the microprocessor. (a) insert a byte in the given string (b) delete a byte in the given string (c) move a block of data from one memory location to the other memory location (d) Reverse of a given string.
WEEK V	**INTERFACING STEPPER MOTOR USING 8086 MICROPROCESSOR**
	(a) Develop a program to translate electrical pulses into mechanical movements by interfacing a stepper motor to 8086 microprocessor. in clockwise / anti clockwise direction (b) Develop a program to translate electrical pulses into mechanical movements by interfacing a stepper motor to 8086 microprocessor in different step angles
WEEK VI	**INTERFACING ANALOG TO DIGITAL CONVETER WITH 8086 MICROPROCESSOR**
	(a) (a) Develop a program to produce a digital output for 0V to 5V by interface A/D converter module (ADC) to the 8086 microprocessor. (b) Develop a program to produce a digital output for 0V to 12V by interface A/D converter module (ADC) to the 8086 microprocessor.
WEEK VII	**INTERFACING DIGTAL TO ANALOG CONVERTER WITH 8086 MICROPROCESSOR**
	(a) Develop a program to generate an analog output signals (triangular and square waveforms) by interface D/A converter module to one of to the 8086 microprocessor. (b) Develop a program to generate saw tooth wave with period of 200µs and address of output device is 55H for 8086 microprocessor.

WEEK VIII	**INTERFACING KEYBOARD-DISPLAY WITH 8086**
	((a) Develop a program to display the data pattern output on the LCD by interfacing hex keypad module to 8086 microprocessor. (b) Develop a program to display the data pattern output on the LCD by interfacing matrix keypad module to 8086 microprocessor.
WEEK IX	**SERIAL AND PARALLEL COMMUNICATION WITH 8086**
	(a) Develop a program to implement an asynchronous serial communications port to operate full duplex mode using by interfacing Parallel communication between two microprocessors using 8255 (b) Develop a program to implement an asynchronous serial communications port to operate full duplex mode using by interfacing Serial communication between two microprocessor kits using 8251
WEEK X	**INTERFACING TRAFFIC LIGHT CONTROLLER WITH 8086**
	Simulate the function of four way traffic light controller by interfacing I/O device to 8086 microprocessor
WEEK XI	**INTERFACING TONE GENERATOR WITH 8086**
	Generate the musical/audio tone by interfacing tone generator I/O device to 8086 microprocessor.
WEEK XII	**ARITHMETIC AND LOGICAL OPERATIONS USING 8051 MICROCONTROLLER**
	(a) Debugg the assembly language program and examine the results of 16 Bit arithmetic and logical operations using 8051 microcontroller. (b) Implement a program to generate a pulse signal and display the generated signal on an oscilloscope.
WEEK XIII	**TIMER/COUNTER WITH 8051 MICROCONTROLLER**
	(a) Develop a Program for timer that counts from zero upwards for measuring time and counter is displays the number from 00 to FF in Timer 0 and Timer 1 in Counter Mode Operation (b) Develop a Program for timer that counts from zero upwards for measuring time and counter is displays the number from 00 to FF in Timer 0 and Timer 1 in Gated Mode Operation.
WEEK XIV	**INTERFACING UART WITH 8051 MICROCONTROLLER**
	(a) The Interfacing UART with 8051 program is display a text in PC from 8051 microcontroller through UART. Some delay is occurring when a single data is sent to PC. (b) Develop an ALP program to transfer the message " IARE" serially at 4800 baud rate in mode 1(8 bit UART) in 8051.
WEEK XV	**INTERRUPT HANDLING WITH 8051 MICROCONTROLLER**
	(a) Develop a program for Interrupts are the events that temporarily suspend by interfacing interrupt handling with 8051 microcontroller. (b) Interface an 8051 microcontroller trainer kit to pc and establish a communication between them through RS 232.

TEXTBOOKS

1. Ray A.K, Bhurchandi K.M, “Advanced Microprocessor and Peripherals”, TMH, 2nd Edition, 2012
2. Muhammad Ali Mazidi, J.G. Mazidi, R.D McKinlay,” The 8051 Microcontroller and Embedded systems using Assembly and C”, Pearson education, 2nd Edition, 2009.
3. Douglas V. Hall, “Microprocessors and Interfacing Programming and Hardware”, TMGH, 2nd Edition, 1994.

REFERENCE BOOKS:

1. Kenneth J. Ayala, “The 8051 Microcontroller”, Thomson Learning, 3rd edition, 2005.
2. Manish K. Patel, “The 8051 Microcontroller Based Embedded Systems”, McGraw Hill, 1st Edition, 2014.
3. Ajay V Deshmukh, ”Microcontrollers”, TATA McGraw Hill publications, 2nd Edition, 2012.

XVI COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO’s	Reference
1	Design a program using win862(orientation lab)	CO 1/ CO 2	T1: 3.3
2	Basic programs using 8086 microprocessor	CO1/ CO2	T1: 3.4
3	Programs to sort numbers 8086 microprocessor	CO1/ CO2	T1: 3.4
4	Programs for string manipulations operations 8086 microprocessor	CO1/ CO2	T1: 3.4
5	Interfacing stepper motor using 8086 microprocessor	CO1/ CO3/ CO4	T1: 3.4
6	Interfacing analog to digital conveter with 8086 microprocessor	CO1/ CO4	T1: 3.4
7	Interfacing digtal to analog converter with 8086 microprocessor	CO1/ CO4	T1: 5.8
8	Interfacing keyboard-display with 8086	CO1/ CO4/ CO6	T1: 5.6, 5.7
9	Serial and parallel communication with 8086	CO1/ CO6	T1: 6.3
10	Interfacing traffic light controller with 8086	CO1/ CO3/ CO6	T1: 6.4
11	Interfacing tone generator with 8086	CO1/ CO6	T1: 6.5, 6.6
12	Arithmetic and logical operations using 8051 microcontroller	CO1/ CO2	R1: 4,5
13	Timer/counter with 8051 microcontroller	CO1/ CO5/ CO6	R1: 2
14	Interfacing uart with 8051 microcontroller	CO1/ CO6	R1: 8
15	Interrupt handling with 8051 microcontroller	CO1/ CO6	R1: 9.2

XVII EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Write an Assembly Language Program to rotate a 200 teeth, 4 phase stepper motor with 5 rotations clockwise and then 5 rotations anticlockwise, Rotate through angle 135o in 2 sec, rotate the shaft at a speed of 10 rotations per minute.
2	Develop an Assembly Language program to interface 8251 with 8086 at an address 80H, initialize it in asynchronous transmit mode, with 7 bits character size, baud factor 16, one start bit and 1 stop bit, even parity enabled and then transmit a message "HAPPY NEW YEAR" in ASCII form to a modem.
3	Interface ADC 0808 with 8086 using 8255 ports. Use Port A of 8255 for transferring digital data output of ADC to the CPU and Port C for control signals. Assume that an analog input is present at I/P2 of the ADC and a clock input of suitable frequency is available for ADC. Draw the schematic and timing diagram of different signals of ADC0808.
4	Interface 12-bit DAC with 8086 and develop the Assembly Language program to generate the step waveform of duration 1sec, maximum voltage 3 volts and determine the duration of each step.
5	Write a program to initialize 8251 in synchronous mode with even parity, single SYNCH character, 7-bit data character. Then receive FFH bytes of data from a remote terminal and store it in the memory at address 5000H: 2000H.
6	A switch is connected to pin P1.2. Write an 8051 Assembly Language program to monitor SW and create the following frequencies on pin P1.7. SW=0: 500Hz, SW=1: 750Hz, use Timer 0, mode 1 for both of them.
7	Write an Assembly Language program for 8051 Microcontroller to count number of interrupts arriving on external interrupt pin INT1. Stop when counter overflows and disable the interrupt. Give the indication on pin P0.0

Signature of Course Coordinator **HOD,ECE**
Mr.Mohd Khadir, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING
COURSE DESCRIPTION

<table>
<tr><td>Course Title</td><td colspan="5">VIRTUAL INSTRUMENTATION LABORATORY</td></tr>
<tr><td>Course Code</td><td colspan="5">AECC30</td></tr>
<tr><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>Semester</td><td colspan="5">V</td></tr>
<tr><td>Course Type</td><td colspan="5">Core</td></tr>
<tr><td>Regulation</td><td colspan="5">IARE-UG20</td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>3</td><td>1.5</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Ms K.S.Indrani, Assistant Professor, ECE</td></tr>
</table>

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECC03	III	Digital System Design

II COURSE OVERVIEW:

The Laboratory Virtual Instrument Engineering Workbench (LabVIEW) is a development environment designed by National Instruments that creates graphic-based programs and simulate actual laboratory instruments. The experimental objective of this lab is to design basic operations and data acquisition using myDAQ and myRIO's.Design,verify proto type models for electrical,electronic and mechanical applications using LabVIEW.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Virtual Instrumentation Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	To test the preparedness for the experiment.	-
20 %	To test the performance in the laboratory.	-
20 %	To test the calculations and graphs related to the concern experiment.	-
20 %	To test the results and the error analysis of the experiment.	-
20 %	To test the subject knowledge through viva – voce.	-

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component	**Laboratory**		**Total Marks**
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
-	-	-	-	-	-

VI COURSE OBJECTIVES:

The students will try to learn:

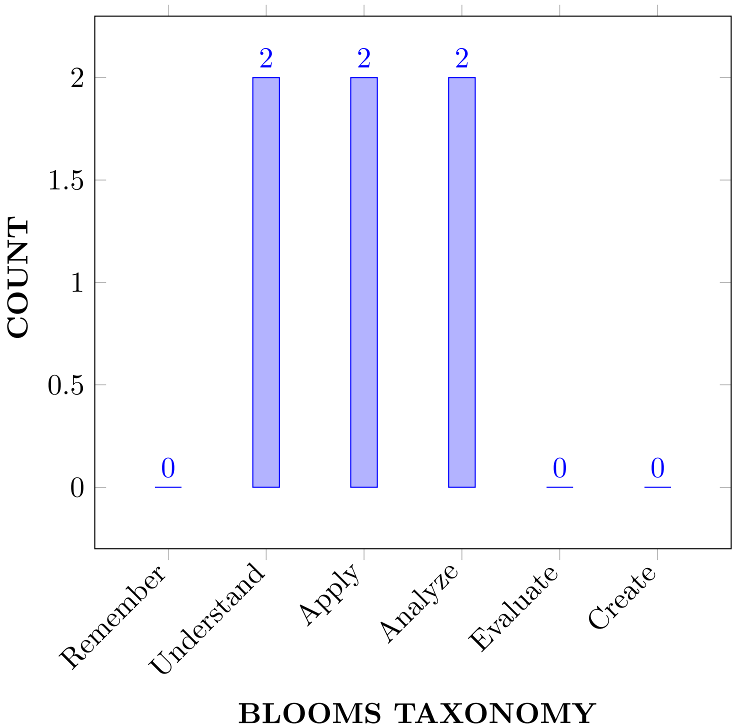
I	The concept of virtual instrumentation used to develop basic VI programs using loops, case structures for image, signal processing and motion control applications.
II	LabVIEW tool to design basic operations and data acquisition using myDAQ and myRIO's.
III	Prototype model for distribute stand-alone applications using LabVIEW.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Demonstrate** the LabVIEW graphical programming environment for virtual instrumentation applications.	Understand
CO 2	**Make use of** single and nested -loop design patterns for implementing iterative operations in LabVIEW.	Apply
CO 3	**Apply** cluster and frame based techniques on data for collective and distributive data application .	Analyze
CO 4	**Demonstrate** the mathematical operations on waveforms using LabVIEW for signal processing and communication applications.	Apply
CO 5	**Build** data acquisition system for measuring physical parameters from the transducers.	Understand
CO 6	**Test** , control performance parameters of Electrical motors using My DAQ and My RIO.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Lab Experiments / CIE / SEE

PO 2	Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	Lab Experiments / CIE / SEE
PO 3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Lab Experiments / CIE / SEE
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Lab Experiments / CIE / SEE
PO 5	Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations.	3	Lab Experiments / CIE / SEE
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	Lab Experiments / CIE / SEE

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	1	Lab Experiments / CIE / SEE

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	✓	-	-	-	-	✓	-	-	-	-	-
CO 2	✓	✓	-	-	✓	-	-	-	-	✓	-	-	-	-	-
CO 3	✓	✓	-	-	✓	-	-	-	-	✓	-	-	-	-	-
CO 4	✓	✓	✓	✓	✓	-	-	-	-	✓	-	-	-	✓	-
CO 5	✓	✓	✓	✓	✓	-	-	-	-	✓	-	-	-	✓	-
CO 6	✓	✓	✓	✓	✓	-	-	-	-	✓	-	-	-	✓	-

XII JUSTIFICATIONS FOR CO – PO / PSO) MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies matched.
CO 1	PO 1	**(Recall)** the basic arithmetic and logical operations apply them in virtual instrumentation with the knowledge of **own engineering discipline, science principles and methodology.**	2
	PO 2	Understand the given **problem statement** and implement electronic,mechanical and electrical model circuits in Labview graphical environment and **validate** the result of the circuit .	2
	PO 5	**Use modern** tools to implement basic arithmetic and logical operations using virtual instrumentation .	1
	PO 10	**Summarize** the basic of Labview to do arithmetic and logical operations**(Subject matter)**.	1
CO 2	PO 1	**Design** the model using single loop and multiple loop with the knowledge of **own engineering discipline, scientific principles and methodology.**	2
	PO 2	Understand the given **problem statement** and **formulate** the (complex) engineering problems into model, **translate the information** and implement using loop designs based on the number of iterations required in order to perform repetition of functionality of the circuit,**validate** the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	5
	PO 5	**Make use of** iteration loop operation in Labview to perform a function.	1
	PO 10	**Outline fluently** about the importance of single loop and multi loop designs based on the knowledge of circuit**(Subject matter)**.	1
CO 3	PO 1	**Develop** the circuit models on data to implement cluster and frame based techniques in Labview environment with the knowledge of **own engineering discipline, scientific principles and methodology.**	2
	PO 2	Understand the given **problem statement** , **translate the information** into the system model in order to perform collective and distributive data applications and **validate** the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	4
	PO 5	**Implement** clustering and sequence operations on data using virtual instrumentation.	1
	PO 10	**Explain fluently** about the applications and techniques on data set of the system with**(technical knowledge)**.	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies matched.
CO 4	PO 1	**Summarize** the mathematical operations on waveform in Labview virtual environment which are used for signal processing and communication applications with **basic knowledge of science and engineering fundamentals.**	2
	PO 2	Understand the given **problem statement** and **formulate** the (complex) engineering problems related to signal processing and image processing, **translate the information** into the prototype systems from the provided **information and data, develop** modulation techniques on the signal in Labview, **validate** the output by using various controlling operations.	7
	PO 3	**Develop** circuits ,**based on customer needs for design of** models in virtual instrumentation workbench , to use in signal processing and communication fields and **evaluate outcomes of the designs.**	5
	PO 4	**Use research based knowledge and research method including experimental design** using Labview for proto type design of electrical and electronic circuits to do mathematical operations on waveform and **(synthesize the information to validate conclusions)**.	5
	PO 5	**Use Virtual instrumentation** tools to perform mathematical operations on signals which are for signal processing and image processing applications.	1
	PO 10	**Outline fluently** about the importance of formulae node,modulation and discrete cosine transform techniques in Labview **(Subject matter)**.	1
	PSO 2	**Design proto type model** for signal processing ,**SOC** and communication applications using **virtual instrumentation**.	1
CO 5	PO 1	**Demonstrate** the importance of data acquisition systems **applying basic knowledge of science and engineering fundamentals.**	2
	PO 2	Understand the given **problem statement** and **formulate** the engineering problems related to data acquisition **translate the information** into the model and prototype systems from the provided **information and data, develop solutions** by interfacing transducers, **validate** the performance parameters in reaching substantiated conclusions by the **interpretation of results**.	7
	PO 3	**Develop** solution from acquiring data by interfacing transducers and **establishing innovative solutions** to improve performance parameters .	5

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies matched.
	PO 4	**Use research based knowledge and research method including experimental design** using my RIO , my DAQ cards and interfacing various transducers **(synthesize the information to validate conclusions)**.	5
	PO 5	**Use latest** tools of virtual instrumentation using data cards my RIO and my DAQ for home automation applications.	1
	PO 10	**Communicate effectively** about advantages and applications of data acquisition systems of my RIO and my DAQ cards.	1
	PSO 2	**Inspect,Design,analyze** various sensor based models **using LabVIEW** and by interfacing external hardware .	3
CO 6	PO 1	**Build** the models using electrical motors by interfacing with virtual instruments with the **knowledge of mathematics, science and engineering fundamentals.**	2
	PO 2	Understand the given **problem statement** and **formulate** the (complex) engineering problems of improving the performance of electrical motors , **translate the information** into prototype systems from the provided **information and data, develop solutions** system using LabVIEW , data acquisition cards **validate** the design in reaching substantiated conclusions by the **interpretation of results**.	7
	PO 3	**Design** solutions for complex engineering problems such as mechanical,electrical and electronic system by doing **innovative solution and implementing them using modern tools** such as labview , my Rio amd my Daq.	5
	PO 4	Use **research-based knowledge,research methods including design of multidisciplinary models** using virtual instrumentation lab and data acquisition **analyze the result (Subject matter)**.	5
	PO 5	**Outline fluently** about the importance of interfacing and procedure to improve physical quantities with the knowledge of **(Subject matter)**.	1
	PO 10	**Explain orally** the interfacing of electrical motors and verifying the physical quantities with the **technical knowledge**	1
	PSO 2	**Inspect,Design,analyze** various electric, mechanical models **using LabVIEW** and by interfacing external hardware .	3

Note: For Key Attributes refer **Annexure - I**

XIII MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	**10**	**10**	**11**	**1**	**5**	**3**	**3**	**12**	**5**	**12**	**8**	**5**	**11**	**7**
CO 1	2	2	-	-	1	-	-	-	-	1	-	-	-	-	-
CO 2	2	5	-	-	1	-	-	-	-	1	-	-	-	-	-
CO 3	2	5	-	-	1	-	-	-	-	1	-	-	-	-	-
CO 4	2	7	5	5	1	-	-	-	-	1	-	-	-	1	-
CO 5	2	7	5	5	1	-	-	-	-	1	-	-	-	3	-
CO 6	2	7	5	5	1	-	-	-	-	1	-	-	-	3	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO–(PO / PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	**10**	**10**	**11**	**1**	**5**	**3**	**3**	**12**	**5**	**12**	**8**	**5**	**11**	**7**
CO 1	66.7	20	-	-	100	-	-	-	-	20	-	-	-	-	-
CO 2	66.7	50	-	-	100	-	-	-	-	20	-	-	-	-	-
CO 3	66.7	50	-	-	100	-	-	-	-	20	-	-	-	-	-
CO 4	66.7	70	50	45	100	-	-	-	-	20	-	-	-	10	-
CO 5	66.7	70	50	45	100	-	-	-	-	20	-	-	-	30	-
CO 6	66.7	70	50	45	100	-	-	-	-	20	-	-	-	30	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 - $0 \leq$ C<5% – No correlation

1 -5 <C< 40% – Low/ Slight

2 - 40 % <C < 60% –Moderate

3 - 60% < C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	1	-	-	3	-	-	-	-	1	-	-	-	-	-
CO 2	3	2	-	-	3	-	-	-	-	1	-	-	-	-	-
CO 3	3	2	-	-	3	-	-	-	-	1	-	-	-	-	-
CO 4	3	3	2	2	3	-	-	-	-	1	-	-	-	1	-
CO 5	3	3	2	2	3	-	-	-	-	1	-	-	-	1	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 6	3	3	2	2	3	-	-	-	-	1	-	-	-	1	-
TOTAL	**18**	**14**	**6**	**6**	**9**	**0**	**0**	**0**	**0**	**6**	**0**	**0**	**0**	**3**	**0**
AVERAGE	**3**	**2.3**	**2**	**2**	**3**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

WEEK-I	**OPEN AND RUN A VIRTUAL INSTRUMENT**
	(a) Build VI to implement arithmetic and boolean operations using graphical environment. (b) Build a VI to calculate the area and perimeter of the rectangle, and the area and circumference of the circle.
WEEK-II	**SUM OF "n" NUMBERS USING "FOR" LOOP AND WHILE LOOP FACTORIAL OF A GIVE NUMBER USING FOR LOOP AND WHILE LOOP**
	(a)Design sum and factorial of "n" numbers using FOR loop , WHILE loop in VI (Virtual Instrumentation) environment (b)Write a program in LabVIEW to generate a Fibonacci series of n numbers where n is defined by the programmer. Example for the Fibonacci series is: 1 1 2 3 5 8 13 21 34 and so on.
WEEK-III	**BUNDLE AND UNBUNDLE CLUSTER**
	(a) Develop VI to bundle and unbundle a cluster of objects based on properties and segregate (b) Build VI to display marks of a student , percentage obtained individual and over all subjects in that semester.
WEEK-IV	**APPLICATION USING FORMULA NODE & DISCRETE COSINE TRANSFORM**
	(a) Build a VI to create a sine wave using formula node and to perform discrete cosine transform on the given signal. (b) Build VI for seven segment display using case structure.

WEEK-V	**FLAT AND STACKED SEQUENCE**
	(a) Build a VI to perform using flat and stacked sequence on LabVIEW platform. (b)Design a traffic light controller using flat sequence on LabVIEW platform.
WEEK-VI	**AMPLITUDE MODULATION**
	(a) Build a VI to perform Amplitude modulation and demodulation using Labview.
	(b) Build a VI to perform Double side band suppressed carrier modulation on sinusoidal signal and estimate output power.
WEEK-VII	**REAL TIME TEMPERATURE MONITORING USING VIRTUAL INSTRUMENTATION.**
	(a) Develop a program for real time temperature monitoring by using LM35 temperature sensor. (b) Build a VI to convert Celsius to Fahrenheit heat and Fahrenheit heat to Celsius.
WEEK-VIII	**MEASURE DISTANCE USING IR RANGER AND MYDAQ**
	(a) Build VI to measure distance using IR RANGER and MYDAQ. (b) Build VI to detect obstacles using Ultrasonic sensor and myDAQ .
WEEK-IX	**MEASUREMENT OF VIBRATIONS USING PIZEO ELECTRIC TRANSDUCER AND MYDAQ**
	(a) Develop a program for measurement of vibrations using pizeo electric transducer and myDAQ. (b) Develop a program for measurement mechanical stress using pizeo electric transducer and myDAQ.
WEEK-X	**MEASUREMENT OF VIBRATIONS USING PIZEO ELECTRIC TRANSDUCER AND MYRIO**
	(a) Develop a program for measurement vibrations using pizeo electric transducer and myRIO using lab view (b) Develop a program for measurement mechanical stress using pizeo electric transducer and myRIO using lab view.
WEEK-XI	**INTERFACE SERVO MOTOR AND DC MOTORS USING MYDAQ**
	(a) Develop a program to control speed of servo motors by interfacing using myDAQ (b)Develop a program to control speed of dc motors by interfacing using myDAQ.
WEEK-XII	**INTERFACE SERVO MOTOR AND DC MOTORS USING MYRIO**
	(a) Develop a program to control speed of servo motors by interfacing using myRIO. (b) Develop a program to control speed of dc motors by interfacing using myRIO.
WEEK-XIII	**MEASURE DISTANCE USING IR RANGER AND MYRIO**
	(a) Develop a program for measure distance using IR ranger and myRIO. (b) Build a VI to detect obstacles using Ultrasonic sensor and myRIO .

WEEK-XIV	**DEVELOPING SIGNAL GENERATOR USING DAQ CARDS.**
	(a) Develop a program to develop square wave and triangular signals by using myDAQ cards. (b) Develop a program to develop square wave having 10KHZ and 10V signals by using myDAQ cards.

REFERENCE BOOKS:

1. Jim Kring, Jeffrey Travis , —LabVIEW for Everyone: Graphical Programming Made Easy and Fun‖ Prentice Hall, 3rd Edition, 2006.

2. Richard Jennings Gary W.Johnson, —Labview Graphical Programming‖, McGraw-Hill Education, 4th Edition, 2011.

3. Rick Bitter, Taqi Mohiuddin,, Matt Nawrocki, —LabView: Advanced Programming Techniques‖, CRC Press, 2nd Edition, 2006.

4. Sanjay Gupta, —Virtual Instrumentation using LABVIEW‖, McGraw-Hill Education, 2nd edition, 2010.

WEB REFERENCE BOOKS::

1. http://www.ni.com/pdf/manuals/373427j.pdf

2. http://home.hit.no/ hansha/documents/labview/Introduction to LabVIEW.htm

3. https://www.pearsonhighered.com/samplechapter/0130153621.pdf

4. http://k12lab-support-pages.s3.amazonaws.com/lvbasichome1.html

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	(a) Build VI to implement arithmetic and boolean operations using graphical environment. (b) Build a VI to calculate the area and perimeter of the rectangle, and the area and circumference of the circle.	CO 1	R1:11.1-11.5
2	(a)Design sum and factorial of "n" numbers using FOR loop , WHILE loop in VI (Virtual Instrumentation) environment. (b)Write a program in LabVIEW to generate a Fibonacci series of n numbers where n is defined by the programmer. Example for the Fibonacci series is: 1 1 2 3 5 8 13 21 34 and so on.	CO 2	R1:11.1-11.5
3	(a) Develop VI to bundle and unbundle a cluster of objects based on properties and segregate (b) Build VI to display marks of a student , percentage obtained individual and over all subjects in that semester.	CO 3	R1:4.8 , R1:7.2
4	(a) Build a VI to create a sine wave using formula node and to perform discrete cosine transform on the given signal. (b) Build VI for seven segment display using case structure.	CO 4	R1:4.8 , R1:7.2

5	(a) Build a VI to perform using flat and stacked sequence on LabVIEW platform. (b)Design a traffic light controller using flat sequence on LabVIEW platform.	CO 3	R2:10.4 , R2:7.2
6	(a) Build a VI to perform Amplitude modulation and demodulation using Labview. (b) Build a VI to perform Double side band suppressed carrier modulation on sinusoidal signal and estimate output power.	CO 4	R2:10.4 , R1:7.2
7	(a) Develop a program for real time temperature monitoring by using LM35 temperature sensor. (b) Build a VI to convert Celsius to Fahrenheit heat and Fahrenheit heat to Celsius.	CO 4	R2:10.4 , R1:7.2
8	(a) Build VI to measure distance using IR RANGER and MYDAQ. (b) Build VI to detect obstacles using Ultrasonic sensor and myDAQ .	CO 5	R1:8.2-8.5
9	(a) Develop a program for measurement of vibrations using pizeo electric transducer and myDAQ. (b) Develop a program for measurement mechanical stress using pizeo electric transducer and myDAQ. .	CO 5	R1:11.1-11.5
10	(a) Develop a program for measurement vibrations using pizeo electric transducer and myRIO using lab view. (b) Develop a program for measurement mechanical stress using pizeo electric transducer and myRIO using lab view.	CO 5	R1:10.1 , R1:10.2
11	(a) Develop a program to control speed of servo motors by interfacing using myDAQ. (b)Develop a program to control speed of dc motors by interfacing using myDAQ.	CO 6	R1:11.1-11.5
12	(a) Develop a program to control speed of servo motors by interfacing using myRIO. (b) Develop a program to control speed of dc motors by interfacing using myRIO.	CO 6	R3:3.12 , R1:12.7
13	(a) Develop a program for measure distance using IR ranger and myRIO. (b) Build a VI to detect obstacles using Ultrasonic sensor and myRIO .	CO 6	R3:3.12 , .R1:12.7
14	(a) Develop a program to develop square wave and triangular signals by using myDAQ cards	CO 6	R3:3.12 , .R1:12.7
	(b) Develop a program to develop square wave having 10KHZ and 10V signals by using myDAQ cards.	CO 6	R3:3.12 , R1:12.7

XX EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Measurement & Controlling of Temperature through LabVIEW.
2	Speech Recognition Project using LabVIEW.
3	LabVIEW & DAQ based Data Monitoring in Real-Time for PV Solar Cell.
4	Home Automation with Energy Gentrification using LabVIEW.
5	LabVIEW based Security System of Railway Track & Gate.

Course Coordinator **HOD,ECE**
Mrs. K.S.Indrani, Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**

	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**

	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PO Number	**NBA Statement / Key Competencies Features (KCF)**	**No. of KCF's**
PSO1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications 1. Analyze and solve real time problems in Robotics 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications 3. Develop embedded systems modules using Real Time Operating System 4. Undertake research and development projects in the field of Embedded Systems 5. Adopt the engineering professional code and conduct	**5**
PSO2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs 1. Inspect, survey and analyze types of ASIC chip designs 2.Design ASIC prototypes using Verilog and VHDL languages 3. Analyze microprocessor subsystems with memories and I/O interfacs for SOC designs 4. Explore hardware components for designig SOC 5. Adopt the engineering professional code and conduct 6.Designing prototypes of SOC using programming tools like MATLAB, LabVIEW 7.Familiarize with the design flow of ASIC prototype 8.Realize SOC using Register-Transfer-Level designs 9. Analyse and develop models for system level descriptions for synthesis of SOC 10. Inspect and survey the abstractions and principles for the specification, simulation, verification, and synthesis of systems on chip (SoC) 11. Programming and hands-on skills to meet requirements of global environment	**11**

PSO3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications 1. Explicit software and programming tools for antenna design 2. Adopt technical library resources and literature search 3. Explore smart antennas 4. Model, program for operation and control of smart antennas for wireless communication applications 5. Interface automation tools 6. Research, analysis, problem solving and presentation using software aids 7.Programming and hands-on skills to meet requirements of global environment	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**ELECTRONICS AND COMMUNICATION ENGINEERING**				
Course Title	**MICROWAVE AND RADAR ENGINEERING**				
Course Code	AECC32				
Program	B.Tech				
Semester	VI				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4		
Course Coordinator	Dr. V Siva Nagaraju, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECC11	IV	Electromagnetic Waves and Transmission Lines
B.Tech	AECC18	V	Antennas and Wave Propagation

II COURSE OVERVIEW:

This course allows students to study and analyze microwave systems at high frequencies, typically in the MHz and GHz range where lumped elements (e.g., resistors, capacitors, inductors) are no longer appropriate. It also deals with the concepts of radar systems. The main applications such as electronic warfare, navigation system, missile terminal guidance and landing systems of air and space vehicles.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Fluid Dynamics	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	x	Tech talk	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
%	Remember
50 %	Understand
50 %	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	0%

VI COURSE OBJECTIVES:

The students will try to learn:

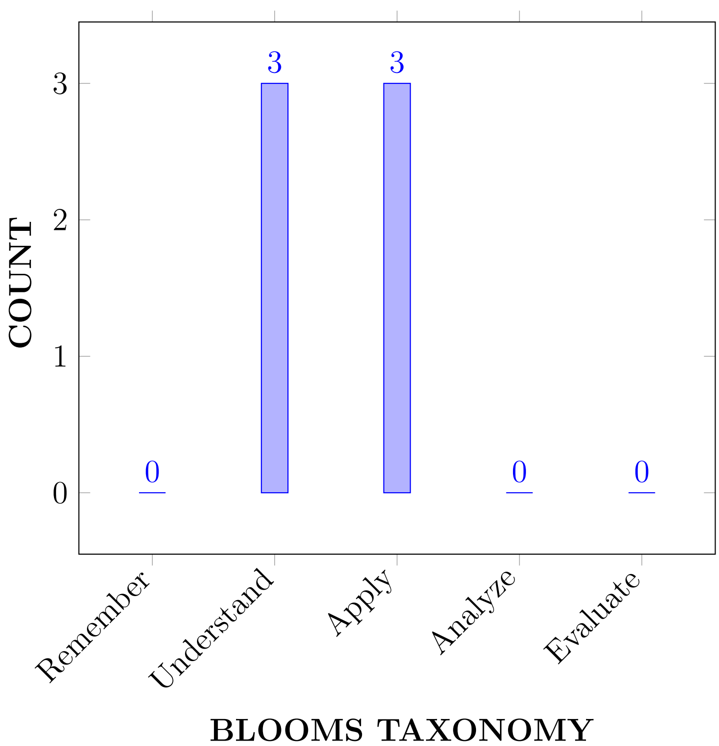
I	The concepts of wave guide components and electromagnetic wave propagation for microwave communication using Maxwell's equations.
II	The generation of microwave signals to measure different parameters using microwave test bench.
III	The principle and operation of radar systems and radar range equation for communication.
IV	The use of Doppler frequency shift to detect moving target in stationary clutter , continuous wave radar system in altimeter applications

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Illustrate** the principle of waveguide components to couple microwave power and make the relation between input and output power	Understand
CO 2	**Demonstrate** the operation of microwave tubes, solid state devices for the generation and transmission of the microwave frequencies.	Understand
CO 3	**Make use of** microwave bench set-up for measuring the parameters of microwave signal	Apply
CO 4	**Outline** the working principle and operation of radar using radar range equation to calculate transmitted power in CW radar	Understand
CO 5	**Identify** the importance of avoiding blind speed phenomenon, staggered PRF MTI systems are used in modern radar for detection of high-speed moving targets	Apply
CO 6	**Choose** the appropriate solid state sources, amplifiers and mixers for employing the transmitters and receivers in radar	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE/ CIE, AAT, QUIZ
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	SEE/ CIE, AAT, QUIZ
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	SEE/ CIE, AAT, QUIZ
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions	2	SEE/ CIE, AAT, QUIZ

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 3	Make use of High frequency structure simulator (HFSS) for modeling and evaluating the patch and smart antennas for wired and wireless communication applications.	2	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	✓	-	-	-	-	-	✓	-		-	-	-
CO 2	✓	✓	-	✓	-	-	-	-	-	✓	-	-	-	-	-
CO 3	✓	-	-	✓	-	-	-	-	-	✓	-	-	-	-	-
CO 4	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 5	✓	-	-	✓	-	-	-	-	-	✓	-	-	-	-	✓
CO 6	✓	✓	-	✓	-	-	-	-	-	✓	-	-	-	-	✓

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Recall** the concepts of transmission lines and waveguides (knowledge) to derive the field components of wave equations i.e TE,TM and TEM by **applying the scientific and mathematical principles to own engineering discipline**.	3
	PO 2	**Formulate and analyze (Problem analysis) the complex engineering problems** for determining the mode analysis in waveguides **using information and data collection** with **result** analysis and **experimental evaluation**	5
	PO 4	**Understanding the contexts** of microwave components **knowledge** in evaluating the methods of s-parameters on power dividers including **use of technical literature** in **design of experiments, analysis of complex problems**	5
	PO 10	**Communicate orally on** the concepts of transmission lines and waveguides (knowledge) and **write effective reports** on the field components of wave equations i.e TE,TM and TEM modes	2
CO 2	PO 1	**Understand** the performance characteristics of a Reflex klystron and two-cavity (knowledge) for calculating the input and output power and efficiency by **applying the scientific and mathematical principles to own engineering discipline**.	3
	PO 2	**Formulate and analyze (Problem analysis) the complex Engineering problems** to evaluate the performance of microwave sources using **Information and data collection** with **result** analysis and **experimental evaluation.**	5
	PO 4	**Analyze** the microwave power sources **(knowledge)** including **use of technical literature** in **design of experiments, analysis of complex problems**	5

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 10	**Communicate orally on** the concepts of microwave sources and **write effective reports** on types of sources	2
CO 3	PO 1	**Apply** the knowledge of Engineering fundamentals to the description of microwave bench setup for measurements of parameters of microwave signal by **applying the scientific and mathematical principles to own engineering discipline**.	3
	PO 4	**Use research-based knowledge** in **design of experiments, analysis and interpretation of data** by **Knowledge of characteristics of particular equipment in laboratory** for using microwave bench setup	5
	PO 10	**Communicate orally on** the concepts of microwave bench setup and **write effective reports** on measurements	2
CO 4	PO 1	**Understand** the principle of frequency modulated –continuous wave radar by **applying the scientific and mathematical principles to own engineering discipline**.	3
	PO 2	**Analyze** the concept FMCW and apply it for altimeter applications **use research-based knowledge and of data to provide valid conclusions** to measure short distances, high range accuracy, and low power requirements	3
	PO 10	**Communicate orally on** the concepts of Radar Range equation and **write effective reports** on Pulse Radar	2
CO 5	PO 1	**Understand** the principle of moving target indicator radar and Pulse Doppler radar by **applying the scientific and mathematical principles to own engineering discipline**.	3
	PO 4	**Analyze** the MTI radar for moving target indication and clutter rejection using the principle of Doppler effect **engineering knowledge** with **design solutions for complex engineering problems** with **awareness of quality issues, intellectual property and contractual issues**	6
	PO 10	**Communicate orally on** the concept of matched filters in Radar receivers and **write effective reports** on matched filters	2
	PSO 3	**Analyze** the concept of MF response characteristics using **explicit software and programming tools for antenna design, adopt technical library resources and literature search** for **wireless communication applications**	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 6	PO 1	**Understand** the methods for employing solid-state transmitters using the **principles of mathematics, science to the solutions of complex engineering problems.**	2
	PO 2	**Review** the concept of noise figure in mixers **using research-based knowledge and interpretation of data to provide valid conclusions**	4
	PO 10	**Communicate orally on** the concepts of of display devices and and **write effective reports** on duplexers	2
	PSO 3	**Analyze** the concept of display devices and duplexers using **explicit software and programming tools for antenna design, adopt technical library resources and literature search** for **wireless communication applications**	3

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	3	5	-	5	-	-	-	-	-	2	-		-	-	-
CO 2	3	5	-	5	-	-	-	-	-	2	-	-	-	-	-
CO 3	3	-	-	5	-	-	-	-	-	2	-	-	-	-	-
CO 4	3	3	-	-	-	-	-	-	-	2	-		-	-	-
CO 5	3	-	-	6	-	-	-	-	-	2	-	-	-	-	3
CO 6	2	4	-	-	-	-	-	-	-	2	-		-	-	3

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	100	50	-	45	-	-	-	-	-	40	-		-	-	-
CO 2	100	50	-	45	-	-	-	-	-	40	-	-	-	-	-
CO 3	100	-	-	45	-	-	-	-	-	40	-	-	-	-	-
CO 4	100	30	-	-		-	-	-	-	40	-		-	-	-
CO 5	100	-	-	54.5	-	-	-	-	-	40	-	-	-	-	42.8
CO 6	66.6	40	-	-	-	-	-	-	-	40	-		-	-	42.8

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation
1 -5 $< C \leq 40\%$ – Low/ Slight
2 - 40 % $< C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	2	-	-	-	-	-	2	-	-	-	-	
CO 2	3	2	-	2	-	-	-	-	-	2	-	-	-	-	-
CO 3	3	-	-	2	-	-	-	-	-	2	-	-	-	-	-
CO 4	3	1	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 5	3	-	-	2	-	-	-	-	-	2	-	-	-	-	2
CO 6	3	2	-	-	-	-	-	-	-	2	-	-	-	-	2
TOTAL	18	7	-	8	-	-	-	-	-	12	-	-	-	-	4
AVERAGE	3	1.75	-	2	-	-	-	-	-	2	-	-	-	-	2

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Tech - Talk	✓	Certification	-
Term Paper	-	Concept Video	✓	Open Ended Experiments	✓
Assignments	-				

XVII ASSESSMENT METHODOLOGY-INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	WAVE-GUIDES AND COMPONENTS
	Introduction, microwave spectrum and bands, applications of microwaves, types of waveguides, rectangular waveguides, field equations in rectangular waveguide, field components of TM and TE waves for rectangular waveguide, modes of TM and TE waves in rectangular waveguide, impossibility of TEM waves, cut off frequency of rectangular waveguide; Wave impedance in rectangular waveguide: Wave impedance for a TM and TE wave in rectangular waveguide, Dominant mode and degenerate modes, mode characteristics of phase velocity, group velocity, wavelength and impedance relations; waveguide multiport junctions: E plane Tee, H plane Tee, Magic Tee, applications of Magic Tee, hybrid ring; Ferrites: Faraday rotation principle, gyrator, isolator, circulator illustrative problems.

MODULE II	**MICROWAVE LINEAR BEAM AND CROSS FIELD TUBES (O-TYPE AND M-TYPE)**
	Microwave linear beam tubes (O type): Limitations of conventional tubes at microwave frequencies; Klystron: Velocity modulation process, bunching process, output power and beam loading; Multicavity Klystron amplifiers: Beam current density, output current and output power of two cavity Klystron; Reflex Klystron: Velocity modulation, power output and efficiency. Helix Traveling Wave tube: Slow wave structures, amplification process, conventional current; Microwave cross field tubes (M type): Introduction, cross-field effects; Magnetrons: Different types, 8- cavity cylindrical travelling wave Magnetron, Hull cut-off and Hartree conditions, modes of resonance and PI-mode operation.
MODULE III	**MICROWAVE MEASUREMENTS, CW AND PULSE RADAR**
	Description of microwave bench: Different blocks and their features, precautions; Microwave power measurement: Bolometer; Measurement of attenuation; Frequency standing wave measurements: measurement of low and high VSWR; Cavity Q; Impedance measurements. Radar Range equation; Pulse Radar: Block diagram and Operation; Maximum unambiguous range; Radar wave forms; Prediction of Target range; Integration of echo pulses, PRF and Range ambiguities; system losses. CW Radar: Introduction, Block Diagram, Isolation between transmitter and receiver, Non-zero IF receiver, Receiver bandwidth requirements, Applications; Frequency Modulated CW radar: Range and Doppler measurement, Mathematical Analysis, Block Diagram and characteristics, FM-CW altimeter, multiple frequency CW radar, Ambiguity Diagram & its application.
MODULE IV	**RADAR DETECTION IN NOISE**
	Moving target indication (MTI) on A scope, butterfly effect, MTI using delay line canceller (DLC), Doppler measurement using Pulse radar, MTI radar (with power amplifier transmitter), MTI radar (with power oscillator transmitter), filter characteristics of DLC, blind speeds, double DLCs, Blind speeds, Staggered PRFs. Matched Filter (MF) receiver, MF response characteristics; Correlation Receiver, Efficiency of non-matched filters, Matched filter with non-white noise, Automatic Detection of radar signals: Tapped Delay Line (TDL) detection, CFAR receiver, Radar Clutter: Land and Sea clutter (without mathematical treatment)
MODULE V	**RADAR TRANSMITTERS & RECEIVERS**
	Hybrid Linear-Beam Amplifier and Crossed-Field Amplifiers, Solid State Sources & Amplifiers, Methods for employing solid-state transmitters. Receiver Noise Figure (NF) - Noise Temperature; Measurement of NF, NF of Mixers, Basics of Radar Displays and Duplexers.

TEXTBOOKS

1. M. Kulkarni, "Microwave and radar engineering ", Umesh Publications,5th Edition,2016.
2. Samuel Y. Liao, "Microwave Devices and Circuits", Pearson, 3rd Edition, 2003.
3. Merrill I Skolnik, "Introduction to Radar Systems", TMH Special Indian Edition, 2nd Edition, 2007

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1. Herbert J. Reich, J.G. Skolnik, P.F. Ordung and H.L. Krauss, "Microwave Principles, CBS Publishers and Distributors, New Delhi, 1st Edition, 2004.

2. F.E. Terman, "Electronic and Radio Engineering", Tata McGraw-Hill Publications, 4th Edition, 1955.

3. Warren L. Stutzman, Gary A. Thiele, "Antenna Theory and Design", 3rd Edition, 2012.

WEB REFERENCES:

1. https://www.microwaves101.com/uploads/MESA-front.pdf

2. https:// www.onlinecourses.nptel.ac.in/noc20_ee63/preview

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	https://lms.iare.ac.in/ index? route=course/details& course id_127
CONTENT DELIVERY (THEORY)			
2	Introduction, microwave spectrum and bands, applications of microwaves	CO 1	T1-1.0-1.4
3	types of waveguides, rectangular waveguides, field equations in rectangular waveguide	CO 1	T1-4.1.1-4.1.3
4	field components of TM and TE waves for rectangular waveguide	CO 1	T1-4.1.1-4.1.3
5	modes of TM and TE waves in rectangular waveguide	CO 1	T1-4.1.1-4.1.3
6	Impossibility of TEM waves, cut off frequency of rectangular waveguide; Wave impedance in rectangular waveguide and Wave impedance for a TM and TE wave in rectangular waveguide	CO 1	T1-4.1.6-4.1.7
7	Dominant mode and degenerate modes, mode characteristics of phase velocity, group velocity, wavelength and impedance relations	CO1	T1-4.1.8-4.1.11
8	waveguide multiport junctions: E plane Tee, H plane Tee	CO 1	T1-5.4- 5.5
9	Magic Tee, applications of Magic Tee, hybrid ring	CO 1	T1-5.4- 5.5
10	Ferrites: Faraday rotation principle, gyrator, isolator, circulator illustrative problems.	CO 1	T1 -5.6
11	Microwave linear beam tubes (O type): Limitations of conventional tubes at microwave frequencies	CO 2	T1 - 6.1
12	Klystron: Velocity modulation process, bunching process	CO 2	T1 - 6.2- 6.3
13	Output power and beam loading; Multicavity Klystron amplifiers	CO 2	T1 - 6.4.2-6.4.3
14	Beam current density, output current and output power of two cavity Klystron	CO 2	T1 - 6.4.2-6.4.3

15	Reflex Klystron: Velocity modulation, power output and efficiency	CO 2	T1 - 6.4.1
16	Helix Traveling Wave tube: Slow wave structures, amplification process, conventional current	CO 2	T1-7.5
17	Microwave cross field tubes (M type): Introduction, cross-field effects; Magnetrons: Different types	CO 2	T1-7.6
18	8- cavity cylindrical travelling wave Magnetron, Hull cut-off and Hartree conditions	CO 2	T1-7.1.1-7.1.2
19	modes of resonance and PI-mode operation.	CO 2	T1-7.1.1-7.1.2
20	Description of microwave bench: Different blocks and their features, precautions	CO 3	T1-9.1-9.2
21	Numbering and grouping, setup access	CO 3	T1-5.3.3,5.4
21	Microwave power measurement: Bolometer; Measurement of attenuation	CO 3	T1-9.1-9.2
22	Frequency measurements, measurement of low and high VSWR; Cavity Q; Impedance measurements.	CO 3	T1-9.1-9.2
23	Radar Range equation; Pulse Radar: Block diagram and Operation; Maximum unambiguous range	CO 4	T2: 1.3-1.6
24	Radar wave forms, Prediction of target range, integration of echo pulses, PRF and range ambiguities; system losses	CO 4	T2:2.7-2.12
25	cell splitting, micro cells, vehicle locating methods	CO 4	T1-5.11
26	CW Radar: Introduction, Block Diagram, Isolation between transmitter and receiver	CO 4	T2:3.3-3.4
27	Non-zero IF receiver, receiver bandwidth requirements, Applications	CO 4	T2:3.5-3.6
28	Frequency Modulated CW radar: Range and Doppler measurement, Mathematical Analysis	CO 4	T2:3.7-3.8
29	Block Diagram and characteristics, FM-CW altimeter	CO 4	T2:3.6-3.7
30	multiple frequency CW radar, Ambiguity Diagram & its application.	CO 4	T2:3.8-3.9
31	Moving target indication (MTI) on A scope, butterfly effect, MTI using delay line canceller (DLC), Doppler measurement using Pulse radar	CO 5	T2:4.1-4.8
32	MTI radar (with power amplifier transmitter), MTI radar (with power oscillator transmitter)	CO 5	T2:4.9-4.10
33	Filter characteristics of DLC, blind speeds, double DLCs, Blind speeds, Staggered PRFs	CO 5	T2:4.2-4.4
34	Matched Filter (MF) receiver, MF response characteristics; Correlation Receiver	CO 5	T2:10.1- 10.3
35	Efficiency of non-matched filters, Matched filter with non-white noise	CO 5	T2:10.4- 10.7
36	Automatic Detection of radar signals: Tapped Delay Line (TDL) detection	CO 5	T1:10.8- 10.9
37	CFAR receiver, Radar Clutter: Land and Sea clutter (without mathematical treatment)	CO 5	T2: 13.1-13.4

38	Hybrid Linear-Beam Amplifier and Crossed-Field Amplifiers	CO 6	T2:6.1-6.2
39	Solid State Sources & amplifiers, Methods for employing solid-state transmitters	CO 6	T2:6.3-6.6
40	Receiver Noise Figure (NF) - Noise Temperature; Measurement of NF, NF of Mixers	CO 6	T2:9.1-9.3
41	Basics of Radar Displays and Duplexers	CO 6	T2:9.4-9.5
PROBLEM SOLVING/ CASE STUDIES			
42	Problems on Phase velocity, group velocity, wavelength and impedance relations	CO 1	T1-4.3- 4.4
43	Problems on Cut off frequency of rectangular waveguide	CO 1	T1-4.6
44	Problems on Waveguide multiport junctions	CO 1	T1-7.1-7.3, 8.4
45	Problems on Klystrons	CO 2	T1-8.5-8.6
46	Problems on Helix Traveling Wave tube: Slow wave structures	CO 2	T1-8.6-8.7
47	Problems on Microwave cross field tubes (M type)-Magnetrons	CO 2	T1-9.1-9.3
48	Problems on Radar Range equation and Maximum unambiguous range	CO 4	T2-4.3.1-4.3.3
49	Problems on Pulse and CW Radar	CO 4	T2-4.4- 4.5
50	Problems on Doppler measurement using Pulse radar	CO 4	T2-8.1-8.3
51	Problems on MTI Radar	CO 5	T2:4.5-4.8
52	Problems on Pulse and CW Radar	CO 5	T2-4.4- 4.5
53	Problems on Delay line canceller (DLC)	CO 5	T2-7.13
54	Problems on Receiver Noise Figure (NF)	CO 6	T2-9.1-9.3
55	Problems on Microwave measurements	CO 3	T1–11.4
56	Problems on Duplexers	CO 6	T2-9.5
DISCUSSION ON DEFINITION AND TERMINOLOGY			
57	Microwave Transmission lines	CO 1	T1-4.3.1
58	Microwave tubes	CO 2	T1- 7.13
59	Microwave measurements,CW and frequency modulated radar	CO 3, CO 4	T1-9.3
60	Moving Target Indication and Pulse Doppler radar	CO 5	T2- 7.13
61	Radar Displays and Duplexers	CO 6	T2-9.1-9.3

DISCUSSION ON QUESTION BANK			
62	Rectangular waveguides	CO 1	T1-4.3.1
63	Microwave linear beam and cross field tubes	CO 2	T1-5.4-5.5
64	Microwave measurements, Radar Range equation	CO 3, CO 4	T1-9.3
65	Moving Target Indication and Pulse Doppler radar	CO 5	T2-4.3.1
66	Radar Transmitters and Receivers	CO 6	T2-9.1-9.3

Signature of Course Coordinator **HOD,ECE**
Dr. V Siva Nagaraju, Associate Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES and PROGRAM SPECIFIC OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences **(Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations **(Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**

	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**

	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications 1. Analyze and solve real time problems in Robotics. 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications 3. Develop embedded systems modules using Real Time Operating System 4. Undertake research and development projects in the field of Embedded Systems. 5. Adopt the engineering professional code and conduct	**5**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs. 1. Inspect, survey and analyze types of ASIC chip designs. 2. Design ASIC prototypes using Verilog and VHDL languages. 3. Analyze microprocessor subsystems with memories and I/O interfaces for SOC designs 4. Explore hardware components for designig SOC 5. Adopt the engineering professional code and conduct. 6. Designing prototypes of SOC using programming tools like MATLAB, LabVIEW. 7. Familiarize with the design flow of ASIC prototypes. 8. Realize SOC using Register-Transfer-Level designs. 9. Analyse and develop models for system level descriptions for synthesis of SOC. 10. Inspect and survey the abstractions and principles for the specification, simulation, verification, and synthesis of systems on chip (SoC). 11. Programming and hands-on skills to meet requirements of global environment.	**11**

PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications. 1. Explicit software and programming tools for antenna design. 2.Adopt technical library resources and literature search. 3. Explore smart antennas. 4. Model, program for operation and control of smart antennas for wireless communication applications. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

<table>
<tr><td>Department</td><td colspan="5">Electronics and Communication Engineering</td></tr>
<tr><td>Course Title</td><td colspan="5">Information Theroy and Coding Techniques</td></tr>
<tr><td>Course Code</td><td colspan="5">AECC34</td></tr>
<tr><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>Semester</td><td colspan="5">VI</td></tr>
<tr><td>Course Type</td><td colspan="5">Professional Elective-V</td></tr>
<tr><td>Regulation</td><td colspan="5">UG-20</td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>3</td><td>-</td><td>3</td><td>-</td><td>-</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Mr.Mohammad Khadir, Assistant Prfoessor</td></tr>
</table>

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECC10	IV	Analog and Digital Communications

II COURSE OVERVIEW:

Information theory and coding is the study of the quantification, storage and Communication of digital information with the properties of codes for specific applications. This course covers classifications of error control coding and source coding techniques, coding algorithms for audio, speech, image and video compression techniques. The applications include cryptography, error detection and correction in digital communication systems.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Information Theory and Coding	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
00%	Remember
30%	Understand
60 %	Apply
10%	Analyze
0%	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table.

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	00%

VI COURSE OBJECTIVES:

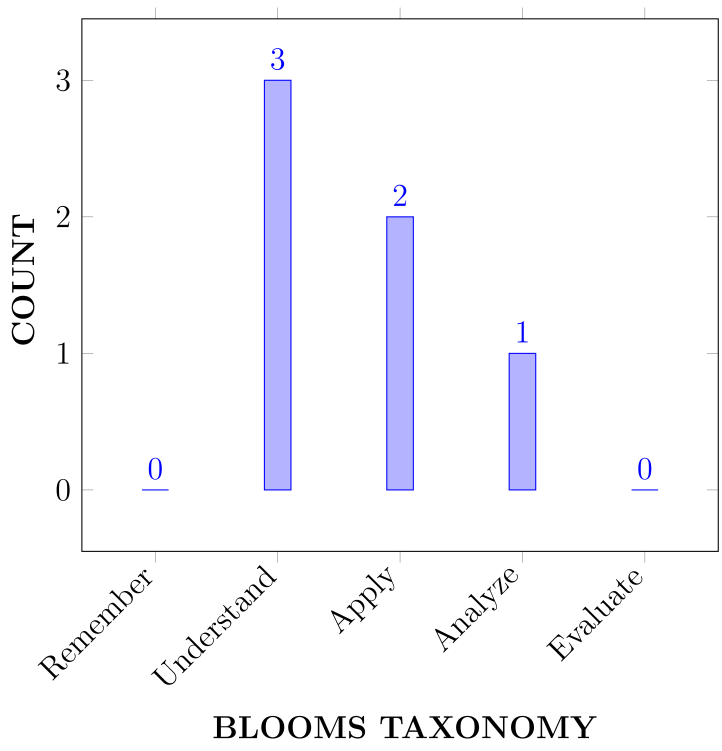
The students will try to learn:	
I	The concepts, principles and applications of information theory on communication systems
II	The data compression techniques with text, audio, speech, image and video for real world applications
III	The block codes and convolutional codes for coding and decoding of digital data

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Illustrate** source and channel coding techniques for error-free transmission of message over a noisy communication channel.	Understand
CO 2	**Makeuseof** linear and cyclic block codes for the performance analysis of error detection and correction in terms of efficiency.	Understand
CO 3	**Outline** the various types of convolutional codes for channel encoding processing data streaming.	Apply
CO 4	**Choose** the Viterbi and turbo decoder algorithms for detection of the convolutional code sequence in error controlling.	Apply
CO 5	**Relate** the various source coding techniques and algorithms for text, audio and speech processing	Understand
CO 6	**Categorize** the image and video formats and compression methods for data storage and compression.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Program Outcomes	
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE / CIE / AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	SEE / CIE / AAT

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	SEE / CIE / AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	AAT

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications	2	Research papers /Project
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	2	Research papers /Project

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	✓
CO 2	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-
CO 3	✓	✓	-	-	-	-	-	-	-	✓	-	-	✓	-	✓
CO 4	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-
CO 5	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	✓
CO 6	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT :

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO1	PO 1	**List out** the coding techniques **knowledge** for information entropy and Channel capacity using the **principles of science and mathematics** for the solution of **complex engineering problems.**	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	**Understand** binary code words (problem statement) and **formulate** the various block codes and information theory for error correction and detection of information for a binary system **(Solution development)** the provided information and substantiate with the **interpretation** of variations in the results.	5
	PO 3	**Develop** various block codes and information theory procedures (identify) and **understand** the performance of error correction and detection for customer and user needs and **identify** the cost limitations for the selection of parameters by applying the methods (design process) for innovative solutions.	5
	PO 10	**Effective presentation and speaking style** various block codes and information theory procedures (identify) and **and write subject matter effectively on basic** the performance of error correction and detection.	2
	PSO 1	**Understand** the problem statement of one dimensional probability scheme to **implement** two dimensional cases for calculating different entropies.	2
	PSO 3	**Understand** the knowledge of information theory to **Calculate** amount of information for a binary system.	2
CO2	PO1	**Interpret** the process of block codes, Convolutional codes by **applying** (mathematics, science) and **principles of engineering fundamentals**	3
	PO 2	**Illustrate** the principles of linear and cyclic block codes **Make use of** linear and cyclic block codes for the **performance analysis** of error detection and correction.	5
	PO 3	**Illustrate (knowledge)** the concept of block codes, Convolutional codes and **identify** the various codes to reduce the errors using encoders and decoders **(complex problem analysis)** to **implement** (Solution development) required communication systems for data transmission from the provided **information and validate** the results	5
	PO 10	**Effective presentation and speaking style** on the process of block codes, Convolutional codes and **and write subject matter effectively on** Viterbi algorithm for decoding a bitstream that has been encoded using a convolutional code.	2
CO 3	PO 1	**Outline** the various types of convolutional codes for channel encoding process in data streaming using the **principles of science and mathematics** for the solution of **complex engineering problems.**	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	**Understand** the performance of the reliable transmission of digital data using systematic and non-systematic codes **to solve engineering problems** the provided information to**interpretation of the results**	4
	PO 3	**Utilize** the BCH & RS codes for Channel performance improvement and **analyze** the **performance** of channel improvement for **customer and user needs** and **identify** the cost limitations for the selection of parameters, use **creativity in applying** the methods of model for innovative solutions.	5
	PO 10	**Effective presentation and speaking style** various types of convolutional codes for channel encoding(identify) and **and write subject matter effectively on** the performance of the reliable transmission of digital data using systematic and non-systematic codes.	2
	PSO 1	**Interpret (knowledge)** the performance of different error control schemes using the **principles of mathematics and engineering science.**	2
	PSO 3	**Understanding** the performance of different error control schemes by **formulating and evaluating** in the field of embedded applications	2
CO4	PO 1	**Identify** the receptional source coding techniques and layers for audio, text and speech processing using the **principles of science and mathematics** for the solution of **complex engineering problems.**	3
	PO 2	**Choose** the Viterbi and turbo decoder algorithms for detection of the convolutional code sequence in error**(problem statement)** controlling**to solve engineering problems** the provided information to **interpretation of the results**.	4
	PO 3	**Make use of** the Viterbi algorithm for decoding a bitstream that has been encoded using a convolutional code or trellis code **(complex problem analysis)**for **customer and user needs and identify the cost** limitations for the selection of parameters, use **creativity** in applying the methods of model for **innovative solutions.**	5
	PO 10	**Effective presentation and speaking style** source coding techniques and layers for audio, text and speech processing(identify) and **and write subject matter effectively on** Viterbi algorithm for decoding a bitstream that has been encoded using a convolutional code.	2
	PSO3	**Identify** the Viterbi decoder examines an entire received sequence of a given length and the decoder computes a metric for each path and makes a **decision based on this metric.**	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 5	PO 1	**Relate** the various source coding techniques and algorithms for text type data processing using the **principles of science and mathematics** for the solution of **complex engineering problems.**	3
	PO 2	**Select** encoder and decoder technique and **Analyze**the data **(problem statement)** implement coding techniques for text ,speech and audio processing using modern tools **engineering tools** like MATLAB for image compression from the provided information to **interpretation of the results**.	5
	PO 10	**Effective presentation and speaking style** source coding techniques and algorithms for text type data processing and **and write subject matter effectively on** implement coding techniques for text ,speech and audio processing using modern tools.	2
CO 6	PO 1	**Apply** the source symbols can be exactly recovered from the binary bits (lossless source coding) or recovered within some distortion (lossy source coding) using the **principles of science and mathematics** for the solution of **complex engineering problems.**	3
	PO 3	**Develop** a image with various image transform properties types (lossy source coding) and its types **using Scientific principles and methodology fundamental mathematics**for the solution **complex engineering problems** of customer and user needs and **identify** the cost limitations for the **selection** of parameters, use **creativity** in applying the methods of model for **innovative solutions.**	5
	PO 10	**Effective presentation and speaking style** source symbols can be exactly recovered from the binary bits (lossless source coding)and **and write subject matter effectively on** image with various image transform properties types (lossy source coding) and its types.	2
	PSO 3	**Understand** the concepts of measuring instrument systems to measure different electrical parameters using **embedded hardware design**.	2

Note:For Key Competencies refer Annexure - I

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	3	5	5	-	-	-	-	-	-	2	-	-	2	-	2
CO 2	3	5	5	-	-	-	-	-	-	2	-	-	-	-	-
CO 3	3	4	5	-	-	-	-	-	-	2	-	-	2	-	2
CO 4	3	4	5	-	-	-	-	-	-	2	-	-	-	-	2
CO 5	3	5	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 6	3	-	5	-	-	-	-	-	-	2	-	-	2	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	50	50	-	-	-	-	-	-	10	-	-	100	-	100
CO 2	100	50	50	-	-	-	-	-	-	40	-	-	-	-	-
CO 3	100	40	50	-	-	-	-	-	-	40	-	-	100	-	100
CO 4	100	40	50	-	-	-	-	-	-	40	-	-	-	-	100
CO 5	100	50	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 6	100	-	50	-	-	-	-	-	-	40	-	-	100	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation
1 -$5 < C \leq 40\%$ – Low/ Slight
2 - $40\% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	0	0	0	0	0	0	1	0	0	2	0	2
CO 2	3	2	2	0	0	0	0	0	0	1	0	0	0	0	0
CO 3	3	2	2	0	0	0	0	0	0	1	0	0	2	0	2
CO 4	3	2	2	0	0	0	0	0	0	1	0	0	0	0	0
CO 5	3	2	0	0	0	0	0	0	0	1	0	0	0	0	0
CO 6	3	0	2	0	0	0	0	0	0	1	0	0	2	0	0

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
TOTAL	18	10	10	0	0	0	0	0	0	12	0	0	8	0	6
AVERAGE	3	2	2	0	0	0	0	0	0	2	0	0	2	0	2

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	-
Quiz	-	Tech - Talk	✓	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	✓	Open Ended Experiments	✓
Micro Projects	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**INFORMATION THEORY**
	Information – Entropy, Information rate, classification of codes, Kraft McMillan inequality, Source coding theorem, Shannon- Fano coding, Huffman coding, Extended Huffman coding – Joint and conditional entropies, Mutual information - Discrete memory less channels – BSC, BEC – Channel capacity, Shannon limit
MODULE II	**ERROR CONTROL CODING: BLOCK CODES**
	Definitions and Principles: Hamming weight, Hamming distance, Minimum distance decoding, Single parity codes, Hamming codes, Repetition codes - Linear block codes, Cyclic codes – Syndrome calculation, Encoder and decoder - CRC
MODULE III	**ERROR CONTROL CODING: CONVOLUTIONAL CODES**
	Convolutional codes – code tree, trellis, state diagram - Encoding Decoding: Sequential search and Viterbi algorithm – Principle of Turbo coding
MODULE IV	**SOURCE CODING: TEXT, AUDIO AND SPEECH**
	Text: Adaptive Huffman Coding, Arithmetic Coding, LZW algorithm – Audio: Perceptual coding, Masking techniques, Psychoacoustic model, MEG Audio layers I,II,III, Dolby AC3 - Speech: Channel Vocoder, Linear Predictive Coding
MODULE V	**SOURCE CODING: IMAGE AND VIDEO**
	Image and Video Formats – GIF, TIFF, SIF, CIF, QCIF – Image compression: READ, JPEG – Video Compression: Principles-I,B,P frames, Motion estimation, Motion compensation, H.261, MPEG standard

TEXTBOOKS

1. R Bose, "Information Theory, Coding and Cryptography", TMH 2007

2. Fred Halsall, “Multidedia Communications: Applications, Networks, Protocols and Standards”, Perason Education Asia, 2002

REFERENCE BOOKS:

1. K Sayood, “Introduction to Data Compression” 3/e, Elsevier 2006
2. S Gravano, “Introduction to Error Control Codes”, Oxford University Press 2007
3. Amitabha Bhattacharya, “Digital Communication”, TMH 2006

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

OBE DISCUSSION			
I	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	-
CONTENT DELIVERY (THEORY)			
1	Understand the concept of information theory and coding	CO 1	T2-9.2, R1-12.5-12.6
2	Illustrate the concepts of entropy	CO 1	T2-9.5, R3-10.2
3	List and illustrate the classification of codes	CO 1	T1-13.7, R3-11.1 to 11.7
4	Understand the concept of Kraft McMillan inequality	CO 1	T2-10.7, R3-11.1-11.3
5	Understand the concept of source coding theorem.	CO 1	T1-14.5, R3-12.3 to 12.5
6	Explain the mathematical model of information,	CO 1	T1-14.7, R3-12.7 to 12.9
7	Demonstrate a logarithmic measure of information	CO 1	T2-11.5, R2-9.2
8	Explain with examples of Shannon-Fano coding, Huffman coding	CO 1	T2-12.9, R3-11.4
9	Illustrate the extended Huffman coding–Joint and conditional entropies	CO 1	T1-13.4, R3-11.6
10	Understand the concept of mutual information	CO 1	T2-10.5, R3-12.2
11	Understand the concept discrete memory less channels–BSC, BEC–Channel capacity, Shannon limit.	CO 1	T2-13.7, R3-13.1
12	Understand the concept discrete memory less channels–BSC, BEC–Channel capacity, Shannon limit.	CO 1	T2-13.7, R3-13.1
13	Definitions and Principles: Hamming weight, Hamming distance	CO 2	T1-9.5, R3-12.2
14	Definitions and Principles: Hamming weight, Hamming distance	CO 2	T1-9.5, R3-12.2
15	Illustrate the minimum distance decoding, single parity codes,	CO 2	T2-10.5, R3-12.2
16	Explain Hamming codes, repetition code	CO 2	T1-13.1, R1-8,4

17	Discuss linear block codes, cyclic codes with examples	CO 2	T2-14.4, R2-15.3-15.5
18	Expalin syndrome calculation, shortened cyclic codes	CO 2	T1-11.9, R3-18.3
19	majority logic decoding for cyclic codes	CO 2	T2-15.8, R1-10.7-10.9
20	encoder and decoder, CRC	CO 2	T1-9.5, R2-16.3
21	Understand Convolutional codes – code tree	CO 3	T2-16.9, R3-9.6
22	Understand trellis, state diagram	CO 3	T2-10.5, R3-12.2
23	Encoding Decoding: Sequential search	CO 3	T2-11.3, R3-11.9
24	Encoding Decoding: Viterbi algorithm.	CO 3	T1-13.1, R1-8.4
25	Discuss about the Principle of turbo coding	CO 4	T2-14.4, R2-15.3-15.5
26	List out the types of errors	CO 4	T1-11.9, R3-18.3
27	List and explain the error control strategies.	CO 4	T2-10.1, R2-17.3
28	Source code: Definition, techniques	CO 5	T2-15.8, R1-10.7-10.9
29	Explain Text: Adaptive Huffman coding	CO 5	T1-9.5, R2-16.3
30	Understand arithmetic coding, variable-length codes	CO 5	T2-16.2, R1-12.1 to 12.3
31	Explain LZW-algorithm –	CO 5	T2-11.5, R2-9.2
31	Understand about Audio: Linear predictive coding (LPC)	CO 5	T1-13.4, R3-11.6
32	List and expalin Perceptual coding, masking techniques	CO 5	T2-10.5, R3-12.2
33	Explain psychoacoustic model,l	CO 5	T1-9.5, R3-12.2
34	Explain MEG audio layers I,II,III,Dolby AC3	CO 5	T2-10.5, R3-12.2
35	Speech: Channel vocoder, linear predictive coding	CO 5	T2-14.4, R2-15.3-15.5
36	Understand the Image and Video Formats – GIF, TIFF, SIF, CIF, QCIF –	CO 6	T2-10.5, R3-12.2
37	Image compression: READ, JPEG	CO 6	T1-11.9, R3-18.3
38	Video Compression: Principles-I,B,P frame	CO 6	T2-10.1, R2-17.3

39	motion estimation, motion compensation	CO 6	T2-15.8, R1-10.7-10.9
40	H.261, MPEG standard, standards-based and nonstandard approaches to coding.	CO 6	T1-9.5, R2-16.3
PROBLEM SOLVING/CASE STUDIES			
41	Solve the problems on source coding theorem, mathematical model of information	CO 1	T2-16.2, R1-12.1 to 12.3
42	Solve the problems on Shannon-Fano coding, Huffman coding, extended Huffman coding	CO 1	T2-10.1, R2-17.3
43	Solve the problems on Channel performance improvement by using the BCH and RS codes	CO 1	T1-13.1, R1-8.4
44	Solve the problems on discrete memory less channels–BSC, BEC–Channel capacity, Shannon limit.	CO 1	T1-13.7, R3-11.1 to 11.7
45	Solve the problems on Hamming distance, minimum distance decoding, single parity codes	CO 2	T2-16.2, R1-12.1 to 12.3
46	Solve the problems on Hamming codes, repetition codes, linear block codes, cyclic codes	CO 2	T1:1.1-19,2.1-2.8,3.1-3.8,4.1-4.25,5.1-5.10
47	Solve the problems on majority logic decoding for cyclic codes, encoder and decoder, CRC.	CO 2	T1:7.1-7.32
48	Solve the problems on Convolutional codes – code tree, trellis, state diagram	CO 3,	T1:8.1-8.10,9.1-9.6
49	Solve the problems on Encoding Decoding: Sequential search and Viterbi algorithm.	CO 3	T1:11.1.-11.18
50	Solve the problems on error control strategies.	CO 4	T1:13.1-13.25
51	Solve the problems on Adaptive Huffman coding, arithmetic coding	CO 5	T1:13.1-13.25
52	Solve the problems on LZW algorithm	CO 5	T1:13.1-13.25
53	Solve the problems on : Linear predictive coding (LPC)	CO 5	T1:13.1-13.25
54	Solve the problems on Channel vocoder, linear predictive coding.	CO 5	T1:13.1-13.25
55	Solve the problems on motion estimation, standards-based and nonstandard approaches to coding	CO 6	T1:13.1-13.25
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Module-I: Information Theory	CO 1	T1:1.1-19,2.1-2.8,3.1-3.8,4.1-4.25,5.1-5.10
57	Module-II: Error Control Coding: Block Codes	CO 2	T1:7.1-7.32

58	Module-III: Error Control Coding: Convolutional Codes	CO 3,4	T1:8.1-8.10,9.1-9.6
59	Module-IV: Source Coding: Text, Audio and Speech	CO 5	T1:11.1.-11.18
60	Module-V: Source Coding: Image And Video	CO 6	T1:13.1-13.25
DISCUSSION OF QUESTION BANK			
61	Module-I: Information Theory	CO 1	T1:1.1-19,2.1-2.8,3.1-3.8,4.1-4.25,5.1-5.10
62	Module-II: Error Control Coding: Block Codes	CO 2	T1:7.1-7.32
63	Module-III: Error Control Coding: Convolutional Codes	CO 3,4	T1:8.1-8.10,9.1-9.6
64	Module-IV: Source Coding: Text, Audio and Speech	CO 5	T1:11.1.-11.18
65	Module-V: Source Coding: Image And Video	CO 6	T1:13.1-13.25

Signature of Course Coordinator **HOD,ECE**
Mr.Mohammad Khadir, Assistant Professor

ANNEXURE - I

KEY COMPETENCIES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	**10**

PO 4.	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**

PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project. 6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	**12**

PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043
COURSE DESCRIPTION

Department	**Electronics and Communication Engineering**				
Course Title	**Computer Architecture**				
Course Code	ACSC24				
Program	B.Tech				
Semester	VI				
Course Type	Open Elective				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mrs P. Ganga Bhavani, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECC03	III	Digital System Design

II COURSE OVERVIEW:

This course intended to provide the structure, internal working and implementation of a computer system. The fundamentals of various functional units of computer, computer instructions, addressing modes, computer arithmetic and logic unit, registers, data transfer, memory and input output system. It focuses on analysis of computer performance and functioning in modern computers.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Computer Architecture	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	x	Chalk & Talk	x	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with ”either” or ”choice” will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
50.0%	Understand
33.3%	Apply
16.6%	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	-

VI COURSE OBJECTIVES:

The students will try to learn:

I	The basic concepts of the various functional units and characteristics of computer systems.
II	The concepts of central processing unit design and perform basic operations with signed and unsigned integers in decimal and binary number systems.
III	The function of each element of a memory hierarchy and compare the different methods for computer input and output.

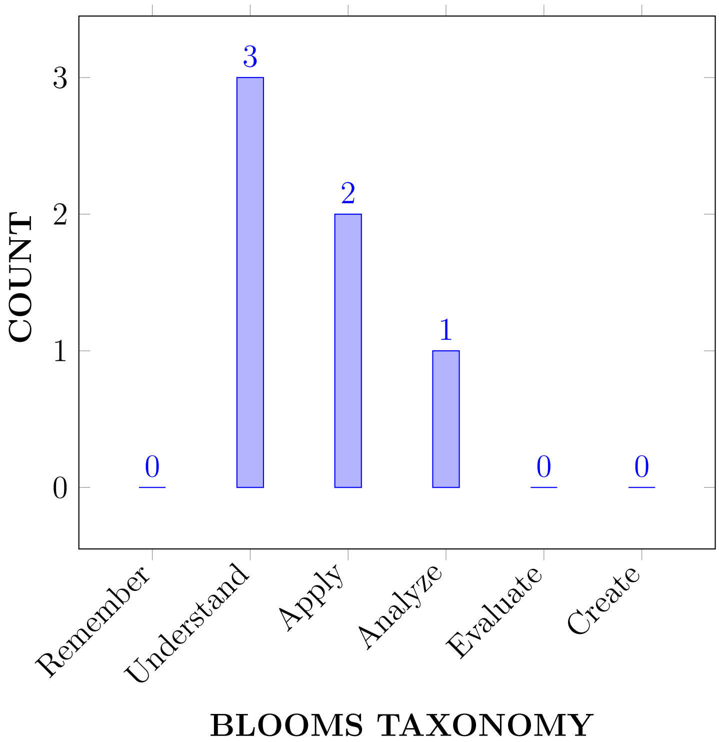
VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Illustrate** the structure, characteristics of computer systems and the various functional units for understanding the components of computers.	Understand
CO 2	**Demonstrate** the computer languages, machine, symbolic and assembly levels for understanding execution of program.	Understand

CO 3	**Make use of** the number system their representations and conversion for the usage of instructions in digital computers.	Apply
CO 4	**Summarize** the register transfer language, represent memory and Arithmetic/ Logic/ Shift operations for implementation of micro operations.	Understand
CO 5	**Identify** the basics of hardwired and micro-programmed control of the CPU which generates the control signals to fetch and execute instructions.	Apply
CO 6	**Compare** different types of addressing modes for specifying the location of an operand.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Program Outcomes	
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE / CIE / QUIZ / AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	1	SEE / CIE / QUIZ / AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	SEE / CIE / QUIZ / AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	**Build** embedded software and digital circuit development platform for robotics, embedded systems and digital signal processing applications	2	Research papers /Project
PSO 2	**Focus** on the Application Specific Integrated Circuits (ASIC) prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	–	–
PSO 3	**Make use of** High Frequency Structure Simulator (HFSS) for modeling and evaluating the patch and smart antennas for wired and wireless communication applications.	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 2	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	✓	✓	-	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 4	✓	✓	-	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 5	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 6	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUT COMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Understand the structure and characteristics of computer system (knowledge) for understanding components function of computer by applying the principles of science to engineering problems	1
	PO 10	Communicate effectively on **complex Engineering** activities with the Engineering community and with society at large.	1
CO 2	PO 1	Understand the concept (knowledge) of computer languages for execution of program.	2
	PO 10	Communicate effectively on **complex Engineering** activities with the Engineering community and with society at large.	1

CO 3	PO 1	Illustrate the arithmetic formulate (knowledge) of instructions used in digital computers by applying the principles of mathematics and science for solving complex engineering problems.	2
	PO 2	Understand the given arithmetic functions and formulate to the organization of computer using principles of mathematics and engineering science	3
	PO 10	Communicate effectively on **complex Engineering** activities with the Engineering community and with society at large.	1
	PSO1	Apply the concept of number system for obtaining of digital data to build the embedded system	1
CO 4	PO 1	Apply (knowledge) the register transfer language, bus and memory transfer characteristics for implement the micro operations by analyzing complex engineering problems using the principles of mathematics, engineering science.	2
	PO 2	Understand the register transfer language bus and memory transfer problem statement and finding the solution implementation of micro operations by analyzing complex engineering problems	2
	PO 10	Communicate effectively on **complex Engineering** activities with the Engineering community and with society at large.	1
	PSO1	Understanding the register transfer language for developing the processor in embedded technology	1
CO 5	PO 1	Illustrate characteristics of hardwired and microprogrammed control of the CPU for solving complex engineering problems generates control signals by applying mathematics, science and engineering fundamentals.	3
	PO 2	Analyze execute instruction problem statements control signals using mathematics principles.	1
	PO 10	Communicate effectively on **complex Engineering** activities with the Engineering community and with society at large.	1
CO 6	PO 1	Discuss (Understand) different types of addressing modes (knowledge) for specifying the location of an operand.	2
	PO 10	Communicate effectively on **complex Engineering** activities with the Engineering community and with society at large.	1

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	2	3	-	-	-	-	-	-	-	1	-	-	1	-	-
CO 4	2	2	-	-	-	-	-	-	-	1	-	-	1	-	-
CO 5	3	1	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	33.3	-	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 2	66.6	-	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 3	66.6	30.0	-	-	-	-	-	-	-	20	-	-	100	-	-
CO 4	66.6	20.0	-	-	-	-	-	-	-	20	-	-	100	-	-
CO 5	100	10.0	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 6	66.6	-	-	-	-	-	-	-	-	20	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation
2 - $40\ \% < C < 60\%$ –Moderate
1-5 $< C \leq 40\%$ – Low/ Slight
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	1	1	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	1	-	-	-	-	-	-	-	1	-	-	2	-	-
CO 5	3	1	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	3	-	-	-	-	-	-	-	-	1	-	-	2	-	-
TOTAL	**15**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**6**	**-**	**-**	**4**	**-**	**-**
AVERAGE	**2.5**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**2**	**-**	**-**

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	✓	Tech - Talk	-	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	-	Open Ended Experiments	-
Micro Projects	-				

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION TO COMPUTER ORGANIZATION**
	Basic computer organization, CPU organization, memory subsystem organization and interfacing, input or output subsystem organization and interfacing, simple computer levels of programming languages, assembly language instructions, and a simple instruction set architecture.
MODULE II	**ORGANIZATION OF A COMPUTER**
	Register transfer: Register transfer language, register transfer, bus and memory transfers, arithmetic micro operations, logic micro operations, and shift micro operations; Control memory.
MODULE III	**CPU AND COMPUTER ARITHMETIC**
	CPU design: Instruction cycle, data representation, memory reference instructions, input- output, and interrupt, addressing modes, data transfer and manipulation, program control. Computer arithmetic: Addition and subtraction, floating point arithmetic operations, decimal arithmetic unit.
MODULE IV	**INPUT-OUTPUT ORGANIZATION**
	Input or output organization: Input or output Interface, asynchronous data transfer, modes of transfer, priority interrupt, direct memory access.
MODULE V	**MEMORY ORGANIZATION**
	Memory organization: Memory hierarchy, main memory, auxiliary memory, associative memory, cache memory, virtual memory; Pipeline: Parallel processing, Instruction pipeline

TEXTBOOKS

1. M. Morris Mano, "Computer Systems Architecture", Pearson, 3rd Edition, 2015
2. Patterson, Hennessy, "Computer Organization and Design: The Hardware/Software Interface", Morgan Kaufmann, 5th Edition, 2013.

REFERENCE BOOKS:

1. John. P. Hayes, "Computer System Architecture", McGraw-Hill, 3rd Edition, 1998.
2. Carl Hamacher, Zvonko G Vranesic, Safwat G Zaky, "Computer Organization", McGraw- Hill, 5 th Edition, 2002.

3. William Stallings, “Computer Organization and Architecture”, Pearson Edition, 8th Edition,2010

COURSE WEB PAGE:

https://lms.iare.ac.in/index ?route=course/details& course id=137

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	https://lms.iare.ac.in/index ?route=course/details& course id_137
CONTENT DELIVERY (THEORY)			
2	Introduction to Computer Organization	CO 1	T1-3.1-3.2
3	Basic Computer Organization and Architecture	CO 1	T1-3.3-3.4
4	CPU Organization	CO 1	T1-3.3-3.4
5	Memory subsystem organization and Interfacing	CO 1	T1-3.5
6	Input or output subsystem organization and Interfacing	CO 1	T1-4.2
7	Simple computer levels of programming languages	CO 2	T1-4.4
8	Assembly language instructions	CO 2	T1-.5.1,4.5.2
9	A simple instruction set architecture	CO 2	T1-4.6
10	Register transfer language	CO 3	T1-4.7
11	Register transfer	CO 3	T1-4.10
12	Bus and memory transfers	CO 3	T1-4.10.6
13	Arithmetic micro operations	CO 3	T1-4.11
14	CPU and Computer Arithmetic	CO 3	T1-4.2
15	Instruction Cycle	CO 3	T1-5.1.1
16	Data Representation	CO 4	T1-5.1.1
17	Memory Reference Instructions	CO 4	T1-5.1.1
18	Input- Output, and Interrupt	CO 3	T1-5.2
19	Addressing Modes	CO 3	T1-5.3
20	Data transfer and Manipulation	CO 4	T1-5.3.2
21	Program Control	CO 4	T1-5.3.3,5.4
22	Computer Arithmetic	CO 4	T1-5.4.2
23	Addition and Subtraction	CO 4	T1-5.5
24	Multiplication Algorithm	CO 3	T1-5.11
25	Decimal Arithmetic unit	CO 6	T1-5.11
26	Input or Output Organization	CO 3	T1-5.11
27	Input or output Interface	CO 5	T1-7.1,7.2
28	Problems on computation of rms delay	CO 2	T1-5.3.2

29	Problems on total power in the carrier	CO 2	T1-5.1.1
30	Asynchronous data transfer	CO 5	T1-7.3,7.4
31	Modes of transfer	CO 5	T1-7.6,7.7
32	Priority interrupt	CO 5	T1-7.7.2
33	Direct memory access	CO 5	T1-7.8
34	Memory Organization	CO 5	T1-7.8.1,8.2
35	Memory hierarchy	CO 5	T1-7.10,11
36	Pipeline: Parallel processing	CO 5	T1-7.10.2-3
37	Instruction pipeline	CO 5	T1-7.10.3
38	I/O Processor	CO 6	R3-P184
39	Characteristics of Multiprocessors	CO 6	R3-P185
40	Serial Communication	CO 6	R3-P191
41	RAM and its Organization	CO 6	R3-P190
42	Reduced Instruction Set Computer	CO 6	R3-P191
PROBLEM SOLVING/ CASE STUDIES			
43	Problems on BCD Conversions	CO 1	T1-3.1-3.2
44	Problems on Multiplication Algorithms	CO 1	T1-3.1-3.2
45	Problems on Restoring Division	CO 1	T1-3.3-3.4
46	Problems on Non- Restoring Division	CO 2	T1-4.6
47	Problems on BCD Addition	CO 2	T1-4.7
48	Problems on BCD Subtraction	CO 2	T1-5.1.1
49	Problems on BCD Multiplication	CO 2	T1-4.6
50	Problems on computation of rms delay	CO 2	T1-5.3.2
51	Problems on total power in the carrier	CO 2	T1-5.1.1
52	Problems on memory organization allocation and design	CO 3	T2:19.2,16.4.4
53	Problems on Booths Algorithm	CO 3	T2:13.3.2, 13.4.
54	Problems on Booths Algorithm	CO 3	T2:13.3.2, 13.4.
55	Problems on logic gate design and operations	CO 3	T2:19.2, 14.4.4
56	Problems on K maps and logic gate operations	CO 3	T2:19.2, 18.4.4
57	Problems on memory organization allocation and design	CO 3	T2:19.2, 16.4.4
DISCUSSION ON DEFINITION AND TERMINOLOGY			
58	Introduction to Computer Organization	CO 1, CO 2	T1-3.1-3.24
59	Organization of a Computer	CO 3, CO 4	T1-5.1 to 5.16
60	CPU and Computer Arithmetic	CO 5, CO 6	T1-4.1 to 4.9
61	Input-Output Organization	CO 5, CO 6	T1-7.1 to 7.14
62	Memory Organization	CO 5, CO 6	R3

DISCUSSION ON QUESTION BANK			
63	Introduction to Computer Organization	CO 1, CO 2	T1-3.1-3.24
64	Organization of a Computer	CO 3, CO 4	T1-5.1 to 5.16
65	CPU and Computer Arithmetic	CO 5, CO 6	T1-4.1 to 4.9
66	Input-Output Organization	CO 5, CO 6	T1-7.1 to 7.14
67	Memory Organization	CO 5, CO 6	R3

Signature of Course Coordinator **HOD,ECE**

ANNEXURE

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**

	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**

	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Electronics and Communication Engineering**				
Course Title	**Digital Signal Processing**				
Course Code	AECC33				
Program	B.Tech				
Semester	VI				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Dr.S.China Venkateswarlu, Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSB11	III	Mathematical Transform Techniques
B.Tech	AECB14	IV	Signals and Systems

II COURSE OVERVIEW:

This course provides the design of discrete-time systems and analytical tools to analyze the discrete signals and systems. It focuses on the classification of discrete-time signals and systems, linear time invariant systems, discrete fourier transform, fast fourier transform algorithms, digital filter design and multi rate signal processing. Digital signal processing applications are used in speech processing,image processing, audio and video data compression, communication systems.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Digital Signal Processing	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
%	Remember
%	Understand
%	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

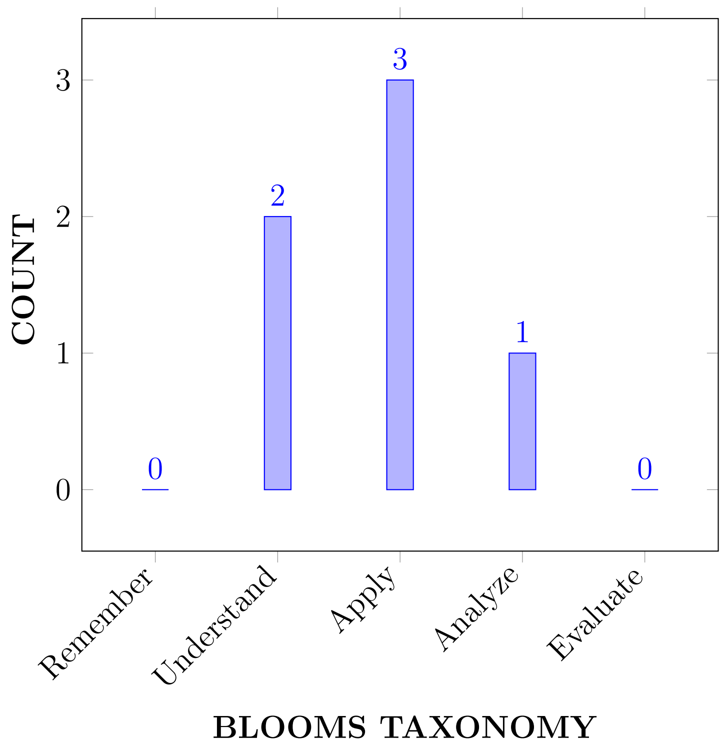
I	The classification and analysis of discrete time signals and systems in time and frequency domain tabularnewline
II	The design and realization structures of finite and infinite impulse response filters and multi rate filters
III	The implementation of digital filter algorithms using MATLAB tool..

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Illustrate** the concept of discrete time signals and systems for analysing the response of LTI system in time domain and frequency domain.	Understand
CO 2	**Construct** the Decimation-in-time fast fourier transform and decimation-in-frequency fast fourier transform for reducing computational complexity of DFT..	Apply
CO 3	**Implement** the digital filters and their realization structures using various transformation technique	Apply
CO 4	**Analyze** the performance characteristics of digital filters to meet expected system specifications using MATLAB..	Analyze
CO 5	**Interpret** the efficient implementation of sample rate conversion of digital signals to interface the digital systems with different sampling rates.	Understand
CO 6	**Identify** the errors in analog to digital conversion for tolerating finite word length effects.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/ AAT / SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	CIE/ AAT / SEE
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	CIE/ AAT / SEE
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	AAT / Projects
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations.	3	SEE / CIE
PO 10	**Communication: :** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	CIE/ AAT .

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build embedded software and digital circuit development platform for robotics, embedded systems and signal processing applications.	2	–

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	✓	-		-		-
CO 2	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 3	✓	✓	✓	✓	-	-	-	-	-	✓	-	-	✓	-	-
CO 4	✓	✓	✓	✓	✓	-	-	-	-	✓	-	-	✓		-
CO 5	✓	✓	-	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 6	✓	✓	-	-	-	-	-	-	-	✓	-	-	✓	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Explain(knowledge)** the classification and properties of discrete time signals and systems to analyze the response of linear time invariant systems(complex) in time and frequency domain by applying the fundamental concepts of **mathematical principles and engineering and science.**	3
	PO 2	**Understand** the given **problem statement and formulate (complex)** to analyze the response of LTI system in the time domain and frequency domain from provided **information and data**.	6
	PO 10	**Demonstrate** the ability to communicate effectively on discrte signals and systems.	1
CO 2	PO 1	**Apply the knowledge of mathematics, science, engineering fundamentals** to solve the fast fourier transform of discrete signals.	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	Formulate and analyze **(problem analysis) complex engineering problems** for fast fourier transform of discrete sigals using first principles of **mathematics and engineering sciencesto analyze** spectral characteristics of given signal and **validate the results** of decimation in time fast fourier transform and decimation in frequency fast fourier transform with discrete fourier transform in reaching substantiated conclusions by the **interpretation of results.**	7
	PO 3	**Understand the customer needs, use creativity and manage design process** to apply fast fourier transform algorithms for the given signal to **evaluate outcomes.**	5
	PO 10	**Demonstrate** the ability to communicate effectively on discrte fourier transform.	1
	PSO 1	**Develop** the capability to **analyze and apply FFT** on discrete signals and applications by its **mathematical models.**	1
CO 3	PO 1	**Apply the knowledge of mathematics, science, engineering fundamentals** to understand finite impulse response and infinite impulse filters.	3
	PO 2	**Understand the given problem statement and formulate** the design (complex) digital filters from the provided **information and data** in reaching substantiated conclusions by the **interpretation of results.**	7
	PO 3	**Design** IIR and FIR filters for determining magnitude and phase response **by applying the principles of mathematics, science to the solutions of complex engineering problems and design system components.**	6
	PO 4	**Design** FIR and IIR filters from the provided **information and data** in reaching substantiated conclusions by the **interpretation of results.**	5
	PO 10	**Demonstrate** the ability to communicate effectively on digital filters.	1
	PSO 1	**Apply** filter transformation methods to convert digital filters from analog filters	1
CO 4	PO 1	**Simulate** the FIR and IIR filters using MATLAB tool to analyze **performance parameters the knowledge of mathematics, science, engineering fundamentals.**	3
	PO 2	**Understand** the given **problem statement and formulate** the design (complex) digital filters from the provided **information and data** in reaching substantiated conclusions by the **interpretation of results by simulating in MATLAB.**	7

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 3	**Develop** the MATLAB program to design IIR and FIR filters for determining magnitude and phase response by applying the principles of **mathematics, science to the solutions of complex engineering problems and design system components.**	6
	PO 4	**Apply (knowledge)** MATLAB code for designing digital filers and properties corresponding context of the engineering knowledge to given signal for spectral analysis of given signal.	5
	PO 5	**Analyze** the performance parameters of IIR and FIR filters using MATLAB to meet system specifications including prediction and modeling to **complex engineering** activities with an understanding of the limitations.	1
	PO 10	**Demonstrate** the ability to communicate effectively on MATLAB programs.	1
	PSO 1	**Understand** the analog and digital filters and apply transformation formulas to convert digital filters in MATLAB tool.	1
CO 5	PO 1	**Understand** the concept of multi rate signal processing which by applying the fundamental concepts of mathematical principles and **engineering and science**	3
	PO 2	**Illustrate** multi rate signal processing which are **important for design solutions for complex engineering problems.**	5
	PO 10	**Demonstrate** the ability to communicate effectively on multi rate signal processing	1
CO 6	PO 1	**Understand (knowledge)** concept of finite word length effects which by applying the fundamental concepts of mathematical principles and **engineering and science of mathematical principles.**	3
	PO 2	**Identify** the finite word length effects **while implementing signal processing techniques(analyze complex engineering problems) on digital signal processor(engineering sciences).**	5
	PO 10	**Demonstrate** the ability to communicate effectively on multi rate signal processing	1

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	6	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	7	5	-	-	-	-	-	-	1	-	-	1	-	-

CO 3	3	7	6	5	-	-	-	-	-	1	-	-	1	-	-
CO 4	3	7	6	5	1	-	-	-	-	1	-	-	1	-	-
CO 5	3	5	-	-	-	-	-	-	-	1	-	-	1	-	-
CO 6	3	5	-	-	-	-	-	-	-	1	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	60	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 2	100	70	50	-	-	-	-	-	-	20	-	-	50	-	-
CO 3	100	70	6 0	45	-	-	-	-	-	20	-	-	50	-	-
CO 4	100	70	60	45	100	-	-	-	-	20	-		50	-	-
CO 5	100	50	-	-	-	-	-	-	-	20	-	-	50	-	-
CO 6	100	50	-	-	-	-	-	-	-	20	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -$5 < C \leq 40\%$ – Low/ Slight

2 - $40\ \% < C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	-	-	-	-	-	-	-	1	-	-	-	-	
CO 2	3	3	-	-	-	-	-	-	-	1	-	-	2	-	-
CO 3	3	3	1	-	-	-	-	-	-	1	-	-	2	-	-
CO 4	3	3	2	1	3	-	-	-	-	1	-	-	2	-	-
CO 5	3	2	2	2	-	-	-	-	-	1	-	-	2	-	-
CO 6	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
TOTAL	**18**	**14**	**5**	**3**	**3**	-	-	-	-	**6**	-	-	**8**	-	-
AVERAGE	**3**	**2.67**	**1.66**	**1.5**	**3**	-	-	-	-	**1**	-	-	**2**	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	-
Quiz	-	Tech - Talk	✓	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	✓	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY-INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**REVIEW OF DISCRETE TIME SIGNALS AND SYSTEMS:**
	Discrete time signal definition; Signal classification; Elementary signals; Transformation of elementary signals; Concept of digital frequency; Discrete time system definition; System classification; Linear time invariant (LTI) system; Properties of the LTI system; Time domain analysis of discrete time systems; Impulse response; The convolution sum; Methods of evaluating the convolution sum; Filtering using overlap-save and overlap-add method; Realization of digital filters: Concept of IIR and FIR filters; Realization structures for IIR and FIR filters using direct form-I and direct form-II, cascade, lattice and parallel.
MODULE II	**DISCRETE FOURIER TRANSFORM AND EFFICIENT COMPUTATION:**
	Introduction to discrete time Fourier transform (DTFT); Discrete Fourier transform (DFT) definition; Properties of DFT; Linear and circular convolution using DFT; Fast-Fourier-Transform (FFT): Direct computation of DFT; Need for efficient computation of the DFT (FFT algorithms); Radix-2 FFT algorithm for the computation of DFT and IDFT using decimation-in-time and decimation-in-frequency algorithms; General Radix-N FFT.
MODULE III	**STRUCUTRE OF IIR FILTERS:**
	Analog filters: Butterworth filters; Chebyshev type-1 and type-2 filters; Analog transformation of prototype LPF to HPF/BPF/BSF. Transformation of analog filters into equivalent digital filters using impulse invariant method and bilinear transform method; Matlab programs of IIR filters.
MODULE IV	**SYMMETRIC AND ANTISYMMETRIC FIR FILTERS**
	Design of linear phase FIR filters windowing and frequency sampling methods; Equiripple linear phase FIR filters; Parks-McClellan algorithm and remez algorithm; Least-mean-square error filter design; Design of FIR differentiators; Matlab programs of FIR filters; Comparison of FIR and IIR.
MODULE V	**APPLICATIONS OF DSP:**
	Multirate signal processing; Decimation; Interpolation; Polyphase structures for decimation and interpolation filters; Structures for rational sampling rate conversion; Applications of multirate signal processing for design of phase shifters, interfacing of digital systems with different sampling rates, sub band coding of speech signals. Analysis of finite word length effects: Representation of numbers; ADC quantization noise, coefficient quantization error, product quantization error, truncation and rounding errors; Limit cycle due to product round-off error; Round-off noise power; Limit cycle oscillations due to overflow in digital filters; Principle of scaling; Dead band effects.

TEXTBOOKS

1. John G. Proakis, Dimitris G. Manolakis, Digital signal processing, Principles, Algorithms and Applications, Prentice Hall, 4th Edition, 2007
2. Sanjit K Mitra, Digital signal processing, A computer base approach, McGraw-Hill Higher Education, 4th Edition, 2011.
3. Emmanuel C, Ifeacher, Barrie. W. Jervis, DSP-A Practical Approach, Pearson Education, 2nd Edition, 2002.
4. A.V. Oppenheim, R.W. Schaffer, Discrete Time Signal Processing, PHI, 2nd Edition, 2006.

REFERENCE BOOKS:

1. Li tan, Digital signal processing: fundamentals and applications, Elsevier Science and. Technology Books, 2nd Edition, 2008.
2. Robert J.schilling, Sandra. L.harris, Fundamentals of Digital signal processing using Matlab, Thomson Engineering, 2nd Edition, 2005.
3. Salivahanan, Vallavaraj, Gnanapriya, Digital signal processing‖, McGraw-Hill Higher Education, 2nd Edition, 2009.

WEB REFERENCES:

1.https://lms.iare.ac.in/index?route=course/details&course_id=128
2. https://nptel.ac.in/courses/117/102/117102060/

COURSE WEB PAGE:

https://lms.iare.ac.in/index?route=course/details&course_id=128

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping.	-	-
CONTENT DELIVERY (THEORY)			
2	Introduction to DSP	CO 1	T1:2.1-2.2
3	Discrete time signal definition; Elementary signals; Signal classification	CO 1	T1:2.1-2.2
4	Transformation of elementary signals;	CO 1	T1:2.1-2.2
5	Discrete time system definition; System classification;	CO 1	T1:2.3-2.4
6	Linear time invariant (LTI) system; Properties of the LTI system;Impulse response;	CO 1	T1:2.3-2.4
7	Time domain analysis of discrete time systems;	CO 1	T1: 2.3.3
8	The convolution sum; Methods of evaluating the convolution sum;	CO 2	T1: 2.3.4
9	Filtering using overlap-save method	CO 1	T1: 2.3.4
10	Filtering using overlap-add method	CO 1	T1: 2.3.4

11	Realization of digital filters: Concept of IIR and FIR filters;	CO 3	T1: 9.2-9.3
12	Realization structures for IIR and FIR filters using direct form-I and direct form-II.	CO 3	T1: 9.2-9.3
13	Realization structures for IIR and FIR filters using cascade, lattice and parallel.	CO 3	T1: 7.1
14	Introduction to DTFT,DFT	CO 2	T1: 7.3
15	Properties of DFT	CO 2	T1: 7.3
16	Linear and circular convolution using DFT	CO 2	T1: 8.1
17	Fast-Fourier-transform (FFT): Direct computation of DFT	CO 2	T1: 8.1
18	DIT FFT Algorithm	CO 2	T1: 8.2
19	DIF FFT Algorithm	CO 2	T1: 10.3
20	IDFT using decimation-in-time and decimation-in-frequency algorithms; General Radix-N FFT.	CO 2	T1: 10.3
21	Introduction to digital filters	CO 3	T1: 10.3
22	Analog filters: Butterworth filters	CO 3	T1: 10.3
23	Design Chebyshev type-1 and type-2 filters;	CO 3	T1: 10.3
24	Analog transformation of prototype LPF to HPF/BPF/BSF.	CO 3	T1: 10.2
25	Transformation of analog filters into equivalent digital filters using impulse invariant method	CO 3	T1: 10.2
26	Bilinear transform method	CO 3	T1: 10.2
27	Matlab programs of IIR filters.	CO 4	T1: 10.2
28	Linear phase FIR filters	CO 3	T1: 10.2
29	Symmetric and asymmetric FIR filters	CO 3	T1: 10.2
30	Design of linear phase FIR filters using windowing method	CO 3	T1: 10.2
31	Design of linear phase FIR filters using Frequency sampling method	CO 3	T1: 10.2
32	Equiripple linear phase FIR filters	CO 3	T1: 10.2
33	Parks-McClellan algorithm and remez algorithm;	CO 3	T3:6.6
34	Least-mean-square error filter design	CO 3	T1: 11.1-11.3
35	Design of FIR differentiators	CO 3	T1: 11.1-11.3
36	Matlab programs of FIR filters; Comparison of FIR and IIR.	CO 4	T1: 11.6
37	Multirate signal processing; Decimation; Interpolation	CO 5	T1: 11.6
38	Polyphase structures for decimation and interpolation filters	CO 5	T1: 11.6
39	Structures for rational sampling rate conversion	CO 5	T1: 11.6
40	Applications of multirate signal processing for design of phase shifters	CO 5	T1: 11.6
41	Interfacing of digital systems with different sampling rates Sub band coding of speech signals	CO 5	T1: 11.6

42	Analysis of finite word length effects: Representation of numbers; ADC quantization noise	CO 6	T1: 11.7
43	coefficient quantization error, product quantization error, truncation and rounding errors	CO 6	T1: 11.7
44	Limit cycle due to product round-off error; Round-off noise power	CO 6	T1: 11.7
45	Limit cycle oscillations due to overflow in digital filters; Principle of scaling; Dead band effects.	CO 6	T1: 11.7
PROBLEM SOLVING/ CASE STUDIES			
1	Operation on signals, System characteristics	CO 1	T2:1.12
2	Time domain analysis of discrete time systems	CO 1	T1:1.2
3	Linear convolution and circular convolution	CO 1	T1:3.2
4	Overlap add method,Overlap save method	CO 1	T1:3.2
5	Realization structures of digital filters direct form I and II	CO 3	T1: 9.2-9.3
6	Realization structures of digital filters cascade and paralle form	CO 3	T1: 9.2-9.3
7	DFT Properties problems	CO 2	T1: 8.1
8	DIT FFT	CO 2	T1: 8.1
9	DIF FFT	CO 2	T1: 8.1
10	IIR Filters-butterworth filters	CO 3	T1: 10.3
11	IIR Filters- Chebyshev type-1 filters	CO 36	T1: 10.3
12	Impulse invariant method and bilinear transformation	CO 3	T1: 10.3
13	FIR filters -windowing method	CO 3	T1: 10.2
14	FIR filters -frequency sampling method	CO 3	T1: 10.2
15	Finite word length effects	CO 6	T1: 9.4-9.5, T1:9.6
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	System characteristics, impulse response	CO 1	T2:1.12
2	DFT and FFT	CO 2	T1: 7.2, T1: 8.1
3	IIR and FIR filters	CO 3	T1: 10.2, T1: 10.3
4	Multi rate signal processing	CO 5	T1: 11.6
5	Finite word length effects	CO 6	T1: 9.4-9.5, T1:9.6

DISCUSSION OF QUESTION BANK			
1	System characteristics,Time domain analysis,convolution sum	CO1, CO2	T1:1.12
2	Realization structures	CO 3	T1: 9.2-9.3
3	DFT and FFT	CO 2	T1: 8.1
4	IIR and FIR filters	CO 3	T1: 10.3, T1: 10.2
5	Multirate signal processing	CO 5, CO6	T1: 9.4-9.5,

Signature of Course Coordinator **HOD,ECE**

Dr. S China Venkateswarlu, Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	**10**

PO 4.	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**

PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project. 6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	**12**
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**

PO11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Electronics and Communication l Engineering**				
Course Title	**Business Economics and Financial Analysis**				
Course Code	AHSC13				
Program	B.Tech				
Semester	VI				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr. K Jagannayaki, Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

II COURSE OVERVIEW:

The present course is designed in such a way that it gives an overview of concepts of Economics. Managerial Economics enables students to understand micro environment in which markets operate how price determination is done under different kinds of competitions. Financial Analysis gives clear idea about concepts, conventions and accounting procedures along with introducing students to fundamentals of ratio analysis and interpretation of financial statements. Break Even Analysis is very helpful to the Business Concern for Decision Making, controlling and forward Strategic Planning. Ratio analysis gives an idea about financial forecasting, financial planning, controlling the business and decision making.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
BEFA	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	✓	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
16.67%	Remember
16.67%	Understand
16.67%	Apply
50 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

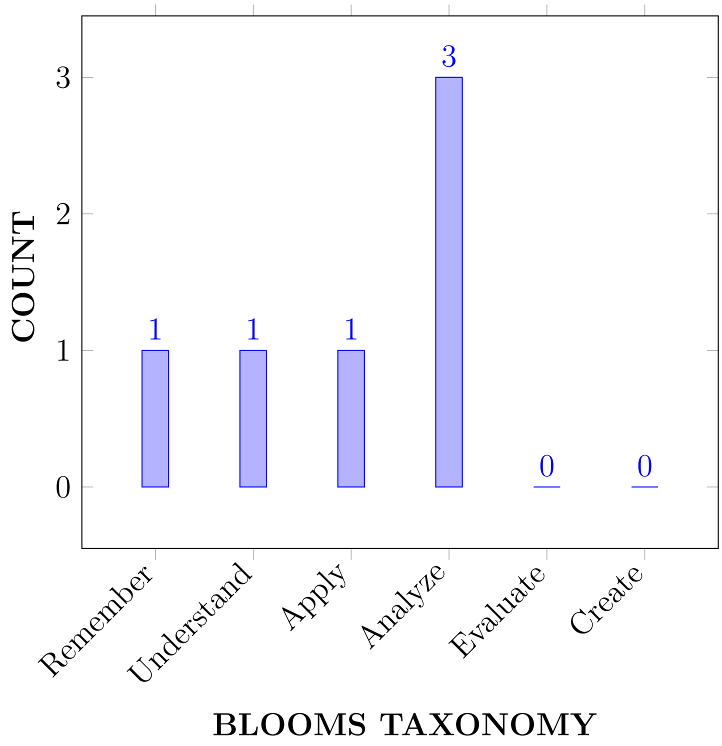
I	The concepts of business economics and demand analysis helps in optimal decision making in business environment
II	The functional relationship between Production and factors of production and able to compute breakeven point to illustrate the various uses of breakeven analysis.
III	The features, merits and demerits of different forms of business organizations existing in the modern business environment and market structures.
IV	The concept of capital budgeting and allocations of the resources through capital budgeting methods and compute simple problems for project management.
V	Various accounting concepts and different types of financial ratios for knowing financial positions of business concern.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**List** the basic concepts of managerial economics and analysis, measurement of demand and its forecasting to know the current status of goods and services.	Remember
CO 2	**Examine** to know the current status of goods and services. to know the economies and diseconomies of scale in manufacturing sector.	Analyze
CO 3	**Summarize** the four basic market models like perfect competition, monopoly, monopolistic competition, and oligopoly to know the price and quantity are determined in each model.	Understand
CO 4	**Compare** various types of business organizations and discuss their implications for resource allocation to strengthen the market environment.	Analyze
CO 5	**Analyze** different project proposals by applying capital budgeting techniques to interpret the solutions for real time problems in various business projects.	Analyze
CO 6	**Develop** the ability to use a basic accounting system along with the application of ratios to create (record, classify, and summarize) the data needed to know the financial position of the organization.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Program Outcomes	
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/Quiz/AAT
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice	1	Seminar/ Conferences
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	3	Assignments/ Discussion
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	3	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build embedded software and digital circuit development platform for robotics, embedded systems and signal processing applications.	-	-
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	-	-
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications..	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	✓	✓	-	✓	-	-	-	-
CO 2	✓	✓	-	-	-	-	-	✓	✓	-	✓	-	-	-	-
CO 3	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
CO 5	✓	-	-	-	-	-	-	-	-	-	✓	-	-	-	-
CO 6	-	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Recall** (knowledge) the scientific fundamentals of economic activities performed by the businessmen in the business for profit earning.	2
	PO 2	**Interpret** and identify the demand and its analysis with the mathematical and natural principles of demand forecasting methods.	6
	PO 8	**Define** (knowledge) the responsibilities of the engineering practices by knowing the best economical practices.	1
	PO 9	**Match** (knowledge) the economical implication to effectively function as a team member, and as a member or leader in diverse teams.	5

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 11	**Relate** (knowledge) the knowledge and understanding of the economic principles and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	6
CO 2	PO 1	**Recall** (Knowledge) the knowledge of mathematics, science in the production function through Different Combination of variable inputs with Economies of Scale.	2
	PO 2	**Demonstrate** the different cost concepts and determine the significance of Break Even Analysis.	5
	PO 8	**Relate** (Knowledge) (Knowledge) the ethical principles and commit to professional ethics and responsibilities and norms of the production management	2
	PO 9	**Show** (Fundamentals) the production function implications for effective implementation of gang compositions in a team work and in multidisciplinary settings.	6
	PO 11	**Define** the economies of scale in production function and Break Even Analysis knowledge applied in one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	5
CO 3	PO 8	**List** (Knowledge) (Knowledge) different structures of market and how price is determined under different market structures commit to professional ethics and responsibilities and norms of the engineering practice.	2
	PO 9	**Match** the market structures and the market entry strategies as an individual, and as a member in diverse teams.	6
CO 4	PO 8	**Categorize** the ethical principles and commit to professional ethics and responsibilities belongs to different forms of business organizations existing in the modern business.	2
	PO 9	**Classify** various business organizations and their functioning as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	6
CO 5	PO 1	**Explain** the ethical issues involved in the allocation of funds under the concept of capital budgeting.	1
	PO 11	**Summarize** the concept of capital budgeting and allocations of the resources through capital budgeting methods of the management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	8
CO 6	PO 2	**Explain** the GAAP principles and ratios to analyse complex engineering problems reaching substantiated conclusions using first principles of accounts and profitability and efficiency of the organization.	6

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 11	**Illustrate**the accounting methods and procedures and accounting principles to manage the financial aspects in a project.	8

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	6	-	-	-	-	-	1	5	-	6	-	-	-	-
CO 2	2	5	-	-	-	-	-	2	6	-	5	-	-	-	-
CO 3	-	-	-	-	-	-	-	2	6	-	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	2	6	-	-	-	-	-	-
CO 5	1	-	-	-	-	-	-	-	-	-	8	-	-	-	-
CO 6	-	2	-	-	-	-	-	-	-	-	8	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	66.7	60.0	-	-	-	-	-	33.3	41.6	-	50.0	-	-	-	-
CO 2	66.7	50.0	-	-	-	-	-	66.7	50.0	-	41.6	-	-	-	-
CO 3	-	-	-	-	-	-	-	66.7	50.0	-	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	66.7	50.0	-	-	-	-	-	-
CO 5	33.3	-	-	-	-	-	-	-	-	-	75.0	-	-	-	-
CO 6	-	20.0	-	-	-	-	-	-	-	-	75.0	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -$5 < C \leq 40\%$ – Low/ Slight

2 - $40\% < C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	-	-	-	-	-	1	2	-	2	-	-	-	-
CO 2	3	2	-	-	-	-	-	3	2	-	2	-	-	-	-
CO 3	-	-	-	-	-	-	-	3	2	-	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	3	2	-	-	-	-	-	-
CO 5	1	-	-	-	-	-	-	-	-	-	3	-	-	-	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 6	-	1	-	-	-	-	-	-	-	-	3	-	-	-	-
TOTAL	7	7	-	-	-	-	-	10	8	-	-	-	-	-	-
AVERAGE	2.3	2.3	-	-	-	-	-	2.5	2	-	2.5	-	-	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	✓
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	✓				

XVII ASSESSMENT METHODOLOGY-INDIRECT:

X	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**INTRODUCTION&DEMAND ANALYSIS**
	Introduction to Business Economics: Definition, Nature and Scope of Managerial Economics – Demand Analysis: Demand Determinants, Law of Demand and its exceptions. Elasticity of Demand: Definition, Types, Measurement and Significance of Elasticity of Demand. Demand Forecasting, Factors governing demand forecasting, methods of demand forecasting
MODULE II	**PRODUCTION & COST ANALYSIS**
	Theory of Production and Cost Analysis: Production Function – Iso-quants and Iso-costs, MRTS, Least Cost Combination of Inputs, Cobb-Douglas Production function, Laws of Returns, Internal and External Economies of Scale. Cost Analysis: Cost concepts; Break-even analysis, Determination of Break – Even point (Simple Problems) , Managerial Significance of BEA.
MODULE III	**MARKETS & NEW ECONOMIC ENVIRONMENT**
	LMarket structures: Types of competition, Features of perfect competition, Monopoly and monopolistic competition. Price determination & Price Statistics: Price Output determination in case of perfect competition and monopoly. Features and evaluation of different forms of Business organization: Sole proprietorship, partnership, Joint Stock Company, public enterprises and their types.
MODULE IV	**CAPITAL BUDGETING**
	Capital and its significance, types of capital, estimation of fixed and working capital requirements, methods and sources of raising capital- Trading Forecast, Capital budget, Cash Budget. Features of capital budgeting proposals, methods of capital budgeting – payback method, Accounting rate of return(ARR), Net Present Value Method (simple problems).

MODULE V	**INTRODUCTION TO FINANCIAL ACCOUNTING AND FINANCIAL ANALYSIS**
	Financial accounting objectives, functions, importance; Accounting concepts and accounting conventions - double-entry book keeping, journal, ledger, trial balance; Final accounts: Trading account, profit and loss account and balance sheet with simple adjustments; Financial analysis: Analysis and interpretation of liquidity ratios, activity ratios, capital structure ratios and profitability ratios (simple problems), Du Pont chart.

TEXTBOOKS

1. Aryasri, “Managerial Economics and Financial Analysis”, TMH publications, 4thEdition,2012.
2. M. KasiReddy, Saraswathi, “Managerial Economics and Financial Analysis”, PHI Publications, New Delhi, 2ndEdition,2012.
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1. D.N. Dwivedi, “Managerial Economics”, Vikas Publication House Pvt.Ltd, 2ndEdition,2012.
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10. https://caknowledge.com/how-to-prepare-final-accounts/
11. https://corporatefinanceinstitute.com/resources/knowledge/finance/ratio-analysis/

COURSE WEB PAGE:

https://lms.iare.ac.in/index?route=publicprofile&id=5201

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Discussion on Course Outcomes and how these COs mapped with POs and PSOs.		
CONTENT DELIVERY (THEORY)			
2	Concept of managerial economics according to the business	CO 1	T1- 1.3-1.8 R1-1.5-1.7
3	Nature and scope of business economics.	CO 1	T1- 1.3-1.8 R1-1.5-1.7
4	Meaning of demand analysis, Demand determinants and demand Function.	CO 1	T1-2.2-2.11 R1-3.3-3.20
5	Law of Demand and Exceptions of Law of Demand.	CO 1	T1-2.2-2.11 R1-3.3-3.20
6	Understand elasticity of the demand of the product and different types of Elasticity of Demand.	CO 1	T1-3.3-3.20 R1- 5.29-6.8
7	Measurement of Elasticity of Demand and Factors influencing on Elasticity of Demand.	CO 1	T1-3.3-3.20 R1- 5.29-6.8
8	State different methods of Demand Forecasting and the factors governing Demand Forecasting.	CO 1	T1-4.6-4.19
9	Demonstrate the Production function, features of Iso-Quants and Iso-Costs.	CO 2	T1- 5.3-5.18 R1- 5.29-6.8
10	Cobb-Dougles production function.	CO 2	T1- 5.3-5.18 R1- 5.29-6.8
11	Economies of Scale and Types of Economes of Scale.	CO 2	T1- 5.3-5.18
12	External and Internal Economies with appropriate examples.	CO 2	T1- 5.3-5.18
13	Advantages and Disadvantages of Economies.	CO 2	T1- 5.3-5.18
14	Illustrate different types of costs	CO 2	T1- 5.29-6.8
15	Marginal cost equation	CO 2	T1- 5.29-6.8
16	Explain the Significance and Limitations of Break-Even Analysis	CO 2	T1- 7.13-7.14
17	Profit-Volume Ratio	CO 2	T1- 7.13-7.14
18	Calculate Break-Even Point (Simple Problems)	CO 2	T1- 7.1-7.12
19	Calculate Margin of safety and P/E Ratio (Simple Problems)	CO 2	T1- 7.1-7.12
20	Illustrate the features, price-output determination under Perfect Competition.	CO 3	T1- 8.4-8.16 R2- 5.29-6.8
21	Monopoly and Monopolistic competition Markets.	CO 3	T1- 8.4-8.16 R2- 5.29-6.8
22	Demonstrate the price-output determination under perfect competition.	CO 3	T1- 8.21-8.25
23	Price-output determination under monopoly business.	CO 3	T1- 8.21-8.25
24	Illustrate the concept of Oligopoly and Duopoly with suitable examples.	CO 3	T1- 8.21-8.25
25	Describe Features of business, Definitions of Various forms of Business Units.	CO 4	T1-9.3-9.15

26	Features of Partnership and types of partners.	CO 4	T1-9.3-9.15
27	State the Merits & Demerits of Sole Proprietorship.	CO 4	T1-9.2-10.23 R1- 8.21-8.25
28	Features of Joint Stock Company.	CO 4	T1-9.2-10.23 R1- 8.21-8.25
29	Importance of Cooperative societies .	CO 4	T1-9.2-10.23 R1- 8.21-8.25
30	Significance and types of Capital.	CO 5	T1-9.2-10.23 R1- 8.21-8.25
31	Methods and Sources of Raising Finance.	CO 5	T1-9.2-10.23
32	Estimation of fixed and working capital requirements.	CO 5	T1-9.2-10.23
33	Demonstrate the concept of capital budgeting and allocations of the resources through capital budgeting methods.	CO 5	T1-11.3-11.5 R2-12.3-12.5
34	Illustrate the Significance of Financial Accounting, Double Entry book keeping.	CO 6	T1-11.3-11.5 R2-12.3-12.5
35	Accounting Concepts and Conventions	CO 6	T1-12.1-12.26
36	Journal Entries of business transactions	CO 6	T1-12.1-12.26
37	Ledger posting	CO 6	T1-12.1-12.26
38	Explain the meaning, advantages and Limitations of Trial Balance and Final Accounts and Solve simple Problems.	CO 6	T1-13.4-13.15 R2-11.3-11.5
39	Describe Meaning, Definitions and Limitations of Ratio Analysis .	CO 6	T1-13.4-13.15 R2-11.3-11.5
40	Compute different types of Financial Ratios (Problems) .	CO 6	T1-13.4-13.15 R2-11.3-11.5
PROBLEM SOLVING/ CASE STUDIES			
41	Problems relating to Demand elasticty measurement and Forecasting	CO 1	T1: 1.1 - 2.8, R1:2.1
42	Problems relation to Break Even Point	CO 2	T2: 3.0 to 3.6, 5.0 to5.5 , R2:4.4
43	Problems in determining the price in different types of markets	CO 3,4	T3: 6.0 to 6.4, R1:5.1
44	Problems relating to Pay back period	CO 5	R2:7.5
45	Problems relating to Accounting Rate of Return	CO 5	R2:7.5
46	Problems relating to Net Present Value	CO 5	R2:7.5
47	Problems relating to Internal Rate of Return	CO 5	R2:7.5
48	Problems relating to Profitability Index	CO 5	R2:7.5
49	Problems relating to Journal Entries	CO 6	R3: 4.1
50	Problems relating to Ledger posting	CO 6	R3: 4.1
51	Problems relating to Trial Balance	CO 6	R3: 4.1
52	Problems relating to P& L Account	CO 6	R3: 4.1
53	Problems relating to Balance Sheet	CO 6	R3: 4.1
54	Problems relating to Profitability Ratios	CO 6	R3: 4.1
55	Problems relating to Liquidity Ratios	CO 6	R3: 4.1

DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Demand Forecasting	CO 1	T1: 1.1 - 2.8, R1:2.1
57	Production and Cost Analysis	CO 2	T2: 3.0 to 3.6, 5.0 to5.5 , R2:4.4
58	Markets and New Environment	CO 3,4	T3: 6.0 to 6.4, R1:5.1
59	Capital Budgeting	CO 5	R2:7.5
60	Introduciton to Financial Accounting and Financial Analysis	CO 6	R3: 4.1
DISCUSSION OF QUESTION BANK			
61	Introduction and Demand Analysis	CO 1	T1: 1.1 - 2.8, R1:2.1
62	Production and Cost Analysis	CO 2	T2: 3.0 to 3.6, 5.0 to5.5 , R2:4.4
63	Markets and New Environment	CO 3,4	T3: 6.0 to 6.4, R1:5.1
64	Capital Budgeting	CO 5	R2:7.5
65	Introduciton to Financial Accounting and Financial Analysis	CO 6	R3: 4.1

Signature of Course Coordinator **HOD,MBA**
Dr. K Jagannayaki, Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Course Title	**INTELLECTUAL PROPERTY RIGHTS**				
Course Code	AHSC19				
Program	B.Tech				
Semester	VI	ECE			
Course Type	Open Elective				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr. B Ravi Kumar, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	-	-	-

II COURSE OVERVIEW:

This course provides the trade related intellectual property rights and investment measures. This course emphesis on how to avail the intellectual property rights of the inventors or owners for their assets like patents on innovative design, copy rights on literary and artistic works, trademark on goods & services and geographical indiactions on products famous for specific geographical areas.This course makes use of the potential future economic benefits to the intellectual property owner or authorized user.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Intellectual Property Rights	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with ”either” or ”choice” will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
85 %	Understand
15 %	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Component	Theory			Total Marks
Type of Assessment	CIE Exam	Quiz	AAT	
CIA Marks	20	-	10	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz - Online Examination
Two Quiz exams shall be online examination consisting of 50 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	-

VI COURSE OBJECTIVES:

The students will try to learn:

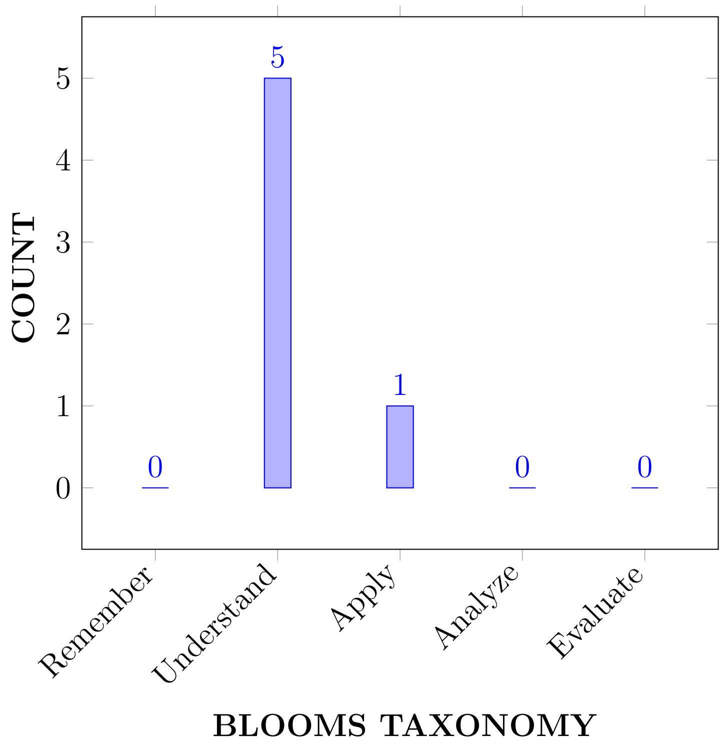
I	The knowledge on world trade organization, trade agreements and investments.
II	The importance of intellectual property rights to develop trade mark law, copy right law and patent law.
III	The new developments in the law of intellectual property rights in order to bring progressive changes towards a free market society and international trade practices under the Trade Related Intellectual Property Rights Agreement (TRIPS)

VII COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Summerize** the general agreement on tariffs and trade (GATT) eight rounds for the substantial reduction of tariffs and other barriers of trade.	Understand
CO 2	**Relate** the world trade organization agreements for trade related intellectual property rights and investments.	Understand
CO 3	**Elaborate** the involvement of World Intellectual Property Organization to promote the protection of intellectual property throughout the world.	Understand
CO 4	**Demonstrate** the legal procedure and document for claiming patent of invention.	Understand
CO 5	**Illustrate** the different geographical Indications of products which corresponding to specific location for aviling brand of location to products .	Understand
CO 6	**Identify** different types of intellectual properties,the right of ownership,scope of protection to create and extract value from IP.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Program Outcomes	
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 6	**The engineer and society:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/Quiz/AAT

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	3	Seminar
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear.	2	Seminar
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	1	Seminar

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	**Build** Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	-	-
PSO 2	**Focus** on the Application Specific Integrated Circuit (ASIC) prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	-	-
PSO 3	**Make use of** High Frequency Structure Simulator (HFSS) for modeling and evaluating the patch and smart antennas for wired and wireless communication applications.	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 2	-	-	-	-	-	✓	-	-	-	✓	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	✓	-	✓	-	-	-	-	-
CO 4	-	-	-	-	-	✓	-	✓	-	✓	-	✓	-	-	-
CO 5	✓	-	-	-	-	-	-	✓	-	✓	-	✓	-	-	-
CO 6	✓	-	-	-	-	✓	-	✓	-	✓	-	✓	-	-	

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Identify** different types of Intellectual Properties (IPs), the right of ownership in **scientific principles and methodolgy** , scope of protection as well as the ways to create and to extract value from IP	1
	PO 10	**Describe** the intellectual property rights of ownership and **communicate effectivly(speaking style)** in concept video or tech talk	1
CO 2	PO 6	**Explain** WTO agreements helpful for **engineering activities to promot sustainable development** and **legal requirements** in new product and service development.	2
	PO 10	**Describe** the importance of WTO agreements for trade related intellectual property rights **communicate effectively(speaking style)** in tech-talk	1
CO 3	PO 8	**Demonstrate the ethical behaviour** and **responsibilities** of world intellectual property organization and its **degree of trust and integrity** to protect intellectual property rights of the owner	3
	PO 10	**Describe** the support of WIPO in connection with intellectual property rights and **communicate effectivly(speaking style)** in tech-talk	1
CO 4	PO 6	**Explore the knowledge and understanding of commercial** management of IP and **identify the highlevel of professional conduct** of intellectual property management for claiming patent of invention	2
	PO 8	**Explain** how to prepare the **ethical** document for patent of invention by following **legal belief** and **high degree of trust and integrity**	3
	PO 10	**Describe** the steps involved in patent filing in india namely drafting, filing the patent application**(writing)** and **communicate effectivly(speaking style)** in concept video and tech-talk.	2
	PO 12	**Understand** the need of **advanced engineering concepts** interms of **ongoing learning** which is suitable to intellectual work.	2
CO 5	PO 1	**Explore** on the **engineering scientific principles** and **mathematical principles** which are helpful for availing geographical indication and procedure for applying geographical indications of products of specific locations	2
	PO 8	**Extend** on various IPR components to **make ethical production** and process of filing a document for geographical indication by following **professional ethics** and **integrity of resourse of region** .	3
	PO 10	**Describe** the geographical indiaction for famous products in a given location and **communicate effectively(speaking style)** in tech-talk.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 12	**Understand** the need of **advanced engineering concepts** interms of **ongoing learning** which is suitable to get permission for geographical indication of products.	2
CO 6	**PO 1**	**Explore** the **engineering knowledge** which is useful for preparing the trademark and then **apply methodology** for trade mark based on trademark and merchandise act 1958 which prevents misuse of marks.	2
	PO 6	**Illustrate** international copyright law with respect to ownership and registration of copyright by following the awareness of **legal requirements**. Understand the **professional and ethical conduct** to get copy right for literary and artistic works	2
	PO 8	**Summarize** the trade mark and trade secrets **with knowledge of professional ethics** and **integrity** protection before submitting application to trademark office. **Demonstrate the ethical behaviour**of stoping illegal trademark	3
	PO 10	**Describe** the IPR to get trademark for unique marks and copy right**(for literature writing)** for new artistic works and and **communicate effectively(speaking style)** in tech-talk.	2
	PO 12	**Analyze** the the **project mangement** for international developments in trademarks law , copyright law and patent law. **Significant skills** are applied to get intellectual property rights.	2

Note: For Key Attributes refer **Annexure - I**

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	-	-	-	-	-	2	-	-	-	1	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	3	-	1	-	-	-	-	-
CO 4	-	-	-	-	-	2	-	3	-	2	-	2	-	-	-
CO 5	2	-	-	-	-	-	-	3	-	2	-	2	-	-	-
CO 6	2	-	-	-	-	2	-	3	-	2	-	2	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	33.3	-	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 2	-	-	-	-	-	40	-	-	-	20	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	100	-	20	-	-	-	-	-
CO 4	-	-	-	-	-	40	-	100	-	40	-	25	-	-	-
CO 5	66.7	-	-	-	-	-	-	100	-	40	-	25	-	-	-
CO 6	66.7	-	-	-	-	40	-	100	-	40	-	25	-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq$ C$\leq$ 5% – No correlation
1 -5 <C$\leq$ 40% – Low/ Slight
2 - 40 % <C < 60% –Moderate
3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	-	-	-	-	-	2	-	-	-	1	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	3	-	1	-	-	-	-	-
CO 4	-	-	-	-	-	2	-	3	-	2	-	1	-	-	-
CO 5	3	-	-	-	-	-	-	3	-	2	-	1	-	-	-
CO 6	3	-	-	-	-	2	-	3	-	2	-	1	-	-	-
Total	7	-	-	-	-	6	-	12	-	9	-	3	-	-	-
Average	**2.3**	-	-	-	-	**2**	-	**3**	-	**1.5**	-	**1**	-	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments					

XVII ASSESSMENT METHODOLOGY-INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of mini projects by experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION**
	General agreement on tariffs and trade (GATT) eight rounds: Uruguay round, world trade organization: structure, technology transfer, dispute resolution mechanism, Doha declaration world trade organization agreements including trade related intellectual properties rights and trade related investment measures.
MODULE II	**WORLD INTELLECTUAL PROPERTY ORGANIZATION**
	Paris convention, Bern convention, Budapest treaty, Madrid agreement, hague agreement.
MODULE III	**INTELLECTUAL PROPERTY RIGHTS AND PROTECTIONS**
	Patents, the patenting process, patent cooperation treaties: International treaties and conventions on IPRs. Patent act of India, patent amendment act, design act, trademark act, and geographical indication act. Digital innovations and developments as knowledge assets – IP laws, cyber law and digital content protection.
MODULE IV	**ROLL OF PATENTS AND GEOGRAPHICAL INDICATIONS**
	Patents, patentable and non-patentable inventions. Legal requirements for patents, types of patent applications, patent document: specification and claims, important procedural aspects. Geographical indication: definition, what can be registered, who can apply, rights, term, restrictions. Case studies of patent infringement, design and geographical indications.
MODULE V	**TRADEMARK AND COPYRIGHTS**
	Definition, classification of trademarks, classifications of goods and services, Vienna classification, trademarks procedure, trademarks enforcement: infringement and passing off, remedies, copyrights, term of copyrights, and procedure of copyright assignment of copyright, copyright infringement remedies. Case studies of trademark and copy rights.

TEXTBOOKS

1. P. K. Vasudeva,World Trade Organization: Implications on Indian Economy, Pearson Education,2015.
2. P.KrishnaRao, WTO, Text and cases, Excel Books, 2015.
3. Carlos M.Correa- Intellectual property rights, The WTO and Developing countries-Zed books

REFERENCE BOOKS:

1. Yuan S W, “Foundations of fluid Mechanics”, Prentice-Hall, 2nd Edition, 1987.

WEB REFERENCES:

1. Caves, Frankel, Jones, World Trade and Payments-An Introduction, Pearson4. Education, 2015.
2. Carlos M.Correa- Intellectual property rights, The WTO and Developing countries-Zed books.
3. Peter-Tobias stoll, Jan busche, Katrianarend- WTO- Trade –related aspects of IPR-Library of Congress

COURSE WEB PAGE:

https://lms.iare.ac.in/index?route=course/details&course_id=367

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping		
CONTENT DELIVERY (THEORY)			
1	General agreement on tariffs and trade (GATT) eight rounds	CO 1	T1:1.4-1.5
2	Uruguay round	CO 1	T1:1.4-1.5
3	World trade organization: structure	CO 1	T1:2.4-2.5
4	Technology transfer	CO 1	T1:2.4-2.5
5	Dispute resolution mechanism	CO 1	T1:2.4-2.5
6	Doha declaration	CO 2	T1:2.6-2.6.8; R2: 5.8-5.10
7	world trade organization agreements	CO 2	T1:2.6-2.6.8; R2: 5.8-5.10
8	Trade related intellectual properties rights	CO 2	T1:3.1-3.6
9	Paris convention	CO 2	T1:3.1-3.6
10	Bern convention	CO 2	T1:3.1-3.6
11	Budapest treaty	CO 2	T1:3.1-3.6
12	Madrid agreement	CO 3	T1:3.1-3.6
13	Hague agreement	CO 3	T1:3.1-3.6
14	Historical background of intellectual property rights	CO 3	T1:3.1-3.8
15	introduction, definition and classification of intellectual property	CO 3	T1:3.1-3.8
16	Patents, patentable and non-patentable inventions	CO 3	T1:3.1-3.8
17	Legal requirements for patents	CO 3	T1:3.1-3.8; R2: 7.4-7.5
18	Types of patent applications	CO 3	T1:3.1-3.8; R2: 7.4-7.5

19	patent document: specification and claims	CO 3	T1:3.1-3.8; R2: 7.4-7.5
20	important procedural aspects	CO 3	T1:3.1-3.8; R2: 7.4-7.5
21	management of intellectual property rights assets	CO 4	T1:4.1-4.6
22	intellectual property portfolio	CO 4	T1:4.1-4.6
23	Commercial exploitation of intellectual property	CO 4	T1:4.1-4.6
24	Designs: basic requirements	CO 4	T1:4.1-4.6
25	Designs: Procedure	CO 4	T1:4.1-4.6
26	Designs: Convention application term, date	CO 5	T1:10.1-10.6
27	Geographical indication: definition	CO 5	T1:10.1-10.6
28	What can be registered	CO 5	T1:10.1-10.6
29	Who can apply	CO 5	T1:10.1-10.6
30	Rights, term, restrictions	CO 5	T1:10.1-10.6 ; T1:9.1-9.6
31	TRADEMARK AND COPYRIGHTS: Definition, classification of trademarks	CO 5	T1:10.1-10.6; T1:9.1-9.6
32	Classifications of goods and services	CO 5	T1:9.1-9.6
33	Vienna classification	CO 5	T1:9.1-9.6
34	Trademarks procedure	CO 5	T1:9.1-9.6
35	Trademarks enforcement: infringement and passing off , remedies	CO61	T1:8.1-8.3 ; R2: 7.4-7.5
36	copyrights, term of copyrights	CO 6	T1:8.1-8.3; R2: 7.4-7.5
37	procedure of copyright	CO 6	T1:8.1-8.3; R2: 7.4-7.5
38	Assignment of copyright	CO 6	T1-8.1-8.1.7

39	Copyright infringement remedies	CO 6	T1-8.1-8.1.7
40	Copyright infringement remedies	CO 6	T1-8.1-8.1.7
PROBLEM SOLVING/ CASE STUDIES			
1	Trademarks	CO 2	T1:2.6-2.6.8; R2: 5.8-5.10
2	Copyrights	CO 3	T1:3.1-3.6
3	Which are the types of geographical indication/?	CO 2	T1:3.1-3.6
4	How many geographical indications are there in India/?	CO 2	T1:3.1-3.6
5	What means intellectual property/?	CO 3	T1:3.1-3.6
6	What is IPR and its features/?	CO 3	T1:3.1-3.8
7	What is a violation of intellectual property/?	CO 3	T1:3.1-3.8
8	What is trademark with example/?	CO 3	T1:4.1-4.6
9	What are the two categories of intellectual property/?	CO 3	T1:4.1-4.6
10	What happened in the Uruguay Round/?	CO 4	T1:4.1-4.6
11	What was a result of the Uruguay Round quizlet/?	CO 5	T1:10.1-10.6
12	What is the purpose of WIPO/?	CO 5	T1:10.1-10.6
13	How many countries are in WIPO/?	CO5	T1:10.1-10.6
14	What is the difference between a geographical indication and a trademark/?	CO 6	T1:8.1-8.3; R2: 7.4-7.5
15	What trademark means/?	CO 6	T1:8.1-8.3; R2: 7.4-7.5
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	What is World Trade Organization (WTO)/?	CO 1	T1:1.4-1.5
2	What is the purpose of WIPO/?	CO 3	T1:3.1-3.8
3	What means intellectual property/?	CO 4	T1:4.1-4.6
4	What do you mean by geographical indications/?	CO 5	T1:10.1-10.6

5	What trademark means/?	CO 6	T1:8.1-8.3; R2: 7.4-7.5
DISCUSSION OF QUESTION BANK			
1	Explain why agencies responsible for intellectual property registration with any two examples.	CO 2	T1:1.4-1.5
2	What is patent/? How the patents are related with intellectual property rights/?	CO 3	T1:3.1-3.8
3	Explain with one real time example the patentable and non-patentable inventions.	CO 4	T1:3.1-3.8; R2: 7.4-7.5
4	How intellectual property is helpful to the society and what are the legal requirements are needed for patents/?	CO 5	T1:10.1-10.6
5	What is the most important criteria for an applicant who seek to register a geographical indication/?	CO 6	T1:8.1-8.3; R2: 7.4-7.5

Signature of Course Coordinator **HOD,ECE**
DR. B Ravi Kumar, Associate Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES/ PROGRAM SPECIFIC OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**

	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**

	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**
PSO 1	Build Embedded Software and Digital Circuit Development platformfor Robotics, Embedded Systems and Signal Processing Applications. 1. Analyze and solve real time problems in Robotics. 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications 3. Develop embedded systems modules using Real Time Operating System. 4. Undertake research and development projects in the field of Embedded Systems. 5. Adopt the engineering professional code and conduct	**5**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototypedesigns, Virtual Instrumentation and System on Chip (SOC) designs.. 1. Inspect, survey and analyze types of ASIC chip designs. 2. Design ASIC prototypes using Verilog and VHDL languages. 3. Analyze microprocessor subsystems with memories and I/O interfacs for SOC designs 4. Explore hardware components for designig SOC 5. Adopt the engineering professional code and conduct 6. Designing prototypes of SOC using programming tools like MATLAB, LabVIEW. 7. Familiarize with the design flow of ASIC prototypes. 8. Realize SOC using Register Transfer-Level designs 9. Analyse and develop models for system level descriptions for synthesis of SOC 10. Inspect and survey the abstractions and principles for the specification, simulation, verification, and synthesis of systems on chip (SoC) 11. Programming and hands-on skills to meet requirements of global environment.	**11**

PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications. 1. Explicit software and programming tools for antenna design. 2. Adopt technical library resources and literature search. 3. Explore smart antennas. 4. Model, program for operation and control of smart antennas for wireless communication applications. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING
COURSE DESCRIPTION

Course Title	**DIGITAL SIGNAL PROCESSING LABORATORY**				
Course Code	AECC42				
Program	B.Tech				
Semester	VI	ECE			
Course Type	Core				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	2	1
Course Coordinator	Ms. Mary swarna latha G, Asssistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECC14	IV	Analog and Digital Communications Laboratory

II COURSE OVERVIEW:

This course is concerned with the implementation of digital signal processing algorithms using different computational platforms such as MATLAB and DSP tools that give core knowledge to develop the real time applications in the area of DSP. It focuses on the convolution, discrete Fourier transform, fast Fourier transform algorithms, digital filter design and multi rate signal processing. Digital signal processing applications are used in speech processing, image processing, audio and video data compression, communication systems.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Digital signal processig laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
-	-	-	-	-	-

VI COURSE OBJECTIVES:

The students will try to learn:

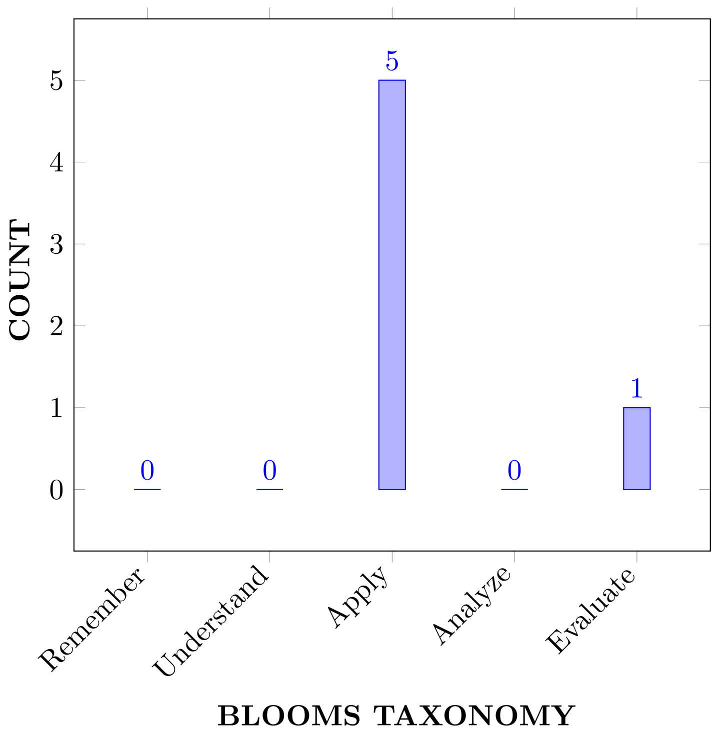
I	The behavior of discrete time signals and systems in time and frequency domain.
II	The analysis of IIR, FIR digital filters and multi rate signal processing systems.
III	The implementation of real time digital signal processing algorithms using MATLAB tool and TI TMSC67XX target board.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Make use of** linear and circular convolution for analyzing the response of linear time invariant system. .	Apply
CO 2	**Apply** discrte Fourier transform using direct method and fast Fourier transform algorithms for spectral analysis of discrete signals.	Apply
CO 3	**Develop** the various convolution sum methods for filtering long duration sequences efficiently in MATLAB.	Apply
CO 4	**Compare** the magnitude and phase characteristics of IIR digital filter using Butterworth method and Chebyshev methods.	Evaluate
CO 5	**Build** Nth order FIR digital filters using windows and frequency sampling methods.	Apply
CO 6	**Apply** multi-rate signal processing methods such as decimation and interpolation and Goertzel algorithm for interfacing the digital systems with different sampling rates and DTMF signalling.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	Lab Exercises/ CIE/ SEE
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	Lab Exercises/ CIE/ SEE
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	3	Lab Exercises/ CIE/ SEE
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	1	Lab Exercises/ Projects

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	2	Lab Exercises/ CIE/ SEE

3 = High; 2 = Medium; 1 = Low

X JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 2	Understand the given **problem statement and formulate** to analyze the response of LTI system in the time domain and frequency domain from provided **information and data.**	3
	PO 5	**Apply** the concept of convolution for finding the response of LTI system using MATLAB tool.	1
CO 2	PO 2	Understand the given **problem statement and formulate**the design (complex) engineering problems of spectral characteristics of discrete time signals from the provided **information and data** in reaching substantiated conclusions by the **interpretation of results.**	4

	PO 5	Select MATLAB tool for analyzing the discrete signals and systems in frequency domain to meet system specifications including **prediction and modeling to complex engineering activities** with an understanding of the limitations.	1
	PSO 1	Develop the capability to (**analyze and apply** DFT and their properties on discrete signals in applications by its **mathematical models**	1
CO 3	PO 2	Understand the given (**problem statement and formulate**)(complex) convolution sum by using overlap add and overlap save method from provided **information and data**in reaching substantiated conclusions by the **interpretation of results.**	4
	PO 5	Apply overlap add method and overlap save methods for filtering of long duration of sequences using MATLAB to meet system specifications including prediction and modeling to **complex engineering activities** with an understanding of the limitations.	1
CO 4	PO 2	Formulate and analyze **(Problem analysis) complex Engineering problems** for fast Fourier transform of discrete signals using first principles of **mathematics and Engineering sciences.**	3
	PO 5	Apply fast Fourier transform algorithms for reducing computational complexity using MATLAB to meet system specifications including prediction and modeling to **complex engineering activities** with an understanding of the limitations.	1
	PSO 1	Develop the capability to analyze the spectral characteristics by applying fast Fourier transform(FFT) algorithms on discrete signals and systems applications by its **mathematical models.**	1
CO 5	PO 2	Understand the given **problem statement and formulate** for designing the (complex) infinite impulse response(IIR)digital filters from the provided **information and data** in reaching substantiated conclusions by the **interpretation of results.**	4
	PO 3	Design infinite impulse response(IIR) digital filters using Butterworth and chebyshev for determining magnitude and phase response by applying the principles of **mathematics, science to the solutions of complex engineering problems and design system components.**	3
	PO 5	Analyze the performance parameters of IIR filters using chebyshev in MATLAB to meet system specifications including **prediction and modeling to complex engineering activities** with an understanding of the limitations.	1

CO 6	PO 2	Understand the given **problem statement and formulate**for designing the (complex) engineering problems of FIR filters from the provided **information and data**in reaching substantiated conclusions by the **interpretation of results.**	4
	PO 3	Design FIR filters using windows and frequency sampling methods using **principles of mathematics and engineering sciences.**	2
	PO 5	Analyze the performance parameters of FIR filters using chebyshev in MATLAB to meet system specifications including **prediction and modeling to complex engineering activities** with an understanding of the limitations.	1
	PSO 1	Develop the capability to **analyze and apply** windows and frequency sampling methods for designing of FIR filters by its **mathematical models.**	2

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES				PSO'S
	PO 2	PO 3	PO 5	PO 9	PSO 1
CO 1	1		3		
CO 2	1		3		2
CO 3	1		3		
CO 4	1		3		2
CO 5	1	1	3		
CO 6	1	1	3		3

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK I	**LINEAR CONVOLUTION VS CIRCULAR CONVOLUTION**
	Generate linear convolution and circular convolution without using built in function and the function conv in MATLAB .
WEEK II	**DFT AND IDFT**
	Compute the Discrete Fourier Transform and IDFT with and without fft and ifft in MATLAB. **Solutions Expected:**
WEEK III	**OVERLAPADD AND OVERLAP-SAVE METHODS**
	Implement Linear convolution using DFT (Overlapadd and
WEEK IV	**DIT-FFT ALGORITHM**
	ImplementDecimation-in-time radix-2 FFT algorithm.
WEEK V	**DIF-FFT ALGORITHM**
	Implement Decimation-in-frequency radix-2 FFT algorithm. **Solutions Expected:**
WEEK VI	**IIR DIGITAL FILTERUSING BUTTERWORTH METHOD AND BILINEAR TRANSFORMATION**
	Implement IIR digital filter using Butterworth method and bilinear transformation.
WEEK VII	**IIR Digital Filter Using Chebyshev (Type I And II) Method**
	Implement IIR digital filter using Chebyshev (Type I and II) method.
WEEK VIII	**FIR DIGITAL FILTER USING WINDOWS**
	Implement FIR digital filter using window (Rectangular, Hamming, Hanning, Bartlett) methods.
WEEK IX	**FIR DIGITAL FILTER USING FREQUENCY SAMPLING METHOD**
	Implement FIR digital filter using frequency sampling method.
WEEK X	**OPTIMUM EQUIRIPPLE FIR DIGITAL FILTER**
	Implement optimum equiripple FIR digital filter using window methods.
WEEK XI	**DTMF TONE GENERATION AND DETECTION**
	Generation and Detection of DTMF Tone Using Goertzel Algorithm.
WEEK XII	**SAMPLING RATE CONVERSION**
	Implement sampling rate conversion by decimation, interpolation and a rational factor using MATLAB.
WEEK XIII	**SINE WAVE GENERATION**
	a) Implement DFT b) Generate sine wave generation using lookup table with values generated from MATLAB.
WEEK XIV	**IIR AND FIR FILTERS USING DSP KITS**
	Implement IIR and FIR Filter using DSP Kits.

TEXTBOOKS

1. John G. Proakis, Dimitris G. Manolakis, Digital signal processing, Principles, Algorithms and Applications, Prentice Hall, 4^{th} Edition, 2007 .
2. Sanjit K Mitra, Digital signal processing, A computer base approach, McGraw-Hill Higher Education, 4^{th} Edition, 2011.

3. Emmanuel C, Ifeacher, Barrie. W. Jervis, DSP-A Practical Approach, Pearson Education, 2nd Edition, 2002.

4. A.V. Oppenheim, R.W. Schaffer, Discrete Time Signal Processing, PHI, 2nd Edition, 2006.

REFERENCE BOOKS:

1. RobertJ.schilling,Sandra.L.harris, "Fundamentals of Digital Signal Processing using MATlab" , Thomson Engineering, 2nd Edition,2005.

2. Vinay K. Ingle , John G. Proakis, "Digital Signal Processing Using MATlab", Cengage 4th Edition, 2009.

3. DSK Donald Reay, Rulph Chassaing, "Digital Signal Processing and Applications with the TMS 320C6713 and TMS 320C6416" Wiley 2nd Edition.

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Linear convolution vs circular convolution	CO 1	T1: 2.3.3
2	DFT and IDFT	CO 2	T1: 7.2
3	Overlap-add and overlap-save methods	CO 3	T1: 2.3.4
4	DIT-FFT algorithm	CO 4	T1: 8.1
5	DIT-FFT algorithm	CO 4	T1: 8.2
6	IIR digital filter using Butterworth method and bilinear transformation	CO 4	T1: 10.3
7	IIR digital filter using Chebyshev (Type I and II) method	CO 4	T1: 10.3
8	FIR digital filter using windows	CO 5	T1: 10.2
9	FIR digital filter using frequency sampling method	CO 5	T1: 10.3
10	Optimum equiripple FIR digital filter	CO 5	T1: 10.4
11	DTMF tone generation and detection	CO 6	T3:6.6
12	Sampling rate conversion	CO 6	T1: 11.6
13	Sine wave generation	CO 6	T1:2.1-2.2
14	IIR and FIR filters using DSP kits	CO 5	T1: 10.3

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Design an audio application such as to plot a time and frequency display of microphone plus a cosine using DSP chip .
2	Develop compressors and expanders to decrease and increase the dynamic range of audio signals in computer music.
3	Converting CD DATA TO DVD DATA.
4	Design Vocoders (voice coder) to reduce the bandwidth requirements of normal voice signal using analysis-synthesis sections.
5	Noise removal: Add noise above 3 KHz and then remove interference suppression using 400 Hz tone.

Signature of Course Coordinator **HOD,ECE**
Ms. Mary swarna latha G, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING
COURSE DESCRIPTION

Course Title	**ANTENNAS AND MICROWAVE ENGINEERING LABORATORY**				
Course Code	AECC41				
Program	B.Tech				
Semester	VI	ECE			
Course Type	Core				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	2
Course Coordinator	Dr. V Kishen Ajay Kumar, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECC18	V	Antennas and Wave Propagation
B.Tech	AECC32	VI	Microwave And Radar Engineering

II COURSE OVERVIEW:

This course deals with the measurements of the signals at micro frequency range. This course introduces students to the broad area of RF microwave engineering. It involves measurement of frequency, wave length, VSWR, impedance and scattering parameters of various micro wave devices like circulator, directional coupler, and magic-tee. Microwave devices support larger bandwidth and hence higher data rates are transmitted. There are a wide variety of applications for microwaves like outdoor broadcasting transmissions and long distance telephone calls.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Microwave Engineering Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks for internal assessment and 70 marks for semester end lab examination. Out of 30 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end lab examination for 70 marks shall be conducted by two examiners, one of them being Internal Examiner and the other being External Examiner, both nominated by the Principal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria.

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
-	-	-	-	-	-

VI COURSE OBJECTIVES:

The students will try to learn:

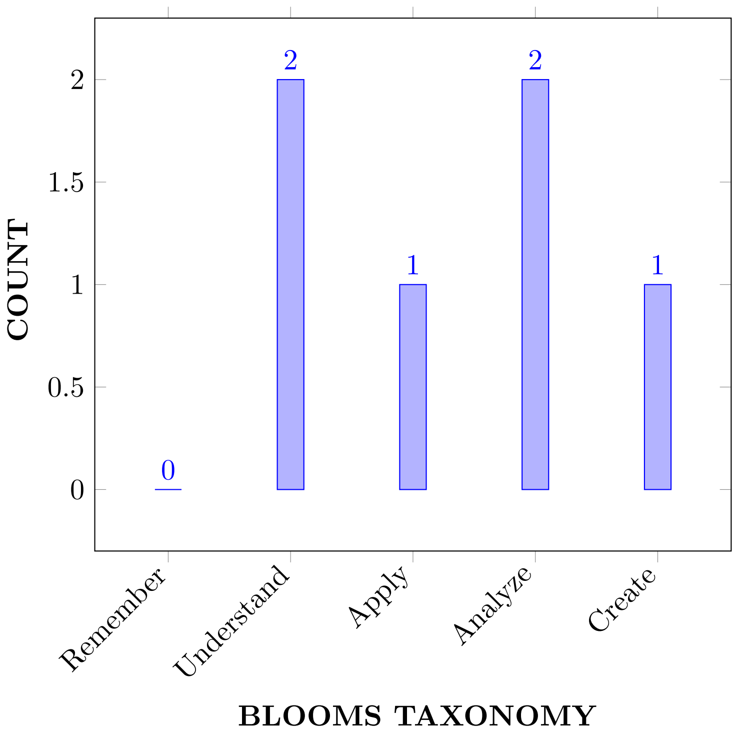
I	The experiments on microwave test equipment to make measurements of microwave parameters and devices.
II	The measurement of S-Parameters of microwave components to gain the practical hands on experience on the microwave test bench.
III	The simulation to plot the radiation pattern for an antenna using High Frequency Software Simulator.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Summarize** the waveguide components and their specifications using microwave test bench set-up. .	Understand
CO 2	**Sketch** the characteristics of reflex klystron. to obtain the electronic tuning range using klystron bench set up.	Apply
CO 3	**Analyze** the characteristics of directional coupler, circulator and magic tee using microwave test bench setup.	Analyze
CO 4	**Distinguish** the low and high voltage standing wave ratio of unknown load load to find out the reflection coefficient using slotted line section.	Analyze
CO 5	**Identify** fundamental parameters of the antenna to measure far-field radiation pattern using High frequency Structure Simulator	Understand
CO 6	**Design** various antennas to find out the antenna parameters using test setup and High Frequency Structure Simulator.	Create

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	Lab Experiments / CIE / SEE
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	3	Lab Experiments / CIE / SEE
PO 5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	2	Lab Experiments / CIE / SEE
PO 9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	3	Lab Experiments / CIE / SEE
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	Lab Experiments / CIE / SEE

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 3	Make use of High frequency structure simulator (HFSS) for modeling and evaluating the patch and smart antennas for wired and wireless communication applications.	1	Lab Exercises

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE	PROGRAM OUTCOMES												PSO'S		
OUTCOMES	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	-	✓	-	-	✓	-	-	-	-	-	-		-	-	-
CO 2	-	✓	✓	-	-	-	-	-	✓	-	-	-	✓	-	-
CO 3	-	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	-	✓	✓	-	-	-	-	-	-	-	-		-	-	-

CO 5	-	✓	✓	-	✓	-	-	-	✓	✓	-	-	-	-	-
CO 6	-	✓	✓	-	✓	-	-	-	✓	-	-		✓	-	✓

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 2	**Identify** the Waveguide components and their specifications using microwave test bench set-up, **analyze** complex **engineering problems** from the element, and find out **conclusions** from the radiating components using the **principles of mathematics** and **natural sciences.**	6
	PO 5	**Summarize** the Waveguide components and their specifications using microwave test bench set-up by **applying modern Engineering and IT tools.**	2
CO 2	PO 2	**Identify the characteristics of Reflex klystron and Gunn diode, formulate the modes using Klystron bench set up, apply the principles of mathematics, natural sciences, and engineering sciences** .	5
	PO 3	**Examine (Design) the characteristics** of reflex klystron and find out its tuning range using design solutions for **complex engineering problems** that meet the specified needs with appropriate consideration.	2
	PO 9	**Use research-based knowledge** and **research methods** including **design of experiments** to **analyze** the characteristics of reflex klystron and Gunn diode and **interpretation of data, function effectively** as an **individual**, and as **a member** to obtain the readings	8
CO 3	PO 2	**Identify** the characteristics of Directional coupler, circulator and magic tee using microwave test bench setup, **analyze** the **complex design considerations** using **principles of mathematics** and **evaluate the appropriate solution**	6
	PO 3	**Understand** the characteristics of Directional coupler, circulator and magic tee using various system components and identify solutions that meet the specified needs for the **societal and environmental considerations**.	2
CO 4	PO 2	**Understand the (Problem analysis)** concept of microwave junction and S-Parameters using review research literature, and analyze **complex engineering problems** reaching substantiated conclusions using **first principles engineering sciences**	2
	PO 3	**Obtain** the S-parameters for different microwave components to measure coupling factor, insertion and isolation using microwave test bench to meet the specified needs with appropriate consideration.	1

CO 5	PO 2	**Understand the (Problem analysis)** concept of VSWR and reflection coefficient using review research literature, and analyze complex engineering problems reaching substantiated conclusions **using first principles engineering sciences** .	2
	PO 3	**Measure** low VSWR to find out reflection coefficient and SWR using microwave test bench using design solutions for complex engineering problems that meet the specified needs with appropriate consideration .	1
	PO 5	**Analyze** the polar pattern of different Microwave antennas to find out gain, beam width and level of the first side lobe using Create, select, and apply **appropriate techniques** resources, and **modern Engineering and IT tools** including prediction and modeling to complex Engineering activities with an understanding of the limitations.	3
	PO 9	**(Team work)Individual and team work: Function effectively as an individual, and as a member** to obtain the readings .	6
	PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1
CO 6	PO 2	**Analyze** the radiation pattern of dipole antenna to find out the antenna parameters using **test setup** and **High Frequency Software Simulator**	5
	PO 3	**Obtain** the radiation pattern of various antennas to find out the antenna parameters using High Frequency Software Simulator for **complex engineering problems** that meet the specified needs with appropriate consideration.	2
	PO 5	**Analyze** the radiation pattern of microstrip feed antenna to find out the antenna parameters using **modern Engineering and IT tools** such as High Frequency Software Simulator.	2
	PO 9	**(Team work) Individual and team work:** Function effectively as an **individual**, and as a **member** to **obtain** the readings.	8
	PSO 3	**Make use** of High frequency structure simulator (HFSS) to **analyze** the radiation pattern of various antennas to find out the antenna parameters .	2

XIII MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

COURSE OUTCOMES	Program Outcomes/ No. of Key Competencies Matched												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	-	6	-	-	2	-	-	-	-	-	-		-	-	-
CO 2	-	5	2	-	-	-	-	-	8	-	-	-	-	-	-
CO 3	-	6	2	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	-	2	1	-	-	-	-	-	-	-	-		-	-	-
CO 5	-	2	1	-	3	-	-	-	6	1	-	-	-	-	-
CO 6	-	5	2	-	2	-	-	-	8	-	-		-	-	2

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	Program Outcomes/ No. of Key Competencies Matched												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	-	60	-	-	20	-	-	-	-	-	-		-	-	-
CO 2	-	50	-	-	-	-	-	-	66.7	-	-	-	-	-	-
CO 3	-	60	20	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	-	20	50	-	-	-	-	-	-	-	-		-	-	-
CO 5	-	20	50	-	50	-	-	-	50	20	-	-	-	-	-
CO 6	-	50	50	-	50	-	-	-	66.7	-	-		-	-	100

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation
1 - $40\% < C < 60\%$ –Moderate
2 - $5\% < C \leq 40\%$ – Low/ Slight
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	-	3	-	-	1	-	-	-	-	-	-		-	-	-
CO 2	-	2	2	-	-	-	-	-	3	-	-	-	-	-	-
CO 3	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	-	1	2	-	-	-	-	-	-	-	-		-	-	-
CO 5	-	1	2	-	2	-	-	-	2	1	-	-	-	-	-
CO 6	-	2	2	-	2	-	-	-	3	-	-		-	-	-

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

Week-1	**STUDY OF MICROWAVE COMPONENTS**
	To study the different wave guide components in the microwave bench setup.
Week-2	**MODE CHARACTERISTICS OF REFLEX KLYSTRON**
	To study the characteristics of Reflex Klystron oscillator, finding the mode numbers and efficiencies of different modes.
Week-3	**GUNN DIODE CHARACTERISTICS**
	To study the characteristics of Gunn diode oscillator. .
Week-4	**DIRECTIONAL COUPLER CHARACTERISTICS**
	To measure coupling factor, insertion loss, isolation and directivity of a Directional coupler.
Week-5	**MEASUREMENT OF VSWR**
	To measure the low and high VSWRs of matched terminals.
Week-6	**CIRCULATOR CHARACTERISTICS**
	To measure the isolation and insertion loss of a three port circulator
Week-7	**MEASURMENT OF SCATTERING PARAMETERS OF MAGIC TEE**
	To find the scattering parameters of a four port Magic Tee.
Week-8	**INTRODUCTION TO HFSS**
	Introduction To HFSS Tool.
Week-9	**MONOPOLE ANTENNA DESIGN**
	To find the gain of Monopole Antenna.
Week-10	**DIPOLE ANTENNA DESIGN**
	To draw the Radiation Pattern of Dipole Antenna Design.
Week-11	**MICROSTRIP FEED ANTENNA DESIGN**
	To find the gain and radiation pattern of Microstrip Feed Antenna Design.
Week-12	**PROBE FEED PATCH ANTENNA DESIGN**
	To draw the 3D polar plot of Probe Feed Patch Antenna Design.
Week-13	**SLOT COUPLED PATCH ANTENNA**
	To draw the 3D rectangular plot of Slot Coupled Patch Antenna.
Week-14	**MICROSTRIP LINE DESIGN**
	To find the gain of Microstrip Line Design.

REFERENCE BOOKS

1. Samuel Y. Liao, —Microwave Devices and Circuits‖, Pearson, 3 rd Edition, 2003.
2. Herbert J. Reich, J.G. Skalnik, P.F. Ordung and H.L. Krauss, —Microwave Principles‖ ,CBS Publishers and Distributors, New Delhi, 1st Edition, 2004.
3. F.E. Terman, —Electronic and Radio Engineering‖, Tata McGraw-Hill Publications, 4 th Edition, 1955.

WEB REFERENCES:

1. http://www.ee.iitkgp.ac.in
2. http://www.citchennai.edu.in

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Study of Microwave Components.	CO 1	R1
2	Mode characteristics of reflex klystron	CO 2	R1,R2
3	Gunn diode characteristics.	CO 3	R1,R2
4	Directional coupler characteristics	CO 3	R1,R2
5	Measurement of VSWR	CO 3	R1,R2
6	Circulator characteristics	CO 3	R1,R2
7	Measurement of scattering parameters of magic tee	CO 3	R1,R2
8	Introduction to HFSS	CO 5	R1,R3
9	Monopole antenna design	CO 6	R1,R3
10	Dipole antenna design	CO 5	R1,R3
11	Microstrip feed antenna design.	CO 5	T1–17.1 to 17.6
12	Probe feed patch antenna design	CO 6	R1,R3
13	Slot coupled patch antenna.	CO 4	R1,R2
14	Microstrip line design.	CO 5	R1,R2

XX EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Design microwave components such as: Directional couplers, circulators and Hybrid junctions using Simulation software.
2	Design antenna arrays such as: Binomial, Chebyshev using Simulation
3	RF based Wireless Chatting.
4	RF Communication based Data Encryption and Decryption Wirelessly.
5	Electronic eye with Security System using RF with Message Broad Casting.
6	Secret code Enabled Secure communication using RF Communication.
7	Unique office communication system using RF.

Signature of Course Coordinator **HOD,ECE**
Dr. V Kishen Ajay Kumar, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043
COURSE DESCRIPTION

Department	**Electronics and Communication Engineering**				
Course Title	**Digital Design Through Verilog**				
Course Code	AECC49				
Program	B.Tech				
Semester	VII				
Course Type	Professional Elective				
Regulation	UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Ms.Y.Meghamala , Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECB07	III	Digital System Design

II COURSE OVERVIEW:

This course introduces the hardware description language for design and development of digital integrated circuits and field programmable devices. Provides hardware description language elements, synthesizable register transfer logic models in gate level, dataflow, behavioral, switch level modeling of combinational and sequential circuits. Allows to use computer aided design tools at the levels of system design, logic design and IC design.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Digital Design Through Verilog	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	✓	Tech Talk	x	Mini Project	✓	Concept Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Remember
40 %	Understand
50 %	Apply
0 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

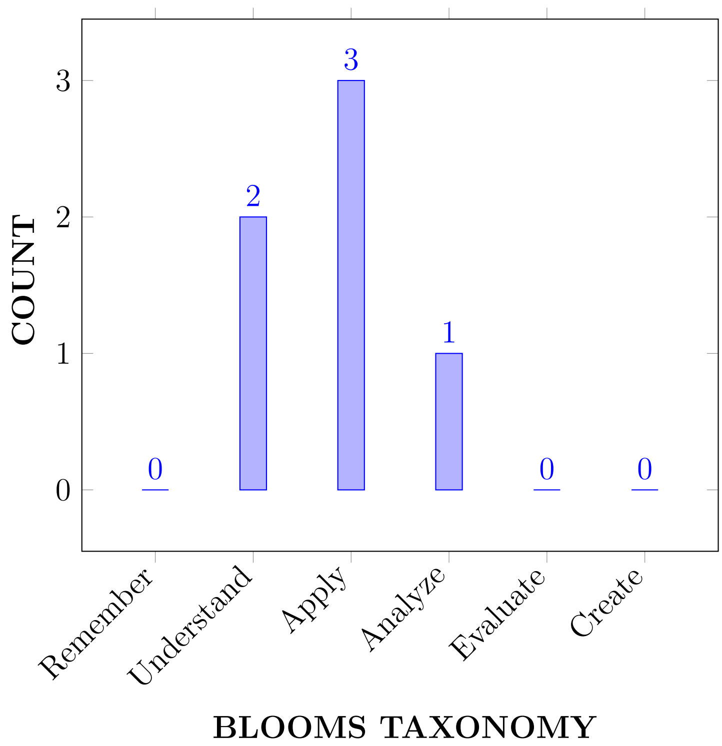
I	The fundamental principles of the verilog hardware descriptive language and its constructs used in synthesizable register transfer level (RTL) design implementation of digital logic systems.
II	The concepts of gate level, behavioral, dataflow and switch level modeling of fundamental digital logic circuits using verilog hardware description language.
III	The exposure to various stages of a typical state of the art CAD VLSI tool for simulation, synthesis, place and route, layout and power and clock routing modules.
IV	The analytical skills needed to model finite state machines using field programmable gate arrays, fault-tolerant high-speed computer arithmetic circuits, built-in self-test circuit (BIST).

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Describe** the basic language elements and data flow modelling constructs to implement the combinational and sequential circuits in Verilog.	Understand
CO 2	**Utilize** the basic logic gate primitives and user defined primitives for implementing digital circuits in gate level modelling.	Apply
CO 3	**Illustrate** the significance of structured procedures in behavioral modeling using blocking and nonblocking procedural assignments.	Understand
CO 4	**Make use of** loop and conditional statements to describe the digital circuits in behavioral modeling.	Apply
CO 5	**Identify** the methods to specify delays on switch primitives for designing modules with time delays in switch level modeling.	Apply
CO 6	**Distinguish** the synchronous and asynchronous sequential state machines for synthesizing the sequential circuits.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

PROGRAM OUTCOMES	
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO 6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE / CIE / AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	SEE / CIE / AAT
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	SEE / CIE / AAT
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	SEE / CIE / AAT

PO 5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	3	SEE / CIE

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	2	—

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	✓	-	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-
CO 3	✓	✓	-	✓	✓	-	-	-	-	-	-	-	-	✓	-
CO 4	✓	✓	✓	-	✓	-	-	-	-	-	-	-	-	✓	-
CO 5	✓	✓	✓	-	✓	-	-	-	-	-	-	-	-	✓	-
CO 6	-	✓	-	✓	✓	-	-	-	-	-	-	-	-	✓	-

XII JUSTIFICATIONS FOR CO – PO / PSO MAPPING -DIRECT:

COURSE OUT COMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	**PO 1**	**Recall** the basic constructs and conventions in verilog and these constructs provide the necessary framework for verilog HDL by applying the **own Engineering discipline, Science principles and methodology**.	2

COURSE OUT COMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 2	**PO 1**	**Explain** the logic value set and strengths to model the functionality of real hardware supported by verilog HDL and data types such as nets, registers, vectors, numbers, simulation time, arrays, parameters, memories, and strings in verilog model actual data storage by applying the **mathematical principles, Scientific principles and methodology**	2
	PO 3	**Understand the customer needs, use creativity and manage design process** to model the complex digital circuits by using basic logic gate primitives and user defined primitives provided in verilog with the help of **modern engineering tools**.	4
CO 2	**PO 4**	Understand the **complex engineering problems** Use appropriate logic gate primitives and user defined primitives in the **design** of experiments for **analysis and interpretation of data, and synthesis of the information** to provide valid conclusions.	5
	PO 5	Select and apply appropriate logic gate primitives and user defined primitives to model the complex digital circuits by making use of **modern engineering tools**.	1
	PSO 2	Using the basic logic gate primitives and user defined primitives can design a **prototype of ASIC**, such as PLDs, memory and processors.	1
CO 3	**PO 1**	Define the syntax of blocking and non blocking procedural constructs to build the digital circuits in behavioral modeling with **the knowledge of mathematics, science and engineering fundamentals**.	2
	PO 2	Understand the given **problem statement and formulate** the (complex) engineering problems of digital circuits, **translate the information** into the model and prototype systems from the provided **information and data, develop solutions** based on the functionality of the data translation, validate the output of the circuit in reaching substantiated conclusions by the **interpretation of results**.	7

COURSE OUT COMES	PO'S PSO'S	**Justification for mapping (Students will be able to)**	No. of Key Competencies
	PO 4	**Use** appropriate procedural constructs in the **design** of combinational and sequential logic circuits in behavioral modeling for **analysis** and **interpretation** of data, and synthesis of the information to provide valid conclusions.	4
	PO 5	Select and apply appropriate procedural constructs in behavioral modeling to model the complex digital circuits by making use of **modern engineering tools**.	1
	PSO 2	Using the loop, case and conditional statements can design a **prototype of ASIC**, such as PLDs, memory and processors.	1
CO 4	**PO 1**	Define the syntax of loop, case and conditional statements used to build the digital circuits in behavioral modeling with **the knowledge of mathematics, science and engineering fundamentals**.	2
CO 4	**PO 2**	Demonstrate the significance of loop, case and conditional statements in behavioral modeling and develop the verilog description for the hardware from the provided **information and data, develop solutions** based on the functionality of the data translation, validate the output of the circuit in reaching substantiated conclusions by the **interpretation of results**.	4
	PO 3	**Understand the customer needs, use creativity and manage design process** to model the complex digital circuits making use of loop, case and conditional statements provided in verilog with the help of modern engineering tools in the design of **system components to establish innovative solutions** in digital system design.	4
	PO 5	Select either loop or conditional statements and delays to model the **complex** digital circuits.	1
	PSO 2	Using the loop, case and conditional statements can design a **prototype of ASIC**, such as PLDs, memory and processors.	1
CO 5	**PO 1**	Define the types of delays on basic transistor switch and CMOS switch for implementing digital circuits in switch level modeling **using knowledge of mathematics, science and engineering fundamentals.**	2

COURSE OUT COMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 2	Demonstrate the methods to specify delays on basic MOS switches and bidirectional pass switches and develop the verilog description with delays for the hardware in switch level modeling to **identify, formulate** and state a problem.	3
	PO 3	Design solutions for complex Engineering problems and design system components using digital system by **innovative solution and implementing them with modern tools** such as Xilinx and Vivado.	2
	PO 5	Select and apply appropriate basic transistor and MOS switches to model the complex digital circuits by making use of **modern engineering tools**.	1
	PSO 2	Using the basic transistor and MOS switches can design a **prototype of ASIC**, such as PLDs, memory and processors.	1
CO 6	**PO 2**	Demonstrate the methods to synthesize asynchronous and synchronous circuits and compare the verilog description to **identify, formulate and state a problem**.	3
	PO 4	Understand the **complex engineering problems**, use appropriate verilog description in the synthesis of asynchronous and synchronous sequential circuits for **analysis, interpretation of data, and synthesis of the information** to provide valid conclusions.	5
CO 6	**PO 5**	Select and apply appropriate design style to model the complex synchronous and asynchronous sequential circuits by making use of **modern engineering tools**	1
	PSO 2	Using the synthesis of synchronous and asynchronous sequential machines can design a **prototype of ASIC**, such as PLDs, memory and processors.	1

Note: For Key Attributes refer **Annexure - I**

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO / PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	-	4	5	1	-	-	-	-	-	-	-	-	1	-
CO 3	2	7	-	4	1	-	-	-	-	-	-	-	-	1	-
CO 4	2	4	4	-	1	-	-	-	-	-	-	-	-	1	-
CO 5	2	3	2	-	1	-	-	-	-	-	-	-	-	1	-
CO 6	-	3	-	5	1	-	-	-	-	-	-	-	-	1	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO / PSO:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	66.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	66.7	-	40	45.5	100	-	-	-	-	-	-	-	-	50	-
CO 3	66.7	70	-	36.4	100	-	-	-	-	-	-	-	-	50	-
CO 4	66.7	40	40	-	100	-	-	-	-	-	-	-	-	50	-
CO 5	66.7	30	20	-	100	-	-	-	-	-	-	-	-	50	-
CO 6	-	30	-	36.4	100	-	-	-	-	-	-	-	-	50	-

XV COURSE ARTICULATION MATRIX PO / PSO MAPPING:

CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 - 0≤ C≤ 5% – No correlation ***2***-40 <C≤ 60% – Moderate.

1 - 5<C≤ 40% – Low/ Slight ***3***-60 <C≤ 100% –Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	-	2	2	3	-	-	-	-	-	-	-	-	2	-
CO 3	3	3	-	1	3	-	-	-	-	-	-	-	-	2	-
CO 4	3	2	2	-	3	-	-	-	-	-	-	-	-	2	-
CO 5	3	1	1	-	3	-	-	-	-	-	-	-	-	2	-

CO 6	-	1	-	1	3	-	-	-	-	-	-	-	-	2	-
TOTAL	**27**	**7**	**5**	**4**	**15**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**0**
AVERAGE	**3**	**1.75**	**1.67**	**1.33**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	-
Quiz	-	Tech - Talk	✓	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	✓	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION TO VERILOG HDL**
	Popularity of Verilog HDL, Introduction to Verilog, Module Concept, Module Modeling Styles, Language Elements: Comments, Identifiers, Keywords, Value Set, Data Types, Memory Element, Constant, Parameter, Operators. Dataflow Modeling: Continuous Assignment, Implicit Continuous Assignment, Delays, Design examples using data flow modeling.
MODULE II	**GATE LEVEL MODELING**
	Multiple-Input Gates, Gate Delays, Design Examples, User-Defined Primitives: UDP Basics Combinational User-Defined Primitives, Sequential User-Defined Primitives, Combinational Logic Modules: Decoders, Encoders, Multiplexers, Demultiplexers, Magnitude Comparators
MODULE III	**BEHAVIORAL MODELING**
	Procedural Constructs, Procedural Assignments, Timing Control, Conditional Statements, Case Statement Design examples using behavioral modeling Loop Statements: For Loop, While Loop, Repeat Loop, Forever Loop, Block Statements Procedural Continuous Assignment, Design examples using behavioral modeling
MODULE IV	**SWITCH LEVEL MODELLING**

	Basic Transistor Switches, CMOS Switch, Bi – directional Gates, Time Delays with Switch Primitives, Instantiations with Strengths and Delays, Strength Contention with Trireg Nets.
MODULE V	**SEQUENTIAL LOGIC**
	Analysis of Synchronous Sequential Machines, Synthesis of Synchronous Sequential Machines, Analysis of Asynchronous Sequential Machines, Synthesis of Asynchronous Sequential Machines, Synthesis: Design flow of ASICs and FPGA-Based Systems, Design Environment and Constraints, Logic Synthesis.

TEXTBOOKS

1. Joseph Cavanagh, "Verilog HDL: Digital Design and Modeling", CRC Press, 1 st Edition, 2007.
2. Michael D. Ciletti, "Advanced Digital Design with Verilog HDL", PHI, 2005.
3. Joseph Cavanagh, "Digital Design and Verilog HDL Fundamentals", CRC Press, 1 st Edition, 2008

REFERENCE BOOKS:

1. Stephen Brown and Zvonko Vranesic, "Fundamentals of Digital Logic design with Verilog Design", TMH, 2nd Edition, 2010.
2. Sunggu Lee "Advanced Digital Logic Design using Verilog, State Machine & Synthesis for FPGA", Cengage Learning, 2012.
3. Samir Palnitkar, "Verilog HDL", Pearson Education, 2nd Edition, 2009.
4. T. R. Padmanabhan and B. Bala Tripura Sundari, "Design through Verilog HDL", Wiley, 2009.
5. Zainalabdien Navabi, "Verilog Digital System Design", TMH, 2nd Edition, 2009.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/108/108108111/

COURSE WEB PAGE:

https://lms.iare.ac.in/index?route=course/details&course_id=184

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	https://lms.iare.ac.in/index?route=course/details&course_id=184
CONTENT DELIVERY (THEORY)			

S.No	Topics to be covered	CO's	Reference
2	Introduction to verilog HDL	CO 1	T1:1
3	Overview of digital design with verilog HDL.	CO 1	T1:2.1-2.2
4	Hierarchical modeling concepts	CO 1	T1: 2.3-2.10
5	Lexical conventions	CO 1	T1: 3.2 – 3.14
6	Data types	CO 1	T1: 4.1 – 4.4
7	Modules and ports	CO 1	T1: 4.5
8	Gate-level modeling	CO 2	T1: 4.6 – 4.7
9	Gate delays	CO 2	T1: 5.2
10	Dataflow modeling	CO 2	T1: 5.3- 5.5
11	Continuous dataflow modeling assignments	CO 2	T1: 5.6
12	Operator types	CO 2	T1: 6.2 – 6.5
13	Dataflow modeling examples	CO 2	T1: 6.6
14	Gate-level modeling examples	CO 2	T1: 7.1 – 7.5
15	Behavioral modeling	CO 3	T1: 7.6
16	Structured procedures	CO 3	T1: 7.7 – 7.9
17	Procedural assignments	CO 3	T1: 7.10
18	Timing controls	CO 3	T1: 7.11
19	Conditional statements	CO 3	T1: 7.12
20	Multi way branching	CO 3	T1: 8.2 – 8.8
21	Loops	CO 4	T1 : 8.9 – 8.11
22	Sequential and parallel blocks	CO 4	T1: 10.2 – 10.7
23	Generate blocks	CO 4	T1: 11.2 – 11.4
24	Tasks and functions	CO 4	T2: 5.1
25	Port connection rules	CO 4	T2: 5.2
26	Combinational user defined primitives	CO 4	T2: 5.3
27	Sequential user-defined primitives	CO 4	T2: 5.4
28	Behavioral modeling examples	CO 4	T1:1
29	Switch-level modeling	CO 5	T1:2.1-2.2
30	Switch-modeling elements	CO 5	T1: 2.3-2.10
31	Delay specification on switches	CO 5	T1: 3.2 – 3.14
32	Switch-level modeling examples	CO 5	T1: 4.1 – 4.4
33	Guidelines for UDP design	CO 5	T1: 4.5
34	Sequential logic	CO 6	T1: 4.6 – 4.7
35	Mealy machine	CO 6	T1: 5.2
36	Moore machine	CO 6	T1: 5.3- 5.5
37	Linear feedback shift register (LFSR)	CO 6	T1: 5.6
38	Synthesis of synchronous sequential machines	CO 6	T1: 6.2 – 6.5
39	Synthesis of asynchronous sequential machines	CO 6	T1: 6.6

S.No	Topics to be covered	CO's	Reference
40	Synchronous sequential machines examples	CO 6	T1: 7.1 – 7.5
41	Asynchronous sequential machines examples	CO 6	T1: 7.6
PROBLEM SOLVING			
42	8 to 1 multiplexer in dataflow modeling	CO 1	T1: 7.10
43	2 to 4 priority encoder dataflow modeling.	CO 1	T1: 7.11
44	1 to 8 de multiplexer using gate level modeling	CO 1	T1: 7.12
45	D flip flop using NAND gates in gate level modeling	CO 1	T1: 8.2 – 8.8
46	BCD adder module using gate level modeling	CO 2	T1 : 8.9 – 8.11
47	Full adder using 2 half adders in gate level modeling	CO 2	T1: 10.2 – 10.7
48	8 to 3 encoder using gate level modeling.	CO 2	T1: 11.2 – 11.4
49	4-bit binary to gray code converter using gate level modeling.	CO 3	T2: 5.1
50	8-bit up-down counter using behavioral modeling	CO 3	T2: 5.2
51	3 to 8 decoder using behavioral modeling	CO 4	T2: 5.3
52	8 to 1 multiplexer using case statement.	CO 4	T2: 5.4
53	4-bit universal shift register in behavioral modeling using case statement.	CO 5	T1:1
54	16-to-1 multiplexer using function	CO 5	T1:2.1-2.2
55	Left/Right shifter.	CO 6	T1: 2.3-2.10
56	101 Moore detectors and also obtain its test bench.	CO 6	T1: 3.2 – 3.14
DISCUSSION ON DEFINITIONS AND TERMINOLOGY			
57	Introduction to verilog HDL.	CO 1	T1: 4.5
58	Gate level modeling	CO 2	T1: 4.6 – 4.7
59	Behavioral modeling	CO 3	T1: 5.2
60	Switch level modelling	CO 4	T1: 5.3- 5.5
61	Sequential logic	CO 5	T1: 5.6
DISCUSSION ON TUTORIAL QUESTION BANK			
62	Introduction to verilog HDL.	CO 1	T1: 6.6
63	Gate level modeling	CO 2	T1: 7.1 – 7.5
64	Behavioral modeling	CO 3	T1: 7.6
65	Switch level modelling	CO 4	T1: 7.7 – 7.9
66	Sequential logic	CO 5	T1: 7.10

Course Coordinator **HOD,ECE**
Ms.Y.Meghamala, Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences **(Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**

PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	**10**

PO 4.	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**

PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project. 6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	**12**

PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**ELECTRONICS AND COMMUNICATION ENGINEERING**				
Course Title	**DIGITAL IMAGE PROCESSING**				
Course Code	AECC56				
Program	B.Tech				
Semester	VII				
Course Type	PROFESSIONAL ELECTIVE - V				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mr. Bala Thimmaiah N, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
UG	AECC02	III	Signals and Systems

II COURSE OVERVIEW:

The course is intended to provide image processing fundamentals, representation, sampling, quantization, image acquisition and imaging geometry. Transform techniques including two dimensional Fourier transforms, Walsh, Hotelling, Haar and Slant transforms. Analyze image processing filters and techniques for the applications of enhancement, segmentation and compression.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Image Processing	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with ”either” or ”choice” will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
75%	Understand
25%	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

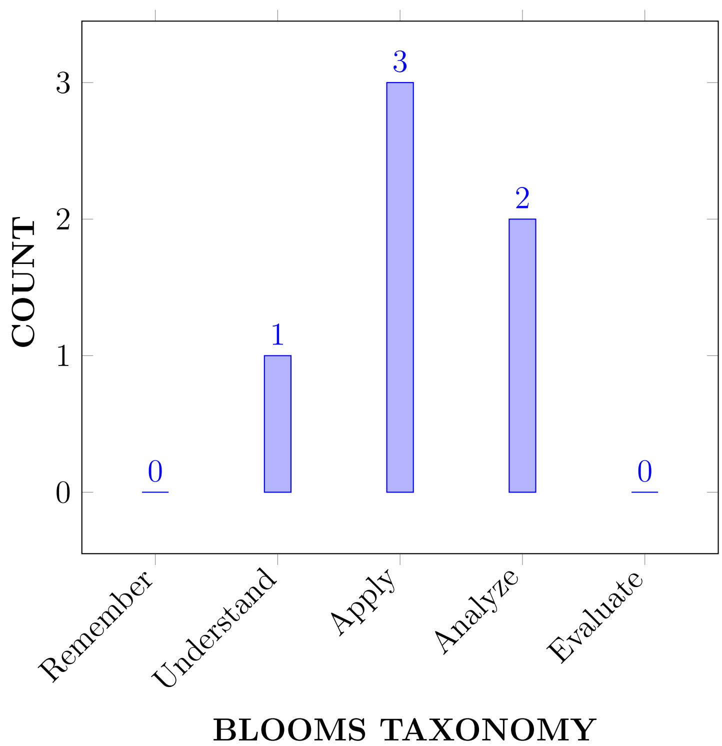
I	The 2D drawings of machine components and modify commands for simple geometric assemblies
II	The 2D Sectinal views for part drawing and assemblies, and generation of 2D, 3D models through different features
III	The Simulation software used for anlyse stresses in various beams and truss
IV	The fundamentals of CNC turning and milling, Part programming and interpolation techniques using CAM software.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Interpret** the principles and terminology of digital image processing for describing the features of image.	Understand
CO 2	**Make use of** image transform techniques for analyzing images in transformation domain for image pre-processing.	Apply
CO 3	**Construct** image intensity transformation and filtering techniques for image enhancement in the spatial and frequency domain.	Apply
CO 4	**Apply** region-based morphological operations and edge-based image segmentation techniques for detection of objects in images to remove the imperfections in the structure of the image.	Apply
CO5	**Analyze** the image restoration in the spatial and frequency domains to deal with noise models for removing degradation from given image.	Analyze
CO 6	**Compare** the lossy and lossless compression models for achieving image compression.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE/CIE/ Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	SEE/CIE, Quiz/AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	1	SEE/CIE, Quiz/AAT
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	SEE /CIE, Quiz/AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	TECH TALK/ CONCEPT VIDEOS
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	2	Projects/ Research on advanced technologies

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build the Embedded software and digital circuit development platform for robotics, embedded systems and signal processing applications.	2	SEE, PROJECTS

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 2	✓	✓	-	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 3	✓	✓	✓	✓	-	-	-	-	-	✓	-	✓	✓	-	-
CO 4	✓	✓	✓	✓	-	-	-	-	-	✓	-	✓	✓	-	-
CO 5	✓	✓	-	-	-	-	-	-	-	✓	-	✓	✓	-	-
CO 6	✓	✓	-	-	-	-	-	-	-	✓	-	✓	-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Illustrate the principles of the Digital Image Processing terminology **(knowledge)** for understanding image and its representation, pixel, intensity, gray level, relationship between the pixels by applying the principles of **engineering science to complex engineering problems**	3
	PO 10	**Effective presentation and Speaking Style** on sampling and quantization and **write Subject Matter Effectively** the difference between analog and digital images.	1
CO 2	PO 1	**Develop a image with various** image transform properties types and its types using **Scientific principles and methodology fundamental mathematics.**	3
	PO 2	**Formulate and analyze (Problem analysis) complex Engineering problems** for image transforms using **first principles of mathematics and Engineering sciences.**	2
	PO 10	**Effective presentation and Speaking Style** on properties of transforms and **write Subject Matter Effectively** on types of transforms.	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PSO 1	**Design of experiments** on image transforms **with project development and execution process** of **modern** tools such as MATLAB with image processing tool box, python, CV2.	2
CO 3	PO 1	**Illustrate the principles of an image find by using engineering** techniques for image enhancement by using **mathematical methods.**	3
	PO 2	**Illustrate** the filter processing **model translation** for spatial domain and **formulate** the time domain filter.	2
	PO 3	**Develop** a histogram techniques **complex engineering problem with appropriate considerations** and environmental considerations for image enhancement.	1
	PO 4	**Demonstrate** the **Use** image enhancement **analyze and interpretation and Ability to apply quantitative methods** in frequency domain processing technique to **provide valid** digital image.	2
	PO 10	**Effective presentation and Speaking Style** on histogram processing **Write Subject Matter Effectively** on manipulation technique of an digital image.	1
	PO 12	**Get aware of advancements** of Image enhancement techniques that would happen from to time	2
	PSO 1	**Design of experiments with project development and execution** modern tools such as MATLAB with image processing tool box, python, CV2.	2
CO 4	PO 1	Distinguish the image restoration in the spatial and frequency domains **(knowledge)** to remove the noise present the image by applying the principles of **(mathematics, engineering science for complex engineering problems.**	3
	PO 2	Formulate and analyze **(Problem analysis) complex Engineering problems** for image restoration using first principles of **mathematics and Engineering sciences**	2
	PO 3	**(Develop** spatial and frequency domain techniques **complex engineering problem with appropriate considerations** and **environmental considerations** for image restoration.	1
	PO 4	Understand the image restoration in the spatial and frequency domains **(knowledge)** methods **including design of experiments, analysis of complex problems.**	2
	PO 10	**Effective presentation and Speaking Style and write** on degradation models and noise sources for image restoration of digital images	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 12	**Get aware of advancements** of Image segmentation techniques and morphological Image processing that would happen from to time	2
	PSO 1	**Design of experiments with project development and execution** image restoration with modern tools such as MATLAB with image processing tool box, python, CV2.	2
CO 5	PO 1	**Interpret** Image Segmentation and formulate representation techniques to apply **Mathematical principles fundamental mathematics.**	3
	PO 2	**Apply Problem statement** the segmentation techniques for edge linking and boundaries by using **principles of mathematics and formulate** segmentation techniques.	2
	PO 10	**Effective presentation and Speaking Style and write on** image segmentation techniques.	1
	PO 12	**Get aware of advancements** of Image restoration techniques that would happen from to time	2
	PSO1	**Design of experiments with project development and execution** image segmentation with modern tools such as MATLAB with image processing tool box, python, CV2.	2
CO6	PO 1	**Understand the** various source coding techniques and Interpret Image Compression standards using **engineering science and mathematical models.**	3
	PO 2	**Identify and analyze** fidelity criteria, image compression models **implement** using **engineering science, design system components** for source Encoder and decoder, error free compression and **model translation** using **principal of mathematics.**	2
	PO 10	**Present effectively** and **Clarity** source encoder and **write effectively subject matter** on decoder techniques.	1
	PO 12	**Get aware of advancements** of Image compression techniques and wavelet based Image compression techniques that would happen from to time	2

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	1	-	-	2	-	-
CO 3	3	1	1	2	-	-	-	-	-	1	-	2	2	-	-
CO 4	3	2	1	2	-	-	-	-	-	1	-	2	2	-	-

CO 5	3	2	-	-	-	-	-	-	-	1	-	2	2	-	-
CO 6	3	2	-	-	-	-	-	-	-	1	-	2	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0	0.0	0.0	0.0
CO 2	100	66.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0	66.6	0.0	0.0
CO 3	100	33.3	33.3	66.6	0.0	0.0	0.0	0.0	0.0	33.3	0.0	66.6	66.6	0.0	0.0
CO 4	100	66.6	33.3	66.6	0.0	0.0	0.0	0.0	0.0	33.3	0.0	66.6	66.6	0.0	0.0
CO 5	100	66.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	66.6	66.6	0.0	0.0
CO 6	100	66.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	66.6	0.0	0.0	0.0

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq$ C$\leq$ 5% – No correlation
1 -5 <C$\leq$ 40% – Low/ Slight
2 - 40 % <C < 60% –Moderate
3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	1	-	-	3	-	-
CO 3	3	1	1	2	-	-	-	-	-	1	-	2	3	-	-
CO 4	3	2	1	2	-	-	-	-	-	1	-	2	3	-	-
CO 5	3	2	-	-	-	-	-	-	-	1	-	2	3	-	-
CO 6	3	2	-	-	-	-	-	-	-	1	-	2	-	-	-
TOTAL	18	9	2	4	-	-	-	-	-	6	-	8	12	-	-
AVERAGE	3	1.8	1	2	-	-	-	-	-	1	-	2	3	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	-	Tech-Talk	✓		

XVII ASSESSMENT METHODOLOGY-INDIRECT:

-	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**INTRODUCTION**
	Digital image fundamentals and image transforms digital image fundamentals, sampling and quantization, relationship between pixels; Image transforms: 2-D FFT, properties, Walsh transform, Hadamard transform, discrete cosine transform, Haar transform, Slant transform, Hoteling transform.
MODULE II	**IMAGE ENHANCEMENT**
	Introduction, image enhancement in spatial domain, enhancement through point processing, types of point processing, histogram manipulation, linear and non-linear gray level transformation, local or neighborhood operation, median filter processing; Spatial domain high pass filtering, filtering in frequency domain, obtaining frequency domain filters from spatial filters, generating filters directly in the frequency domain, low pass (smoothing) and high pass (sharpening) filters in frequency domain.
MODULE III	**IMAGE SEGMENTATION AND MORPHOLOGICAL IMAGE PROCESSING**
	Image segmentation detection of discontinuities, edge linking and boundary detection, threshold, region oriented segmentation, Watershed transformation. Morphological image processing dilation and erosion, structuring element decomposition, the Strel function, erosion; Combining dilation and erosion: Opening and closing the hit and miss transformation, Boundary extraction ,Region filling, Extracted of connected components, convex hull ,skeletons, pruning, Thinning , Thickening.
MODULE IV	**IMAGE RESTORATION**
	Image restoration degradation model, Noise models, Restoration in the presence of noise only (Spatial Filtering), Estimating the degradation function, Inverse filtering, Least mean square filters, constrained least square restoration.
MODULE V	**IMAGE COMPRESSION AND WAVELET BASED IMAGE PROCESSING**
	Image compression: Redundancies and their removal methods, fidelity criteria, image compression models, source encoder and decoder, error free compression, lossy compression, Wavelet transform: Continuous wavelet transformation, 2D continuous wavelet transformation, Examples of wavelets, Wavelet based image compression.

TEXTBOOKS

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2. S. Jayaraman, S. Esakkirajan, T. Veerakumar, "Digital Image Processing", TMH, 3rd Edition, 2010.

REFERENCE BOOKS:

1. A.K.Jain, —Fundamentals of Digital Image Processing, PHI. 3RD Edition, 2003.

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COURSE WEB PAGE:

1. https://akanksha.iare.ac.in/index?route=course/details&course_id=129

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
	OBE DISCUSSION		
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping		
	CONTENT DELIVERY (THEORY)		
1	Introduction to Digital Image Processing	CO 1	T1:1.4-1.5
2	Digital Image Fundamentals	CO 1	T1:1.4-1.5
3	Analyze sampling and quantization	CO 1	T1:2.4-2.5
4	Relationship between pixels	CO 1	T1:2.4-2.5
5	Introduction to Image transforms	CO 2	T1:2.4-2.5
6	2D-FFT	CO 2	T1:2.6-2.6.8; R2: 5.8-5.10
7	Properties of 2D-FFT	CO 2	T1:2.6-2.6.8; R2: 5.8-5.10
8	Walsh transform	CO 2	T1:3.1-3.6
9	Hadamard transform ,Discrete cosine transform	CO 2	T1:3.1-3.6
10	Haar transform, Slant transform	CO 2	T1:3.1-3.6
11	Hoteling transform	CO 2	T1:3.1-3.6
12	Introduction to image enhancement	CO 3	T1:3.1-3.6
13	Image enhancement in spatial domain	CO 3	T1:3.1-3.6
14	Enhancement through point processing	CO 3	T1:3.1-3.8
15	Types of point processing	CO 3	T1:3.1-3.8

16	Histogram manipulation	CO 3	T1:3.1-3.8
17	Linear and non-linear gray level transformation	CO 3	T1:3.1-3.8; R2: 7.4-7.5
18	Local or neighbourhood operation	CO 3	T1:3.1-3.8; R2: 7.4-7.5
19	Median filter processing	CO 3	T1:3.1-3.8; R2: 7.4-7.5
20	Spatial domain high pass filtering	CO 3	T1:3.1-3.8; R2: 7.4-7.5
21	Histogram equalization	CO 3	T1:3.1-3.8; R2: 7.4-7.5
22	Apply the Histogram processing technique for image enhancement	CO 3	T1:3.1-3.8; R2: 7.4-7.5
23	Understand filtering in frequency domain	CO 3	T1:4.1-4.6
24	Obtaining frequency domain filters from spatial filters	CO 3	T1:4.1-4.6
25	Generating filters directly in the frequency domain	CO 3	T1:4.1-4.6
26	Low pass (smoothing) filter in frequency domain.	CO 3	T1:4.1-4.6
27	High pass (sharpening) filter in frequency domain	CO 3	T1:4.1-4.6
28	Introduction to Image segmentation	CO 4	T1:10.1-10.6
29	Detection of discontinuities	CO 4	T1:10.1-10.6
30	Edge linking and boundary detection	CO 4	T1:10.1-10.6
30	Threshold techniques for image segmentation	CO 4	T1:10.1-10.6
31	Understand region oriented segmentation	CO 4	T1:10.1-10.6 ; T1:9.1-9.6
32	Watershed transformation	CO 4	T1:10.1-10.6 ; T1:9.1-9.6
32	Morphological image processing, dilation and erosion	CO 4	T1:10.1-10.6; T1:9.1-9.6
33	Understand structuring element decomposition, the Strel function, erosion;	CO 4	T1:9.1-9.6
34	Combining dilation and erosion: Opening and closing	CO 4	T1:9.1-9.6
35	The hit and miss transformation	CO 4	T1:9.1-9.6
36	Boundary extraction ,Region filling	CO 4	T1:9.1-9.6
37	Extracted of connected components, convex hull	CO 4	T1:9.1-9.6
38	skeletons, pruning	CO 4	T1:9.1-9.6
39	Thinning , Thickening	CO 4	T1:9.1-9.6
40	Introduction to Image restoration	CO5	T1:8.1-8.3 ; R2: 7.4-7.5
41	Degradation model, Noise models	CO5	T1:8.1-8.3 ; R2: 7.4-7.5

42	Restoration in the presence of noise only (Spatial Filtering)	CO5	T1:8.1-8.3 ; R2: 7.4-7.5
43	Estimating the degradation function	CO5	T1:8.1-8.3 ; R2: 7.4-7.5
44	Inverse filtering	CO5	T1:8.1-8.3 ; R2: 7.4-7.5
45	Least mean square filters	CO5	T1:8.1-8.3 ; R2: 7.4-7.5
46	Constrained least square restoration	CO5	T1:8.1-8.3 ; R2: 7.4-7.5
47	Introduction to Image compression	CO6	T1:8.1-8.3 ; R2: 7.4-7.5
48	Redundancies and their removal methods	CO 6	T1:8.1-8.3; R2: 7.4-7.5
49	Fidelity criteria, image compression models	CO 6	T1:8.1-8.3; R2: 7.4-7.5
50	Understand source encoder and decoder	CO 6	T1-8.1-8.1.7
51	Error free compression	CO 6	T1-8.1-8.1.7
52	Lossy compression & JPEG 2000 standard	CO 6	T1-8.1-8.1.7
53	Wavelet transform: Continuous wavelet transformation	CO 6	T1-8.1-8.1.7
54	2D continuous wavelet transformation	CO 6	T1-8.1-8.1.7
55	Examples of wavelets	CO 6	T1-8.1-8.1.7
56	Wavelet based image compression	CO 6	T1-8.1-8.1.7
PROBLEM SOLVING/ CASE STUDIES			
1	Problem solving on 2-D FFT and it's properties	CO 2	T1:2.6-2.6.8; R2: 5.8-5.10
2	Problem solving on Walsh transform, Hadamard transform	CO 3	T1:3.1-3.6
3	Problem solving on Haar Transform	CO 2	T1:3.1-3.6
4	Problem solving on Slant, Hoteling and discrete cosine transform	CO 2	T1:3.1-3.6
5	Problem solving on image enhancement in spatial domain and point processing	CO 3	T1:3.1-3.6
6	Problem solving on histogram manipulation and equalization	CO 3	T1:3.1-3.8
7	Problem solving on gray-level transformation and median filter processing	CO 3	T1:3.1-3.8
8	Problem solving on image enhancement using filtering methods	CO 3	T1:4.1-4.6
9	Problem solving on image enhancement using filtering methods	CO 3	T1:4.1-4.6
10	Problem solving on image restoration using filtering techniques	CO 4	T1:4.1-4.6
11	Problem solving on image segmentation using edge linking and boundary detection	CO 5	T1:10.1-10.6
12	Problem solving on image segmentation using region orientation morphological processing	CO 5	T1:10.1-10.6

13	Problem solving on image segmentation using dilation and erosion	CO5	T1:10.1-10.6
14	Problem solving on image compression using removal of redundancies	CO 6	T1:8.1-8.3; R2: 7.4-7.5
15	Problem solving on image compression using JPEG 2000 standard	CO 6	T1:8.1-8.3; R2: 7.4-7.5
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Definitions and terminologies on Introduction to Digital image processing	CO 1	T1:1.4-1.5
2	Definitions and terminologies on image enhancement	CO 3	T1:3.1-3.8
3	Definitions and terminologies on image restoration	CO 4	T1:4.1-4.6
4	Definitions and terminologies on image segmentation	CO 5	T1:10.1-10.6
5	Definitions and terminologies on image compression	CO 6	T1:8.1-8.3; R2: 7.4-7.5
DISCUSSION OF QUESTION BANK			
1	Discussion on question bank of introduction to digital image processing	CO 2	T1:1.4-1.5
2	Discussion on question bank of image enhancement	CO 3	T1:3.1-3.8
3	Discussion on question bank of image restoration	CO 4	T1:3.1-3.8; R2: 7.4-7.5
4	Discussion on question bank of image segmentation	CO 5	T1:10.1-10.6
5	Discussion on question bank of image compression	CO 6	T1:8.1-8.3; R2: 7.4-7.5

Signature of Course Coordinator **HOD,ECE**
Bala Thimmaiah N, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

<table>
<tr><td>Department</td><td colspan="5">Electronics and Communication Engineering</td></tr>
<tr><td>Course Title</td><td colspan="5">Embedded System Design</td></tr>
<tr><td>Course Code</td><td colspan="5">AECC43</td></tr>
<tr><td>Program</td><td colspan="5">B. Tech</td></tr>
<tr><td>Semester</td><td colspan="5">VII</td></tr>
<tr><td>Course Type</td><td colspan="5">Core</td></tr>
<tr><td>Regulation</td><td colspan="5">UG-20</td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>3</td><td>-</td><td>3</td><td>-</td><td>-</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Mr. B. Brahmaiah, Assistant Professor</td></tr>
</table>

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
B.Tech	ACSC24	VI	Computer Organization and Architecture	3
B.Tech	AECC19	V	Microprocessors and Microcontrollers	4

II COURSE OVERVIEW:

This course allows students to learn the fundamentals of embedded system hardware and firmware design. It focusses on embedded system design process, embedded C, interfacing modules, software development tools for debugging and testing of embedded applications, ARM and SHARC processor architectures and memory organization. It provides hands-on experience on implementation of embedded application prototype design using embedded C.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Embedded Systems	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
66.6%	Understand
16.6 %	Apply
16.6 %	Analyze
0%	Evaluate
0%	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Videos	Tech-talk	Open Ended Experiment
40%	50%	10

VI COURSE OBJECTIVES:

The students will try to learn:

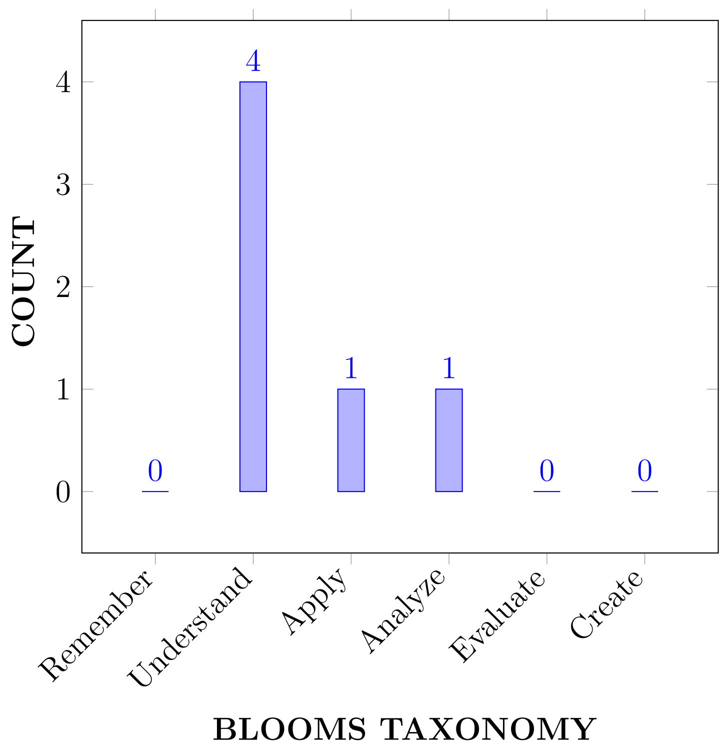
I	The concepts of embedded computing, embedded C, RTOS and embedded software tools for implementing embedded systems.
II	Embedded software development tools for debugging and testing of embedded applications, architectures of ARM and SHARC processors.
III	Interfacing with external environments using sensors, actuators and communication in distributed embedded systems.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Summarize** the concepts of Embedded Systems and formalisms for system design with examples.	Understand
CO 2	**Examine** and write the Embedded Systems programming in C with Keil Integrated Development Environment (IDE).	Analyze
CO 3	**Demonstrate** the principles of RTOS and the methods used for saving memory and power in real time environments.	Understand
CO 4	**Make use of** embedded software development tools for debugging and testing of embedded applications.	Apply
CO 5	**Illustrate** the architecture, memory organization and instruction level parallelism of ARM and SHARC processors used in Embedded Systems.	Understand
CO 6	**Interpret** the concepts of Internet of Things used in the embedded systems applications.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE/CIE/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	SEE/CIE/AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	1	SEE/CIE/AAT
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	3	SEE/CIE/AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	SEE/CIE/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	**Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.**	1	AAT / Projects

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 2	✓	✓	✓	-	✓	-	-	-	-	✓	-	-	✓	-	-
CO 3	✓	-	-	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 4	✓	✓	✓	-	✓	-	-	-	-	✓	-	-	-	-	-
CO 5	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 6	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO1	PO 1	Illustrate the concepts (knowledge) of embedded systems using their architectures by using **mathematics, science, engineering fundamentals** to the solution of complex engineering problems.	3
	PO 10	Describe the concepts of Embedded Systems and formalisms by **giving effective presentations and take clear instructions** for system design with examples.	1
	PSO1	To **Develop embedded systems modules using Real Time Operating System**. and **undertake research and development projects in the field of Embedded Systems.**	2
CO2	PO 1	Apply the integration of sensors, actuators and on-chip peripherals of microcontroller architectures for prototype design by applying **science** and **engineering fundamentals**.	2
	PO 2	Understand the given embedded application **problem statement** and finding the solution implementation and select proper language for **information and data collection** for **solution development** by writing embedded C language programming efficient and **interpretation of results**.The prototype embedded system design by analyzing complex engineering problems.	4
	PO 3	**Manage the design process** and make **use of creativity to establish solutions** by selecting proper syntaxes to write the embedded C language programming by **understanding of the requirement for engineering activities to promote sustainable development** and design solutions for complex Engineering problems and design system components of embedded applications that meet the specified needs with appropriate consideration for the public **health and safety, and the cultural, societal, and Environmental considerations.**	4

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO2	PO 5	Select and apply appropriate techniques of **(Modern Tool Usage)** Keil Integrated Development Environment, for design of the basic embedded modules using different electronic circuits to provide valid conclusions.	1
	PO 10	Use Keil Integrated Development Environment by **giving effective presentations and take clear instructions** for analyzing the Embedded Systems programming in C.	1
	PSO1	To **Develop embedded systems modules using Real Time Operating System**. and **undertake research and development projects in the field of Embedded Systems.**	2
CO3	PO 1	Demonstrate (knowledge) the principles of RTOS such as interrupt latency and context switching in hard real time environments by applying the knowledge of **mathematical model, science and engineering fundamentals**	3
	PO 10	Describe the principles of RTOS and the methods used for saving memory and power with Keil Integrated Development Environment by **giving effective presentations and take clear instructions** in real time environments.	1
	PSO1	To **Develop embedded systems modules using Real Time Operating System**. and **undertake research and development projects in the field of Embedded Systems.**	2
CO4	PO 1	Make use of embedded software development tools (knowledge) for debugging and testing of embedded applications to the solution of complex engineering problems using **mathematics, science, engineering fundamentals**.	3
	PO 2	**Identify the problem** and understand the given embedded application and choose necessary hardware and software interface for **information and data collection** and **conduct experimental design** and **finding the solution implementation** of embedded applications using development tools by analyzing complex engineering problems.	4
	PO 3	**Understand the customer and user needs** and select an appropriate RTOS and Software development tools by **managing the design process and evaluate outcomes** to **promote sustainable development** for data transfer between the devices using **creativity to establish innovative solutions**.	4

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering tools including prediction and modelling the embedded circuits using **Keil integrated development environment tool** to complex Engineering activities with an understanding of the limitations.	1
	PO 10	Use embedded software development tools by **giving effective presentations and take clear instructions** for debugging and testing of embedded applications.	1
CO5	PO 1	Understand (knowledge) the architecture, memory management and application development using ARM and SHARC processors by applying **science and engineering fundamentals**.	2
	PO 10	Explain the architecture, memory organization and instruction level parallelism of ARM and SHARC processors by **giving effective presentations and taking clear instructions**.	1
CO6	PO 1	Model a embedded application prototype using embedded C by applying **engineering fundamentals**.	1
	PO 2	Understand the **problem statement** and **solve** embedded **prototype implementation** using the concepts of Internet Of Things **(information and data collection)** and **interpret the results** in global engineering applications in complex problem analysis using mathematics.	5
	PO 3	**Using creativity to establish innovative solutions** and **understanding of the requirement for engineering activities to promote sustainable development** for design a complex engineering problems and real time processes that meet the specified needs with appropriate consideration for the **public health and environmental considerations**.	3
	PO 10	Interpret the concepts of Internet of Things used in embedded systems applications by **giving effective presentations and taking clear instructions**.	1

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	3	-	-	-	-	-	-	-	-	1	-	-	2	-	-
CO 2	2	4	4	-	1	-	-	-	-	1	-	-	2	-	-
CO 3	3	-	-	-	-	-	-	-	-	1	-	-	2	-	-
CO 4	3	4	4	-	1	-	-	-	-	1	-	-	-	-	-
CO 5	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	1	5	3	-	-	-	-	-	-	1	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	-	-	-	-	-	-	-	-	20	-	-	40	-	-
CO 2	66.6	40	40	-	100	-	-	-	-	20	-	-	40	-	-
CO 3	100	-	-	-	-	-	-	-	-	20	-	-	40	-	-
CO 4	100	40	40	-	100	-	-	-	-	20	-	-	-	-	-
CO 5	66.6	-	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 6	33.3	50	30	-	-	-	-	-	-	20	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation
1 -$5 < C \leq 40\%$ – Low/ Slight
2 - $40\% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	1	-	-	1	-	-
CO 2	3	1	1	-	3	-	-	-	-	1	-	-	1	-	-
CO 3	3	-	-	-	-	-	-	-	-	1	-	-	1	-	-
CO 4	3	1	1	-	3	-	-	-	-	1	-	-	-	-	-
CO 5	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	1	2	1	-	-	-	-	-	-	1	-	-	-	-	-
TOTAL	16	4	3	-	6	-	-	-	-	6	-	-	3	-	-
AVERAGE	2.66	1.33	1	-	3	-	-	-	-	1	-	-	1	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	AAT	✓
Quiz	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	-	Open Ended Experiments	-
Seminars	-	Laboratory Practices	-		

XVII ASSESSMENT METHODOLOGY-INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**EMBEDDED COMPUTING**
	Definition of embedded system, embedded systems vs. general computing systems, history of embedded systems, complex systems and microprocessor, classification, major application areas, the embedded system design process, characteristics and quality attributes of embedded systems, formalisms for system design, design examples.
MODULE II	**TYPICAL EMBEDDED SYSTEMS AND ITS APPLICATIONS**
	Typical Embedded System: Core of the Embedded System, General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS). Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Communication Interface: Onboard and External Communication Interfaces. Applications: LED interfacing, LCD display, Seven segment display, DAC and ADC converters interfacing with 8051 Microcontroller.
MODULE III	**RTOS FUNDAMENTALS AND PROGRAMMING**
	Operating system basics, types of operating systems, tasks and task states, process and threads, multiprocessing and multitasking, how to choose an RTOS ,task scheduling, semaphores and queues, hard real-time scheduling considerations, saving memory and power. Task communication: Shared memory, message passing, remote procedure call and sockets; Task synchronization: Task communication synchronization issues, task synchronization techniques, device drivers.
MODULE IV	**EMBEDDED SOFTWARE DEVELOPMENT TOOLS**
	Host and target machines, linker/locators for embedded software, getting embedded software into the target system; Debugging techniques: Testing on host machine, using laboratory tools, an example system.
MODULE V	**INTRODUCTION TO ADVANCED PROCESSOR**
	Introduction to advanced architectures: ARM and SHARC, processor and memory organization and instruction level parallelism; Networked embedded systems: Bus protocols, I2C bus and CAN bus; Internet-Enabled systems, design example-Elevator controller.

TEXTBOOKS

1. Shibu K.V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, 2nd Edition, 2009.
2. Raj Kamal, "Embedded Systems: Architecture, Programming and Design", Tata McGraw-Hill Education, 2nd Edition, 2011.
3. Andrew Sloss, Dominic Symes, Wright, "ARM System Developer's Guide Designing and Optimizing System Software", 1st Edition, 2004.

REFERENCE BOOKS:

1. Wayne Wolf, — Computers as Components, Principles of Embedded Computing Systems Design, Elsevier, 2 nd Edition, 2009
2. Dr. K. V. K. K. Prasad, — Embedded / Real-Time Systems: Concepts, Design & Programming, dreamtech publishers, 1 st Edition, 2003.
3. Frank Vahid, Tony Givargis, —Embedded System Design‖, John Wiley & Sons, 3 rd Edition, 2006
4. Lyla B Das, "Embedded Systems" , Pearson Education, 1st Edition, 2012.
5. David E. Simon, "An Embedded Software Primer", Addison-Wesley, 1st Edition, 1999.
6. Michael J.Pont, "Embedded C", Pearson Education, 2nd Edition, 2008.

WEB REFERENCES:

1. https://www.smartzworld.com/notes/embedded-systems-es/
2. http://notes.specworld.in/embedded-systems-es/
3. http://education.uandistar.net/jntu-study-materials
4. http://www.nptelvideos.in/2012/11/embedded-systems.html

COURSE WEB PAGE:

1. https://lms.iare.ac.in/index?route=course/playercourseid = 228sectionid = 729lessonid = 7135

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	https://lms.iare.ac.in/index?route=course/details&courseid=228
CONTENT DELIVERY (THEORY)			
2	Definition of embedded system, embedded systems vs. general computing systems.	CO 1	T1-1.1
3	History of Embedded systems	CO 1	T1-1.
4	Complex systems and microprocessor, classification,major application areas.	CO 1	T1-1.3
5	The embedded system design process	CO 1	T2-1.4
6	Characteristics and quality attributes of embedded systems	CO 1	T2-1.5
7	Formalisms for system design, design examples.	CO1	R2-1.2
10	Typical Embedded System	CO 1	T1-1.3
11	Core of the Embedded System, General Purpose and Domain Specific Processors.	CO 1	T1-1.4
12	ASICs, PLDs.	CO 1	T1-1.5
13	Commercial Off-The-Shelf Components (COTS).	CO 1	T1-1.6
14	Memory: ROM, RAM	CO 1	T1-1.7
15	Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems.	CO 1	T2-2.1
16	Embedded Systems, Communication Interface: Onboard and External Communication Interfaces.	CO 1	T1-2.3
17	Applications: LED interfacing.	CO 2	R2-3.1
18	LCD display, Seven segment display.	CO 2	R2-3.2
19	DAC converters interfacing with 8051 Microcontroller.	CO 2	R2-3.3
20	ADC converters interfacing with 8051 Microcontroller.	CO 2	R2-3.3
28	RTOS Fundamentals, Operating system basics, types of operating systems	CO 3	R2-3.5
29	Tasks and task states, process and threads	CO 3	R2-3.6
30	Multiprocessing and multitasking, how to choose an RTOS	CO 3	R3-3.7
31	Task scheduling, semaphores and queues	CO 3	R3-3.8
32	Hard real-time scheduling considerations, saving memory and power.	CO 3	R3-4.1
33	Task communication: Shared memory, message passing	CO 3	R3-4.1

34	Remote procedure call and sockets	CO 3	R3-4.2
35	Task synchronization: Task communication synchronization issues	CO 3	R3-4.2
36	Task synchronization techniques, device drivers.	CO 3	R3-4.3
37	Host and target machines	CO 4	R3-4.3
38	Linker for embedded software	CO 4	R3-4.4
39	Locators for embedded software	CO 4	R3-4.4
40	Getting embedded software into the target system	CO 4	R3-4.5
41	Debugging techniques: Testing on host machine	CO 4	R3-4.5
44	Debugging techniques using laboratory tools, an example system.	CO 4	R3-4.5
47	Introduction to advanced architectures: ARM	CO 5	T2-8.1
48	Introduction to advanced architectures: SHARC	CO 5	T2-8.1
49	Processor and memory organization	CO 5	T2-8.2
50	Instruction level parallelism	CO 5	T2-8.2
51	Networked embedded systems: Bus protocols	CO 6	T2-8.3
52	Networked embedded systems: I2C bus and CAN bus	CO 6	T2-8.3
53	Internet-Enabled systems	CO 6	T2-8.4
54	Design example-Elevator controller.	CO 6	T2-8.4
PROBLEM SOLVING/ CASE STUDIES			
8	BMW 850i brake and stability control system	CO 1	T2-1.4
9	Design example of model train controller	CO 1	T3-2.7
21	Embedded C program for Switch bounce	CO 2	R2-3.2
22	Embedded C program for LED interface	CO 2	R3-4.5
23	Embedded C program for Interfacing with keyboards	CO 2	T2-8.2
24	Embedded C program for Interfacing with displays	CO 2	T2-1.4
25	Embedded C program for 7 Segment Display Interfacing	CO 2	T3-2.7
26	Embedded C program for ADC Interfacing with 8051 microcontroller	CO 2	R2-3.2
27	Embedded C program for DAC Interfacing with 8051 microcontroller	CO 2	R3-4.5
45	Design of Digital camera	CO 4	T2-8.2
46	Design of Microwave oven	CO 4	T2-1.4
55	Design of Elevator controller	CO 6	T3-2.7
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Embedded computing	CO 1	T1-1.3
57	Typical embedded system and its applications	CO 1,CO 2	T3-2.4
58	RTOS fundamentals and programming	CO 3	R3-4.2
59	Embedded software development tools	CO 4	R3-4.4
60	Introduction to advanced processors	CO 5, CO 6	T2-8.3
DISCUSSION OF QUESTION BANK			
61	Embedded computing	CO 1	T1-1.3

62	Typical embedded system and its applications	CO 1,CO 2	T3-2.4
63	RTOS fundamentals and programming	CO 3	R3-4.2
64	Embedded software development tools	CO 4	R3-4.4
65	Introduction to advanced processors	CO 5, CO 6	T2-8.3

Course Coordinator **HOD,ECE**
Mr. B.Brahmaiah, Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	**10**

PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**

PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**
	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	

PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	NBA statement / Vital features (VF)	No. of VF's
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications. 1. Analyze and solve real time problems in Robotics. 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications. 3. Develop embedded systems modules using Real Time Operating System. 4. Undertake research and development projects in the field of Embedded Systems. 5. Adopt the engineering professional code and conduct.	**5**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs. 1. Inspect, survey and analyze types of ASIC chip designs. 2. Design ASIC prototypes using Verilog and VHDL languages. 3. Analyze microprocessor subsystems with memories and I/O interfacs for SOC designs 4. Explore hardware components for designig SOC 5. Adopt the engineering professional code and conduct 6. Designing prototypes of SOC using programming tools like MATLAB, LabVIEW. 7. Familiarize with the design flow of ASIC prototypes. 8. Realize SOC using Register-Transfer-Level designs 9. Analyse and develop models for system level descriptions for synthesis of SOC 10. Inspect and survey the abstractions and principles for the specification, simulation, verification, and synthesis of systems on chip (SoC) 11. Programming and hands-on skills to meet requirements of global environment.	**11**
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications. 1. Explicit software and programming tools for antenna design. 2. Adopt technical library resources and literature search. 3. Explore smart antennas. 4. Model, program for operation and control of smart antennas for wireless communication applications. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Course Title	**INTELLECTUAL PROPERTY RIGHTS**				
Course Code	AHSC19				
Program	B.Tech				
Semester	VII	ECE			
Course Type	Open Elective				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Prashant Bachanna, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	-	-	-

II COURSE OVERVIEW:

This course provides the trade related intellectual property rights and investment measures. This course emphesis on how to avail the intellectual property rights of the inventors or owners for their assets like patents on innovative design, copy rights on literary and artistic works, trademark on goods & services and geographical indiactions on products famous for specific geographical areas.This course makes use of the potential future economic benefits to the intellectual property owner or authorized user.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Intellectual Property Rights	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with ”either” or ”choice” will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
50%	Understand
42 %	Apply
8 %	Analyze
0%	Evaluate
0%	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

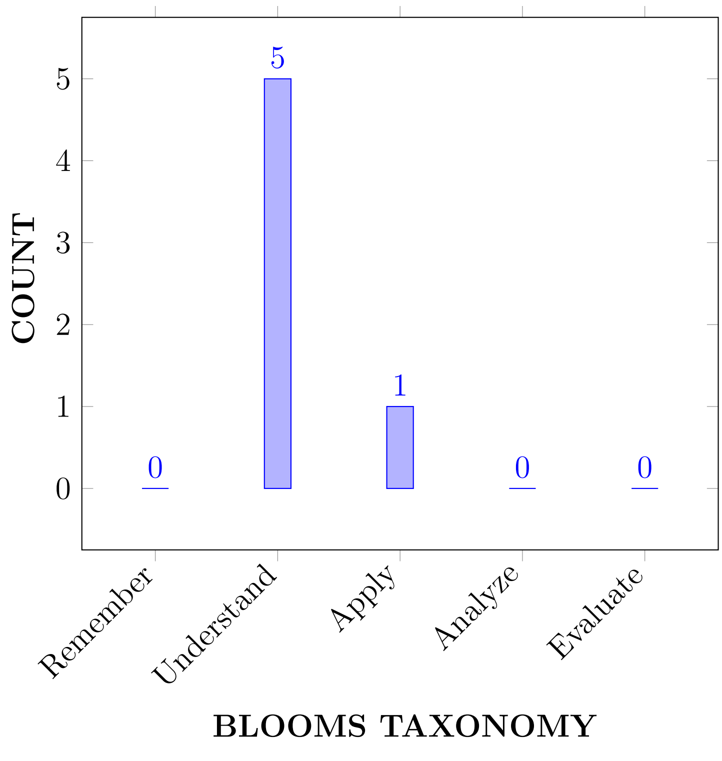
I	The knowledge on world trade organization, trade agreements and investments.
II	The importance of intellectual property rights to develop trade mark law, copy right law and patent law.
III	The new developments in the law of intellectual property rights in order to bring progressive changes towards a free market society and international trade practices under the Trade Related Intellectual Property Rights Agreement (TRIPS)

VII COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Summerize** the general agreement on tariffs and trade (GATT) eight rounds for the substantial reduction of tariffs and other barriers of trade.	Understand
CO 2	**Relate** the world trade organization agreements for trade related intellectual property rights and investments.	Understand
CO 3	**Elaborate** the involvement of World Intellectual Property Organization to promote the protection of intellectual property throughout the world.	Understand
CO 4	**Demonstrate** the legal procedure and document for claiming patent of invention.	Understand
CO 5	**Illustrate** the different geographical Indications of products which corresponding to specific location for aviling brand of location to products .	Understand
CO 6	**Identify** different types of intellectual properties,the right of ownership,scope of protection to create and extract value from IP.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Program Outcomes	
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 6	**The engineer and society:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/Quiz/AAT

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	3	Seminar
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear.	2	Seminar
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	1	Seminar

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	**Build** Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	-	-
PSO 2	**Focus** on the Application Specific Integrated Circuit (ASIC) prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	-	-
PSO 3	**Make use of** High Frequency Structure Simulator (HFSS) for modeling and evaluating the patch and smart antennas for wired and wireless communication applications.	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 2	-	-	-	-	-	✓	-	-	-	✓	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	✓	-	✓	-	-	-	-	-
CO 4	-	-	-	-	-	✓	-	✓	-	✓	-	✓	-	-	-
CO 5	✓	-	-	-	-	-	-	✓	-	✓	-	✓	-	-	-
CO 6	✓	-	-	-	-	✓	-	✓	-	✓	-	✓	-	-	

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Identify** different types of Intellectual Properties (IPs), the right of ownership in **scientific principles and methodolgy** , scope of protection as well as the ways to create and to extract value from IP	1
	PO 10	**Describe** the intellectual property rights of ownership and **communicate effectivly(speaking style)** in concept video or tech talk	1
CO 2	PO 6	**Explain** WTO agreements helpful for **engineering activities to promot sustainable development** and **legal requirements** in new product and service development.	2
	PO 10	**Describe** the importance of WTO agreements for trade related intellectual property rights **communicate effectively(speaking style)** in tech-talk	1
CO 3	PO 8	**Demonstrate the ethical behaviour** and **responsibilities** of world intellectual property organization and its **degree of trust and integrity** to protect intellectual property rights of the owner	3
	PO 10	**Describe** the support of WIPO in connection with intellectual property rights and **communicate effectivly(speaking style)** in tech-talk	1
CO 4	PO 6	**Explore the knowledge and understanding of commercial** management of IP and **identify the highlevel of professional conduct** of intellectual property management for claiming patent of invention	2
	PO 8	**Explain** how to prepare the **ethical** document for patent of invention by following **legal belief** and **high degree of trust and integrity**	3
	PO 10	**Describe** the steps involved in patent filing in india namely drafting, filing the patent application**(writing)** and **communicate effectivly(speaking style)** in concept video and tech-talk.	2
	PO 12	**Understand** the need of **advanced engineering concepts** interms of **ongoing learning** which is suitable to intellectual work.	2
CO 5	PO 1	**Explore** on the **engineering scientific principles** and **mathematical principles** which are helpful for availing geographical indication and procedure for applying geographical indications of products of specific locations	2
	PO 8	**Extend** on various IPR components to **make ethical production** and process of filing a document for geographical indication by following **professional ethics** and **integrity of resourse of region** .	3
	PO 10	**Describe** the geographical indiaction for famous products in a given location and **communicate effectively(speaking style)** in tech-talk.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 12	**Understand** the need of **advanced engineering concepts** interms of **ongoing learning** which is suitable to get permission for geographical indication of products.	2
CO 6	**PO 1**	**Explore** the **engineering knowledge** which is useful for preparing the trademark and then **apply methodology** for trade mark based on trademark and merchandise act 1958 which prevents misuse of marks.	2
	PO 6	**Illustrate** international copyright law with respect to ownership and registration of copyright by following the awareness of **legal requirements**. Understand the **professional and ethical conduct** to get copy right for literary and artistic works	2
	PO 8	**Summarize** the trade mark and trade secrets **with knowledge of professional ethics** and **integrity** protection before submitting application to trademark office. **Demonstrate the ethical behaviour**of stoping illegal trademark	3
	PO 10	**Describe** the IPR to get trademark for unique marks and copy right**(for literature writing)** for new artistic works and and **communicate effectively(speaking style)** in tech-talk.	2
	PO 12	**Analyze** the the **project mangement** for international developments in trademarks law , copyright law and patent law. **Significant skills** are applied to get intellectual property rights.	2

Note: For Key Attributes refer **Annexure - I**

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	-	-	-	-	-	2	-	-	-	1	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	3	-	1	-	-	-	-	-
CO 4	-	-	-	-	-	2	-	3	-	2	-	2	-	-	-
CO 5	2	-	-	-	-	-	-	3	-	2	-	2	-	-	-
CO 6	2	-	-	-	-	2	-	3	-	2	-	2	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	33.3	-	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 2	-	-	-	-	-	40	-	-	-	20	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	100	-	20	-	-	-	-	-
CO 4	-	-	-	-	-	40	-	100	-	40	-	25	-	-	-
CO 5	66.7	-	-	-	-	-	-	100	-	40	-	25	-	-	-
CO 6	66.7	-	-	-	-	40	-	100	-	40	-	25	-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -$5 < C \leq 40\%$ – Low/ Slight

2 - $40\% < C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	-	-	-	-	-	2	-	-	-	1	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	3	-	1	-	-	-	-	-
CO 4	-	-	-	-	-	2	-	3	-	2	-	1	-	-	-
CO 5	3	-	-	-	-	-	-	3	-	2	-	1	-	-	-
CO 6	3	-	-	-	-	2	-	3	-	2	-	1	-	-	-
Total	7	-	-	-	-	6	-	12	-	9	-	3	-	-	-
Average	**2.3**	-	-	-	-	**2**	-	**3**	-	**1.5**	-	**1**	-	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments					

XVII ASSESSMENT METHODOLOGY-INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of mini projects by experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION**
	General agreement on tariffs and trade (GATT) eight rounds: Uruguay round, world trade organization: structure, technology transfer, dispute resolution mechanism, Doha declaration world trade organization agreements including trade related intellectual properties rights and trade related investment measures.
MODULE II	**WORLD INTELLECTUAL PROPERTY ORGANIZATION**
	Paris convention, Bern convention, Budapest treaty, Madrid agreement, hague agreement.
MODULE III	**INTELLECTUAL PROPERTY RIGHTS AND PROTECTIONS**
	Patents, the patenting process, patent cooperation treaties: International treaties and conventions on IPRs. Patent act of India, patent amendment act, design act, trademark act, and geographical indication act. Digital innovations and developments as knowledge assets – IP laws, cyber law and digital content protection.
MODULE IV	**ROLL OF PATENTS AND GEOGRAPHICAL INDICATIONS**
	Patents, patentable and non-patentable inventions. Legal requirements for patents, types of patent applications, patent document: specification and claims, important procedural aspects. Geographical indication: definition, what can be registered, who can apply, rights, term, restrictions. Case studies of patent infringement, design and geographical indications.
MODULE V	**TRADEMARK AND COPYRIGHTS**
	Definition, classification of trademarks, classifications of goods and services, Vienna classification, trademarks procedure, trademarks enforcement: infringement and passing off, remedies, copyrights, term of copyrights, and procedure of copyright assignment of copyright, copyright infringement remedies. Case studies of trademark and copy rights.

TEXTBOOKS

1. P. K. Vasudeva,World Trade Organization: Implications on Indian Economy, Pearson Education,2015.
2. P.KrishnaRao, WTO, Text and cases, Excel Books, 2015.
3. Carlos M.Correa- Intellectual property rights, The WTO and Developing countries-Zed books

REFERENCE BOOKS:

1. Yuan S W, “Foundations of fluid Mechanics”, Prentice-Hall, 2nd Edition, 1987.

WEB REFERENCES:

1. Caves, Frankel, Jones, World Trade and Payments-An Introduction, Pearson4. Education, 2015.
2. Carlos M.Correa- Intellectual property rights, The WTO and Developing countries-Zed books.
3. Peter-Tobias stoll, Jan busche, Katrianarend- WTO- Trade –related aspects of IPR-Library of Congress

COURSE WEB PAGE:

https://lms.iare.ac.in/index?route=course/details&course_id=367

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping		
CONTENT DELIVERY (THEORY)			
1	General agreement on tariffs and trade (GATT) eight rounds	CO 1	T1:1.4-1.5
2	Uruguay round	CO 1	T1:1.4-1.5
3	World trade organization: structure	CO 1	T1:2.4-2.5
4	Technology transfer	CO 1	T1:2.4-2.5
5	Dispute resolution mechanism	CO 1	T1:2.4-2.5
6	Doha declaration	CO 2	T1:2.6-2.6.8; R2: 5.8-5.10
7	world trade organization agreements	CO 2	T1:2.6-2.6.8; R2: 5.8-5.10
8	Trade related intellectual properties rights	CO 2	T1:3.1-3.6
9	Paris convention	CO 2	T1:3.1-3.6
10	Bern convention	CO 2	T1:3.1-3.6
11	Budapest treaty	CO 2	T1:3.1-3.6
12	Madrid agreement	CO 3	T1:3.1-3.6
13	Hague agreement	CO 3	T1:3.1-3.6
14	Historical background of intellectual property rights	CO 3	T1:3.1-3.8
15	introduction, definition and classification of intellectual property	CO 3	T1:3.1-3.8
16	Patents, patentable and non-patentable inventions	CO 3	T1:3.1-3.8
17	Legal requirements for patents	CO 3	T1:3.1-3.8; R2: 7.4-7.5
18	Types of patent applications	CO 3	T1:3.1-3.8; R2: 7.4-7.5

19	patent document: specification and claims	CO 3	T1:3.1-3.8; R2: 7.4-7.5
20	important procedural aspects	CO 3	T1:3.1-3.8; R2: 7.4-7.5
21	management of intellectual property rights assets	CO 4	T1:4.1-4.6
22	intellectual property portfolio	CO 4	T1:4.1-4.6
23	Commercial exploitation of intellectual property	CO 4	T1:4.1-4.6
24	Designs: basic requirements	CO 4	T1:4.1-4.6
25	Designs: Procedure	CO 4	T1:4.1-4.6
26	Designs: Convention application term, date	CO 5	T1:10.1-10.6
27	Geographical indication: definition	CO 5	T1:10.1-10.6
28	What can be registered	CO 5	T1:10.1-10.6
29	Who can apply	CO 5	T1:10.1-10.6
30	Rights, term, restrictions	CO 5	T1:10.1-10.6 ; T1:9.1-9.6
31	TRADEMARK AND COPYRIGHTS: Definition, classification of trademarks	CO 5	T1:10.1-10.6; T1:9.1-9.6
32	Classifications of goods and services	CO 5	T1:9.1-9.6
33	Vienna classification	CO 5	T1:9.1-9.6
34	Trademarks procedure	CO 5	T1:9.1-9.6
35	Trademarks enforcement: infringement and passing off , remedies	CO61	T1:8.1-8.3 ; R2: 7.4-7.5
36	copyrights, term of copyrights	CO 6	T1:8.1-8.3; R2: 7.4-7.5
37	procedure of copyright	CO 6	T1:8.1-8.3; R2: 7.4-7.5
38	Assignment of copyright	CO 6	T1-8.1-8.1.7

39	Copyright infringement remedies	CO 6	T1-8.1-8.1.7
40	Copyright infringement remedies	CO 6	T1-8.1-8.1.7
PROBLEM SOLVING/ CASE STUDIES			
1	Trademarks	CO 2	T1:2.6-2.6.8; R2: 5.8-5.10
2	Copyrights	CO 3	T1:3.1-3.6
3	Which are the types of geographical indication/?	CO 2	T1:3.1-3.6
4	How many geographical indications are there in India/?	CO 2	T1:3.1-3.6
5	What means intellectual property/?	CO 3	T1:3.1-3.6
6	What is IPR and its features/?	CO 3	T1:3.1-3.8
7	What is a violation of intellectual property/?	CO 3	T1:3.1-3.8
8	What is trademark with example/?	CO 3	T1:4.1-4.6
9	What are the two categories of intellectual property/?	CO 3	T1:4.1-4.6
10	What happened in the Uruguay Round/?	CO 4	T1:4.1-4.6
11	What was a result of the Uruguay Round quizlet/?	CO 5	T1:10.1-10.6
12	What is the purpose of WIPO/?	CO 5	T1:10.1-10.6
13	How many countries are in WIPO/?	CO5	T1:10.1-10.6
14	What is the difference between a geographical indication and a trademark/?	CO 6	T1:8.1-8.3; R2: 7.4-7.5
15	What trademark means/?	CO 6	T1:8.1-8.3; R2: 7.4-7.5
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	What is World Trade Organization (WTO)/?	CO 1	T1:1.4-1.5
2	What is the purpose of WIPO/?	CO 3	T1:3.1-3.8
3	What means intellectual property/?	CO 4	T1:4.1-4.6
4	What do you mean by geographical indications/?	CO 5	T1:10.1-10.6

5	What trademark means/?	CO 6	T1:8.1-8.3; R2: 7.4-7.5
DISCUSSION OF QUESTION BANK			
1	Explain why agencies responsible for intellectual property registration with any two examples.	CO 2	T1:1.4-1.5
2	What is patent/? How the patents are related with intellectual property rights/?	CO 3	T1:3.1-3.8
3	Explain with one real time example the patentable and non-patentable inventions.	CO 4	T1:3.1-3.8; R2: 7.4-7.5
4	How intellectual property is helpful to the society and what are the legal requirements are needed for patents/?	CO 5	T1:10.1-10.6
5	What is the most important criteria for an applicant who seek to register a geographical indication/?	CO 6	T1:8.1-8.3; R2: 7.4-7.5

Signature of Course Coordinator **HOD,ECE**
Prashant Bachanna, Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES/ PROGRAM SPECIFIC OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**

	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**

	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**
PSO 1	Build Embedded Software and Digital Circuit Development platformfor Robotics, Embedded Systems and Signal Processing Applications. 1. Analyze and solve real time problems in Robotics. 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications 3. Develop embedded systems modules using Real Time Operating System. 4. Undertake research and development projects in the field of Embedded Systems. 5. Adopt the engineering professional code and conduct	**5**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototypedesigns, Virtual Instrumentation and System on Chip (SOC) designs.. 1. Inspect, survey and analyze types of ASIC chip designs. 2. Design ASIC prototypes using Verilog and VHDL languages. 3. Analyze microprocessor subsystems with memories and I/O interfacs for SOC designs 4. Explore hardware components for designig SOC 5. Adopt the engineering professional code and conduct 6. Designing prototypes of SOC using programming tools like MATLAB, LabVIEW. 7. Familiarize with the design flow of ASIC prototypes. 8. Realize SOC using Register Transfer-Level designs 9. Analyse and develop models for system level descriptions for synthesis of SOC 10. Inspect and survey the abstractions and principles for the specification, simulation, verification, and synthesis of systems on chip (SoC) 11. Programming and hands-on skills to meet requirements of global environment.	**11**

PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications. 1. Explicit software and programming tools for antenna design. 2. Adopt technical library resources and literature search. 3. Explore smart antennas. 4. Model, program for operation and control of smart antennas for wireless communication applications. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Electronics and Communication Engineering**				
Course Title	**Microcontrollers and Applications**				
Course Code	AECC60				
Program	B.Tech				
Semester	VII				
Course Type	Elective				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Mr. A.Prashanth, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECB07	III	Digital System Design
B.Tech	AECC19	V	Microprocessors and Microcontrollers

II COURSE OVERVIEW:

Microcontroller cores are the key components in most of the modern embedded and system on-chip designs. This course outlines the architecture and signal description of 8 bit and 16 bit microcontrollers and I/O devices interfacing with microcontrollers for real time applications. This course will enable the students in development of embedded hardware projects and models for engineering and scientific applications.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Microcontrollers and Applications	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
✓	Open Ended Experiments	✓	Tech talk	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
50%	Understand
50%	Apply
0%	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

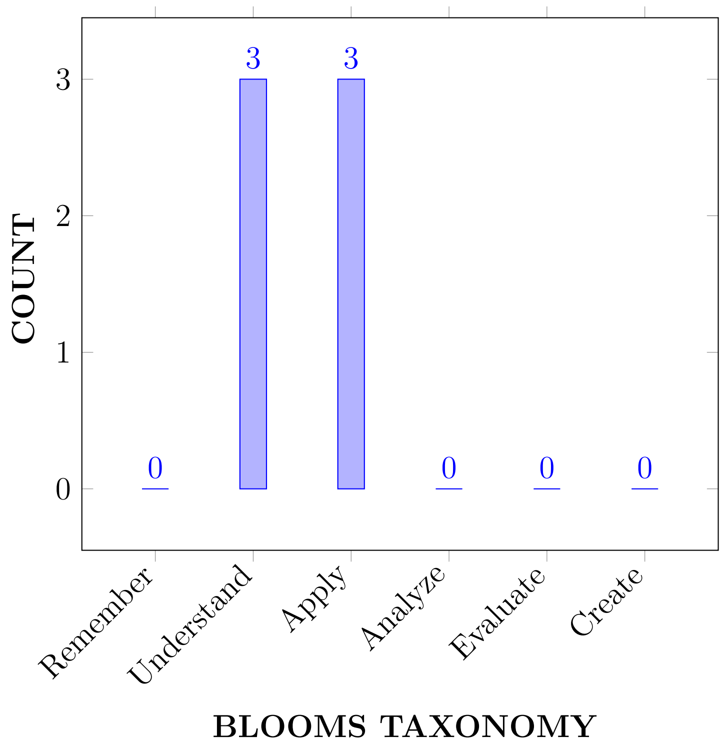
I	The signal descriptions along with functional architecture and hardware interfacing skills using microprocessors and micro controllers.
II	The instruction set and logic to build assembly language programs for arithmetic, logic and automated electronic systems.
III	The essential concepts of development through a practical hands-on approach on advanced ARM processors and Internet of Things based systems.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Demonstrate** the internal architecture and modes of operation of peripheral devices for interfacing memory and I/O devices.	Understand
CO 2	**Make use of** addressing modes and instruction set of target microcontrollers for writing efficient assembly language programs.	Apply
CO 3	**Describe** the features of intel processors and microcontrollers for signal description and architecture.	Understand
CO 4	**Illustrate** the interrupt handling mechanism in microcontrollers using interrupt controller.	Understand
CO 5	**Choose** an appropriate data transfer scheme and hardware for data transfer between the devices.	Apply
CO 6	**Develop** micro controller based applications using appropriate input and output devices.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations

Program Outcomes	
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE, CIE, AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	SEE, CIE, AAT

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	SEE, CIE, AAT
PO 10	**Communication:** Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	SEE, CIE, AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build embedded software and digital circuit development platform for robotics, embedded systems and signal processing applications.	3	AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	✓	-	-	-	-	-	-	-	-	✓	-		-	-	-
CO 2	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 3	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-
CO 4	-	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-
CO 5	-	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-
CO 6	✓	✓	✓	-	-	-	-	-	-	✓	-	-	✓	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Describe the features and architectures of Intel 8086 processor and Intel 8051 microcontroller (knowledge) by applying the knowledge of **mathematics, Engineering fundamentals,** and electronics **engineering specialization** for understanding the operation.	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 10	Explain the functional components of microprocessors and microcontrollers by **giving effective presentations and clear instructions** for understanding the operation of architectures.	1
CO 2	PO 1	Illustrate instructions from the set library (knowledge) for efficient assembly level programming by applying the knowledge of **science, engineering fundamentals and mathematics.**	3
	PO 2	Select proper instructions from the instruction set by **Information and data collection** for **Solution development** by writing assembly language level programming efficient and **Interpretation of results**	3
	PO 3	**Manage the design process** and make use of **creativity to establish solutions** by selecting proper mnemonics to write the assembly language level programming by **Understanding of the requirement for engineering activities to promote sustainable development.**	3
	PO 10	Utilize addressing modes and instruction set of target microprocessors and micro controllers micro controllers by **with clarity.**	1
	PSO 1	Develop software program skills to write efficient programs by **understanding the performance parameters** of software/ Hardware systems for **robotics, embedded systems and signal processing applications**	2
CO 3	PO 1	Illustrate the internal architecture and modes of operation of peripheral devices like PPI, DMA controller, PIC, USART by applying the principles of **mathematics, engineering fundamentals, electronics engineering specialization** for the solution of complex engineering problems.	3
	PO 2	Explain the **Problem statement and system definition** for interfacing devices with microprocessor and microcontroller by **Information and data collection** using peripheral devices like PPI, DMA controller, PIC, USART for **Solution development** and **Interpret the results**	4
	PO 3	**Manage the design process and evaluate outcomes** by interfacing devices with microprocessor and microcontroller using Programmable Peripheral Interface (PPI) and Interrupt Controllers **to establish innovative solutions** by**Understanding of the requirement for engineering activities to promote sustainable development**	3
	PO 10	Describe the internal architecture and modes of operation of peripheral devices by **giving effective presentations.** for interfacing memory and I/O devices.	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 4	PO 2	Explain the functionality of various types of interrupts and their structure with **Information and data collection** for controlling the processor or controller with program execution flow and**Interpret the results** for **solution development** using interrupt controller.	3
	PO 3	**Understand the requirement for engineering activities to promote sustainable development** in Interrupt handling and **use creativity to establish innovative solutions** using interrupt controller by **Managing the design process and evaluate outcomes**	3
	PO 10	Explain the interrupt handling mechanism in microprocessors and micro controllers with **clarity.**	1
CO 5	PO 2	Formulate and analyze (Problem analysis) **complex Engineering problems** by differentiating synchronous & asynchronous communication with **Information and data collection** for data transfer between the devices using first principles of **mathematics and Engineering sciences** and then **Interpret the results**	4
	PO 3	**understand the customer and user needs** and select an appropriate data transfer scheme and hardware by **Managing the design process and evaluate outcomes** to **promote sustainable development** for data transfer between the devices **using creativity to establish innovative solutions**	4
	PO 10	Select an appropriate data transfer scheme and hardware by **giving effective presentations and receive clear instructions** for data transfer between the devices.	1
CO 6	PO 1	Build (Apply)necessary hardware and software interface using microcomputer based systems to provide solution for real world problems by applying **knowledge of mathematics, engineering fundamentals, engineering specialization.**	3
	PO 2	**Identify problem** and Choose necessary hardware and software interface **(information and data collection)** and conduct **experimental design** with **model translation** to provide **solution development** for real world problems **by interpreting results.**	6

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 3	Organize necessary hardware and software interface **based on user needs and importance of considerations** for **innovative solutions, of the problem including all aspects to manage design process** , in microcomputer based systems **by applying different techniques, to achieve required sustained development, with legal requirements governing engineering activities, including personnel, health, safety, and risk issues.**	6
	PO 10	Build micro processor and micro controller based applications using necessary input and output devices and **give effective oral presentations and instructions.**	1
	PSO 1	Develop microprocessor and microcontroller based applications in the fields of r**obotics and embedded systems** using **embedded software** and necessary input output devices.	2

Note: For Key Attributes refer **Annexure - I**

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	3	3	-	-	-	-	-	-	1		-	2	-	-
CO 3	3	4	3	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	-	3	3	-	-	-	-	-	-	1	-	-	-	-	-
CO 5	-	4	4	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	3	6	6	-	-	-	-	-	-	1	-	-	2	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	100	-	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 2	100	30	30	-	-	-	-	-	-	20	-	-	40	-	-
CO 3	100	40	30	-	-	-	-	-	-	20	-	-	-	-	-
CO 4	-	30	30	-	-	-	-	-	-	20	-	-	-	-	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 5	-	40	40	-	-	-	-	-	-	20	-	-	-	-	-
CO 6	40	60	60	-	-	-	-	-	-	20	-	-	40	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq$ C$\leq$ 5% – No correlation

1 -5 <C$\leq$ 40% – Low/ Slight

2 - 40 % <C < 60% –Moderate

3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	1	1	-	-	-	-	-	-	1	-	-	3	-	-
CO 3	3	2	1	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	-	1	1	-	-	-	-	-	-	1	-	-	-	-	-
CO 5	-	2	2	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	3	3	3	-	-	-	-	-	-	1	-	-	3	-	-
TOTAL	**12**	**9**	**8**	-	-	-	-	-	-	6	-	-	**6**	-	-
AVERAGE	**3**	**1.8**	**1.6**	-	-	-	-	-	-	1	-	-	**3**	-	-

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	-
Quiz	-	Tech - Talk	✓	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	✓	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**OVERVIEW OF ARCHITECTURE AND MICROCONTROLLER RESOURCES**
	Architecture of a microcontroller, Microcontroller resources, Resources in advanced and next generation microcontrollers, 8051 microcontroller –Internal and External memories, Counters and Timers, Synchronous and asynchronous serial communication, Interrupts, Instruction set of 8051 microcontroller, Basic assembly language programming.
MODULE II	**REAL TIME CONTROL**
	Interrupts: Interrupt handling structure of an MCU, Interrupt Latency and Interrupt deadline, Multiple sources of the interrupts, Non-maskable interrupt sources, Enabling or disabling of the sources, Polling to determine the interrupt source and assignment of the priorities among them, Interrupt structure in Intel 8051. TIMERS : Programmable Timers in the MCU's, Free running counter and real time control, Interrupt interval and density constraints.
MODULE III	**SYSTEMS DESIGN**
	Digital And Analog Interfacing Methods: Switch, Keypad and Keyboard interfacings, LED and Array of LEDs, Keyboard/ Display controller (8279), Alphanumeric Devices, Display Systems and its interfaces, Printer interfaces, Programmable instruments interface using IEEE 488 Bus, Interfacing with the Flash Memory. Interfaces – Interfacing to High Power Devices, Analog input interfacing, Analog output interfacing, Optical motor shaft encoders, Industrial control, Industrial process control system, Prototype MCU based Measuring instruments, Robotics and Embedded control, Digital Signal Processing and Digital Filters.
MODULE IV	**REAL TIME OPERATING SYSTEM FOR MICROCONTROLLERS**
	Real Time operating system, RTOS of Keil (RTX51), Use of RTOS in Design, Software development tools for Microcontrollers.
MODULE V	**16-BIT MICROCONTROLLERS**
	Hardware – Memory map in Intel 80196 family MCU system, IO ports, Programmable Timers and High-speed outputs and input captures, Interrupts – instructions.ARM 32 Bit MCUs : Introduction to 16/32 Bit processors, ARM architecture and organization, ARM / Thumb programming model, ARM / Thumb instruction set, Development tools.

TEXTBOOKS

1. Raj Kamal, "Microcontrollers Architecture, Programming, Interfacing and System Design", Pearson Education, 2005.

2. Mazidi and Mazidi, "The 8051 Microcontroller and Embedded Systems , PHI, 2000.

REFERENCE BOOKS:

1. A.V. Deshmuk, "Microcontrollers (Theory & Applications)", WTMH, 2005.

2. John B. Peatman, "Design with PIC Microcontrollers", Pearson Education, 2005.

WEB REFERENCES:

1. https://www.vectorindia.org 8051 microcontroller

2. https://www.digikey.in

COURSE WEB PAGE:

1. http://engineersevanigam.blogspot.in/2013/07/Microcontroller-by.html
2. https://www.scribd.com/doc/153593067/Microcontroller-by-A-P-Godse-D-A-Godse

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	https://lms.iare.ac.in/index?route=course/details&course_id=135
CONTENT DELIVERY (THEORY)			
2	Architecture of a microcontroller	CO 1	T1:1.1 R2:1.3
3	Microcontroller resources	CO 1	T1:1.2 R2:1.1,6.1
4	Resources in advanced and next generation microcontrollers,	CO 1	T1:1.5,1.6,1.7
5	8051 microcontroller Internal and External memories	CO 1	T1:1.8 R2:6.3
6	Counters and Timers	CO 2	T1:2.1 R2:3.1
7	Synchronous serial communication	CO 2	T1:2.3 R2:3.2
8	Asynchronous serial communication	CO 2	T1: 2.3 R2:3.4,3.5
9	Interrupts	CO 2	T1: 2.3 R2:3.7
11	Instruction set of 8051 microcontroller	CO 2	T1: 2.3 R2:3.6
12	Basic assembly language programming	CO 2	T1: 2.3 R2:4.1
13	Interrupts	CO 1	T1:4.1,4.2
14	Interrupt handling structure of an MCU, Interrupt Latency and Interrupt deadline	CO 3	T1:5.3
15	Multiple sources of the interrupts	CO 4	T1:4.3 R2:8.1
16	Non-maskable interrupt sources	CO 6	T1:5.6,5.7 R2:9.8,9.9
17	Enabling or disabling of the sources	CO 6	T1:5.9

18	Polling to determine the interrupt source and assignment of the priorities among them, Interrupt structure in Intel 8051.	CO 4	T1:6.2 R2:10.3
19	TIMERS : Programmable Timers in the MCUs	CO 6	T1:6.3 R2:10.2
24	Free running counter and real time control	CO 5	T1:6.4 R2:11.3
25	Interrupt interval and density constraint	CO 3	T1:7.1 R2:11.6
26	Digital And Analog Interfacing Methods: Switch, Keypad and Keyboard interfacings	CO 1	T1:17.2 R2:20.1
27	LED and Array of LEDs	CO 2	T1:17.3
28	Keyboard/ Display controller (8279)	CO 1	T1:17.4 R2:19.10
29	Alphanumeric Devices, Display Systems and its interfaces, Printer interfaces	CO 5	T1:17.6 R2:20.6
30	Programmable instruments interface using IEEE 488 Bus	CO 4	T1:17.7 R2:20.5
31	Interfacing with the Flash Memory	CO 1	T3:1.1 to 1.4
33	Interfaces – Interfacing to High Power Devices, Analog input interfacing,	CO 1	T3:2.1 to 2.4
34	Analog output interfacing	CO 1	T3:2.1 to 2.4
35	Optical motor shaft encoders, Industrial control	CO 1	T3:2.1 to 2.2
36	Industrial process control system	CO 1	T3:2.3 R2:10.3
38	Prototype MCU based Measuring instruments,	CO 1	T3:2.4 to T3:2.8
40	Robotics and Embedded control, Digital Signal Processing and Digital Filters	CO 1	T3:3.1 to T3:3.2
41	Real Time operating system,	CO 1	T3:3.1 to T3:3.3
42	RTOS of Keil (RTX51)	CO 1	T3:3.1 to T3:3.3
43	Use of RTOS in Design	CO 1	T3:3.4 to T3:3.5
44	Software development tools for Microcontrollers.	CO 1	T3:3.6 to T3:3.7
45	Hardware – Memory map in Intel 80196 family MCU system, IO ports,	CO 1	T3:3.7 to T3:3.8
46	Programmable Timers and High-speed outputs and input captures	CO 1	T3:1.3 to 1.4
47	Interrupts – instructions.	CO 1	T3:1.3 to 1.4
48	ARM 32 Bit MCUs : Introduction to 16/32 Bit processors, ARM architecture and organization	CO 1	T3: 2.1 to 2.2
49	ARM / Thumb programming model, ARM / Thumb instruction set, Development tools.	CO 1	T3: 2.3 to 2.3.1

PROBLEM SOLVING/ CASE STUDIES			
6	Physical address calculation	CO 1	T1:1.1 R2:1.1
20	Assembly language programs For Sorting of numbers using 8086 microprocessor	CO 2	T1:3.4 R2:4.7
21	Assembly language programs for multibyte addition and subtraction, sum of squares using 8086 microprocessor	CO 2	T1:3.4 R2:4.7
22	Assembly language programs for String manipulations using 8086 microprocessor	CO 2	T1:3.4 R2:4.1
23	Assembly language programs for Code conversions using 8086 microprocessor	CO 2	T1:3.4 R2:4.4,4.5
28	Memory interfacing to 8086 microprocessor (Static RAM)	CO 3	T1:5.1 R2:12.2,12.3
29	Memory interfacing to 8086 microprocessor (EPROM)	CO 3	T1:5.2 R2:12.4
32	Interfacing A/D and D/A converters with 8086 microprocessor	CO 6	T1:5.6,5.7 R2:9.8,9.9
34	Assembly language programs to rotate stepper motor in clockwise and anticlock wise direction	CO 2	T1:5.8 R2:9.11
37	Cascading of Interrupt Controller and its importance, interfacing 8259 PIC with 8086 microprocessor	CO 4	T1:6.2 R2:10.3,10.4
39	Interfacing keyboard /display controller 8279 to 8086 microprocessor	CO 6	T1:6.3 R2:10.2
41	Interfacing programmable communication interface 8251 USART to 8086 microprocessor	CO 5	T1:6.4 R2:11.3
47	Assembly language programming using data transfer, arithmetic, logical and branch instructions	CO 2	T1:17.8 R2:19.3
51	Real world interfacing of 8051 microcontroller with external memory	CO 6	T1:17.6 R2:20.2
52	Interfacing 8051 microcontroller with LCD	CO 6	T1:17.9 R2:21.3
53	Interfacing 8051 microcontroller with ADC and DAC	CO 6	T1:17.9 R2:21.1
DISCUSSION OF DEFINITION AND TERMINOLOGY			
54	8051 microcontroller	CO 1, CO 2	T1, R2
55	Interfacing Devices	CO 1, CO 2, CO 4	T1, R2
56	microcontroller Applications	CO 2, CO 3,	T1, R2
57	System design using microcontroller	CO 1, CO 2,	T1, R2
58	ARM Architecture	CO 3, CO 4,	T1, R2

DISCUSSION OF QUESTION BANK			
59	Architecture of a microcontroller	CO 1, CO 2	T1, R2
60	Programmable Timers in the MCU	CO 2, CO 4	T1, R2
61	Memory interfacing to 8086 microprocessor	CO 2, CO 5	T1, R2
62	Interfacing programmable communication interface	CO 1, CO 2	T1, R2
63	ARM Architecture and applications	CO 4, CO 5	T1, R2

Signature of Course Coordinator
Mr. A.Prashanth, Assistant Professor **HOD, ECE**

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**

	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**

	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions **(Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments **(Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications 1. Analyze and solve real time problems in Robotics. 2. . Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications 3. Develop embedded systems modules using Real Time Operating System 4. Undertake research and development projects in the field of Embedded Systems. 5. Adopt the engineering professional code and conduct	**5**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs 1. Inspect, survey and analyze types of ASIC chip designs. 2. Design ASIC prototypes using Verilog and VHDL languages. 3. Analyze microprocessor subsystems with memories and I/O interfaces for SOC designs 4. Explore hardware components for designig SOC 5. Adopt the engineering professional code and conduct/ new technology 6. Designing prototypes of SOC using programming tools like MATLAB, LabVIEW 7. Familiarize with the design flow of ASIC prototypes. 8. Realize SOC using Register-Transfer-Level designs. 9. Analyse and develop models for system level descriptions for synthesis of SOC. 10. Inspect and survey the abstractions and principles for the specification, simulation, verification, and synthesis of systems on chip (SoC) 11. Programming and hands-on skills to meet requirements of global environment.	**11**

PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications 1. Explicit software and programming tools for antenna design. 2. Adopt technical library resources and literature search. 3. Explore smart antennas. 4. Model, program for operation and control of smart antennas for wireless communication applications. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**ELECTRONICS AND COMMUNICATION ENGINEERING**				
Course Title	**VLSI Design**				
Course Code	AECC44				
Program	B.Tech				
Semester	VII				
Course Type	Core				
Regulation	IARE-R20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mr V.R.Seshagiri Rao, Associate Professor, ECE				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECC03	III	Digital System Design
B.Tech	AECC12	IV	Integrated Circuits Applications

II COURSE OVERVIEW:

This course introduces students about the fabrication techniques of design and implementation of very large scale (VLSI) circuits. Specific topics include: CMOS logic, MOSFET theory, design rules & layout procedures and logic and circuit simulations. The course further gives information on data path subsystems, PLD's performance parameters and testing approaches for the circuits.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
VLSI design	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage

in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
66.6%	Understand
16.6 %	Apply
16.6 %	Analyze
0%	Evaluate
0%	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Videos	Tech-talk	Open Ended Experiment
50%	50%	-

VI COURSE OBJECTIVES:

The students will try to learn:

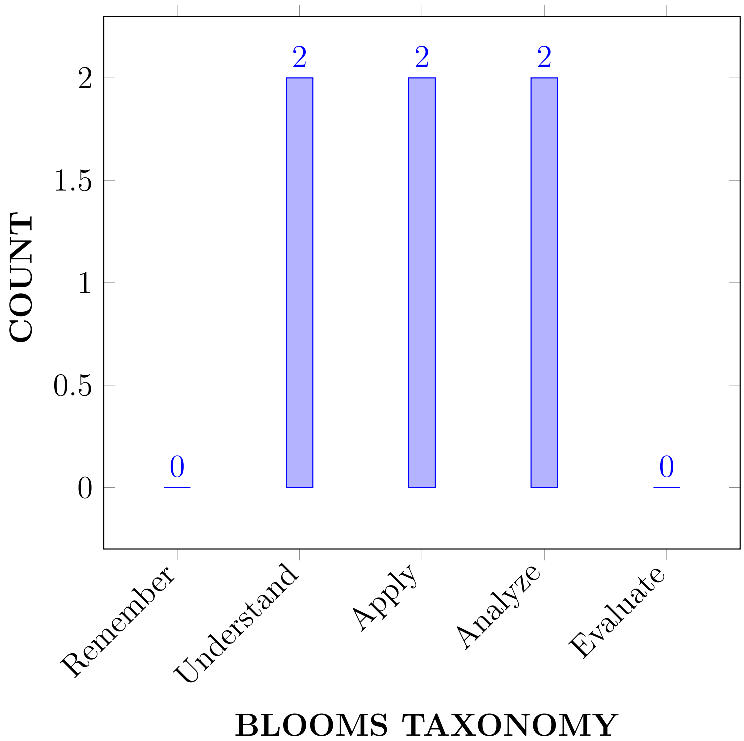
I	The aspects of hierarchical VLSI design from the metal oxide semiconductor transistor up to the system level, fabrication and testing.
II	The subsystem design incorporating into a VLSI chip with contemporary techniques for achieving high-speed, low-power and low area overhead.
III	Advanced modern tools such as vivado and cadence for front end and back end for chip design through a practical approach.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Summarize** the MOSFET fabrication process , electrical properties and scaling for understanding latest developments in VLSI.	Understand
CO 2	**Make use of** stick diagrams and layout designs to convey layer information in MOSFET circuits.	Apply
CO 3	**Analyze** inverters, complex gates and dynamic CMOS circuits to calculate power consumption, distortion and speed of operation	Analyze
CO 4	**Illustrate** data path subsystems and array subsystems using stick diagrams and layouts.	Apply
CO 5	**Outline** the role of Programmable logic devices for realization of complex boolean functions.	Understand
CO 6	**Examine** the test strategies, implementation approach on full custom and semi custom design for optimising speed, cost, reconfiguration and reliability parameters.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE, CIE, AAT, QUIZ
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	SEE, CIE, AAT, QUIZ
PO 3	**Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	1	SEE, CIE, AAT, QUIZ
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	AAT
PO 10	**Communication:** Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions	1	Discussions

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 2	Focus on the application specific integrated circuit (ASIC) prototype designs, virtual instrumentation and system on chip (SoC) designs.	3	SEE, CIE, AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 2	✓	✓	-	✓	-	-	-	-	-	✓	-	-	-	✓	-
CO 3	✓	✓	-	✓	-	-	-	-	-	✓	-	-	-	-	-
CO 4	✓	✓	✓	✓		-	-	-	-	✓	-	-	-	✓	-
CO 5	✓	✓	✓	✓	-	-	-	-	-	✓	-	-	-	-	-
CO 6	✓	✓	✓	✓	-	-	-	-	-	✓	-	-	-	✓	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Relate the fabrication process **(knowledge)** ,occurrence of latch up by applying the principles of **mathematics, science and engineering fundamentals**	3
	PO 2	Formulate and analyze **(problem analysis) complex Engineering problems for** MOSFET scaling and its effect using the first principles of **mathematics and engineering sciences**	3
	PO 10	Describe the effects of scaling on MOS circuits for area, delay, power with **clarity**	1
CO 2	PO 1	**Build** the stick diagrams, layouts of MOS circuits **(knowledge)** by following design rules with **mathematics, science and engineering fundamentals**	3
	PO 2	Understand the given **problem statement** and **formulate** the circuit design, **translate the information** into the model using stick diagram and layout **validate** the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	5
	PO 4	**Design** layout of transistors from stick diagram **using experimental design and analyze** the characteristics of circuit	1
	PO 10	Explain the stick diagrams, layouts of MOS circuits using lambda, absolute and Euler physical design rules with **clarity**	1
	PSO 2	**Design,Inspect** and **Analyze** any type of **ASIC ,SOC** designs using **cadence tools** to **survey** the speed, area and delay with the knowledge of layout to **Familiarize with the design flow of ASIC prototypes** using **verilog** and **vhdl languages**.	8

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 3	PO 1	Examine the conditions mathematically for improved performance of inverters, static and dynamic gates regarding symmetry of transfer characteristics, rise, fall times **(knowledge)** by applying the field effect transistor **fundamentals** with support from other engineering disciplines, **mathematics, and scientific methodologies**	2
	PO 2	Understand the given **problem statement and formulate** conditions for improved performance of inverters, static and dynamic gates from the given **information and data** in reaching substantiated conclusions by the **interpretation of results**	4
	PO 4	**Design** the circuit using various CMOS logics **using experimental design and analyze** the features of circuit in terms of area ,delay	1
	PO 10	Describe inverters, complex gates and dynamic CMOS circuits for power consumption, distortion and speed of operation with **clarity**	1
CO 4	PO 1	**Describe** data path subsystems **(knowledge)** consisting of shifters, adders, multipliers, ALUs, parity generators, counters and comparators with the support of **VLSI engineering tools such as stick diagrams and layouts, mathematics, science and engineering fundamentals**	3
	PO 2	Formulate and analyze **(problem analysis) complex Engineering problems** for data path subsystems consisting of shifters, adders, multipliers, ALUs, parity generators, counters and comparators using first principles of **mathematics and engineering sciences**	5
	PO 3	**Design solutions** using data path subsystems with **innovative solution** and implementing them using modern tools such as cadence software, verilog and VHDLtools.	3
	PO 4	**Design** various data path subsystems using **research-based knowledge and research methods** including design of experiments.	1
	PO 10	Explain data path subsystems containing arithmetic logic units, parity generators, comparators and memories using stick diagrams and layouts. with **clarity**	1
	PSO 2	**Explore** on the data path subsystems and array subsystems for **design** of **ASIC** and **SOC**system prototypes and **Familiarize** with the design flow of **ASIC prototypes** to **Inspect and survey** the abstractions and principles for the specifi- cation, simulation, verification, and synthesis of systems on chip(SoC).	8

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 5	PO 1	**Design** the boolean functions with the **(knowledge)** of programmable logic devices, choose appropriate logic device with the **engineering fundamentals**	3
	PO 2	Understand the given **problem statement** and **formulate** the (complex) engineering problems , **translate the information** into the model using boolean function from the provided **information and data**based on the functionality of the circuit,**validate** the output of the circuit in reaching substantiated conclusions by the **interpretation of results** with help of CPLD and FPGA devices.	7
	PO 3	**Design solutions** using programmable logic devices with **innovative solution** and implementing them using modern tools such as cadence software, verilog and VHDLtools.	3
	PO 4	Examine any logic function using **design of experiments, analysis and interpretation of data** with cadence or verilog tools	1
	PO 10	Describe implementation approaches on boolean functions on FPGA with**clarity**	1
CO 6	PO 1	Discuss importance of full custom and semi custom designs with **(knowledge) using** scientific principles and methodology **of VLSI design**	2
	PO 2	Understand the given **problem statement** and **formulate** the (complex) engineering problems of VLSI systems, **translate the information** into the model using cadence software **develop solutions**based on the functionality of the circuit,**validate** the output of the circuit by applying various testing methods and **interpret the results.**	7
	PO 3	**Design solutions for complex engineering problems and design system components** using full custom or semi custom designs **innovative solution** and implementing them using modern tools and verify the results using testing methods	3
	PO 4	Examine sequential and combinational logic circuits with **design of experiments, analysis and interpretation of data** using various test procedures.	1
	PO 10	Prepare for Tech talks and concept video presentations keeping in view of latest trends in technology with **clarity.**	1
	PSO 2	**Design,Analyze and Test application specific integrated circuit prototype designs using programming languages Focus on testing of application specific integrated circuit (ASIC) prototype designs, virtual instrumentation designs and system on chip (SOC) designs** appropriate for entry level job positions in front end or back end to meet the requirements of employers.	8

Note: For Key Attributes refer **Annexure - I**

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PO's / NO. OF VITAL FEATURES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	3	3	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	5	-	1	-	-	-	-	-	1	-	-	-	8	-
CO 3	3	4	-	1	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	5	2	1		-	-	-	-	1	-	-	-	8	-
CO 5	3	7	3	1	-	-	-	-	-	1	-	-	-	-	-
CO 6	2	7	3	1	-	-	-	-	-	1	-	-	-	8	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	30	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 2	100	50	-	9	-	-	-	-	-	20	-	-	-	72	-
CO 3	100	40	-	9	-	-	-	-	-	20	-	-	-	-	-
CO 4	100	50	20	9	-	-	-	-	-	20	-	-	-	72	-
CO 5	100	70	30	9	-	-	-	-	-	20	-	-	-	-	-
CO 6	66	70	30	9	-	-	-	-	-	20	-	-	-	72	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq$ C$\leq$ 5% – No correlation
1 -5 <C$\leq$ 40% – Low/ Slight
2 - 40 % <C < 60% –Moderate
3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	1	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	2	-	1	-	-	-	-	-	1	-	-	-	3	-
CO 3	3	1	-	1	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	2	1	1	-	-	-	-	-	1	-	-	-	3	-
CO 5	3	2	1	1	-	-	-	-	-	1	-	-	-	-	-
CO 6	3	3	1	1	-	-	-	-	-	1	-	-	-	3	-
TOTAL	18	11	3	5	-	-	-	-	-	6	-	-	-	9	-
AVERAGE	3	1.8	1	1	-	-	-	-	-	1	-	-	-	3	-

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	✓	Tech - Talk	✓	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	✓	Open Ended Experiments	✓
Micro Projects	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**BASICS OF MOSFETS**
	Introduction to IC Technology: MOS, PMOS, NMOS, CMOS & BiCMOS; Fabrication Flow; Basic Electrical Properties of MOS and BiCMOS Circuits: Ids-Vds relationships in saturation and ohmic regions, Weak & strong inversion conditions, Threshold voltage concept in MOSFETs, gm, gds, Figure of merit; Pass transistor; NMOS Inverter; Various pull ups; CMOS Inverter analysis and design; Simple form of Bi-CMOS Inverters and it's alternative forms.
MODULE II	**MOS CIRCUIT DESIGN PROCESSES**
	VLSI Design Flow; MOS Layers; Stick Diagrams; Physical design rules: 2 m and lambda CMOS design rules for wires, contacts and transistors; Euler's rule for physical design and Layout; Transistors Layout Diagrams for NMOS and CMOS Inverters; Scaling of MOS circuits; Trends & projections in VLSI design & technology CMOS nanotechnology; FINFET; CNTFET.

MODULE III	**BASIC CIRCUIT CONCEPTS AND GATE LEVEL DESIGN**
	Sheet Resistance and area capacitance of layers; Inverter Time delays; Driving large capacitive loads; Propagation Delays; Wiring capacitances; Fan-in and Fan-out; Choice of layers . VLSI Interconnects; Reliability issues in CMOS VLSI; Latching in VLSI, Electro migration. Gate Level Design: Series and Parallel equivalent circuits, Complex gates; Switch logic;Transmission gates; Other forms of CMOS logic such as Pseudo –nMOS, dynamic CMOS, clocked CMOS, CMOS domino, n-p CMOS and their comparisons.
MODULE IV	**SUBSYSTEM DESIGN**
	Data Path Sub Systems: Sub system design; Shifters, Ripple carry, Carry Look Ahead; Carry select Adders; Manchester carry chain; ALUs; Multipliers; Parity generators; Comparators; Zero/one detectors; Asynchronous and Synchronous; Counters Array Subsystems: SRAM, DRAM, ROM, Floating gate concepts and Flash Memories, Serial access Memories, Content Addressable Memories.
MODULE V	**PROGRAMMABLE LOGIC DEVICES AND CMOS TESTING**
	Programmable Logic Devices: Design Approach – PROM, PLA and PAL; FPGAs; CPLDs; FPGA building block architectures; FPGA interconnect routing procedures; Speed and area tradeoff. Implementation strategies full custom Page and semi custom design; CMOS Testing; Built-in Self –Test Strategies; Test pattern generation using LFSR.

TEXTBOOKS

1. A. Pucknell, Kamran Eshraghian, "BASIC VLSI Design," Third Edition, Prentice Hall of India, 2007. ISBN: 978-81-203-0986-9
2. R. Jacob Baker, Harry W.LI., David E.Boyee, "CMOS Circuit Design, Layout and Simulation," Wiley-IEEE Press, USA, 2005. ISBN: 978-0-470-88132-3
3. Jan Rabaey, Anantha Chandrakasan, B.Nikolic, "Digital Integrated Circuits: A Design Perspective," Second Edition, Phi Learning, 2009. ISBN: 97881203225789

REFERENCE BOOKS:

1. N. Weste, K. Eshraghian, "Principles of CMOS VLSI Design", Second Edition, Addision Wesley, 1993. ISBN: 978-81-317-1942-8
2. M.J. Smith, "Application Specific Integrated Circuits", Addisson Wesley, First edition, 1997. ISBN-13: 978-0321602756
3. John P. Uyemura, "CMOS Logic Circuit Design," Springer, USA, 2007. ISBN: 0-7923-8452-0 Yuan S W, "Foundations of fluid Mechanics", Prentice-Hall, 2nd Edition, 1987.

WEB REFERENCES:

1. https://https://lms.iare.ac.in/index?route=course/details &course_id=361

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Overview, Elaboration of Objectives and Outcomes.		https://lms.iare.ac.in/index?route=course/details&course_id=361
CONTENT DELIVERY (THEORY)			
2	Importance of IC technology and basics of MOSFETs	CO1	T1-1.1-1.3,1.4
3	NMOS, PMOS and CMOS fabrication Flow and twintub	CO1	T1-1.7,1.8
4	Process flow of BiCMOS- Latch up problem in CMOS	CO1	R1-2.1-2.2
5	Different Current - voltage characteristics of a MOSFET, Threshold voltage concept in MOSFETs.	CO 1	T1-2.2
5	Effect of transconductance, output conductance and figure of merit on performance characterstics of MOS.	CO 1	T1-2.12
6	PASS transistors , NMOS inverter design and impedance ratios of Nmos inverter.	CO 3	R1-4.7
7	Alternative forms of Pull –up's, CMOS inverter design and properties	CO 3	R1-2.5.3
8	Various forms of Bi-CMOS inverters	CO 3	T1-2.6
9	Processing steps of VLSI Design	CO 1	T1-3.1, 3.2.
10	Introduction to Stick Diagrams; Physical design rules	CO 2	T1-3.4,3.5
11	Introduction to Lambda based design rules	CO 2	T1-3.3
12	Double metal MOS process rules, 2µm design rules, Contact cuts	CO 2	T1-3.4,3.5
13	Euler's rule for physical design	CO 2	T1-3.3
14	Scaling in MOS circuits	CO 1	R1-4.8
15	Model and effects of scaling	CO 1	R1-4.8
16	VLSI Interconnects, Reliability issues in CMOS VLSI	CO 1	R1-4.5
17	Trends and projections in VLSI design and technology, CMOS Nano technology	CO 1	R1-4.7
18	Sheet Resistance and area capacitance of MOS layers	CO 3	T1-2.13,
19	Inverter Time delays, Driving large capacitive loads	CO 3	T1-6.3

20	Propagation Delays, Wiring capacitances; Fan-in and Fan-out	CO1	T1-6.2
21	Gate level design: complex gates, Switch logic-	CO 3	T1-4.11
22	Transmission gates ,Other forms of CMOS logic such as Pseudo –nMOS	CO 3	T1-4.10, 4.11
23	Architecture Dynamic CMOS,clocked CMOS	CO 3	R1-6.3.7
24	Architecture of CMOS domino; n-p CMOS	CO 3	R1-6.3.2
25	Design Approach – PROM, PLA and PAL	CO 5	T3 -7.7
26	Internal block description of FPGA	CO 5	T3
27	Internal block description of CPLD	CO 5	T3
28	Different types FPGA interconnect routing procedures; Performance tradeoff	CO4	R1-6.3.4
29	implementation strategies: full custom	CO 6	R1-6.6.7
30	implementation strategies: semi custom design	CO 6	R1-8.1,8.2
31	Comparison of FPGA and CPLD	CO 5	T3
32	Comparison of Full custom and semi custom designs	CO 6	R1-6.6.7
33	Design modules in subsystems ,basics of shifters	CO 4	R1-6.3.4
34	Architecture of Ripple carry, Carry Look Ahead, Carry select Adders	CO 4	R1-6.6.7
35	Architecture of Manchester carry chain ,ALUs.	CO 4	R1-8.1,8.2
36	Architectures of Multipliers	CO 4	R1-8.9
37	Architectures of Parity generators; Comparators; Zero/one detectors;	CO 4	R1-8.4
38	Design of Asynchronous and Synchronous Counters	CO 4	R1-8.3,8.5
39	Memory operation of SRAM, DRAM, ROM	CO 4	R1-9.1,9.2, 9.3
40	Memory operation of Floating gate concepts and Flash Memories.CMOS Testing and BIST	CO 6	T3-7.2,7.3
PROBLEM SOLVING/ CASE STUDIES			
41	Finding drain current, drain to source resistance, transconductance	CO 1	R1-2.5.3
42	Finding electrical properties of MOS based on different parameters	CO 1	T1-2.6
43	Finding the shift in characteristics based on impedance ratio and beta ratios	CO 1	T1-2.10
44	Design of stick diagrams	CO 2	T1-3.1, 3.2.
45	Design of Layout of MOS transistor	CO 2	T1-3.4,3.5
46	Design using Euler's physical design	CO 2	T1-3.3
47	Calculation of resistance and capacitance of layers	CO 3	T1-1.1-1.3,1.4

48	Calculation of Delay with respect to circuit	CO 3	T1-1.7,1.8
49	Design of complex gate and transmission gate designs	CO 3	T1-2.5,2.9
50	Design of shifter circuits	CO 4	R1-8.1,8.2
51	Design of adders	CO 4	R1-8.9
52	Design of multipliers	CO 4	R1-8.4
53	Look up tables and FPGA design	CO 5	R1-6.3.2
54	Design of PROM	CO 5	R1-6.3.4
55	Design of PLA,PAL	CO 5	R1-6.6.7
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	MOS transistor fundamental and basic electrical properties	CO 1	T1-1.1-1.3,1.4
57	Stick diagram ,layout, scaling of MOS circuits	CO 2	T1-3.1, 3.2
58	Delay of MOS circuits, gate level circuit design	CO 3	T1-4.6
59	Adders, multipliers, memory units	CO 4	R1-8.1,8.2
60	Architectures of Programmable logical devices and testing	CO 5, CO 6	R1-6.3.2
DISCUSSION OF QUESTION BANK			
61	MOS transistor fundamental and basic electrical properties	CO 1	T1
62	VLSI design styles, Stick diagram ,layout, scaling of MOS circuits	CO 2	T1
63	Basic circuit concepts and gate level design	CO 3	R1
64	Data path subsystems	CO 4	R2
65	Programmable logical devices	CO 5	R1

Signature of Course Coordinator **HOD, ECE**
V.R,Seshagiri Rao,Associate professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**

PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	**10**

PO 4.	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**

PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project. 6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	**12**
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**

PO11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

ANNEXURE - II

Key Competencies for Assessing Program Specific Outcomes

PSO Number	NBA Statement / NBA statement / Vital features	No. of vitalfeatures
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications. 1. Analyze and solve real time problems in Robotics. 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications. 3. Develop embedded systems modules using Real Time Operating System. 4.Undertake research and development projects in the field of Em- bedded Systems. 5. Adopt the engineering professional code and conduct.	5
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs. 1. Inspect, survey and analyze types of ASIC chip designs. 2. Design ASIC prototypes using Verilog and VHDL languages. 3. Analyze microprocessor subsystems with memories and I/O inter- facs for SOC designs 4. Explore hardware components for designig SOC 5.Adopt the engineering professional code and conduct 6. Designing prototypes of SOC using programming tools like MAT- LAB, LabVIEW. 7. Familiarize with the design flow of ASIC prototypes. 8. Realize SOC using Register-Transfer-Level designs 9. Analyse and develop models for system level descriptions for syn- thesis of SOC. 10.Inspect and survey the abstractions and principles for the specifi- cation, simulation, verification, and synthesis of systems on chip (SoC). 11.Programming and hands-on skills to meet requirements of global environment.	**11**

PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications. 1. Explicit software and programming tools for antenna design. 2. Adopt technical library resources and literature search. 3.Explore smart antennas. 4. Model, program for operation and control of smart antennas for wireless communication applications. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Electronics and Communication Engineering**				
Course Title	**Wireless Sensor Networks**				
Course Code	AECC47				
Program	B.Tech				
Semester	VII				
Course Type	Professional Elective				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mrs. P. Ganga Bhavani, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECC25	V	Wireless Communications and Networks

II COURSE OVERVIEW:

Wireless Sensor Networks are beginning to be organized in an enhanced step. It is expected that in 10 to 15 years, the world will be protected with WSNs with entree to them via the Internet. This can be measured as the Internet becoming a physical n/w. This technology is thrilling with infinite potential for many application areas like medical, environmental, transportation, military, entertainment, homeland defense, crisis management and also smart spaces. The most common WSN architecture follows the OSI architecture Model. The architecture of the WSN includes five layers and three cross layers. Mostly in sensor network we require five layers, namely application, transport, network, data link and physical layer.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Wireless Sensor Networks	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
33.3%	Understand
33.3%	Apply
33.3 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	-

VI COURSE OBJECTIVES:

The students will try to learn:

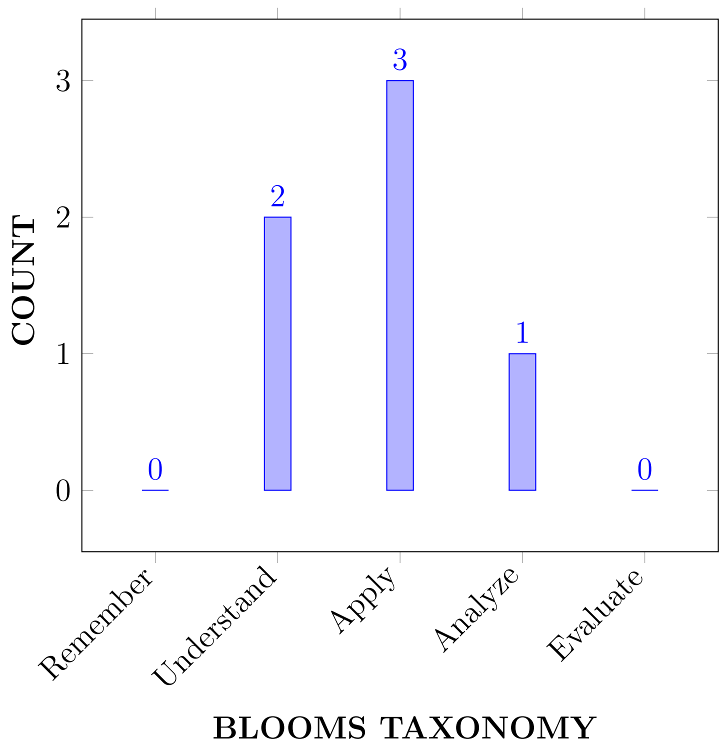
I	The basic WSN technology and supporting protocols, with emphasis placed on standardization basic sensor systems and provide a survey of sensor technology.
II	The medium access control protocols and address physical layer issues.
III	The different routing protocols for sensor networks and main design issues.
IV	The transport layer protocols for sensor networks, and design requirements
V	The sensor management, sensor network middleware, operating systems.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Describe** the overview of Wireless Sensor Networks, node architecture and operating systems for Wireless Sensor Networks.	Understand
CO 2	**Interpret** various MAC protocols that are used for wireless communication.	Understand
CO 3	**Make use of** a routing protocol for maintaining the routes in the network to ensure reliable communication.	Apply
CO 4	**Analyze** the network management system for managing, monitoring and controlling the behaviour of a network.	Analyze
CO 5	**Utilize** the localization methods to identify the current location of the sensor nodes.	Apply
CO 6	**Choose** the protocols and mechanisms for security to meet the challenges of security in wireless sensor networks.	Apply

VIII COURSE KNOWLEDGE COMPETENCY LEVEL



IX PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations

Program Outcomes	
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

X HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE / CIE / QUIZ / AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	SEE / CIE / QUIZ / AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	SEE / CIE / QUIZ / AAT

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	2	SEE / CIE / QUIZ / AAT

3 = High; 2 = Medium; 1 = Low

XI HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build embedded software and digital circuit development platform for robotics, embedded systems and digital signal processing applications.	1	Quiz

3 = High; 2 = Medium; 1 = Low

XII MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 2	✓	✓	-	-	-	-	-	-	-	✓	-	✓	-	-	-
CO 3	✓	✓	-	-	-	-	-	-	-	✓	-	✓	✓	-	-
CO 4	✓	✓	-	-	-	-	-	-	-	✓	-	✓	-	-	-
CO 5	✓	✓	-	-	-	-	-	-	-	✓	-	✓	-	-	-
CO 6	✓	✓	-	-	-	-	-	-	-	✓	-	✓	-	-	-

XIII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Illustrate** the principles of the Wireless Sensor Networks terminology **knowledge** for understanding components of wireless sensor node, Classification of sensor networks, Characteristics of wireless sensor networks, design challenges of wireless sensor networks by applying the **principles of engineering science to complex engineering problems**	2
	PO 2	**Identify** and **analyze** architecture of Wireless Sensor Networks to **interpret** applications of Wireless Sensor Networks and **model** the operating systems using **frst principles of mathematics natural sciences, and Engineering sciences**	5
	PO 10	**Effective presentation and Speaking Style** on Applications of wireless sensor networks and **write Subject Matter Effectively** on the operating systems of WSN.	4

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PSO 1	**Design** of experiments on Wireless Sensor Networks with project development and execution process of **modern tools** such as NS-2 .	2
CO 2	PO 1	**Understand** the source encoding and channel encoding techniques and Interpret physical layer using **engineering science and mathematical models.**	3
	PO 2	**Identify and analyze** wireless MAC protocols and **implement** using **engineering science, design** system components for source Encoding and channel encoding and **model WSN using principles of mathematics.**	5
	PO 10	**Present effectively and Clarity** source encoding, channel encoding and **write effectively** subject matter on wireless MAC protocols.	4
	PO 12	**Recognize the ability** of wireless MAC protocols for **life-long learning** in the broadest context of Wireless Sensor Networks and constant update with the recent trends .	3
CO 3	PO 1	Applying **principles of mathematics, science and engineering** to routing metrics of Wireless Sensor Networks is understood to model network layer in Wireless Sensor Networks.	3
	PO 2	**Define and analyze** Flooding and Gossiping in Wireless Sensor Networks to **model translation** the network layer and **implement** it using **principles of mathematics, science and engineering**.	5
	PO 10	**Communicate** effectively and **orally** present on the different types of routing in sensor networks	2
	PO 12	**Recognize the need** to analyze Wireless MAC Protocols and **ability to improve** analyzing routing metrics and different types of routing in Sensor Networks to meet the **technological needs** with **persistant learning** of ECE and engineerign concepts	4
	PSO 1	**Design** experiment on routing metrics using routing protocols and execute the process with **modern tools** like NS-2	2
CO 4	PO 1	**Applying principles of mathematics, science and engineering** different mechanisms for network management is explained	3
	PO 2	**Identify** various power management aspects for **model translation** using **principles of mathmatics,science and engineering** to **define** power management and **analyze** conceptual architecture	5
	PO 10	**Communicate** effectively and **orally** present on the power management of wireless sensor networks	2
	PO 12	**Recognize the need** to analyze network management of Wireless Sensor Networks and **ability to improve** analyzing power management aspects to meet the **technological needs** with **persistant learning** of ECE and engineering concepts	4

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 5	PO 1	Using **principles of mathematics, science, engineering** calculate resynchronization interval and propagation delay of a sensor node	3
	PO 2	**Analyze**ranging techniques to **define** various types of localization **solve complex** Clocks and the Synchronization Problems	3
	PO 10	**Communicate** effectively and **orally** present on the Time Synchronization Protocols of wireless sensor networks	2
	PO 12	**Recognize the need** of time synchronization protocols and **ability to improve** the localization methods for wireless sensor networks and meet the **technological needs** with **continuing education efforts** in advanced engineering concepts	4
CO 6	PO 1	**Utilize** the principles of mathmatics, science and engineering to solve the security problems of wireless sensor networks	3
	PO 2	**Solve** the aggregation functions by **basic principles of mathematics, science and engineering** to **define** Attacks on Data Aggregation and **model translation** of CIA model for secured wireless communication and **validate** with the Protocols and Mechanisms for Security	5
	PO 10	**Communicate** effectively and **orally** present on the Security Attacks in Sensor Networks	2
	PO 12	**Recognize the need** for Protocols and Mechanisms for Security and **ability to improve** security to meet the **technological needs** with **constant learning** of ECE and advanced engineering concepts	4

XIV TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	5	-	-	-	-	-	-	-	4	-	-	2	-	-
CO 2	3	5	-	-	-	-	-	-	-	4	-	3	-	-	-
CO 3	3	5	-	-	-	-	-	-	-	2	-	4	2	-	-
CO 4	3	5	-	-	-	-	-	-	-	2	-	4	-	-	-
CO 5	3	3	-	-	-	-	-	-	-	2	-	4	-	-	-
CO 6	3	5	-	-	-	-	-	-	-	2	-	4	-	-	-

XV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	66.6	50	-	-	-	-	-	-	-	80	-	-	25	-	-
CO 2	100	50	-	-	-	-	-	-	-	80	-	37.3	-	-	-
CO 3	100	50	-	-	-	-	-	-	-	40	-	50	40	-	-
CO 4	100	50	-	-	-	-	-	-	-	40	-	50	-	-	-
CO 5	100	30	-	-	-	-	-	-	-	40	-	50	-	-	-
CO 6	100	50	-	-	-	-	-	-	-	40	-	50	-	-	-

XVI COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.
0 - $0 \leq C \leq 5\%$ – No correlation
1 -$5 < C \leq 40\%$ – Low/ Slight
2 - $40\ \% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	-	-	-	-	-	-	3	-	-	1	-	-
CO 2	3	2	-	-	-	-	-	-	-	3	-	1	-	-	-
CO 3	3	2	-	-	-	-	-	-	-	1	-	2	1	-	-
CO 4	3	2	-	-	-	-	-	-	-	1	-	2	-	-	-
CO 5	3	1	-	-	-	-	-	-	-	1	-	2	-	-	-
CO 6	3	2	-	-	-	-	-	-	-	1	-	2	-	-	-
TOTAL	**18**	**11**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**10**	**-**	**9**	**2**	**-**	**-**
AVERAGE	3	1.8	-	-	-	-	-	-	-	1.6	-	1.8	1	-	-

XVII ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	-	Tech Talk	✓		

XVIII ASSESSMENT METHODOLOGY-INDIRECT:

-	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XIX SYLLABUS:

MODULE I	**OVERVIEW OF WIRELESS SENSOR NETWORKS**
	Introduction: Components of a wireless sensor node, Motivation for a Network of Wireless Sensor Nodes, Classification of sensor networks, Characteristics of wireless sensor networks, Challenges of wireless sensor networks, Comparison between wireless sensor networks and wireless mesh networks, Limitations in wireless sensor networks, Design challenges, Hardware architecture, Applications : Structural Health Monitoring, Traffic Control, Health Care, .Pipeline Monitoring, Precision Agriculture, Active Volcano, Underground Mining Node Architecture: The Sensing Subsystem, the Processor Subsystem, Communication Interfaces, Prototypes. Operating Systems: Functional Aspects, Nonfunctional Aspects, Prototypes, Evaluation.
MODULE II	**BASIC ARCHITECTURAL FRAMEWORK**
	Physical Layer, Basic Components, Source Encoding, Channel Encoding, Modulation Medium Access Control: Wireless MAC Protocols, Characteristics of MAC Protocols in Sensor Networks, Contention-Free MAC Protocols, Contention-Based MAC Protocols, Hybrid MAC Protocols.
MODULE III	**NETWORK LAYER**
	Network Layer: Routing Metrics, Flooding and Gossiping, Data-Centric Routing, Proactive Routing, On-Demand Routing, Hierarchical Routing, Location-Based Routing, QoS-Based Routing Protocols Node. Network Management: Power Management, Local Power Management aspects, Dynamic Power Management, Conceptual Architecture
MODULE IV	**TIME SYNCHRONIZATION**
	Time Synchronization: Clocks and the Synchronization Problem, Time Synchronization in Wireless Sensor Networks, Basics of Time Synchronization, Time Synchronization Protocols Localization: Ranging Techniques, Range-Based Localization, Range-Free Localization, Event Driven Localization.
MODULE V	**SECURITY**
	Fundamentals of Network Security, Challenges of Security in Wireless Sensor Networks , Security Attacks in Sensor Networks, Protocols and Mechanisms for Security, IEEE 802.15.4 and Zig Bee Security.

XX TEXT BOOKS:

1. Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice", Wiley 2010.
2. Mohammad S. Obaidat, Sudip Misra, "Principles of Wireless Sensor Networks", Cambridge, 2014. Signals", Pearson Education, 2012

XXI REFERENCE BOOKS:

1. Ian F. Akyildiz, Mehmet Can Vuran , "Wireless Sensor Networks", Wiley 2010.
2. C S Raghavendra, K M Sivalingam, Taieb Znati, "Wireless Sensor Networks", Springer, 2010.
3. C. Sivarm murthy and B.S. Manoj, "Adhoc Wireless Networks", PHI-2004.
4. FEI HU., XIAOJUN CAO, "Wireless Sensor Networks", CRC Press, 2013.
5. Feng ZHAO, Leonidas GUIBAS, "Wireless Sensor Networks", ELSEVIER , 2004

XXII WEB REFERENCES:

1. https://www.geeksforgeeks.org/wireless-sensor-network-wsn/
2. https://www.intechopen.com/chapters/38793
3. https://www.elprocus.com/introduction-to-wireless-sensor-networks-types-and-applications/

XXIII COURSE WEB PAGE:

XXIV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Base Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping		
CONTENT DELIVERY (THEORY)			
1	Introduction: Components of a wireless sensor node, Motivation for a Network of Wireless Sensor Nodes,Classification of sensor networks	CO 1	T2:1.2, T1:1.1, T2: 1.3
2	Characteristics of wireless sensor networks, Challenges of wireless sensor networks, Comparison between wireless sensor networks and wireless mesh networks,	CO 1	T2:1.4-1.6
3	Limitations in wireless sensor networks, Design challenges, Hardware architecture	CO 1	T2: 2.1-2.3
4	Applications : Structural Health Monitoring, Traffic Control	CO 1	T1:2.1- 2.2
5	Health Care, Pipeline Monitoring, Precision Agriculture, Active Volcano, Underground Mining	CO 1	T1:2.3-2.7
6	Node Architecture: The Sensing Subsystem, the Processor Subsystem, Communication Interfaces, Prototypes.	CO 1	T1:3.1- 3.4
7	Operating Systems: Functional Aspects, Nonfunctional Aspects	CO 1	T1:4.1-4.2
8	Prototypes, Evaluation.	CO 1	T1:4.3-4.4
9	Physical Layer, Basic Components, Source Encoding	CO 2	T1:5.1- 5.2
10	Channel Encoding,Modulation	CO 2	T1: 5.3-5.4
11	Medium Access Control: Overview	CO 2	T1-6.1
12	Wireless MAC Protocols,	CO 2	T1: 6.2
13	Characteristics of MAC Protocols in Sensor Networks	CO 2	T1: 6.3
14	Contention-Free MAC Protocols,	CO 2	T1: 6.4
15	Contention-Based MAC Protocols,	CO 2	T1: 6.5
16	Hybrid MAC Protocols.	CO 2	T1: 6.6
17	Network Layer: Routing Metrics, Flooding and Gossiping	CO 3	T1:7.2-7.3
18	Data-Centric Routing	CO 3	T1:7.4
19	Proactive Routing, On-Demand Routing	CO 3	T1:7.5-7.6
20	Hierarchical Routing, Location-Based Routing	CO 3	T1:7.7-7.8
21	QoS-Based Routing Protocols Node.	CO 3	T1:7.9

22	Network Management: Power Management, Local Power Management aspects	CO 4	T1:8.0-8.1
23	Dynamic Power Management	CO 4	T1:8.2
24	Conceptual Architecture	CO 4	T1:8.3
25	Time Synchronization: Clocks and the Synchronization Problem	CO 5	T1:9.0-9.1
26	Time Synchronization in Wireless Sensor Networks	CO 5	T1:9.2
27	Basics of Time Synchronization	CO 5	T1:9.3
28	Time Synchronization Protocols	CO 5	T1:9.4
29	Localization: Ranging Techniques	CO 5	T1: 10.1-10.2
30	Range-Based Localization	CO 5	T1:10.3
31	Range-Free Localization	CO 5	T1:10.4
32	Event Driven Localization	CO 5	T1:10.5
33	Fundamentals of Network Security	CO 6	T1: 11.1
34	Challenges of Security in Wireless Sensor Networks	CO 6	T1: 11.2
35	Security Attacks in Sensor Networks-Denial-of-Service, Attacks on Routing	CO 6	T1: 11.3
36	Security Attacks in Sensor Networks-Attacks on Transport Layer, Attacks on Data Aggregation, Privacy Attacks	CO 6	T1: 11.3
37	Protocols and Mechanisms for Security-Symmetric and Public Key Cryptography, Key Management, Defenses Against DoS Attacks, Defenses Against Aggregation Attacks	CO 6	T1: 11.4
38	Protocols and Mechanisms for Security-Defenses Against Routing Attacks, Security Protocols for Sensor Networks,	CO 6	T1: 11.4
39	TinySec, Localized Encryption and Authentication Protocol	CO 6	T1: 11.4
40	IEEE 802.15.4 and Zig Bee Security	CO 6	T1: 11.5
PROBLEM SOLVING/ CASE STUDIES			
1	Problem solving on Calibration of sensor	CO 1	T1:1.1-4.4
2	Problem solving on Applications of sensors and node architecture	CO 1	T1:1.1-4.4
3	problem solving on operating systems	CO 1	T1:1.1-4.4
4	Problem solving on Physical layer	CO 2	T1:5.1-6.6
5	Problem solving on Medium Access Control	CO 2	T1:5.1-6.6
6	Problem solving on Contention-Free MAC Protocols	CO 2	T1:5.1-6.6
7	Problem solving on Network topologies	CO 3, 4	T1:7.1-8.3
8	Problem solving on forwarding strategies	CO 3, 4	T1:7.1-8.3
9	problem solving on network management	CO 3,4	T1:7.1-8.3
10	Problem solving on Time synchronization	CO 5	T1:9.1-10.5
11	Problem solving on Reference-Broadcast Synchronization	CO 5	T1:9.1-10.5
12	Problem solving on Localization	CO 5	T1:9.1-10.5
13	Problem solving on Security	CO 6	T1:11.1-11.5
14	Problem solving on secure aggregration	CO 6	T1:11.1-11.5
15	Problem solving on PIKE scheme	CO 6	T1:11.1-11.5

DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Defnitions and terminologies on Overview of wireless sensor networks	CO 1	T1:1.1-4.4
2	Defnitions and terminologies on Basic architectural framework	CO 2	T1:5.1-6.6
3	Definitions and terminology on network layer	CO 3 ,4	T1:7.1-8.3
4	Definitions and terminology on time synchronization	CO 5	T1:9.1-10.5
5	Definitions and terminilogy on security	CO 6	T1:11.1-11.5
DISCUSSION OF QUESTION BANK			
1	Discussion on question bank of Overview of wireless sensor networks	CO 1	T1:1.1-4.4
2	Discussion on question bank of Basic architectural framework	CO 2	T1:5.1-6.6
3	Discussion on question bank of network layer	CO 3,4	T1:7.1-8.3
4	Discussion on question bank of time synchronization	CO 5	T1:9.1-10.5
5	Discussion on question bank of security	CO 6	T1:11.1-11.5

Signature of Course Coordinator **HOD, ECE**
Mrs. P. Ganga Bhavani, Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**

PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	**10**

PO 4.	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**

PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project. 6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	**12**
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**

PO11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

ANNEXURE - II

Key Competencies for Assessing Program Specific Outcomes

PSO Number	NBA Statement / NBA statement / Vital features	No. of vitalfeatures
PSO 1	Build skills to develop software applications in specialized areas of Computer Science and Engineering such as Artificial Intelligence, Machine Learning, Data Science, Web Development, Gaming, Augmented Reality / Virtual Reality (AR/VR).	5
PSO 2	Focus on exploring supervised, unsupervised and reinforcement learning and apply them to a range of AI problems.	11
PSO 3	Make use of AI and ML techniques for industrial applications in the areas of Autonomous Systems, IOT, Cloud Computing, Robotics, Natural Language Processing and emerging areas.	7

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043
COURSE DESCRIPTION

<table>
<tr><td>Department</td><td colspan="5">Electronics and Communication Engineering</td></tr>
<tr><td>Course Title</td><td colspan="5">VLSI Design Laboratory</td></tr>
<tr><td>Course Code</td><td colspan="5">AECC54</td></tr>
<tr><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>Semester</td><td colspan="5">VII</td></tr>
<tr><td>Course Type</td><td colspan="5">Laboratory</td></tr>
<tr><td>Regulation</td><td colspan="5">UG-20</td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>3</td><td>1.5</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Ms. K.S.Indrani, Assistant Professor</td></tr>
</table>

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECC03	III	Digital System Design
B.Tech	AECC12	IV	Integrated Circuits Applications

II COURSE OVERVIEW:

The art of VLSI circuit design is dynamic with advances in process technology and innovations in the electronic design automation (EDA) industry. The objective of this laboratory course is to demonstrate the various stages in VLSI design flow using cadence software. Hands on training on logic and circuit simulations of MOSFETS, ring oscillators, multiplexers, analog amplifiers etc are included. The course also covers physical layout of complex logic gates for chip design. VLSI designs are widely used in automobiles, mobiles and embedded processors.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
VLSI Design Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component	**Laboratory**		**Total Marks**
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

I	Modern tools for functional level to physical layout with verification at intermediate stages in the VLSI design flow in top-down approach.
II	Design and simulations of analog, digital and mixed circuits for optimum values of area over head, power and time delay.
III	The chip design through a practical approach using advanced modern tools such as vivado and cadence for front end and back end.

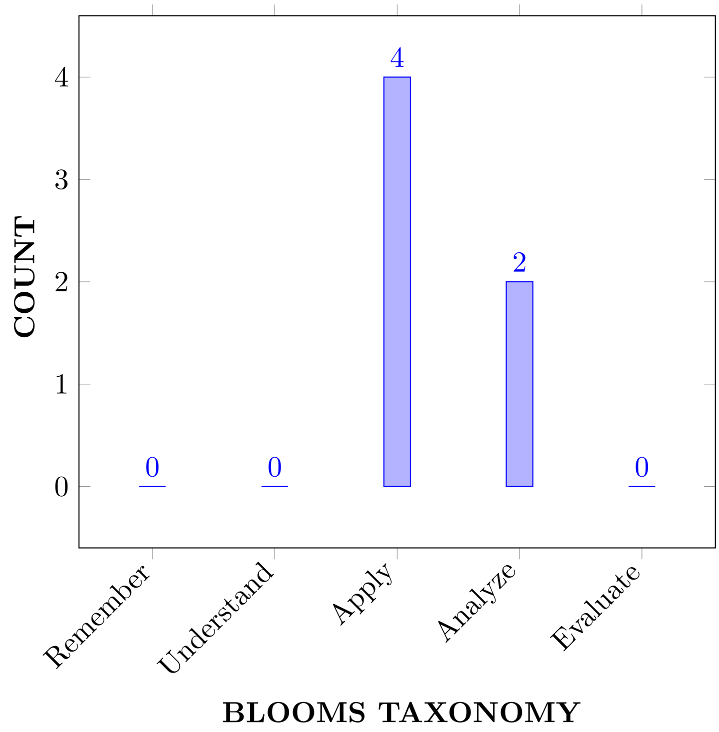
VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Make use of** the static, dynamic and noise margin parameters of CMOS circuits for calculating figure of merit	Apply
CO 2	**Analyze** complex gates, switch logic and transmission gates for performance optimization of distortion, power consumption and circuit delays.	Analyze
CO 3	**Utilize** existing small building block and circuit symbols with necessary inter connections to realize complex designs	Apply

CO 4	**Examine** the conditions for optimum performance of lathes and registers with the knowledge of digital system design	Analyze
CO 5	**Identify** bandwidth, gain, and common mode rejection ratio parameters for cascode amplifiers to protect amplifier from miller effect	Apply
CO 6	**Apply** the design rule check and Layout versus schematic check on layout of MOS circuits to verify spacing rules between layers.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Program Outcomes	
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Lab Experiments / CIE / SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	Lab Experiments / CIE / SEE
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	3	Lab Experiments / CIE / SEE
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	2	Lab Experiments/Discussions

PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	Lab Experiments
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	2	Research paper analysis/ Short term courses

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		**Strength**	**Proficiency Assessed by**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	2	Lab Experiments

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	**PROGRAM OUTCOMES**												**PSO'S**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	✓	-
CO 2	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 3	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 4	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	✓	-
CO 5	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 6	✓	✓	-	-	✓	-	-	-	✓	✓	-	✓	-	✓	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	**PO'S PSO'S**	**Justification for mapping (Students will be able to)**	**No. of Key competencies matched.**
CO 1	PO 1	Identify the conditions practically for improved performance of inverters regarding symmetry of transfer characteristics, rise and fall times (knowledge) by applying the field effect transistor fundamentals with support from other **engineering disciplines, mathematics, and scientific methodologies.**	2
	PO 2	Understand the given **problem statement and formulate** conditions for improved performance of inverter from the provided **information and data** in reaching substantiated conclusions by the **interpretation of results** in the Laboratory.	5

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 10	**Communicate effectively** on CMOS circuit design and **write** effective reports for procedure to calculate static and noise margins	1
	PSO 2	**Design and analyze** layout models for CMOS circuits using **programming languages** Verilog and cadence to calculate noise margins.	3
CO 2	PO 1	Identify the conditions practically for improved performance of complex gates, switch logic and transmission gates regarding performance optimization of distortion, power consumption and circuit delays (knowledge) by applying the digital system fundamentals with support from other **engineering disciplines, mathematics, and scientific methodologies.**	2
	PO 2	Understand the given **problem statement and formulate** conditions for improved performance of complex logic and transmission gates from the provided **information and data** in reaching substantiated conclusions by the **interpretation of results** in the Laboratory.	3
	PO 10	**Communicate effectively** on complex gates, switch logic and transmission gates and **write** effective reports on power consumption, circuit delays	1
CO 3	PO 1	Design multiplexers **(knowledge)** consisting of transmission gates and pass gates with the support of VLSI **engineering tools such as stick diagrams and layouts**.	1
	PO 2	**Formulate and analyze (Problem analysis) complex Engineering problems** for multiplexers (knowledge) consisting of transmission gates and pass gates using first principles of **mathematics and Engineering sciences.**	5
	PO 10	**Communicate effectively** and **write** effective reports for designing 4× 1 multiplexer from 2×1 multiplexer	1
CO 4	PO 1	Design latches b consisting of multiplexers with the support of **VLSI engineering tools such as stick diagrams and layouts**.	1
	PO 2	**Formulate and analyze (Problem analysis)** complex Engineering problems for latches **(knowledge)** consisting of multiplexers using first principles of **mathematics and Engineering sciences.**	5
	PO 10	**Communicate effectively** and **write** effective reports on optimum performance of lathes and registers	1
	PSO 2	**Inspect and survey** lathes and registers using **programming language** like cadence to understand conditions for optimmum performance of VLSI circuits .	3
CO 5	PO 1	Identify the conditions practically for improved performance of Differential, MOSFET and casode amplifiers regarding bandwidth, gain, and common mode rejection ratio parameters **(knowledge)** by applying the oscillation **fundamentals** with support from other engineering disciplines, **mathematics, and scientific methodologies**.	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	**Formulate and analyze (Problem analysis) complex Engineering problems** for Differential, MOSFET and cascode amplifiers **(knowledge)** using first principles of **mathematics and Engineering sciences.**	5
	PO 10	**Communicate effectively** on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions	1
CO 6	PO 1	Build the stick diagrams, layouts of MOS circuits **(knowledge)** by following design rules with **mathematics and engineering sciences.**	2
	PO 2	**Formulate and analyze (Problem analysis) complex Engineering problems** for MOS circuit layouts **(knowledge)** using first principles of **mathematics and Engineering sciences.**	5
	PO 5	Develop layouts **knowledge** of MOS circuits using **modern Engineering and IT tools to reduce area overhead.**	1
	PO 9	Focus on working as a member or leader in developing the layouts for MOS circuits and perform analysis by individual and team work.	7
	PO 10	**Communicate effectively** and **write effective reports** on design procedure for obtaining parasitic values of MOSFET circuits.	1
	PO 12	Build the stick diagrams, layouts of MOS circuits and verify it **(knowledge)** by following design rules with **engineering sciences.**	4
	PSO 2	**Design, analyze and develop** layout models for MOS circuits using **programming languages** Verilog and cadence to **explore hardware components** of SOC.	5

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	5	-	-	-	-	-	-	-	1	-	-	-	3	-
CO 2	2	3	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	1	5	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	1	5	-	-	-	-	-	-	-	1	-	-	-	3	-
CO 5	3	5	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	2	5	-	-	1	-	-	-	7	1	-	4	-	5	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	66.6	50	-	-	-	-	-	-	-	20	-	-	-	28.2	-
CO 2	66.6	30	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 3	33.3	50	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 4	33.3	50	-	-	-	-	-	-	-	20	-	-	-	28.2	-
CO 5	100	50	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 6	66.6	50	-	-	100	-	-	-	58.3	20	-	50	-	45.5	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq$ C$\leq$ 5% – No correlation

1 -5 <C$\leq$ 40% – Low/ Slight

2 - 40 % <C < 60% –Moderate

3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	-	-	-	-	-	-	1	-	-	-	1	-
CO 2	3	1	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	2	-	-	-	-	-	-	-	1	-	-	-	1	-
CO 5	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	3	2	-	-	3	-	-	-	2	1	-	2	-	2	-
TOTAL	18	11	-	-	3	-	-	-	2	6	-	4	-	2	-
AVERAGE	**3**	**1.8**	**-**	**-**	**3**	**-**	**-**	**-**	**2**	**1**	**-**	**2**	**-**	**2**	**-**

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

X	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

WEEK I	**MOSFET**
	To plot the (i) Output characteristics (ii) Transfer characterisctics of an N-channel and P-channel MOSFET.
WEEK II	**CMOS INVERTER**
	To design and plot the static (VTC) and dynamic charateristics of a digital CMOS inverter.
WEEK III	**RING OSCILLATOR**
	To design and plot the output characteristics of a 3-inverter ring oscillator.
WEEK IV	**LOGIC GATES**
	To design and plot the dynamic characteristics of 2-input NAND, NOR, XOR and XNOR logic gates using CMOS technology.
WEEK V	**4×1 MULTIPLEXER**
	To design and plot the characteristics of a 4X1 ditial multiplexer using pass transistor logic.
WEEK VI	**LATCHES**
	To design and plot the characteristics of a positive and negative latch based on multiplexers.
WEEK VII	**REGISTERS**
	To design and plot the characteristics of a master-slave positive and negative edge triggered registers based on multiplexers.
WEEK VIII	**DIFFERENTIAL AMPLIFIER**
	Design and simulation of simple 5 transistor differential amplifier, Measure the values of Gain, ICMR and CMRR.
WEEK IX	**NMOS INVERTER AND CMOS INVERTER**
	To design the layout of NMOS and CMOS inverter.
WEEK X	**LAYOUT OF 2-INPUT NAND, NOR GATES**
	To design the layout of 2-input NAND, NOR gates.
WEEK XI	**COMMON SOURCE AMPLIFIER**
	Analysis of Frequency response of Common source amplifier.
WEEK XII	**COMMON DRAIN AMPLIFIER**
	Analysis of Frequency response of Common drain Amplifier.
WEEK XIII	**SINGLE STAGE CASCODE AMPLIFIER**
	Design and Simulation of Single Stage Cascode Amplifier..
WEEK XIV	**BASIC CURRENT MIRROR, CASCODE CURRENT MIRROR AMPLIFIER**
	Design and Simulation of Basic Current Mirror, Cascode Current Mirror Amplifier

TEXTBOOKS

1. Razavi, Design of Analog CMOS Integrated Circuits, Tata McGraw Hill Publications,2002.
2. Allen Holberg, CMOS Analog Circuit Design, Oxford Publications, 2002.
3. Baker, Li, Boyce, CMOS Mixed Circuit Design, Wiley Publications, 2002.

REFERENCE BOOKS:

1. Mohammad Rashid, "Electronic Devices and Circuits", Cengage learning, 1st Edition, 2014.
2. David A. Bell, "Electronic Devices and Circuits", Oxford University Press, 5th Edition, 2009.

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	To plot the (i) Output characteristics (ii) Transfer characterisctics of an N-channel and P-channel MOSFET.	CO 1	T1: 3.1
2	To design and plot the static (VTC) and dynamic characteristics of a digital CMOS inverter.	CO 1	T1: 3.11
3	To design and plot the output characteristics of a 3-inverter ring oscillator.	CO 2	T1: 4.8
4	To design and plot the dynamic characteristics of 2-input NAND, NOR, XOR and XNOR logic gates using CMOS technology.	CO 3	T1: 4.8
5	To design and plot the characteristics of a 4X1 ditial multiplexer using pass transistor logic.	CO 4	T1: 5.5
6	To design and plot the characteristics of a positive and negative latch based on multiplexers.	CO 5	T1: 5.6
7	To design and plot the characteristics of a master-slave positive and negative edge triggered registers based on multiplexers.	CO 5	T1: 8.3
8	Design and simulation of simple 5 transistor differential amplifier, Measure the values of Gain, ICMR and CMRR.	CO 5	T1: 8.3
9	Analysis of Frequency response of Common source amplifier.	CO 6	T1: 10.6
10	Analysis of Frequency response of Common drain Amplifier.	CO 6	T1: 10.7
11	Design and Simulation of Single Stage Cascode Amplifier.	CO 6	T1:10.7
12	Design and Simulation of Basic Current Mirroe, Cascode Current Mirror Amplifier	CO 6	T1:10.7

XX EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Design and plot the static (VTC) and dynamic characteristics of a digital nMOS inverter with different forms of pull up loads.
2	Design and plot the static (VTC) and dynamic characteristics of a digital Bi CMOS inverter..
3	To design and plot the dynamic characteristics of Non-inverting Boolean Functions using CMOS Technology.
4	To design and plot the characteristics of a 8X1 digital multiplexer using pass transistor logic. .
5	To design the layout of 3-input NAND, NOR gates.

Signature of Course Coordinator **HOD, ECE**
Ms.K.S.Indrani, Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**

PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	**10**

PO 4.	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**

PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project. 6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	**12**

PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

ANNEXURE - II

Key Competencies for Assessing Program Specific Outcomes

PSO Number	NBA Statement / NBA statement / Vital features	No. of vitalfeatures
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications. 1. Analyze and solve real time problems in Robotics. 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications. 3. Develop embedded systems modules using Real Time Operating System. 4.Undertake research and development projects in the field of Em- bedded Systems. 5. Adopt the engineering professional code and conduct.	5
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs. 1. Inspect, survey and analyze types of ASIC chip designs. 2. Design ASIC prototypes using Verilog and VHDL languages. 3. Analyze microprocessor subsystems with memories and I/O inter- facs for SOC designs 4. Explore hardware components for designig SOC 5.Adopt the engineering professional code and conduct 6. Designing prototypes of SOC using programming tools like MAT- LAB, LabVIEW. 7. Familiarize with the design flow of ASIC prototypes. 8. Realize SOC using Register-Transfer-Level designs 9. Analyse and develop models for system level descriptions for syn- thesis of SOC. 10.Inspect and survey the abstractions and principles for the specifi- cation, simulation, verification, and synthesis of systems on chip (SoC). 11.Programming and hands-on skills to meet requirements of global environment.	**11**

PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications. 1. Explicit software and programming tools for antenna design. 2. Adopt technical library resources and literature search. 3.Explore smart antennas. 4. Model, program for operation and control of smart antennas for wireless communication applications. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043
ELECTRONICS AND COMMUNICATION ENGINEERING
COURSE DESCRIPTION

Course Title	**EMBEDDED SYSTEMS DESIGN LABORATORY**				
Course Code	AECC53				
Program	B.Tech				
Semester	VII				
Course Type	Laboratory				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Mrs.P.Annapurna, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECB24	V	Microprocessors and Microcontrollers

II COURSE OVERVIEW:

This course outlines the design and implementation of embedded systems using suitable hardware(ARM and PSOC) and Keil Embedded C software tools.The instruction set, Embedded C programming for I/O and memory interfacing techniques are covered.The hands-on experience acquired by the student's during the course makes them to carry out processor/controller based projects and extend their knowledge on the latest trends and technologies in the field of embedded system.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Embedded Systems Design Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component	**Laboratory**		**Total Marks**
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

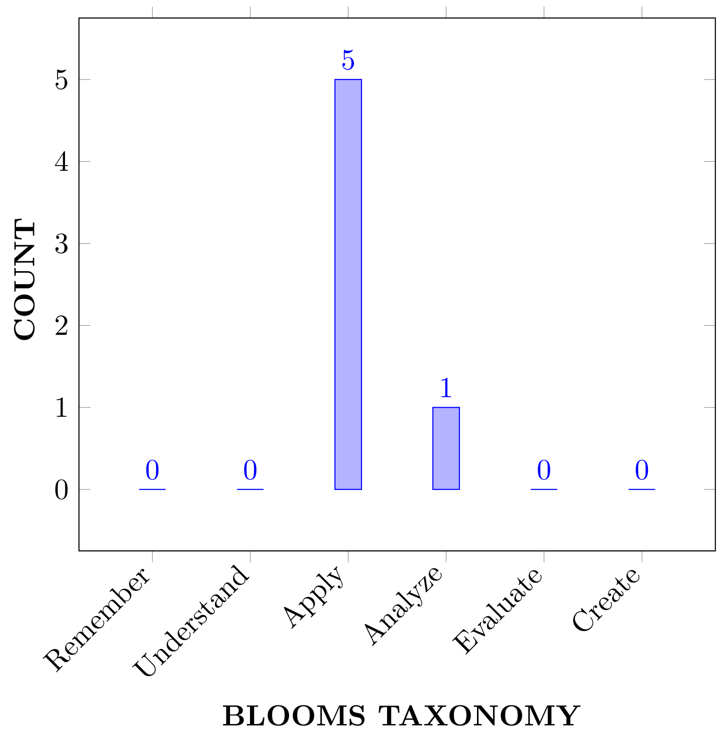
I	The embedded C for reading data from port pins.
II	The interfacing of data I/O devices with microcontroller.
III	The serial communication and port RTOS on microcontroller.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Make use** of emulators and cross-compilers for writing, compiling and running an embedded C language programs on ARM and PSoC training boards.	Apply
CO 2	**Develop** Embedded C language programs for accomplishing code to reading the data from ports, blinking the LED and interfacing of switch and buzzer , temperature sensors and other display units to the ARM processors.	Apply
CO 3	**Select** suitable RTOS of ARM and PSoC and write Embedded C language program to run 2 to 3 tasks simultaneously.	Apply
CO 4	**Identify** different filters and timers in PSoC for transmitting the data between PSOC and peripherals.	Apply
CO 5	**Utilize** Analog to Digital and Digital to Analog converters with PSoC for data conversion.	Apply
CO 6	**Build** an interface between PSoC and peripherals to provide solutions to the real world problems.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

Program Outcomes	
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1	Day to Day Evaluation/CIE/SEE

PO3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	Day to Day Evaluation/CIE/SEE
PO4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Day to Day Evaluation/CIE/SEE

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		**Strength**	**Proficiency Assessed by**
PSO 1	Build embedded software and digital circuit development platform for robotics, embedded systems and signal processing applications.	2	Project

3 = High; 2 = Medium; 1 = Low

XI MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES			PSO'S
	PO 1	PO 3	PO 4	PSO 1
CO 1		4	5	1
CO 2		6	5	2
CO 3		4	5	
CO 4	1	5	5	1
CO 5	1	6	5	3
CO 6	1	6	5	

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-

XIII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XIV SYLLABUS:

WEEK I	**DEVELOP PROGRAM USING KEIL IDE TOOL**
	Design and develop a reprogrammable embedded computer using 8051 microcontrollers and to show thefollowing aspects. a. Programming b. Execution c. Debugging To Demonstrate the Tool Chain for Keil IDE (Embedded Systems Development Tool Chain) with the example of LED Blinking Program.
WEEK II	**INTERFACING LED WITH DIFFERENT PORT PINS**
	a) Program to toggle all the bits of port P1 continuously with 250 ms delay b) Program to toggle only the bit P1.5 continuously with some delay
WEEK III	**INTERFACING BUZZER AND SWITCH**
	Program to interface a switch and a buzzer to two different pins of a port such that the buzzer should sound as long as the switch is pressed.
WEEK IV	**INTERFACING LCD DISPLAY**
	Program to interface LCD data pins to port P1 and display a message on it using P89V51RD2
WEEK V	**INTERFACE HEXA KEYPAD**
	Program to 4*4 interface keypad. Whenever a key is pressed, it should be displayed on LCD
WEEK VI	**INTERFACE SEVEN SEGMENT DISPLAY**
	Program to interface seven segment display using 89V51RD2
WEEK VII	**SERIAL COMMUNICATION INTEFACING**
	Program for serial communication between Microcontroller to PC communication the data should betransfer from microcontroller to PC terminal window
WEEK VIII	**SERIAL COMMUNICATION INTEFACING**
	Program for serial communication between PC to Microcontroller communication the data should betransfer from PC 197 — P a g e to Microcontroller terminal window using 89V51RD2
WEEK IX	**INTERFACING WITH TEMPERATURE SENSOR**
	Program to develop necessary interfacing circuit to read data from Temperature sensor and process using P89V51RD2, the data has to display terminal window
WEEK X	**INTERFACING STEPPER MOTOR**
	Program to interface Stepper Motor to rotate the motor in clockwise and anticlockwise directions
WEEK XI	**INTERFACING MULTPLE DEVICES**
	Program to verify run 2 to 3 tasks simultaneously on P89V51RD2 SDK. Use LCD interface, LED interface, Serial communication
WEEK XII	**INTERFACE ADC DEVICE**
	Program to interface ADC device with P89V51RD2 and display value on LCD
WEEK XIII	**INTERFACE DAC DEVICE**
	Program to interface DAC device with P89V51RD2 and observer the analog output in CRO
WEEK XIV	**INTERFACE RELAY**
	Program to interface Relay with P89V51RD2 using transistor

WEEK XV	**INTERRUPT**
	Program to toggle LEDS using simple INTERRUPT

TEXTBOOKS

1. Andrew Sloss, Dominic systems and Chris wright, ARM System Developers guide designing and optimizing system, Elsevier India private limited, New Delhi, 2009.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, ARM Systems Developer‘s Guides Designing and Optimizing System Software, 2008, Elsevier.

REFERENCE BOOKS:

1. Michael J. Pont, —Embedded C‖, Pearson Education, 2 nd Edition, 2008.
2. Nigel Gardner, —The Microchip PIC in CCS C‖. CCS Inc, 2nd Revision Edition, 2002.

XV COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Develop Program Using Keil IDE Tool .	CO1,CO2,CO3	T1
2	Interfacing Led With Different Port Pins.	CO1,CO2,CO3	T1
3	Interfacing Buzzer and Switch.	CO1,CO2,CO3	T1
4	Interfacing LCD Display	CO1,CO2,CO3	T1
5	Interface HEXA Keypad.	CO1,CO2,CO3	T1
6	Interface Seven Segment Display.	CO1,CO2,CO3	T1
7	Serial Communication Intefacing.	CO1,CO3,CO4	R2
8	Serial Communication Intefacing .	CO1,CO3,CO4	R2
9	Interfacing with Temperature Sensor.	CO1,CO3,CO5	R2
10	Interfacing Stepper Motor	CO1,CO3,CO6	R2
11	Interfacing Multple Devices	CO1,CO3,CO6	R2
12	Interface ADC Device.	CO1,CO3,CO6	R2
13	Interface DAC Device.	CO1,CO3,CO6	R2
14	Interface Relay.	CO1,CO3,CO6	R2
15	Interrupt.	CO1,CO3,CO6	R2

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Program to read data from temperature sensor interfacing with ARM7. .
2	Program to interface a PIR sensor with ARM7.
3	Program to perform UART Communication using ARM7

Signature of Course Coordinator **HOD,ECE**
P.Annapurna, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

<table>
<tr><td>Department</td><td colspan="5">ELECTRONICS AND COMMUNICATION ENGINEERING</td></tr>
<tr><td>Course Title</td><td colspan="5">DIGITAL IMAGE PROCESSING</td></tr>
<tr><td>Course Code</td><td colspan="5">AECC56</td></tr>
<tr><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>Semester</td><td colspan="5">VIII</td></tr>
<tr><td>Course Type</td><td colspan="5">PROFESSIONAL ELECTIVE</td></tr>
<tr><td>Regulation</td><td colspan="5">UG-20</td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>3</td><td>-</td><td>3</td><td>-</td><td>-</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Mr. Bala Thimmaiah N, Assistant Professor</td></tr>
</table>

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
UG	AECC02	III	Signals and Systems

II COURSE OVERVIEW:

The course is intended to provide image processing fundamentals, representation, sampling, quantization, image acquisition and imaging geometry. Transform techniques including two dimensional Fourier transforms, Walsh, Hotelling, Haar and Slant transforms. Analyze image processing filters and techniques for the applications of enhancement, segmentation and compression

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Image Processing	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question. The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
16.7%	Understand
50%	Apply
33.3 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination 1 (Mid-term)	10	30
	Continuous Internal Examination 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz - Online Examination
Two Quiz exams shall be online examination consisting of 50 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc.

VI COURSE OBJECTIVES:

The students will try to learn:

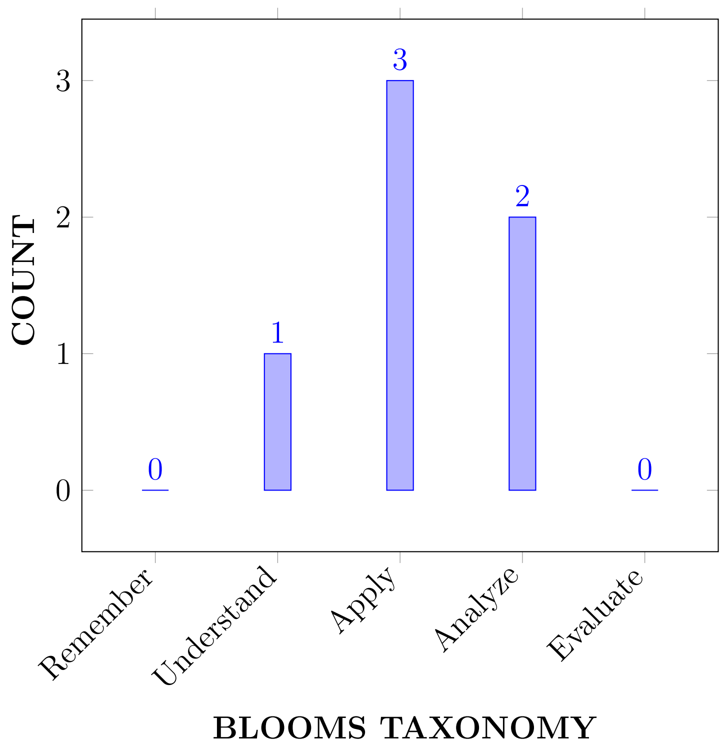
I	The fundamental concepts of digital image processing methods and techniques.
II	The image enhancement, image segmentation and compression techniques in spatial and frequency domains.
III	The algorithms to solve image processing problems to meet design specifications of various applications of image processing in industry, medicine and defense.
IV	Fundamentals of image representation and processing in MATLAB.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Interpret** the principles and terminology of digital image processing for describing the features of image.	Understand
CO 2	**Make use of** image transform techniques for analyzing images in transformation domain for image pre-processing.	Apply
CO 3	**Construct** image intensity transformation and filtering techniques for image enhancement in the spatial and frequency domain.	Apply
CO 4	**Apply** region-based morphological operations and edge-based image segmentation techniques for detection of objects in images to remove the imperfections in the structure of the image.	Apply
CO5	**Analyze** the image restoration in the spatial and frequency domains to deal with noise models for removing degradation from given image.	Analyze
CO 6	**Compare** the lossy and lossless compression models for achieving image compression.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Program Outcomes	
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE/CIE/ Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	SEE/CIE, Quiz/AAT

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	1	SEE/CIE, Quiz/AAT
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	SEE /CIE, Quiz/AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	TECH TALK/ CONCEPT VIDEOS
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	1	Projects/ Research on advanced technologies

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Build the Embedded software and digital circuit development platform for robotics, embedded systems and signal processing applications.	1	SEE, PROJECTS

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 2	✓	✓	-	-	-	-	-	-	-	✓	-	-	✓	-	-
CO 3	✓	✓	✓	✓	-	-	-	-	-	✓	-	✓	✓	-	-
CO 4	✓	✓	✓	✓	-	-	-	-	-	✓	-	✓	✓	-	-
CO 5	✓	✓	-	-	-	-	-	-	-	✓	-	✓	✓	-	-
CO 6	✓	✓	-	-	-	-	-	-	-	✓	-	✓	✓	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	Illustrate the principles of the Digital Image Processing terminology **(knowledge)** for understanding image and its representation, pixel, intensity, gray level, relationship between the pixels by applying the principles of **engineering science to complex engineering problems**	3
	PO 10	**Effective presentation and Speaking Style** on sampling and quantization and **write Subject Matter Effectively** the difference between analog and digital images.	2
CO 2	PO 1	**Develop a image with various** image transform properties types and its types using **Scientific principles and methodology fundamental mathematics.**	3
	PO 2	**Formulate and analyze (Problem analysis) complex Engineering problems** for image transforms using **first principles of mathematics and Engineering sciences.**	5
	PO 10	**Effective presentation and Speaking Style** on properties of transforms and **write Subject Matter Effectively** on types of transforms.	2
	PSO 1	**Design of experiments** on image transforms **with project development and execution process** of **modern** tools such as MATLAB with image processing tool box, python, CV2.	2
CO 3	PO 1	**Illustrate the principles of an image find by using engineering** techniques for image enhancement by using **mathematical methods.**	3
	PO 2	**Illustrate** the filter processing **model translation** for spatial domain and **formulate** the time domain filter.	5
	PO 3	**Develop** a histogram techniques **complex engineering problem with appropriate considerations** and environmental considerations for image enhancement.	2
	PO 4	**Demonstrate** the **Use** image enhancement **analyze and interpretation and Ability to apply quantitative methods** in frequency domain processing technique to **provide valid** digital image.	4
	PO 10	**Effective presentation and Speaking Style** on histogram processing **Write Subject Matter Effectively** on manipulation technique of an digital image.	2
	PO 12	**Get aware of advancements** of Image enhancement techniques that would happen from to time	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PSO 1	**Design of experiments with project development and execution** modern tools such as MATLAB with image processing tool box, python, CV2.	2
CO 4	PO 1	Distinguish the image restoration in the spatial and frequency domains **(knowledge)** to remove the noise present the image by applying the principles of **(mathematics, engineering science for complex engineering problems.**	3
	PO 2	Formulate and analyze **(Problem analysis) complex Engineering problems** for image restoration using first principles of **mathematics and Engineering sciences**	5
	PO 3	**(Develop** spatial and frequency domain techniques **complex engineering problem with appropriate considerations** and **environmental considerations** for image restoration.	2
	PO 4	Understand the image restoration in the spatial and frequency domains **(knowledge)** methods **including design of experiments, analysis of complex problems.**	4
	PO 10	**Effective presentation and Speaking Style and write** on degradation models and noise sources for image restoration of digital images	2
	PO 12	**Get aware of advancements** of Image segmentation techniques and morphological Image processing that would happen from to time	2
	PSO 1	**Design of experiments with project development and execution** image restoration with modern tools such as MATLAB with image processing tool box, python, CV2.	2
CO 5	PO 1	**Interpret** Image Segmentation and formulate representation techniques to apply **Mathematical principles fundamental mathematics.**	3
	PO 2	**Apply Problem statement** the segmentation techniques for edge linking and boundaries by using **principles of mathematics and formulate** segmentation techniques.	5
	PO 10	**Effective presentation and Speaking Style and write on** image segmentation techniques.	2
	PO 12	**Get aware of advancements** of Image restoration techniques that would happen from to time	2
	PSO1	**Design of experiments with project development and execution** image segmentation with modern tools such as MATLAB with image processing tool box, python, CV2.	2
CO6	PO 1	**Understand the** various source coding techniques and Interpret Image Compression standards using **engineering science and mathematical models.**	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	**Identify and analyze** fidelity criteria, image compression models **implement** using **engineering science, design system components** for source Encoder and decoder, error free compression and **model translation** using **principles of mathematics.**	5
	PO 10	**Present effectively** and **Clarity** source encoder and **write effectively subject matter** on decoder techniques.	2
	PO 12	**Get aware of advancements** of Image compression techniques and wavelet based Image compression techniques that would happen from to time	2
	PSO1	**Design of experiments with project development and execution** image compression with modern tools such as MATLAB with image processing tool box, python, CV2.	2

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 2	3	5	-	-	-	-	-	-	-	2	-	-	2	-	-
CO 3	3	5	2	4	-	-	-	-	-	2	-	2	2	-	-
CO 4	3	5	2	4	-	-	-	-	-	2	-	2	2	-	-
CO 5	3	5	-	-	-	-	-	-	-	2	-	2	2	-	-
CO 6	3	5	-	-	-	-	-	-	-	2	-	2	2	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40	0.0	0.0	0.0	0.0	0.0
CO 2	100	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40	0.0	0.0	40	0.0	0.0
CO 3	100	50	20	36.3	0.0	0.0	0.0	0.0	0.0	40	0.0	25	40	0.0	0.0
CO 4	100	50	20	36.3	0.0	0.0	0.0	0.0	0.0	40	0.0	25	40	0.0	0.0
CO 5	100	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40	0.0	25	40	0.0	0.0
CO 6	100	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40	0.0	25	40	0.0	0.0

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation
1 - $5 < C \leq 40\%$ – Low/ Slight
2 - $40\% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	1	-	-	1	-	-
CO 3	3	2	1	1	-	-	-	-	-	1	-	1	1	-	-
CO 4	3	2	1	1	-	-	-	-	-	1	-	1	1	-	-
CO 5	3	2	-	-	-	-	-	-	-	1	-	1	1	-	-
CO 6	3	2	-	-	-	-	-	-	-	1	-	1	1	-	-
TOTAL	18	10	2	2	-	-	-	-	-	6	-	4	5	-	-
AVERAGE	3	2	1	1	-	-	-	-	-	1	-	1	1	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	-	Tech-Talk	✓		

XVII ASSESSMENT METHODOLOGY-INDIRECT:

-	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**INTRODUCTION**
	Digital image fundamentals and image transforms digital image fundamentals, sampling and quantization, relationship between pixels; Image transforms: 2-D FFT, properties, Walsh transform, Hadamard transform, discrete cosine transform, Haar transform, Slant transform, Hoteling transform.
MODULE II	**IMAGE ENHANCEMENT**
	Introduction, image enhancement in spatial domain, enhancement through point processing, types of point processing, histogram manipulation, linear and non-linear gray level transformation, local or neighborhood operation, median filter processing; Spatial domain high pass filtering, filtering in frequency domain, obtaining frequency domain filters from spatial filters, generating filters directly in the frequency domain, low pass (smoothing) and high pass (sharpening) filters in frequency domain.

MODULE III	**IMAGE SEGMENTATION AND MORPHOLOGICAL IMAGE PROCESSING**
	Image segmentation detection of discontinuities, edge linking and boundary detection, threshold, region oriented segmentation, Watershed transformation. Morphological image processing dilation and erosion, structuring element decomposition, the Strel function, erosion; Combining dilation and erosion: Opening and closing the hit and miss transformation, Boundary extraction ,Region filling, Extracted of connected components, convex hull ,skeletons, pruning, Thinning , Thickening.
MODULE IV	**IMAGE RESTORATION**
	Image restoration degradation model, Noise models, Restoration in the presence of noise only (Spatial Filtering), Estimating the degradation function, Inverse filtering, Least mean square filters, constrained least square restoration.
MODULE V	**IMAGE COMPRESSION AND WAVELET BASED IMAGE PROCESSING**
	Image compression: Redundancies and their removal methods, fidelity criteria, image compression models, source encoder and decoder, error free compression, lossy compression, Wavelet transform: Continuous wavelet transformation, 2D continuous wavelet transformation, Examples of wavelets, Wavelet based image compression.

TEXTBOOKS

1. R.C. Gonzalez & R.E. Woods, —Digital Image Processing‖, Addison Wesley/ Pearson education, 2nd Education, 2002.

2. S. Jayaraman, S. Esakkirajan, T. Veerakumar, “Digital Image Processing”, TMH, 3rd Edition, 2010.

REFERENCE BOOKS:

1. A.K.Jain, —Fundamentals of Digital Image Processing, PHI. 3RD Edition, 2003.

2. Rafael C. Gonzalez, Richard E Woods and Steven, —Digital Image Processing using MATLAB‖L. Edition, PEA, 2004.

3. William K. Pratt, John, —Digital Image Processing‖, Wilely, 3rd Edition, 2004.

4. Somka, Hlavac, Boyle, “Digital Image Processing and Computer Vision”, Cengage Learning, 1st Edition, 2008.

5. Adrain Low, “Introductory Computer vision Imaging Techniques and Solutions”, Tata McGraw-Hill, 2nd Edition, 2008.

6. John C. Russ, J. Christian Russ, “Introduction to Image Processing & Analysis”, CRC Press, 1st Edition, 2010.

WEB REFERENCES:

1. https://nptel.ac.in/courses/117105135

2. https://onlinecourses.nptel.ac.in/noc22_ee116/preview

COURSE WEB PAGE:

1. https://akanksha.iare.ac.in/index?route=course/details&course_id=129

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping		
CONTENT DELIVERY (THEORY)			
1	Introduction to Digital Image Processing	CO 1	T1:1.4-1.5
2	Digital Image Fundamentals, pixels	CO 1	T1:1.4-1.5
3	Analyze sampling and quantization	CO 1	T1:2.4-2.5
4	Introduction to Image transforms	CO 2	T1:2.4-2.5; R1:5.4-5.10
5	2D-FFT and Properties of 2D-FFT	CO 2	R1:5.4-5.10; R2: 5.8-5.10
6	Walsh transform and Hadamard transform	CO 2	R1:5.4-5.10
7	Discrete cosine transform , Haar transform	CO 2	R1:5.4-5.10
8	Slant transform, Hoteling transform	CO 2	R1:5.4-5.10
9	Introduction to image enhancement ,enhancement in spatial domain	CO 3	T1:3.1-3.6
10	Enhancement through point processing and types	CO 3	T1:3.1-3.8
11	Linear and non-linear gray level transformation	CO 3	T1:3.1-3.8; R2: 7.4-7.5
12	Local or neighbourhood operation	CO 3	T1:3.1-3.8; R2: 7.4-7.5
13	Median filter processing, Spatial domain high pass filtering	CO 3	T1:3.1-3.8; R2: 7.4-7.5
14	Histogram equalization and processing	CO 3	T1:3.1-3.8; R2: 7.4-7.5
15	Obtaining frequency domain filters from spatial filters	CO 3	T1:4.1-4.6
16	Low pass (smoothing) filter in frequency domain.	CO 3	T1:4.1-4.6
17	High pass (sharpening) filter in frequency domain	CO 3	T1:4.1-4.6
19	Introduction to Image segmentation	CO 4	T1:10.1-10.6
20	Detection of discontinuities, Edge linking and boundary detection	CO 4	T1:10.1-10.6
21	Threshold techniques for image segmentation, region oriented segmentation	CO 4	T1:10.1-10.6
22	Watershed transformation	CO 4	T1:10.1-10.6; T1:9.1-9.6
23	Morphological image processing, dilation and erosion	CO 4	T1:10.1-10.6; T1:9.1-9.6
24	Understand structuring element decomposition, the Strel function, erosion;	CO 4	T1:9.1-9.6
25	Combining dilation and erosion: Opening and closing,The hit and miss transformation	CO 4	T1:9.1-9.6
26	Boundary extraction ,Region filling, Extracted of connected components, convex hull	CO 4	T1:9.1-9.6

27	skeletons, pruning, Thinning , Thickening	CO 4	T1:9.1-9.6
28	Introduction to Image restoration, Degradation model	CO5	T1:8.1-8.3 ; R2: 7.4-7.5
29	Noise models , Restoration in the presence of noise only (Spatial Filtering)	CO5	T1:8.1-8.3 ; R2: 7.4-7.5
30	Estimating the degradation function, Inverse filtering	CO5	T1:8.1-8.3 ; R2: 7.4-7.5
31	Least mean square filters	CO5	T1:8.1-8.3 ; R2: 7.4-7.5
32	Constrained least square restoration	CO5	T1:8.1-8.3 ; R2: 7.4-7.5
33	Introduction to Image compression	CO6	T1:8.1-8.3 ; R2: 7.4-7.5
34	Redundancies and their removal methods	CO 6	T1:8.1-8.3; R2: 7.4-7.5
35	Fidelity criteria, image compression models	CO 6	T1:8.1-8.3; R2: 7.4-7.5
36	Understand source encoder and decoder, Error free compression	CO 6	T1-8.1-8.1.7
37	Lossy compression & JPEG 2000 standard	CO 6	T1-8.1-8.1.7
38	Wavelet transform: Continuous wavelet transformation	CO 6	T1-8.1-8.1.7
39	2D continuous wavelet transformation ,Examples of wavelets	CO 6	T1-8.1-8.1.7
40	Wavelet based image compression	CO 6	T1-8.1-8.1.7
PROBLEM SOLVING/ CASE STUDIES			
1	Problem solving on 2-D FFT and it's properties	CO 2	T1:2.6-2.6.8; R2: 5.8-5.10
2	Problem solving on Walsh transform, Hadamard transform	CO 3	T1:3.1-3.6
3	Problem solving on Haar Transform	CO 2	T1:3.1-3.6
4	Problem solving on Slant, Hoteling and discrete cosine transform	CO 2	T1:3.1-3.6
5	Problem solving on image enhancement in spatial domain and point processing	CO 3	T1:3.1-3.6
6	Problem solving on histogram manipulation and equalization	CO 3	T1:3.1-3.8
7	Problem solving on gray-level transformation and median filter processing	CO 3	T1:3.1-3.8
8	Problem solving on image enhancement using filtering methods	CO 3	T1:4.1-4.6
9	Problem solving on image enhancement using filtering methods	CO 3	T1:4.1-4.6
10	Problem solving on image restoration using filtering techniques	CO 4	T1:4.1-4.6
11	Problem solving on image segmentation using edge linking and boundary detection	CO 5	T1:10.1-10.6

12	Problem solving on image segmentation using region orientation morphological processing	CO 5	T1:10.1-10.6
13	Problem solving on image segmentation using dilation and erosion	CO5	T1:10.1-10.6
14	Problem solving on image compression using removal of redundancies	CO 6	T1:8.1-8.3; R2: 7.4-7.5
15	Problem solving on image compression using JPEG 2000 standard	CO 6	T1:8.1-8.3; R2: 7.4-7.5
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Definitions and terminologies on Introduction to Digital image processing	CO 1	T1:1.4-1.5
2	Definitions and terminologies on image enhancement	CO 3	T1:3.1-3.8
3	Definitions and terminologies on image restoration	CO 4	T1:4.1-4.6
4	Definitions and terminologies on image segmentation	CO 5	T1:10.1-10.6
5	Definitions and terminologies on image compression	CO 6	T1:8.1-8.3; R2: 7.4-7.5
DISCUSSION OF QUESTION BANK			
1	Discussion on question bank of introduction to digital image processing	CO 2	T1:1.4-1.5
2	Discussion on question bank of image enhancement	CO 3	T1:3.1-3.8
3	Discussion on question bank of image restoration	CO 4	T1:3.1-3.8; R2: 7.4-7.5
4	Discussion on question bank of image segmentation	CO 5	T1:10.1-10.6
5	Discussion on question bank of image compression	CO 6	T1:8.1-8.3; R2: 7.4-7.5

Signature of Course Coordinator **HOD,ECE**
Mr. Bala Thimmaiah N, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

<table>
<tr><td>Department</td><td colspan="5">ELECTRONICS AND COMMUNICATION ENGINEERING</td></tr>
<tr><td>Course Title</td><td colspan="5">INTERNET OF THINGS</td></tr>
<tr><td>Course Code</td><td colspan="5">AECC62</td></tr>
<tr><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>Semester</td><td colspan="5">VIII</td></tr>
<tr><td>Course Type</td><td colspan="5">Professional Elective -VI</td></tr>
<tr><td>Regulation</td><td colspan="5">UG-20</td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>3</td><td>-</td><td>3</td><td>-</td><td>-</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Mr. Voodara Devender, Assistant Professor</td></tr>
</table>

I COURSE OVERVIEW:

The Internet of things allows every device to connect the world for exchange of information among the associated devices. It focuses on the concepts of data communication, network protocols, cloud computing and network security fundamental techniques, customs and terms including the basic components of hardware and software. The applications of IoT include home automation, smart parking, smart lighting, and smart phone detection.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECB24	VI	Microprocessors and Microcontrollers

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
IoT and Applications	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
✓	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Tech Talks	x	Concept Videos	x	others		

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
33.3%	Understand
33.3%	Apply
33.3 %	Analyze
0 %	Evaluate
0%	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Tech-talk	**Assignment**	**Complex Problem solving**
50%	50%	-

VI COURSE OBJECTIVES:

The students will try to learn:

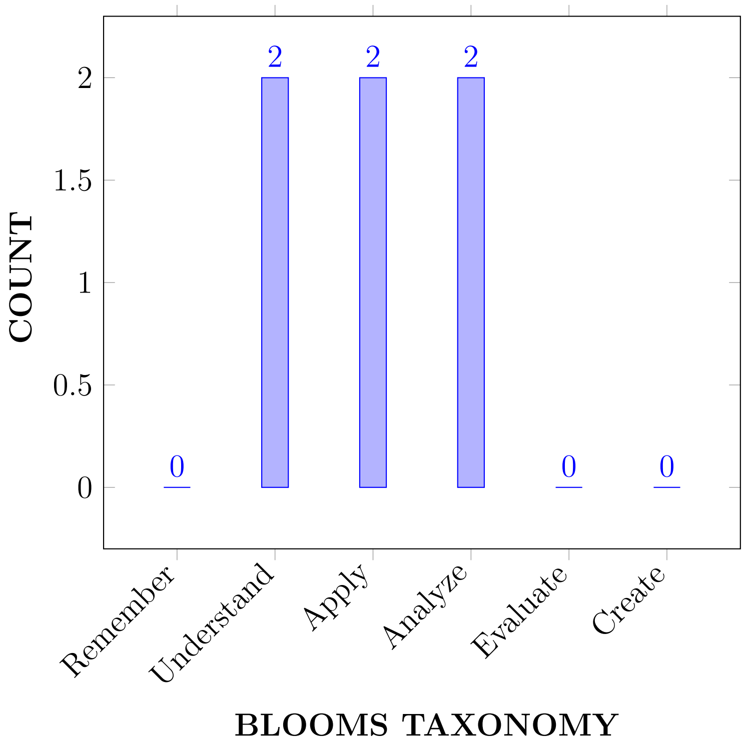
I	The principle and operation of software defined networking and network function virtualization.
II	The knowledge of IoT enabled technologies, security protocols and architectures.
III	Python programming skills to move into specific areas – deep learning (DL), data science, machine learning (ML),artificial intelligence (AI) etc.

VII COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Summarize** the characteristics, physical design and logical design of Internet of things to define the components in IoT.	Understand
CO 2	**Distinguish** the software defined networking with network function virtualization to analyze the improvements in communication.	Analyze
CO 3	**Utilize** the knowledge of python programming to build successful internet of things associated devices.	Apply
CO 4	**Demonstrate** the IoT architecture and reference model for connecting the world through associated devices.	Understand
CO 5	**Make use of** appropriate communication protocols to acquire the knowledge of programming with Raspberry PI.	Apply
CO 6	**Analyze** the cloud storage models and application programming interfaces to understand exchange of the data over the network.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE/CIE/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	SEE/CIE/AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations.	1	SEE/CIE/AAT
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations,	3	SEE/CIE/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	1	SEE/CIE/AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	✓	-	-	-	-	-	-	-	-	-	-	-	✓
CO 2	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	✓
CO 3	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	✓
CO 4	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-
CO 5	-	-	✓	-	✓	-	-	-	-	-	-	-	-	-	✓
CO 6	-	-	✓	-	✓	-	-	-	-	-	-	-	-	-	✓

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Understand** the basic characteristics of IoT along with their enabling technologies by **applying the principles of science to engineering problems.**	3
	PO 3	**Apply** the knowledge of physical design and Logical design to **appropriate consideration for the public health, safety, cultural, societal and environmental Considerations.**	5
	PSO 3	**Apply** the knowledge of physical design and Logical design to **model, program for operation and control of smart antennas for wireless communication applications,explicit software for IoT devices.**	2
CO 2	PO 1	**Understand** the concept of the IoT levels by applying the principles of **science to engineering problem.**	2
	PSO 3	**Understand** the knowledge of the IoT levels and deployment models to **apply on wireless communication applications.**	1
CO 3	PO 2	**Understand** the basic structure of Management system and can collect operational data from IoT devices to applying **mathematics, science and engineering fundamentals.**	5
	PSO 3	**Apply** the knowledge of software defined networking to understand the **research, analysis and presentation using software aids.**	1
CO 4	PO 5	**Observe** the differences between software defined networking and network function virtualization to Apply the **knowledge of engineering fundamentals**	1
CO 5	PO 3	**Understand** the performance of different types of Components by applying **mathematics, science and engineering fundamentals.**	3
	PO 5	**Identify** the different types of Components to design system components or processes that meet the specified needs with **appropriate consideration for the public health, and environmental Considerations**	1
	PSO 3	**Understand** the knowledge of appropriate communication protocols to understand the **programming and hands on skills to meet requirements of global environment.**	1
CO 6	PO 3	**Discuss** (Understand) different types of modules in python to write the programming by applying **mathematics, science and engineering fundamentals.**	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 5	**Apply** the programming knowledge to Design solutions for **complex engineering problems and design system components.**	1
	PSO 3	**Apply** the knowledge of cloud storage models and application programming interfaces to **to interface automation tools and program for operation and control of smart antennas for wireless communication applications**	2

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	3	-	5	-	-	-	-	-	-	-	-		-	-	2
CO 2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO 3	-	5	-	-	-	-	-	-	-	-	-	-	-	-	1
CO 4	-	-	-	-	1	-	-	-	-	-	-		-	-	-
CO 5	-	-	3	-	1	-	-	-	-	-	-	-	-	-	1
CO 6	-	-	3	-	1	-	-	-	-	-	-		-	-	2

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	100	-	50	-	-	-	-	-	-	-	-		-	-	28.6
CO 2	66.6	-	-	-	-	-	-	-	-	-	-	-	-	-	14.2
CO 3	-	30	-	-	-	-	-	-	-	-	-	-	-	-	14.2
CO 4	-	-	-	-	100	-	-	-	-	-	-		-	-	-
CO 5	-	-	30	-	100	-	-	-	-	-	-	-	-	-	14.2
CO 6	-	-	30	-	100	-	-	-	-	-	-		-	-	28.6

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq$ C$\leq$ 5% – No correlation
1 -5 <C$\leq$ 40% – Low/ Slight
2 - 40 % <C < 60% –Moderate
3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	2	-	-	-	-	-	-	-	-	-	-	-	1
CO 2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO 3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	1
CO 4	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO 5	-	-	1	-	3	-	-	-	-	-	-	-	-	-	1
CO 6	-	-	1	-	3	-	-	-	-	-	-	-	-	-	1
TOTAL	**6**	**2**	**4**	**0**	**9**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**
AVERAGE	**3**	**2**	**1.3**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Laboratory Practices	-
Assignments	-	Student Viva	-	Certification	-
Term Paper	-	Concept Videos	✓	Open Ended Experiments	-
Tech Talk	✓				

XVII ASSESSMENT METHODOLOGY-INDIRECT:

✓	Early Semester OBE Feedback	✓	End Semester OBE Feedback	✓	Assessment of activities / modeling and experimental tools in engineering by experts

XVIII SYLLABUS:

MODULE I	**INTRODUCTION TO INTERNET OF THINGS (IoT)**
	Definition and characteristics of IoT, physical design of IoT, logical design of IoT, IoT enabling technologies, IoT levels and deployment, domain specific IoTs.
MODULE II	**IoT AND M2M**
	Introduction, M2M, difference between IoT and M2M, software defined networking (SDN) and network function virtualization (NFV) for IoT, basics of IoT system management with NETCONF-YANG.
MODULE III	**IoT ARCHITECTURE AND PYTHON**
	IoT Architecture: State of the art introduction, state of the art; Architecture reference model: Introduction, reference model and architecture, IoT reference model. Logical design using Python: Installing Python, Python data types and data structures, control flow, functions, modules, packages, file handling
MODULE IV	**IoT PHYSICAL DEVICES AND ENDPOINTS**
	Introduction to Raspberry Pi interfaces (Serial, SPI, I2C), programming Raspberry PI with Python, other IoT devices, Implementation of IoT with Raspberry Pi

MODULE V	**IoT PHYSICAL SERVERS AND CLOUD OFFERINGS**
	Introduction to cloud storage models and communication APIs; WAMP: AutoBahn for IoT, Xively cloud for IoT; Case studies illustrating IoT design: Home automation, smart cities, and smart environment.

TEXTBOOKS

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A Hands-on-Approach", VPT, 1st Edition, 2014.
2. Matt Richardson, Shawn Wallace, "Getting Started with Raspberry Pi", O Reilly (SPD), 3rd Edition, 2014.

REFERENCE BOOKS:

1. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things", John Wiley and Sons, 1st Edition, 2014.
2. Francis Da Costa, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", Apress Publications, 1st Edition, 2013.

WEB REFERENCES:

1. https://nptel.ac.in/courses/112105171/1

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	https://lms.iare.ac.in/index ?route=course/details& course id_127
CONTENT DELIVERY (THEORY)			
2	Pre requisites	CO1	T1-3.1-3.2
3	Introduction to Internet of Things	CO1	T1-3.3-3.4
4	Definition and Characteristics of IoT and application	CO1	T1-3.3-3.4
5	IoT Levels and Templates	CO1	T1-3.7
6	IoT communication models	CO1	T1-3.5
7	IoT enabled Technologies	CO1	T1-3.6
8	Introduction to IoT Architecture	CO1	T1-5.1.1
9	State of the art introduction, state of the art	CO1	T1-.1.1,5.1.2
10	Architecture reference model: Introduction,	CO1	T1-5.2
11	Cloud for IoT and Python web application framework	CO2	T1-7.10.2-3
12	Physical Design of IoT – IoT Protocols	CO2	T1-3.5
13	Domain Specific IoTs	CO2	T1-4.2
14	IoT and machine 2 machine	CO2	T1-4.6

15	Software defined networks and Network function virtualization	CO3	T1-4.7
16	Difference between SDN and NFV for IoT	CO3	T1-4.10.6
17	Basics of IoT System Management with NETCOZF-YANG	CO3	T1-4.11
18	NETCONF, YANG, SNMP Netopeer	CO3	T1-5.1.1
19	IoT Architecture And Python	CO4	T1-5.1.1
20	File handling in python	CO4	TT1-5.11
21	Logical design using Python: Installing Python	CO 5	T1-5.3.2
22	Python data types and data structures	CO 5	T1-5.3.3,5.4
23	Control flow in python	CO 5	T1-5.4.2
24	Functions,Modules,Packages in python.	CO 5	T1-5.5
25	Introduction to Raspberry PI - Interfaces (serial, SPI,I2C)	CO 5	T1-7.1,7.2
26	Programming – Python program with Raspberry PI and external interfacing	CO 5	T1-7.7.2
27	IoT Physical Devices and Endpoints	CO 6	T1-7.3,7.4
28	Serial peripheral interface bus and Inter integrated circuit	CO 6	T1-3.5
29	Communication APIs	CO 6	T1-7.8
30	Types of APIs	CO 6	T1-7.8.1,8.2
31	Webserver – Web server for IoT	CO 6	T1-7.10,11
32	Designing a RESTful web API	CO 6	T1 7.10.3.3
33	Reference model and architecture,	CO 6	T1-5.3
34	Polarization diversity, frequency diversity, time diversity, RAKE receiver.	CO 6	T1-7.10.
35	Introduction to wireless networks, advantages and disadvantages of wireless local area networks	CO 6	R3-P184
36	Wireless local area networks	CO 6	R3-P184
37	WLAN topologies, WLAN standard IEEE 802.11	CO 6	R3-P185
38	IEEE 802.11 medium access control,	CO 6	R3-P191
39	Comparison of IEEE 802.11 a,b,g and n standards	CO 6	R3-P190
40	IEEE 802.16 and its enhancements, Wireless PANs, Hipper LAN, WLL	CO 6	R3-P1911
PROBLEM SOLVING/ CASE STUDIES			
41	SNMP Netopeer	CO 1	T1:5.1.1
42	Serial peripheral interface bus	CO 1	T1:7.3,7.4
43	Diversity techniques	CO 1	T1:5.1.1
44	IoT Architecture and challengee	CO 1	T1:4.2
45	Cloud Offerings	CO 2	T1:1-7.8
46	Inter integrated circuit	CO 2	T1:7.4
47	Raspberry PI - Interfaces (serial, SPI,I2C)	CO 4	T1:7.2

48	Raspberry PI and external interfacing	CO 4	T17-7.2
49	Logical design using Python	CO 4	T1:5.3.2
50	Reference model and architecture	CO 5	T1:4.2
51	Python data types and data structures	CO 5	T1:5.3
52	WLAN standards	CO 6	R3:P185
53	Medium access control,	CO 6	R3-P191
54	High Performance Radio LAN	CO 6	R3-P1911
55	Wireless networks, advantages of wireless local area network	CO 6	R1:184
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Interoperable characteristics of IoT	CO 1	T1:4.2
57	Software defined networking	CO 2	T1:4.6
58	Various Types Of loops in Python	CO 4	T1:5.11
59	Class variables vs instance variables	CO 5	T1:7.1
61	Infrastructure-as-a-Service	CO 6	T1:7.10
DISCUSSION OF QUESTION BANK			
62	Network configuration yang module	CO 2	T1:4.6
63	IoT reference model with diagram	CO 3	T1:5.11
64	IoT Physical Devices and Endpoints	CO 4	T1:7.1
65	Case studies in IoT design	CO 6	T1: 7.10
66	Web-based communication models	CO 6	T1:4.2

Course Coordinator: **HOD, ECE**
Mr. Voodara Devender, Assistant Professor

ANNEXURE

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**
	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	

PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**

PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**
	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	

PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

ANNEXURE

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	NBA Statement / NBA statement / Vital features	No. of vitalfea-tures
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications. 1. Analyze and solve real time problems in Robotics. 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications. 3. Develop embedded systems modules using Real Time Operating System. 4.Undertake research and development projects in the field of Em- bedded Systems. 5. Adopt the engineering professional code and conduct.	5
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs. 1. Inspect, survey and analyze types of ASIC chip designs. 2. Design ASIC prototypes using Verilog and VHDL languages. 3. Analyze microprocessor subsystems with memories and I/O inter- facs for SOC designs 4. Explore hardware components for designig SOC 5.Adopt the engineering professional code and conduct 6. Designing prototypes of SOC using programming tools like MAT- LAB, LabVIEW. 7. Familiarize with the design flow of ASIC prototypes. 8. Realize SOC using Register-Transfer-Level designs 9. Analyse and develop models for system level descriptions for syn- thesis of SOC. 10.Inspect and survey the abstractions and principles for the specifi- cation, simulation, verification, and synthesis of systems on chip (SoC). 11.Programming and hands-on skills to meet requirements of global environment.	**11**
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications. 1. Explicit software and programming tools for antenna design. 2. Adopt technical library resources and literature search. 3.Explore smart antennas. 4. Model, program for operation and control of smart antennas for wireless communication applications. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

<table>
<tr><td>Department</td><td colspan="5">ELECTRONICS AND COMMUNICATION ENGINEERING</td></tr>
<tr><td>Course Title</td><td colspan="5">DISASTER MANAGEMENT</td></tr>
<tr><td>Course Code</td><td colspan="5">ACEC31</td></tr>
<tr><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>Semester</td><td colspan="5">VIII</td></tr>
<tr><td>Course Type</td><td colspan="5">Open Elective</td></tr>
<tr><td>Regulation</td><td colspan="5">IARE-UG20</td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>3</td><td>-</td><td>3</td><td>-</td><td>-</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Ms. Praveena Rao, Assistant Professor</td></tr>
</table>

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

II COURSE OVERVIEW:

The Disaster management provides a fundamental understanding of different aspects. It deals with the concepts and functions of disaster management to build competencies of professionals and development practitioners. It provides effective supporting environment by the governmental locating substantial resources for effective mitigation of disasters. It helps learners to apply the disaster mitigation strategies, preparedness for reducing damage intensity, loss of life and property.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Disaster Management	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

<table>
<tr><td>✓</td><td>Power Point Presentations</td><td>✓</td><td>Chalk & Talk</td><td>x</td><td>Assignments</td><td>x</td><td>MOOC</td></tr>
<tr><td>x</td><td>Open Ended Experiments</td><td>x</td><td>Seminars</td><td>x</td><td>Mini Project</td><td>x</td><td>Videos</td></tr>
<tr><td>x</td><td colspan="7">Others</td></tr>
</table>

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in Table: 1.

Percentage of Cognitive Level	Blooms Taxonomy Level
17%	Remember
83 %	Understand
0%	Apply
0 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered. **Alternative Assessment Tool (AAT)**

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	**Tech-talk**	**Complex Problem Solving**
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

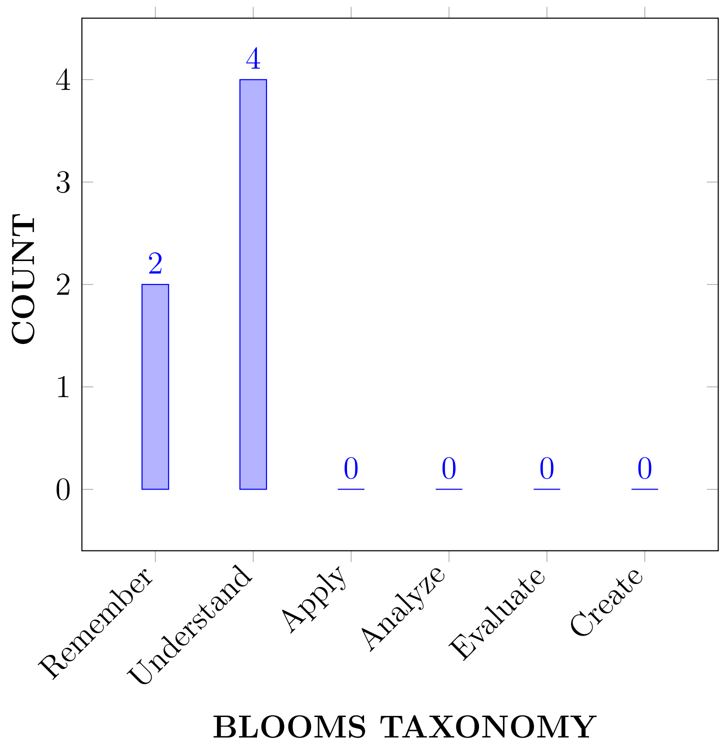
I	The concept of environmental hazards, disasters and various approaches dealing with the mitigation of disasters.
II	The knowledge on various types of environmental disasters and their impacts on human beings and nature.
III	The Different types of endogenous and exogenous hazards and their influence on human life and nature.
IV	The immediate response and damage assessment with information reporting and monitoring tools.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Classify** Environmental hazards for developing modern disaster management system.	Remember
CO 2	**Illustrate** various approaches for reducing the level of risk associated with Disasters.	Understand
CO 3	**Compare** natural and manmade disasters for finding out intensity of damage loss occurred by them.	Understand
CO 4	**List** various hazards and their effects for evaluating their impact on society and Environment.	Remember
CO 5	**Outline** human adjustments and perception towards hazards for mitigation of disasters.	Understand
CO 6	**Summarize** disaster phenomenon and its different contextual aspects for implementing the Disaster Risk Reduction Strategy.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/SEE/AAT
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	3	CIE/SEE/AAT
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	3	CIE/SEE/AAT
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	1	CIE/SEE/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	-	-
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	-	-
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	✓	-	-	-	-	-	✓	-	-	-	-	-	-	-	-
CO 2	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
CO 4	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
CO 5	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-	-
CO 6	✓	-	-	-	-	✓	-	-	✓	-	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Apply the knowledge and principals of mathematics to engineering problems in determining an area enclosed by irregular boundary line using the knowledge of **mathematics and science fundamentals**	2
	PO 7	Understand the disaster management by considering Environmental impacts on the livelihood and their effect on Socio economic issues for sustainable development.	2
CO 2	PO 1	Apply the knowledge on various disaster mitigation approaches in **engineering disciplines** and and use their application in geographical researches.	1
	PO 6	Apply the engineering knowledge in disaster management to **promote sustainable development** and build **Awareness on health, safety,** and **risk issues** associated with Disasters.	4
CO 3	PO 6	Identify **engineering activities including personnel, health, safety, and risk and effective disaster management strategies** for implementing, analyzing disaster impacts on human life and environment.	4
	PO 7	Understand intensity of disasters and their impact on **environment** and influence on **socio economic** parameter for assessment of intensity of risk.	2
CO 4	PO 6	Identify **engineering activities including personnel, health, safety, and risk** for analyzing hazard impacts on environment.	4
	PO 7	Identify the impact of various hazards in **socio-economic and environmental** aspects for developing modern disaster management system.	2

CO 5	PO 1	Understand the **methodology and scientific principal towards** hazards for human adjustments and perception by sharing technological knowledge from **other engineering branches.**	2
	PO 6	Understanding of the need for a **high level of professional and ethical conduct in engineering** for human adjustments, perception with effective **management strategies**for disaster mitigation.	4
CO 6	PO 1	Understand the **knowledge of scientific principal and methodology** in disaster phenomenon for minimizing impact by implementing the Disaster Risk Reduction Strategy.	2
	PO 6	**Appropriate management strategies** are to be applied to reduce the level of risk in disaster mitigation.	1
	PO 9	Apply disaster risk reduction strategy using various organizations and **work effectively as an individual** and **as a member** or **a leader** are to be applied to reduce the level of risk in disaster mitigation.	3

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	Program Outcomes/ No. of Key Competencies Matched												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	1	2	3
CO 1	2	-	-	-	-	-	2	-	-	-	-		-	-	-
CO 2	1	-	-	-	-	4	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	4	2	-	-	-	-		-	-	-
CO 4	-	-	-	-	-	4	2	-	-	-	-	-	-		-
CO 5	2	-	-	-	-	4	-	-	-	-	-	-	-	-	-
CO 6	2	-	-	-	-	1	-	-	3	-	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	1	2	3
CO 1	66.6	-	-	-	-	-	66.6	-	-	-	-	-	-	-	-
CO 2	33.3	-	-	-	-	80	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	80	66.6	-	-	-	-	-	-		-
CO 4	-	-	-	-	-	80	66.6	-	-	-	-	-	-	-	-
CO 5	66.6	-	-	-	-	80	-	-	-	-	-	-	-	-	-
CO 6	66.6	-	-	-	-	20	-	-	25	-	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.
0 - $0 \leq C \leq 5\%$ – No correlation
1 - $5 \leq C \leq 40\%$ – Low/ Slight
2 - $40\ \% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	**PROGRAM OUTCOMES**												**PSO'S**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	1	2	3
CO 1	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO 2	1	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-
CO 4	-	-	-	-	-	3	3	-	-	-	-	-	-		-
CO 5	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO 6	3	-	-	-	-	1	-	-	1	-	-	-	-	-	-
TOTAL	10	-	-	-	-	13	9	-	1	-	-	-	-	-	-
AVERAGE	3	-	-	-	-	3	3	-	1	-	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Term Paper	-	Concept Video	✓	Open Ended Experiments	-
Assignments	-	Mini project	-	Tech Talk	✓

XVII ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of mini projects by Experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**ENVIRONMENTAL HAZARDS AND DISASTERS**
	Environmental hazards and disasters: meaning of environmental hazards, environmental disasters and environmental stress; concept of environmental hazards, environmental stress and environmental disasters, different approaches and relation with human ecology, landscape approach, ecosystem approach, perception approach, human ecology and its application in geographical researches.
MODULE II	**TYPES OF ENVIRONMENTAL HAZARDS AND DISASTERS**
	Types of environmental hazards and disasters: Natural hazards and disasters, man induced hazards and disasters, natural hazards, planetary hazards/ disasters, extra planetary hazards/ disasters, planetary hazards, endogenous hazards, exogenous hazards.

MODULE III	**ENDOGENOUS HAZARDS**
	Endogenous hazards, volcanic eruption, earthquakes, landslides, volcanic hazards/ disasters, causes and distribution of volcanoes, hazardous effects of volcanic eruptions, environmental impacts of volcanic eruptions. Earthquake hazards/ disasters, causes of earthquakes, distribution of earthquakes, hazardous effects of, earthquakes, earthquake hazards in India,human adjustment, perception and mitigation of earthquake.
MODULE IV	**EXOGENOUS HAZARDS**
	Exogenous hazards/disasters, infrequent events, cumulative atmospheric hazards/disasters; Infrequent events: Cyclones , lightning , hailstorms; Cyclones: Tropical cyclones and local storms, destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation); Cumulative atmospheric hazards/ disasters: Floods, droughts, cold waves, heat waves floods; Causes of floods, flood hazards India, flood control measures (human adjustment, perception and mitigation); Droughts:Impacts of droughts, drought hazards in India, drought control measures,extra planetary hazards/ disasters, man induced hazards /disasters, physical hazards/ disasters, soil erosion, Soil erosion: Mechanics and forms of soil erosion, factors and causes of soil erosion, conservation measures of soil erosion; Chemical hazards/ disasters: Release of toxic chemicals, nuclear explosion, sedimentation processes; Sedimentation processes: Global sedimentation problems regional sedimentation problems, sedimentation and environmental problems, corrective measures of erosion and sedimentation,biological hazards/ disasters, population explosion.
MODULE V	**EMERGING APPROACHES IN DISASTER MANAGEMENT**
	Emerging approaches in Disaster Management, Three Stages 1. Pre, disaster stage(preparedness) 2. Emergency Stage 3. Post Disaster stage, Rehabilitation.

TEXTBOOKS

1. Pardeep Sahni, "Disaster Mitigation: Experiences and Reflections", PHI Learning Pvt. Ltd., 1 st Edition, 2001.
2. J.Glynn, GaryW.HeinKe, "Environmental Science and Engineering",Prentice Hall Publishers, 2 nd Edition, 1996.

REFERENCE BOOKS:

1. R.B.Singh (Ed), "Environmental Geography", 2nd Edition, 1990.
2. R.B. Singh (Ed), "Disaster Management", 2nd Edition, 2006.
3. Donald Hyndman "Natural Hazards and Disasters" - 5th edition, 2017.

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be a changes.

S.No	Topics to be covered	CO's	Reference T1: 4.1

OBE DISCUSSION			
1	Course Objectives, Course Outcomes, Program Outcomes, CO-PO Mapping		
CONTENT DELIVERY (THEORY)			
2	Classify Environmental Hazards & Disasters	CO 1	T2:26.3, R2: 3.1
3	Understand the Meaning of Environmental Hazards	CO 1	T2:2.2.2
4	Understand Environmental Stress	CO 1	T2:2.2.2, R3:3.7
5	Understand Environmental stress.	CO 2	T2:2.2.2
6	Obtain knowledge on Concept of Environmental Hazards	CO 2	T1:8.1
7	Capacity to analyze Environmental stress & Environmental Disasters	CO 2	T1:7.1, R2: 1.2
8	Capacity to analyze Ecology concept	CO 2	T2:3.2.3, R2: 1.3
9	Understand Different Approaches	CO 3	T2:4.2.3
10	Understand Landscape Approach -.	CO 3	T2:4.5.2
11	Explain Ecosystem approach -Perception approach.	CO 3	T2:4.7.9
12	Understand Human ecology & its application in geographical researches	CO 4	T2:5.2.1, R2: 6.4
13	Understand Human ecology & its application in geographical researches	CO 4	T2:5.2.1, R2: 6.4
14	Understand Types of Environmental hazards & Disasters	CO 4	T2:5.4
15	Capacity to analyze and evaluate Natural hazards and Disasters	CO 3	T2:5.5.3
16	Capacity to analyze and evaluate Natural hazards and Disasters	CO 3	T2:5.5.3
17	Understand Man induced hazards & Disasters	CO 3	T2:6.2.2
18	Understand Man induced hazards & Disasters	CO 3	T2:6.2.2
19	Obtain knowledge on Natural Hazards- Planetary Hazards/ Disasters	CO 4	R1:2.5, R2: 8.2
20	Obtain knowledge on Natural Hazards- Planetary Hazards/ Disasters	CO 4	R1:2.5, R2: 8.2
21	Analyze the Planetary Hazards-Endogenous Hazards - Exogenous Hazards	CO 4	R2:2.2.5, R2: 9.2
22	Analyze the Planetary Hazards-Endogenous Hazards - Exogenous Hazards	CO 4	R2:2.2.5, R2: 9.2
23	Understand Volcanic Eruption – Earthquakes – Landslides	CO 4	R3:5.4.8, R2: 9.6
24	Understand Volcanic Eruption – Earthquakes – Landslides	CO 4	R3:5.4.8, R2: 9.6
25	Volcanic Hazards/Disasters- Causes and distribution of Volcanoes	CO 4	T2:8.1.2
26	Volcanic Hazards/Disasters- Causes and distribution of Volcanoes	CO 4	T2:8.1.2

27	Explain the Hazardous effects of volcanic eruptions	CO 4	T2:8.3.5, R2: 5.3
28	Explain the Hazardous effects of volcanic eruptions	CO 4	T2:8.3.5, R2: 5.3
29	Understand Environmental impacts of volcanic eruptions - Earthquake Hazards/ disasters - Causes of Earthquakes	CO 4	T2:8.5
30	Understand Environmental impacts of volcanic eruptions - Earthquake Hazards/ disasters - Causes of Earthquakes	CO 4	T2:8.5
31	Distribution of earthquakes - Hazardous effects of - earthquakes - Earthquake Hazards in India	CO 4	T2:8.9.2
32	Explain the Droughts: Impacts of droughts, Drought hazards in India	CO 5	T2:9.2, R3: 4.6
33	Explain the Droughts: Impacts of droughts, Drought hazards in India	CO 5	T2:9.2, R3: 4.6
34	Understand Extra Planetary Hazards/ Disasters- Man induced Hazards /Disasters	CO 5	T2:9.2, R3: 4.7
35	Understand Extra Planetary Hazards/ Disasters- Man induced Hazards /Disasters	CO 5	T2:9.2, R3: 4.7
36	Understand the Infrequent events: Cyclones, Lightning, Hailstorms, Cyclones: Earthquake Hazards in India	CO 5	T2:9.5.3
37	Understand the Infrequent events: Cyclones, Lightning, Hailstorms, Cyclones: Earthquake Hazards in India	CO 5	T2:9.5.3
38	Analyze the Tropical cyclones and Local storms	CO 5	T2:9.6.2, R3: 8.5
39	Understand the Destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation)	CO 5	T2:9.7.5, R3: 8.12
40	Understand the Destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation)	CO 5	T2:9.7.5, R3: 8.12
41	Analyze the Cumulative atmospheric hazards/ disasters : Floods, Droughts, Cold waves, Heat waves Floods	CO 5	T2:9.5.4
42	Analyze the Cumulative atmospheric hazards/ disasters : Floods, Droughts, Cold waves, Heat waves Floods	CO 5	T2:9.5.4
43	Identification of Flood control measures (Human adjustment, perception and mitigation),	CO 6	T2:9.5.4
44	Identification of Flood control measures (Human adjustment, perception and mitigation),	CO 6	T2:9.5.4
45	Analyze the Exogenous hazards/ disasters - Infrequent events- Cumulative atmospheric hazards/ disasters	CO 6	T2:9.5.6
PROBLEM SOLVING/ CASE STUDIES			
1	Case study on modern disaster management system	CO 1	T2:2.2.2
2	Case study on natural disaster	CO 2	T2:2.2.2
3	Case study on manmade disaster	CO 3	T2:2.2.2

2	Case study on Latur earthquake	CO 4	T2:2.2.2
4	Case study on Fukushima Nuclear disaster	CO 4	T2:2.2.2, R3:3.7
5	Case study on tsunami occurred in Japan	CO 5	T2:2.2.2
6	Case study on Hiroshima and Nagasaki	CO 4	T1:8.1
7	Case study on Russian Siberia oil spill	CO 4	T1:7.1, R2: 1.2
8	Case study on Hudhud Cyclone 2014	CO 5	T2:3.2.3, R2: 1.3
9	Case study on South India Floods 2015	CO 5	T2:4.2.3
10	Case study on Bihar Heat Wave 2019	CO 5	T2:4.5.2
11	Case study on Bihar Floods 2019	CO 5	T2:4.7.9
12	Case study on Oil Spillage in Russia 2020	CO 4	T2:5.4
13	Case study on Yellow River Flood in China	CO 4	T2:5.5.3
14	Case study on Bhola Cyclone Bangladesh	CO 5	T2:6.2.2
15	Causes of wild fires and effects	CO 4	T2:9.5.4
16	pre-disaster activities to reduce the impact of cyclones	CO 5	T2:9.5.4
17	Tectonic plate theory	CO 4	T2:9.5.6
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Different approaches and relation with human ecology, landscape approach, ecosystem approach, perception approach	CO 1	T2:2.2.2
2	Natural hazards, planetary hazards/ disasters, extra planetary hazards/ disasters, planetary hazards, endogenous hazards, exogenous hazards	CO 2	T2:2.2.2, R3:3.7
3	Effects of volcanic eruptions, environmental impacts of volcanic eruptions	CO 3, CO 4	T2:2.2.2
4	Lightning , hailstorms; Cyclones: Tropical cyclones and local storms, destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation); Cumulative atmospheric hazards/ disasters:	CO 5	T1:8.1
5	Emerging approaches in Disaster Management, Three Stages 1. Pre, disaster stage(preparedness), 2. Emergency Stage ,3. Post Disaster stage, Rehabilitation.	CO 6	T1:7.1, R2: 1.2
DISCUSSION OF QUESTION BANK			
1	Environmental hazards and disasters	CO 1	R1:2.1
2	Types of environmental hazards and disasters	CO 2	T4:7.3
3	Endogenous hazards, volcanic eruption, earthquakes, landslides, volcanic hazards/ disasters, causes and distribution of volcanoes, hazardous effects of volcanic eruptions, and their environmental impacts.	CO 3, CO 4	R2:5.1

4	Global sedimentation problems regional sedimentation problems, sedimentation and environmental problems, corrective measures of erosion and sedimentation,biological hazards/ disasters, population explosion.	CO 5	T1:7.5
5	Emerging approaches in disaster management	CO 6	T1: 4.1

Signature of Course Coordinator **HOD,CE**