

✓	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 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 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 8th and 17th 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.

VI COURSE OBJECTIVES:

The students will try to learn:

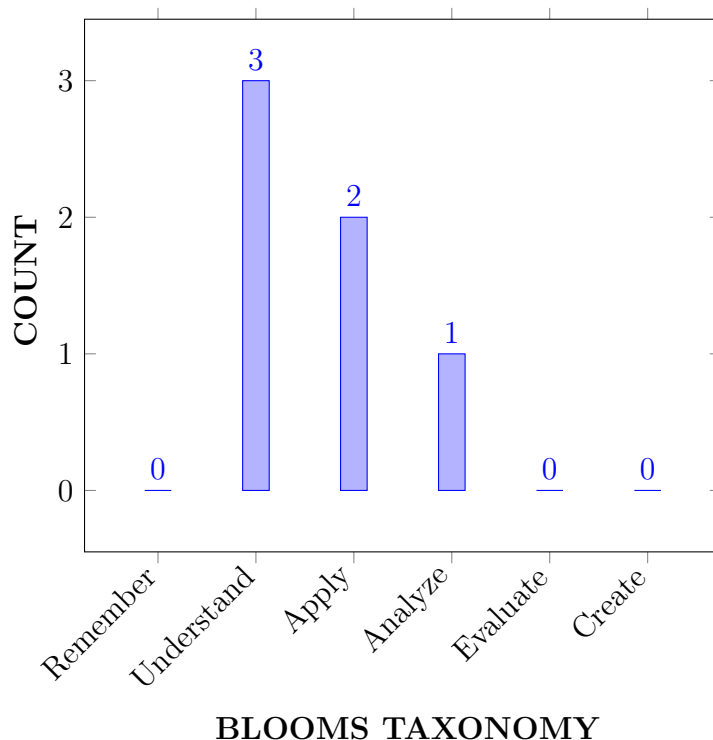
I	the operational principles, characteristics of semiconductor devices and circuits for rectification, amplification, conditioning and voltage regularization of signals.
II	The analytical skills needed to model analog and digital integrated circuits (IC) at discrete and micro circuit level.
III	The foundations 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 and rectifiers.	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.	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.	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 science 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 principles of mathematics and engineering science	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 2	PO 1	Apply (knowledge) the pn junction characteristics for the diode applications of diode as switch and rectifiers by analyzing complex engineering problems using the principles of mathematics, engineering science	2
	PO 2	Understand the given the diode application problem statement and finding the solution implementation of rectifier circuits by analyzing complex engineering problems	4
	PO 3	Design solutions for complex engineering problems and design system components of diode applications that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations.	5
	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 rectifier circuit applications in the field of Intelligent Embedded and Semiconductor technologies	1
CO 3	PO 1	Explain (Understand) DC and AC load line analysis of different amplifiers for optimal operating level by applying mathematics, science engineering for 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 for DC and AC load line analysis using complex problem analysis by the principles of mathematics and engineering sciences .	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
CO 4	PO 1	Design (knowledge) the various biasing techniques for BJT, JFET and MOSFETs amplifier circuits for stable operation by applying mathematics, science and engineering fundamentals for complex engineering problems .	3
	PO 2	Understand the problem statement of biasing techniques for BJT, JFET and MOSFETs amplifier and formulate a proper operating point in complex problem analysis using mathematics .	4
	PO 3	Design solutions for complex engineering problems and design system components of BJT and FET amplifiers that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations.	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
CO 5	PO 1	Estimate (Knowledge) the characteristic parameters of BJT, FET amplifier circuits for solving complex engineering problems using low frequency model by applying mathematics, science and engineering fundamentals .	3
	PO 2	Analyze small signal analysis problem statements of BJT, FET amplifier circuits using mathematics principles .	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	Demonstrate (Understand) the working principle (knowledge) of special purpose semiconductor devices and transistors like Zener diode, Tunnel diode, SCR, UJT and Photo Diode for applications like triggering and voltage regulation by applying science for engineering problems.	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

***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	2	2	2
CO 1	2	3	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 2	2	4	5	-	-	-	-	-	-	2	-	-	1	-	-
CO 3	2	4	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 4	3	4	4	-	-	-	-	-	-	2	-	-	-	-	-
CO 5	3	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	30.0	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 2	66.7	40.0	50.0	-	-	-	-	-	-	40	-	-	50	-	-
CO 3	66.7	40.0	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 4	100	40.0	40.0	-	-	-	-	-	-	40	-	-	-	-	-
CO 5	100	40.0	-	-	-	-	-	-	-	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	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	2	2	-	-	-	-	-	-	1	-	-	2	-	-
CO 3	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	2	2	-	-	-	-	-	-	1	-	-	-	-	-
CO 5	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-
TOTAL	16	9	4	-	-	-	-	-	-	6	-	-	2	-	-
AVERAGE	2.7	1.8	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	SEMICONDUCTOR DIODES
	pn junction diode: Qualitative theory of pn junction, pn junction as a diode, diode Equation, Volt-Ampere characteristics, temperature dependence of V-I characteristic, ideal versus practical – resistance levels (static and dynamic), transition and diffusion capacitances, diode equivalent circuits, load line analysis, breakdown mechanisms in semiconductor diodes, Zener diode characteristics, Zener diode as a voltage regulator.
MODULE II	SPECIAL ELECTRONIC DEVICES AND CIRCUITS
	Special purpose electronic devices: Principles of operation and characteristics of Silicon controlled rectifier, tunnel diode, varactor diode, Photo diode; Half wave rectifier, Full wave rectifier, general filter considerations, Harmonic components in a rectifier Circuit, Inductor filters, Capacitor filters, L-Section filters, multiple of L-C section, RC filter, Comparison of filters.
MODULE III	TRANSISTORS
	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	BIASING AND COMPENSATION TECHNIQUES
	Biasing and Compensation techniques: Operating Point, The DC and AC Load lines, types of biasing circuits, bias Stability, stabilization factors, stabilization against variations in VBE, bias compensation techniques, thermal runaway, thermal stability, biasing the FET and MOSFET.
MODULE V	BJT AND FET AMPLIFIERS
	BJT small signal analysis, BJT hybrid model, determination of h-parameters from transistor characteristics, transistor amplifier, analysis using h-parameters; FET small signal model, FET as common source amplifier, FET as common drain amplifier, FET as common gate amplifier, generalized FET amplifier.

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", 1st Edition, 2009, Wiley India Pvt. Ltd.

COURSE WEB PAGE:

<https://www.iare.ac.in/?q=courses/electronics-and-communication-engineering-autonomous/electronic-devices-and-circuits>

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/electronics-and-communication-engineering-autonomous/electronic-devices-and-circuits
CONTENT DELIVERY (THEORY)			
2	Qualitative theory of pn junction	CO 1	T1: 2.2
3	pn junction as a diode, diode current equation	CO 1	T1: 2.2, 2.4
5	Volt-Ampere characteristics, temperature dependence of V-I characteristic	CO 1	T1: 2.2
6	Diode resistances, equivalent circuit	CO 1	T1: 2.6
8	Diffusion and Transition Capacitances, Load line analysis	CO 1	T1: 2.7
9	Breakdown mechanisms in semiconductor diodes	CO 1	T1: 2.10
10	Zener diode characteristics	CO 6	T1: 2.9
11	Zener diode as a voltage regulator.	CO 6	T1: 2.11
13	SCR	CO 6	T1: 2.16
14	Tunnel diode	CO 6	T1: 2.12
15	varactor diode, Photo diode	CO 6	T1: 2.17
16	Half wave rectifier	CO 2	T1: 3.2
18	Full wave rectifier	CO 2	T1: 3.2

20	Bridge rectifier, harmonic components in a rectifier circuit	CO 2	T1: 3.2, 3.3
21	Rectifiers with capacitive filter	CO 2	T1: 3.6
22	L-Section filters, multiple of L-C section	CO 2	T1: 3.7
23	RC filter, Comparison of filters.	CO 2	T1: 3.9
24	Principle of operation of BJT	CO 1	T1: 4.2
25	Common emitter configuration with characteristics	CO 1	T1: 4.4
26	Common base configuration with characteristics	CO 1	T1: 4.4
27	Common collector configuration with characteristics	CO 1	T1: 4.4
28	Transistor current components and relation among current gains	CO 1	T1: 4.3
30	Field effect transistors: Types of FET, FET construction, symbol, principle of operation	CO 1	T1: 4.12,4.13
31	V-I characteristics, FET parameters, FET as voltage variable resistor	CO 1	T1: 4.14
32	comparison of BJT and FET	CO 1	T1: 4.2
33	MOSFET construction and operation	CO 1	T1: 4.15
34	Uni Junction Transistor: Symbol, Principle of operation, UJT Characteristics, UJT applications.	CO 6	T1: 2.19
35	Operating point, DC & AC load lines	CO 3	T1: 5.3
37	Transistor biasing and stabilization	CO 4	T1: 5.4
38	Fixed Bias, Collector to Base bias	CO 4	T1: 5.4
39	Self-Bias	CO 4	T1: 5.4
40	Bias Compensation using Diodes and Transistors	CO 4	T1: 5.6
44	Thermal Runaway, Thermal Stability	CO 4	T1: 5.7, 5.8
45	Transistor Hybrid parameter model	CO 5	T1: 6.3
46	Exact and approximate analysis of transistor amplifier using low frequency model	CO 5	T1: 6.6, 6.8
47	Analysis of CE amplifier with emitter resistance using low frequency model	CO 5	T1: 6.9
48	Effect of coupling and bypass capacitors on CE Amplifier	CO 5	R4:7.4
49	Analysis of generalized JFET Amplifier	CO 5	T1: 6.15
53	Analysis of CS JFET Amplifier	CO 5	T1:6.16
54	Analysis of CD and CG JFET Amplifier	CO 5	T1:6.17, 6.18
PROBLEM SOLVING/ CASE STUDIES			
4	Diode current equation	CO 1	T1:2.4
7	Diode resistances	CO 1	T1:2.6
12	Zener diode regulator	CO 6	T1:2.11
17	Half wave Rectifier parameters estimation	CO 2	T1:3.2
19	Full wave Rectifier parameters estimation	CO 2	T1:3.2
29	Current gain of transistor configuration	CO 1	T1:4.3
36	Load line analysis of BJT	CO 3	T1:5.3
39	Transistor fixed biasing	CO 4	T1:5.4
40	Transistor collector to base biasing	CO 4	T1:5.4

42	Transistor self-biasing	CO 4	T1:5.4
49	CE Transistor amplifier analysis	CO 5	T1:6.9
50	CB Transistor amplifier analysis	CO 5	T1:6.11
51	CC Transistor amplifier analysis	CO 5	T1:6.10
55	CS Amplifier analysis	CO 5	T1:6.16
56	CD Amplifier analysis	CO 5	T1: 6.17
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Semiconductor diodes	CO 1	T1: 2.2 – 2.9
58	Special electronic devices and rectifiers	CO 2, CO 6	T1: 2.16, 3.2 -3.9
59	Transistors	CO 1, CO 3, CO 5	T1:4.2-4.15
60	Biasing and compensation techniques	CO 4	T1:5.4-5.8
61	BJT and FET amplifiers	CO 5	T1:6.3 -6.18
DISCUSSION OF QUESTION BANK			
62	Semiconductor diodes	CO 1	T1: 2.2 – 2.9
63	Special electronic devices and rectifiers	CO 2, CO 6	T1: 2.16, 3.2 -3.9
64	Transistors	CO 1, CO 3, CO 5	T1:4.2-4.15
65	Biasing and compensation techniques	CO 4	T1:5.4-5.8
66	BJT and FET amplifiers	CO 5	T1:6.3 -6.18

Signature of Course Coordinator
Mr. B Naresh, Assistant 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



INSTITUTE OF AERONAUTICAL ENGINEERING (Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	ELECTRONIC COMMUNICATION AND ENGINEERING				
Course Title	MATHEMATICAL TRANSFORM TECHNIQUES				
Course Code	AHS011				
Program	B. Tech				
Semester	III				
Course Type	Foundation				
Regulation	R-16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Ms. P Rajani, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSB02	I	Linear Algebra and Calculus
B.Tech			
B.Tech			

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 types of matrices, difference calculus methods and differential equations. 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
Mathematical Transform Techniques	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	✓	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
30%	Understand
60 %	Apply
%	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 8th and 17th 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:

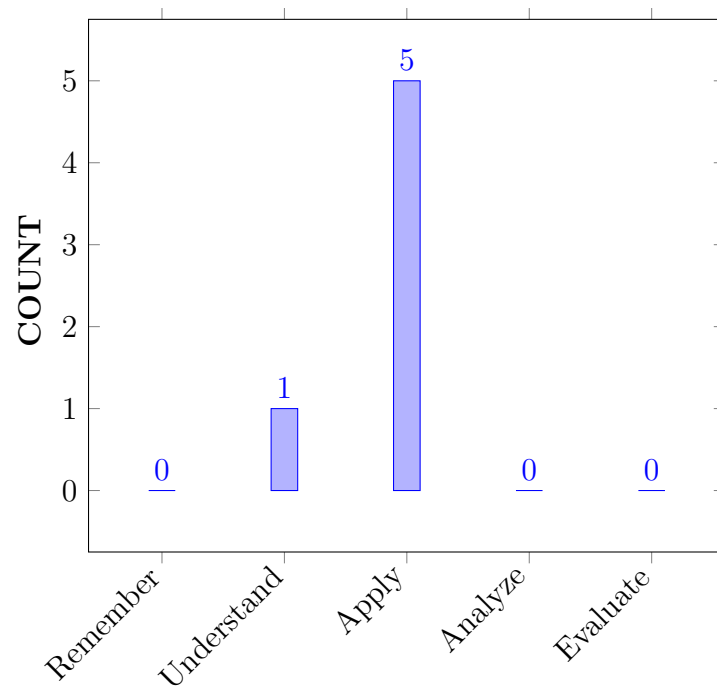
I	The operation of non-periodic functions by Fourier transforms.
II	The transformation of ordinary differential equations in Laplace field and its applications
III	Z-transforms to solve the difference equations
IV	The partial differential equation for solving non-linear equations

VII COURSE OUTCOMES:

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

CO 1	Explain the nature of the Fourier series that represent even and odd functions.	Understand
CO 2	Apply to compute the Fourier series of the function with one variable.	Apply
CO 3	Identify the role of Fourier transform non-periodic functions up to infinity as a mathematical function in transforming a signal from the time domain to the frequency domain	Apply
CO 4	Explain the properties of Laplace and inverse transform to various functions the integral transforms operations of calculus to algebra in linear differential equations	Apply
CO 5	Compute the Z-transforms and inverse of Z-transforms to difference equations by using the methods of partial fractions and convolution method.	Apply
CO 6	Solve the linear, nonlinear partial differential equation by the method of Lagrange's ,separable and Charpit to concern engineering field	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

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	
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	

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
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 Fourier Series to the periodic functions for solving complex engineering problems of various functions such as continuous, piecewise continuous, step and impulsive functions with principle of mathematics .	2
CO 2	PO 1	Apply the Fourier series (understand) to complex engineering problems of various functions such as continuous, piecewise continuous, step and impulsive functions with principle of mathematics.	2
CO3	PO 1	Identify the mathematical function as a signal form from the time domain to the frequency domain in the complex engineering problems by (apply) Fourier transformation. Principle of Mathematics	2
	PO 2	Apply the Fourier integral transform as a formulation of mathematical function in complex engineering problems which transforms a non-periodic functions using principles of mathematics to attain conclusions by the interpretation of results	4
	PO4	Explain the integral transforms in solving ordinary differential equations will be quantitatively measured by using MATLAB computer software .	1
	PSO1	Describe the integral transforms concern Mechanical Engineering (apply) which converts operations of calculus to algebra in solving linear differential equations in the design and implementation of complex systems..	1
CO4	PO 1	Explain the properties of Laplace and inverse transform (understand) to complex engineering problems of various functions the integral transforms operations of calculus to algebra in linear differential equations with principle of mathematics	2
CO5	PO2	Compute the statement of the Z-transforms and inverse of Z-transforms in complex engineering problems which difference equations by using the methods of partial fractions and convolution method using principle of mathematics related to engineering by the interpretation of results .	4
	PSO 1	Compute the properties of complex Z transform concern Mechanical Engineering which intensifies (apply) the boundary value problems in the design and implementation of complex systems .	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO6	PO1	Solve the linear, nonlinear partial differential equation related to complex engineering problems such as the method of Lagrange's ,separable and Charpit to the physical problems of engineering Principle of Mathematics	2
	PO2	Solve 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	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	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	4	-	1	-	-	-	-	-	-	-	-	1	-	-
CO 4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	-	4	-	-	-	-	-	-	-	-	-	-	1	-	-
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	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	66.7	40	-	9	-	-	-	-	-	-	-	-	50	-	-
CO 4	66.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	-	40	-	-	-	-	-	-	-	-	-	-	50	-	-
CO 6	66.7	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	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO 2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	2	-	1	-	-	-	-	-	-	-	-	2	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	-	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 6	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
TOTAL	15	6	-	1	-	-	-	-	-	-	-	-	4	-	-
AVERAGE	3	2	-	1	-	-	-	-	-	-	-	-	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:

✓	Early Semester OBE Feedback	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	FOURIER SERIES
	Definition of periodic function, determination of Fourier coefficients; 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; Half- range Fourier sine and cosine expansions.
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	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.
MODULE IV	Z –TRANSFORMS
	Z-transforms: Elementary properties, inverse Z-transform, convolution theorem, formation and solution of difference equations.
MODULE V	PARTIAL DIFFERENTIAL EQUATIONS AND APPLICATIONS

	Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions, solutions of first order linear equation by Lagrange method; Charpit's method; method of separation of variables; One dimensional heat and wave equations under initial and boundary conditions.

TEXTBOOKS

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 36th 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", John Wiley & Sons, 9th Edition, 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, 2nd Edition, 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/resources/#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	Define periodic function	CO 1	T1:22.5 R1:2.3
3	Solve Fourier coefficients	CO 1	T1:22.5 R1:2.4
4	Apply Fourier series for $(0, 2\pi)$	CO 1	T1:22.6 R1:2.6

5	Determine even and odd function	CO 2	T1:22.7 R1:4.4
6	Determine Fourier series in $(0,2l)$, $(-l,l)$ and also half range series in $(0, l)$	CO 1	T1:22.7 R1:4.10
7	Determine half range series in $(0, \pi)$	CO 2	T1:22.8 R1:4.15
8	Apply Fourier integral theorem to find integrals	CO 2	T1:22.9 R1:5.4
9	Apply Fourier sine and cosine integrals to find integrals	CO 3	T1:22.9 R1:5.8
10	Define and apply Fourier transforms	CO 3	T1:23.10 R1:6.8.
11	Use properties to solve the given functions	CO 3	T1:23.10 R1:6.13
12	Define and apply Inverse transforms	CO 3	T1:23.9 R1:7.5
13	Define and apply Finite Fourier transforms	CO 3	T1:23.10 R1:7.5
14	Define Laplace transform and its property	CO 4	T1:23.10 R1:8.1
15	Define piecewise continuous function	CO 4	T1:23.1 R1:9.2
16	Define and apply shifting theorem, change of scale property	CO 4	T1:23.1 R1:9.4
17	Solve derivatives and integrals, multiplied by t ,divided by t	CO 74	T1:23.1 R1:9.9
18	Define periodic functions	CO 4	T1:23.1 R1:9.10
19	Solve Inverse Laplace transform	CO 4	T2:27.5 R1:10.2
20	Define and apply shifting theorem	CO 4	T2:27.7 R1:11.3
21	Solve multiplied by s , divided by s	CO 4	T2:27.8 R1:11.6
22	Define change of scale property	CO 4	T2:27.7 R1:11.3
23	Divided by s Define Z-transforms, Elementary properties	CO 5	T2:27.12 R1:11.8
24	Change of scale property Define inverse Z-transform	CO 5	T2:27.12 R1:11.9
25	Define inverse Z-transform	CO 5	T2:27.12 R1:11.10
26	Formulate partial differential equations	CO 6	T2:27.14 R1:12.3
27	Solving difference equations by Z transforms	CO 5	T2:27.1 R1:12.7
28	Solve by Charpit's method	CO 6	T2:27.17 R1:12.15

29	Apply method of separation of variables	CO 6	T2:18.2 R1:13.1
30	Define inverse Z-transform	CO 5	T2:18.3- 18.5 R1:13.2 , 13.3
31	Elementary properties	CO 5	T1:17.1- 17.2 R1:16.1- 16.2
32	Elimination of arbitrary constants(Formation of PDE)	CO 6	T1:17.1- 17.2 R1:16.1- 16.2
33	Elimination of arbitrary functions(Formation of PDE)	CO 6	T1:17.5- 17.6 R1:16.3.1
34	Non-Linear Partial differential equation of first order (Standard forms I, II ,III and IV)	CO 6	T1:17.1- 17.2 R1:16.1- 16.2
35	Non-Linear Partial differential equation of first order Standard forms V	CO 6	T1:17.5- 17.6 R1:16.3.1
36	Non-Linear Partial differential equation	CO 6	T1:17.1- 17.2 R1:16.1- 16.2
37	Non-Linear Partial differential equation of first order Standard forms VI	CO 6	T1:17.1- 17.2 R1:16.1- 16.2
38	Lagrange's Linear equation- Method of grouping	CO 6	T1:17.5- 17.6 R1:16.3.1
39	Lagrange's Linear Equation -Method of Multipliers	CO 6	T1:17.1- 17.2 R1:16.1- 16.2
40	Elimination of arbitrary constants(Formation of PDE)	CO 6	T1:17.1- 17.2 R1:16.1- 16.2
41	Elimination of arbitrary functions(Formation of PDE)	CO 6	T1:17.5- 17.6 R1:16.3.1
42	Non-Linear Partial differential equation of first order (Standard forms II)	CO 6	T1:17.5- 17.6 R1:16.3.1- 16.2

43	Non-Linear Partial differential equation of first order (Standard forms III)	CO 6	T1:17.5-17.6 R1:16.3.1-16.2
44	Non-Linear Partial differential equation of first order (Standard forms IV)	CO 6	T1:17.5-17.6 R1:16.3.1-16.2
PROBLEM SOLVING/ CASE STUDIES			
45	Solving problems on Fourier sine and cosine integral	CO 2	T1:17.1-17.2 R1:16.1-16.2
46	Solving problems on finite Fourier transforms	CO 3	T1:17.5-17.6 R1:16.3.1
47	Solving problems on Laplace Transform of First, second shifting theorems and change of scaleproperty	CO4	T1:17.1-17.2 R1:16.1-16.2
48	Solving problems on Inverse Laplace transforms of derivatives, integrals, multiplied by s, divided by s	CO 4	T1:17.5-17.6 R1:16.3.1
49	Solving problems on Convolution theorem	CO 4	T1:17.1-17.2 R1:16.1-16.2
50	Solving problems on Inverse Laplace transforms of derivatives, integrals, multiplied by s, divided by s	CO 4	T1:23.10 R1:8.1
51	Solving problems on Inverse Laplace transforms of derivatives, integrals, multiplied by s, divided by s	CO 4	T1:23.1 R1:9.2
52	Solving problems on first shifting theorems and change of scale property	CO 4	T1:23.1 R1:9.4
53	Solving problems on second shifting theorems and change of scale property	CO 4	T1:23.1 R1:9.9
54	Gauss divergence theorem	CO 4	T1:23.10 R1:8.1
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 Fourier series	CO 1,2	T1:23.10 R1:6.8
58	Definitions and terminology on Fourier transforms	CO 3	T1:23.10 R1:7.5
59	Definitions and terminology on Laplace transforms	CO 4	T1:23.10 R1:8.1
60	Definitions and terminology on z transforms	CO 5	T2:27.12 R1:11.10
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	Descction of Fourier series	CO 1,2	T1:23.10 R1:8.1
63	Descction of Fourier transforms	CO 3	T1:23.10 R1:6.8
64	Descction of Laplace transforms	CO 4	T1:23.10 R1:7.5
65	Descction of z transforms	CO 5	T2:27.12 R1:11.10
66	Descction of partial differential equations	CO 6	T1:17.1- 17.2 R1:16.1- 16.2

Signature of Course Coordinator

HOD,ECE

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).

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 8th and 17th 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.

VI COURSE OBJECTIVES:

The students will try to learn:

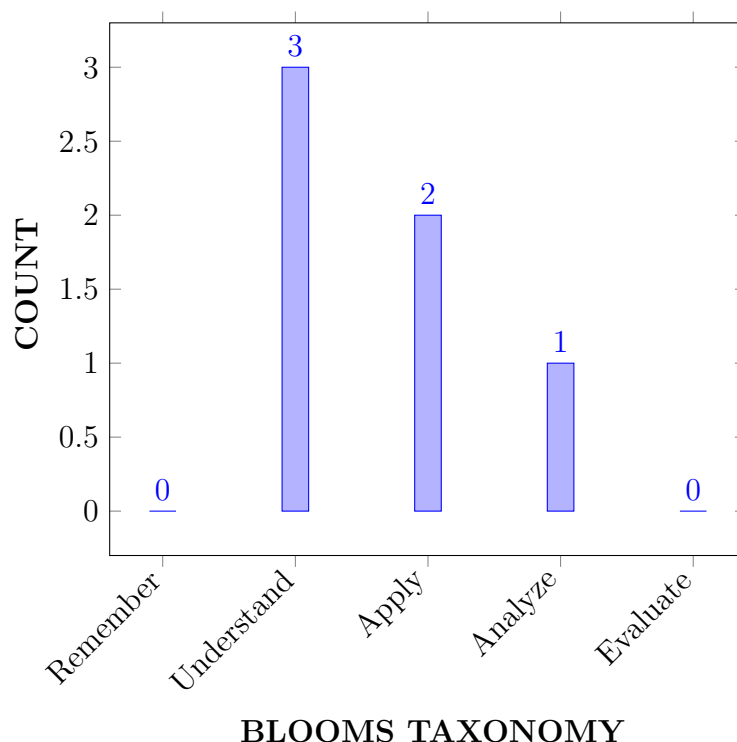
I	Simplification of the logic functions using boolean algebraic theorems and techniques.
II	Implementation of conventional combinational and sequential circuits.
III	The exploration of the logic families and semiconductor memories.
IV	The realization of the micro and macro circuits using VHDL programming.

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	Apply combinational circuits for realization of basic building blocks of 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	Extend the logic design techniques for ECL, TTL and CMOS methodologies for designing the fundamental gate level modelling.	Understand
CO 5	Extend the characteristics of logic families and PLDs to enhance the design skills indigital integrated circuits.	Apply
CO 6	Evaluate synthesis and simulation of VHDL modules for implementing combinational and 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 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.	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.	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	Focus on the practical experience of ASIC prototype designs, virtual instrumentation and SoC designs.	-	-
PSO 2	Focus on the practical experience of ASIC prototype designs, virtual instrumentation and SoC designs.	2	SEE / CIE / AAT
PSO 3	Focus on the practical experience of ASIC prototype designs, virtual instrumentation and SoC designs.	-	-

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

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 4	Design various combinational circuits which are basic requirement of various systems using design of experiments, analysis and interpretation of data.	2
	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	Compare the asynchronous counters using design procedure of sequential circuit and excitation tables of flip – flops with 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 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	Design of a clocked flip-flop conversion from one type of flip-flop to another, registers and counters mathematics, science and engineering fundamentals.	3
	PO 4	Use research-based knowledge on design of asynchronous counters analysis and interpretation of data.	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 counter design for application specific integrated circuit (ASIC) prototype designs, system on chip (SoC) designs	2
CO 4	PO 1	Build tristate TTL, ECL, CMOS families and their interfacing for memory element designs using complex features of logic families.	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.	7

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 3	Design universal gates using the design mechanisms of TTL, ECL, CMOS using the basic transistor models of corresponding logic families.	1
	PO 4	Implement tristate TTL, ECL, CMOS families and their interfacing with memory elements .	2
	PO 10	Understand the given problem statement and communicate the novel implementation to get it published in the scientific community .	1
CO 5	PO 1	Explore the concept of 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 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	Develop digital gates based on customer needs for design of universal gates using the design mechanisms of TTL, ECL, and CMOS using the basic transistor models of corresponding logic families.	1
	PO 4	Implement tristate TTL, ECL, CMOS families and their interfacing with Memory elements .	2
	PO 10	Understand the given problem statement and communicate the novel implementation to get it published in the scientific community .	1
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 and evaluate outcomes of the designs .	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 4	Use knowledge of VHDL programming, able to identify, classify and describe performance of digital designs for various logical operations using laboratory skills and analysis.	2
	PO 10	Understand the given problem statement and communicate the novel implementation to get it published in the scientific community.	1
	PSO 2	Apply digital circuit design in various fields 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	4	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	2	7	3	2	-	-	-	-	-	1	-	-	-	-	-
CO 3	3	6	3	2	-	-	-	-	-	1	-	-	-	1	-
CO 4	2	7	1	2	-	-	-	-	-	1	-	-	-	-	-
CO 5	2	7	3	2	-	-	-	-	-	1	-	-	-	1	-
CO 6	2	7	1	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	67	40	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 2	67	70	30	30	-	-	-	-	-	20	-	-	-	-	-
CO 3	100	60	30	18	-	-	-	-	-	20	-	-	-	50	-
CO 4	67	70	10	18	-	-	-	-	-	20	-	-	-	-	-
CO 5	67	70	30	18	-	-	-	-	-	20	-	-	-	50	-
CO 6	67	70	10	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	-	-	-	-	-	1	-	-	-	-	-
CO 3	3	3	1	1	-	-	-	-	-	1	-	-	-	2	-
CO 4	3	3	1	1	-	-	-	-	-	1	-	-	-	-	-
CO 5	3	3	1	1	-	-	-	-	-	1	-	-	-	2	-
CO 6	3	2	1	1	-	-	-	-	-	1	-	-	-	-	-
TOTAL	18	16	5	5	0	0	0	0	0	6	0	0	0	4	0
AVERAGE	3	2.7	1	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 LOGIC DESIGN
	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	-	https://lms.iare.ac.in/index?route=course/details&course_id=406
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
Dr. V Vijay , 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	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	Probability Theory and Stochastic Process				
Course Code	AEC003				
Program	B.Tech				
Semester	III				
Course Type	Core				
Regulation	R-16				
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	AHS003	I	Computational Mathematics and Integral Calculus
B.Tech	AHS004	II	Complex Analysis and Probability Distributions

II COURSE OVERVIEW:

Stochastic or random 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 analog communication, digital communication and digital signal processing, radar systems and digital image processing. It is also useful for a data science engineer in designing the machine learning algorithms.

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	✓	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
0%	Remember
58 %	Understand
25%	Apply
17 %	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 8th and 17th 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:

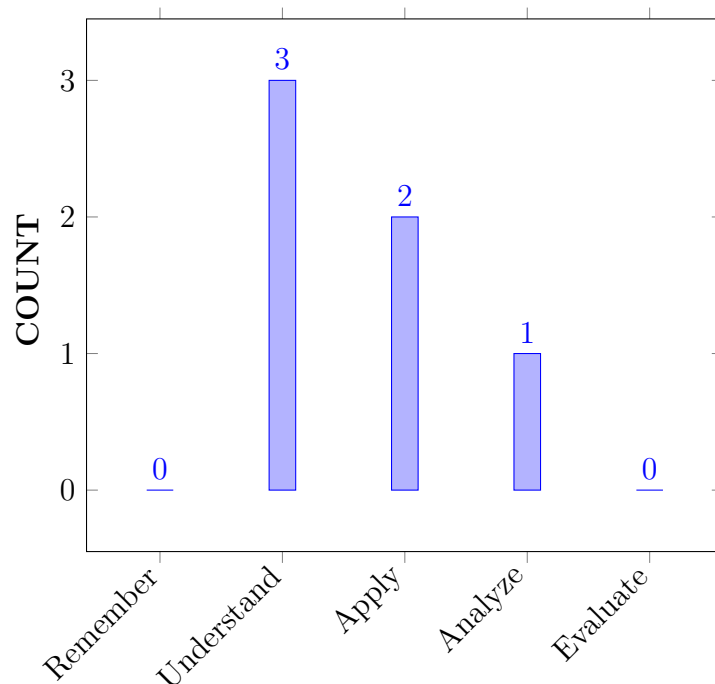
I	The fundamental concepts of the 1-dimensional and 2-dimensional random variables and their characterization in probability space.
II	The stationary random process, its framework and application for analyzing random signals and noises.
III	The characteristics of 1-dimensional stationary random signals 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, event probability, joint event probability, and conditional event probability for proving the Bayes theorem and for computing complex event probabilities and independence of multiple events.	Understand
CO 2	Explain the concept of random variable, the probability distribution function, probability density function and operations on single random variable to analytically derive the moments.	Understand
CO 3	Develop joint distribution, density function, expectation operator and transformations for multiple random variables using the concept of single random variable.	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 analytically 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



BLOOMS TAXONOMY

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.	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.	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	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

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 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 wired and wireless communication applications .	1
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	Explain distribution and density functions of standard random variables for wired and wireless communication applications .	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
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
	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	Explain joint distribution and density functions of standard random variables for wired and wireless communication applications .	1
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

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 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	Explain random process for finding co variance and correlation in wired and wireless communication applications .	1
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	Explain random process for finding co variance and correlation for response of an LTI system in wired and wireless communication applications .	1
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

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	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
	PSO 3	Explain random process for finding power spectral density functions for the response of LTI systems in wired and wireless communication applications .	1

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

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAP-PING:

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	6	6	-	-	-	-	-	-	1	-	-	-	-	1
CO 2	3	3	4	-	-	-	-	-	-	1	-	-	-	-	1
CO 3	3	6	5	-	-	-	-	-	-	1	-	-	-	-	1
CO 4	3	5	5	-	-	-	-	-	-	1	-	-	-	-	1
CO 5	3	5	5	-	-	-	-	-	-	1	-	-	-	-	1
CO 6	3	2	3	-	-	-	-	-	-	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	100	60	60	-	-	-	-	-	-	20	-	-	-	-	50
CO 2	100	30	40	-	-	-	-	-	-	20	-	-	-	-	50
CO 3	100	60	50	-	-	-	-	-	-	20	-	-	-	-	50
CO 4	100	50	50	-	-	-	-	-	-	20	-	-	-	-	50
CO 5	100	50	50	-	-	-	-	-	-	20	-	-	-	-	50
CO 6	100	20	30	-	-	-	-	-	-	20	-	-	-	-	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	3	-	-	-	-	-	-	1	-	-	-	-	2
CO 2	3	1	1	-	-	-	-	-	-	1	-	-	-	-	2
CO 3	3	3	2	-	-	-	-	-	-	1	-	-	-	-	2
CO 4	3	2	2	-	-	-	-	-	-	1	-	-	-	-	2
CO 5	3	2	2	-	-	-	-	-	-	1	-	-	-	-	2
CO 6	3	1	1	-	-	-	-	-	-	1	-	-	-	-	2
TOTAL	18	12	11	-	-	-	-	-	-	6	-	-	-	-	12
AVERAGE	3	2	1.83	-	-	-	-	-	-	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	PROBABILITY AND RANDOM VARIABLE
	Introduction to probability through sets and probability: Relative frequency; Experiments and sample spaces, discrete and continuous sample spaces; Events; Probability definitions and axioms; Mathematical model of experiments; Probability as a relative frequency; Joint probability; Conditional probability, total probability; Baye's theorem and independent events. Random variable: Definition of random variable, conditions for a function to be a random variable, discrete, continuous and mixed random variable
MODULE II	DISTRIBUTION AND DENSITY FUNCTIONS

	Distribution and density functions: Distribution and density functions definitions and properties; Binomial, Poisson, Uniform, Gaussian, Exponential, Rayleigh, Conditional distribution, methods of defining conditioning on an event, conditional density, properties. Operation on one random variable expectations: Introduction, expected value of a random variable, function of a random variable, moments about the origin, central moments, variance and skew; Chebychev's inequality; Characteristic function; Moment generating function; Transformations of a random variable: Monotonic transformations for a continuous random variable; Non monotonic transformations of continuous random variable; Transformation of a discrete random variable.
MODULE III	MULTIPLE RANDOM VARIABLES AND OPERATIONS
	Multiple random variables: Vector random variables, joint distribution function, properties of joint distribution; Marginal distribution functions, conditional distribution and density: Point conditioning, conditional distribution and density: Interval conditioning, statistical independence, sum of two random variables, sum of several random variables; Central limit theorem. Operations on multiple random variables: Expected value of functions of random variables: Joint moments about the origin, joint central moments, joint characteristic functions and jointly Gaussian random variables: Two random variables case and N random variable case, properties; Transformations of multiple random variables; Linear transformations of Gaussian random variables.
MODULE IV	STOCHASTIC PROCESSES: TEMPORAL CHARACTERISTICS
	The random process concept, classification of processes, deterministic and non deterministic processes, distribution and density functions, concept of stationary and statistical independence; First order stationary processes; Second order and wide sense stationarity, N Order and strict sense stationarity, time averages and ergodicity, mean ergodic processes, correlation ergodic processes; Autocorrelation function and its properties; Cross correlation function and its properties; Covariance functions; Gaussian random processes; Poisson random process.
MODULE V	STOCHASTIC PROCESSES: SPECTRAL CHARACTERISTICS
	Power spectrum: Properties, relationship between power spectrum and autocorrelation function; The cross power density spectrum, properties, relationship between cross power spectrum and cross correlation function. Spectral characteristics of system response: Power density spectrum of response; cross-power density spectrums of input and output of a linear system. Introduction to white Gaussian noise process and its properties.

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, 4th Edition, 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 Hajek, "4. Random Processes for Engineers, Cambridge University Press, 2015
Signals, Systems & Communications - B.P. Lathi, B.S. Publications, 2003.

WEB REFERENCES:

1. <https://nptel.ac.in/courses/111/102/111102111/>
2. www.britannica.com/topic/probability-theory
3. www.math.uiuc.edu/~r-ash/BPT.html

COURSE WEB PAGE:

<https://www.iare.ac.in/?q=courses/electronics-and-communication-engineering-autonomous/probability-theory-and-stochastic>

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=358
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 5	T1:6.6, R1: 6.10-6.12
33	Autocorrelation Function of Response, Cross- Correlation between Input and Output	CO 5	T1:8.2, R1: 8.2-8.3
34	Power density spectrum and properties	CO 6	T1:7.1-7.2, R1: 7.2-7.5
35	Cross Power spectral density: definition and properties	CO 6	T1:7.3-7.4, R1: 7.5-7.6
36	Relationship between power density spectrum and autocorrelation function	CO 6	T1:7.1-7.2, R1: 7.2-7.5
37	Relationship between Cross-power Spectrum and Cross-correlation function	CO 6	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 3	T1:3
44	Numerical problems on characteristic function and moment generating function	CO 3	T1:3
45	Numerical problems on Transformation of random variables	CO 3	T1:3
46	Numerical problems on joint distribution and marginal distribution	CO 4	T1:4
47	Numerical problems on joint density and marginal density function	CO 4	T1:4
48	Numerical problems on density function of sum of 2 random variables	CO 5	T1:4
49	Numerical problems on joint characteristic function and joint moment generating function	CO 6	T1:5
50	Numerical problems on linear transformation of Gaussian random variables	CO 7	T1:5
51	Numerical problems on stationarity of random process	CO 8	T1:6
52	Numerical problems on Gaussian and Poisson random process	CO 8	T1:6
53	Numerical problems on correlation function and properties	CO 9	T1:6
54	Numerical problems on power spectral density calculation	CO 10	T1:7
55	Numerical problems on power spectral density of a system output	CO 12	T1:8
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Probability and random variable	CO 1, CO 2, CO 3	T1:1,2,3
57	Multiple random variables	CO 4, CO 5, CO 6	T1:4,5
58	Characteristic function and moment generating function for single and multiple random variables.	CO 3, CO 6	T1:3,5
59	Random process and auto correlation function	CO 8, CO 9	T1:6
60	Power spectral density, output of linear system	CO 10, CO 11	T1:7,8
DISCUSSION OF QUESTION BANK			
61	Probability and random variable	CO 1, CO 2, CO 3	T1:1,2,3
62	Multiple random variables	CO 4, CO 5, CO 6	T1:4,5
63	Transformation of random variables	CO 3, CO 6	T1:3,5

64	Stationarity and auto correlation function	CO 8,CO 9	T1:6
65	Power spectral density	CO 10,CO 11	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



INSTITUTE OF AERONAUTICAL ENGINEERING (Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING COURSE DESCRIPTION

Course Title	ELECTRONIC DEVICES AND CIRCUITS LABORATORY				
Course Code	AEC101				
Program	B.Tech				
Semester	III	ECE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Ms. K Indira, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSC05	I	Physics Laboratory

II COURSE OVERVIEW:

This course provides the hands-on experience by examining the voltage-current characteristics of diodes, Bipolar Junction Transistors, Field Effect Transistors and its applications. Analyze the devices for measuring device characteristic parameters for designing semiconductor circuits. Extract the characteristics of semiconductor devices using multisim simulation tool

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Electronic 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 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
2	2	2	2	2	10

2. Programming Based

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

VI COURSE OBJECTIVES:

The students will try to learn:

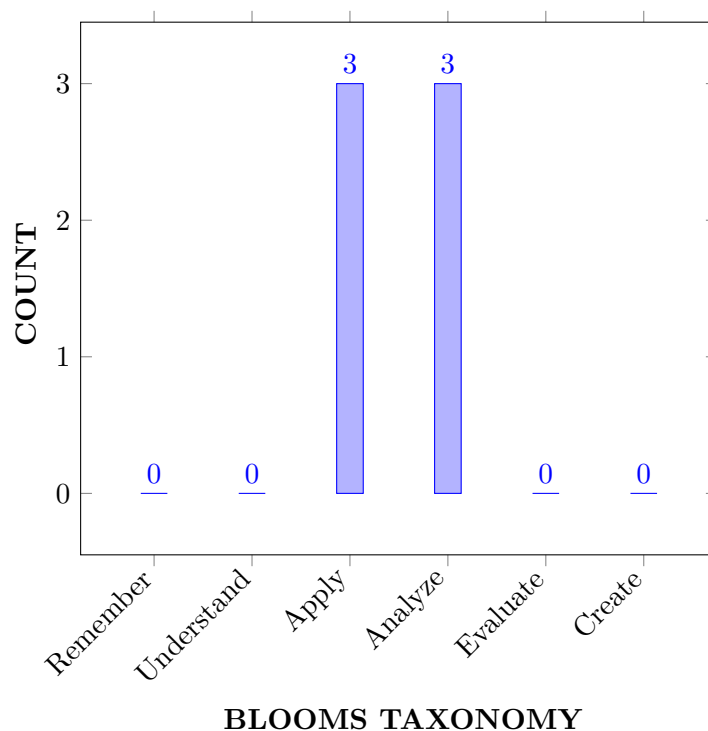
I	The behavior and characteristics of semiconductor devices for designing the semiconductor circuits such as amplifier and rectifiers.
II	Estimation of device characteristics like gain, bandwidth, input and output resistance of bipolar junction transistors and field effect transistors amplifiers to derive 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	Analyze the semiconductor diode characteristics for measuring the static, dynamic resistances and cut-in voltage.	Analyze
CO 2	Construct the pn junction diode and Zener diode characteristics for the diode applications such as rectifiers and voltage regulator.	Apply
CO 3	Examine the input and output characteristics of transistor (BJT and FET) configurations for determining the input - output resistances.	Analyze
CO 4	Compare 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	Determine holding, latching current and break over voltage of silicon controlled rectifier using volt - ampere characteristics.	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 analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	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
PO 10	Design/Development of Solutions: 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

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.	1	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	Identify, formulate, review research literature, Experimental design for calculating forward, reverse resistances, cutin voltage and translate the information into the graphical form from the provided information and data, develop solutions based on inputs applied for the circuit Validation and compare the Interpretation of results with theoretical knowledge with proper Documentation	8
	PO 9	Execution of experiments individually makes the student Independence and Maturity requiring only the achievement of goals to drive their performance, Self-direction to take the decisions	3
	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	4
CO 2	PO 2	Identify, formulate, review research literature, Experimental design for calculating forward, reverse resistances, cutin voltage of zener diode and translate the information into the graphical form from the provided information and data, develop solutions based on inputs applied for the circuit Validation and compare the Interpretation of results with theoretical knowledge with proper Documentation	8
	PO 9	Execution of experiments individually makes the student Independence and Maturity requiring only the achievement of goals to drive their performance, Self-direction to take the decisions	3
	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.	4

CO 3	PO 2	Identify, formulate, review research literature, Experimental design for the input,output characteristic of transistor configurations and translate the information into the graphical form from the provided information and data, develop solutions based on inputs applied for the circuit Validation and compare the Interpretation of results with theoretical knowledge with proper Documentation	8
	PO 9	Execution of experiments individually makes the student Independence and Maturity requiring only the achievement of goals to drive their performance, Self-direction to take the decisions	3
	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.	4
	PSO 1	Formulate and Evaluate the rectifier circuits applications in the field of Intelligent Embedded and Semiconductor technologies	2
CO 4	PO 2	Identify, formulate, review research literature the amplifier construction with BJT and FET 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 9	Execution of experiments individually makes the student Independence and Maturity requiring only the achievement of goals to drive their performance, Self-direction to take the decisions	3
	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	4

CO 5	PO 2	AI Identify, formulate, review research literature, Experimental design for calculating forward,reverse resistances of UJT and translate the information into the graphical form from the provided information and data, develop solutions based on inputs applied for the circuit Validation and compare the Interpretation of results with theoretical knowledge with proper Documentation	8
	PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling the basic electronic circuits using active transistors in multisim simulation tool to complex Engineering activities with an understanding of the limitations.	1
	PO 9	Execution of experiments individually makes the student Independence and Maturity requiring only the achievement of goals to drive their performance, Self-direction to take the decisions	3
	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	4
CO 6	PO 2	Identify, formulate, review research literature,Experimental design for volt Ampere characteristics of SCR and translate the information into the graphical form from the provided information and data, develop solutions based on inputs applied for the circuit Validation and compare the Interpretation of results with theoretical knowledge with proper Documentation	8
	PO 9	Execution of experiments individually makes the student Independence and Maturity requiring only the achievement of goals to drive their performance, Self-direction to take the decisions	3

	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	4

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 1
CO 1	3		1	2	
CO 2	3		1	2	
CO 3	3		1	2	3
CO 4	3		1	2	
CO 5	3	3	1	2	
CO 6	3		1	2	

XII 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	-	-	-	-	-	-	25	50	-	-	-	-	-
CO 2	-	100	-	-	-	-	-	-	25	50	-	-	-	-	-
CO 3	-	100	-	-	-	-	-	-	25	50	-	-	100	-	-
CO 4	-	100	-	-	-	-	-	-	25	50	-	-	-	-	-
CO 5	-	100	-	-	100	-	-	-	25	50	-	-	-	-	-
CO 6	-	100	-	-	-	-	-	-	25	50	-	-	-	-	-

XIII 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	-	-	-	-	-
CO 3	-	3	-	-	-	-	-	-	1	2	-	-	3	-	-
CO 4	-	3	-	-	-	-	-	-	1	2	-	-	-	-	-
CO 5	-	3	-	-	3	-	-	-	1	2	-	-	-	-	-
CO 6	-	3	-	-	-	-	-	-	1	2	-	-	-	-	-
TOTAL	0	18	0	0	3	0	0	0	6	12	0	0	3	0	0
AVERAGE	0	3	0	0	3	0	0	0	1	2	0	0	3	0	0

XIV ASSESSMENT METHODOLOGY DIRECT:

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

XV ASSESSMENT METHODOLOGY INDIRECT:

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

XVI SYLLABUS:

WEEK I	ELECTRONIC WORKSHOP PRACTICE
	Identification, specifications, testing of R, L, C components (Color Codes), potentiometers, switches (SPDT, DPDT and DIP), coils, gang condensers, relays, bread boards, PCBs, identification, specifications and testing of active devices, diodes, BJTs, low power JFETs, MOSFETs, power transistors, LEDs, LCDs, optoelectronic devices, SCR, UJT, DIACs
WEEK II	ELECTRONIC WORKSHOP PRACTICE
	Study and operation of a. Multimeters (Analog and Digital) b. Function Generator c. Regulated Power Supplies d. Study and Operation of CRO
WEEK III	PN DIODE CHARACTERISTICS
	Verification of V-I characteristics of PN diode and calculate static and dynamic resistance using hardware and digital simulation.
WEEK IV	ZENER DIODE CHARACTERISTICS AND VOLTAGE REGULATOR
	Verification of V-I characteristics of Zener diode and perform Zener diode as a Voltage regulator using hardware and digital simulation.
WEEK V	HALF WAVE RECTIFIER
	Verification of half wave rectifier without and with filters using hardware and digital simulation.
WEEK VI	FULL WAVE RECTIFIER
	Verification of Full Wave Rectifier without and with filters using hardware and digital simulation.
WEEK VII	TRANSISTOR CB CHARACTERISTICS
	Verification of Input and Output characteristics of CB configuration using hardware and digital simulation.
WEEK VIII	TRANSISTOR CE CHARACTERISTICS
	Verification of Input and Output Characteristics of CE configuration using hardware and digital simulation
WEEK IX	FREQUENCY RESPONSE OF CE AMPLIFIER
	Determine the Gain and Bandwidth of CE amplifier using hardware and digital simulation.
WEEK X	FREQUENCY RESPONSE OF CC AMPLIFIER
	Determine the Gain and Bandwidth of CC amplifier using hardware and digital simulation.
WEEK XI	UJT CHARACTERISTICS
	Verification of V-I Characteristics of UJT using hardware and digital simulation
WEEK XII	SCR CHARACTERISTICS
	Verification of V-I Characteristics of SCR using hardware and digital simulation.

WEEK XIII	FET CHARACTERISTICS
	Verification of V-I Characteristics of FET using digital simulation.
WEEK XIV	FREQUENCY RESPONSE OF CS AMPLIFIER
	Determine the Gain and Bandwidth of CS amplifier using digital simulation.
WEEK XV	FREQUENCY RESPONSE OF CD AMPLIFIER
	Determine the Gain and Bandwidth of CD amplifier 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.

XVII 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	Electronic workshop practice.	CO 1	
2	pn diode characteristics.	CO 2	T1: 3.1
3	Zener diode characteristics and voltage regulator	CO 2	T1: 3.11
4	Half wave rectifier	CO 3	T1: 4.6
5	Full wave rectifier.	CO 3	T1: 4.8
6	Transistor CB characteristics	CO 4	T1: 5.5
7	Transistor CE characteristics	CO 4	T1: 5.6
8	Frequency response of CE amplifier.	CO 5 CO 6	T1: 8.3
9	Frequency response of CE amplifier.	CO 5 CO 3	T1: 8.3
10	UJT characteristics.	CO 6	T1: 9.2
11	SCR characteristics	CO 4	T1:9.3
12	FET characteristics	CO 4	T1:10.6
13	Frequency response of CS amplifier	CO 5 CO6	T1: 10.7
14	Frequency response of CD amplifier	CO 5 CO 6	T1: 10.7

XVIII 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 $\pm 3V$ 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 k Ω 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 k Ω potentiometer and adjust it to obtain 250 μ A bias current. Select $R_S = 10$ k Ω .
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 = ± 5 V Load Resistance, $R_L = 100\Omega$ 0-to-Peak Output Swing is greater than or equal to 2V Voltage Gain= 50 Input Resistance= 10k Ω

Signature of Course Coordinator
Ms. K Indira, Assistant Professor

HOD,ECE



INSTITUTE OF AERONAUTICAL ENGINEERING (Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTION

Course Title	SIMULATION LABORATORY				
Course Code	AHS107				
Program	B.Tech				
Semester	III	ECE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	Theory		Practical		
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	2
Chief Coordinator	Ms G. Mary swarna latha, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
B.Tech	AHS002	I	Linear Algebra and Ordinary Differential Equations	4
B.Tech	AHS004	II	Complex Analysis and Probability Distributions	4
B.Tech	AEC003	III	Probability Theory and Stochastic Processes	4

II COURSE OVERVIEW:

This course integrates about the generation of both continuous and discrete time signals, basic operations, and frequency transformations of signals and systems. It covers the linear time invariant systems and their analysis in time and frequency domain. It can apply the concepts to obtain the correlation and convolution between signals and sequences, to find distribution and density functions of random variables. It provides the necessary background needed for understanding the signal processing and communications. This lab provides hands-on experience on implementation of communication systems using MATLAB software.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
signals and systems	70 Marks	30 Marks	100

IV CONTENT 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
-	-	-	-	-	-

B. Programming Based:

Preparation	Performance	Calculations and Graph	Results and Error Analysis	Viva	Total
2	2	2	2	2	10

VI MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
signals and systems	70 Marks	30 Marks	100

VII DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

VIII 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
-	-	-	-	-	-

B. Programming Based:

Preparation	Performance	Calculations and Graph	Results and Error Analysis	Viva	Total
2	2	2	2	2	10

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		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 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.	3	Lab Experiments / CIE / SEE
PO 12	Life-long learning: An ability to align with and upgrade to higher learning and research activities along with engaging in life-long learning.	1	Self Learning

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	Lab Exercises / CIE / SEE

3 = High; 2 = Medium; 1 = Low

XI COURSE OBJECTIVES:

The students will try to learn:

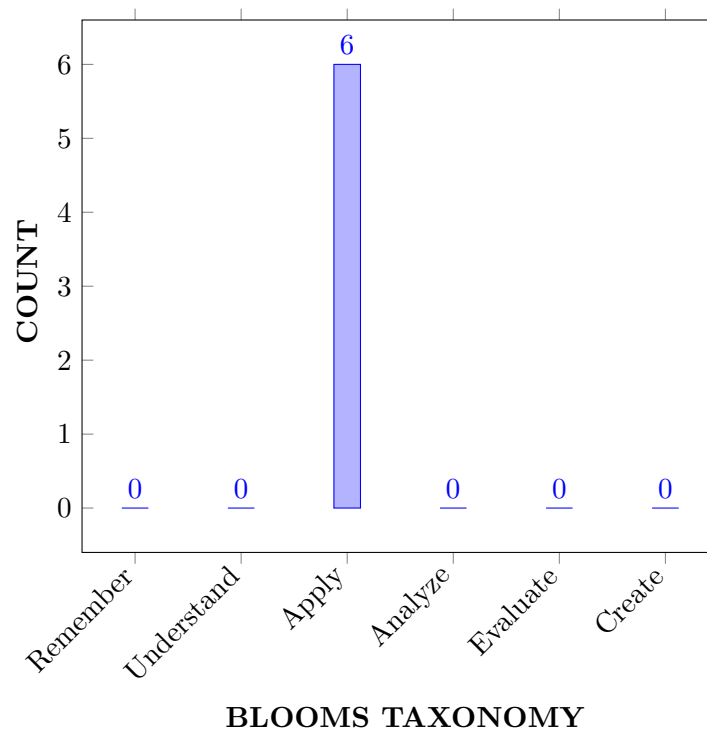
I	The basic syntax of signals, generations and operations of signals and sequences using MATLAB.
II	The spectral characteristics of signals using Fourier, laplace and z transform.
III	The Implementation of convolution and correlation of signals and systems.

XII COURSE OUTCOMES:

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

CO No	Course Outcomes	Knowledge Level (Bloom's Taxonomy)
CO 1	Realize the tool basic operations addition, subtraction, multiplication and division on matrices	Apply
CO 2	Generate standard signals and sequences for performing operations on various signals	Apply
CO 3	Determine Fourier transform, properties of Fourier transform and Inverse Fourier transform of signal and sequence	Apply
CO 4	Locate the poles and zeros of transfer function using Laplace and Z transforms.	Apply
CO 5	Determine convolution and correlation between signals and sequences for analyzing linear time-invariant systems.	Apply
CO 6	Compute mean, mean square and power spectral density of signal to calculate gaussian noise.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



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
CO 1	PO 2	Understand the given problem statement and formulate the mathematical operations on matrices by applying the mathematical principles and engineering science.	3
	PO 5	Make use of MATLAB software to perform matrix manipulation operations.	1
CO 2	PO 2	Understand the given problem statement and formulate mathematical operations on signals and sequences using principles of mathematics and engineering science .	3
	PO 5	Utilize software tool to generate and perform operations of signals and sequences.	1
CO 3	PO 2	Understand the given problem statement and formulate the Fourier transform problems of spectral characteristics of continuous time aperiodic signals and analyze the frequency response of the given system.	3
	PO 5	Make use of MATLAB software tool to perform the transform technique of Fourier transform and verify the properties of Fourier transform.	1
	PSO 1	Develop the capability to analyze and apply Fourier Transform and their properties on continuous signals and applications by its mathematical models	3
CO 4	PO 2	Identify and determine the region of convergence of the Laplace and z transform for given causal and noncausal signals.	2
	PO 5	Identify and determine the Laplace and z transform for given causal and noncausal signals.	1
	PO 12	Ability to understand the basic concepts of Laplace and z transform apply them to various areas, like Communications, Signal processing.	2
	PS01	Ability to analyze and apply Laplace and Z Transform and their properties on continuous and discrete signals and applications by its mathematical models .	3

CO 5	PO 2	Explain (Knowledge) the correlation functions for measuring the similarity of the signals in signal detection for solving complex engineering problems using auto and cross correlation functions by applying mathematics, science and engineering fundamentals .	3
	PO 5	Make use of MATLAB software tool to perform the cross correlation and autocorrelation.	1
	PO 12	Ability to understand the basic concepts of convolution apply them to various areas, like Electronics, Communications, Signal processing.	2
CO 6	PO 2	Develop the capability analyze the spectral densities of a given signal using mathematical theorems.	2
	PO 5	Utilize the software tool to analyze the energy and power spectral density.	1

XIV 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	-	3	-	-	1	-	-	-	-	-	-	-	-	-	-
CO 2	-	3	-	-	1	-	-	-	-	-	-	-	-	-	-
CO 3	-	3	-	-	1	-	-	-	-	-	-	-	2	-	-
CO 4	-	2	-	-	1	-	-	-	-	-	-	2	2	-	-
CO 5	-	3	-	-	1	-	-	-	-	-	-	2	-	-	-
CO 6	-	2	-	-	1	-	-	-	-	-	-	-	-	-	-

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	2	2	2
CO 1	-	30	-	-	10	-	-	-	-	-	-	-	-	-	-
CO 2	-	30	-	-	10	-	-	-	-	-	-	-	-	-	-
CO 3	-	30	-	-	10	-	-	-	-	-	-	-	100	-	-

CO 4	-	20	-	-	10	-	-	-	-	-	-	25	100	-	-
CO 5	-	30	-	-	10	-	-	-	-	-	-	25	-	-	-
CO 6	-	20	-	-	10	-	-	-	-	-	-	-	-	-	-

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	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-
CO 2	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-
CO 3	-	1	-	-	1	-	-	-	-	-	-	-	3	-	-
CO 4	-	1	-	-	1	-	-	-	-	-	-	1	3	-	-
CO 5	-	1	-	-	1	-	-	-	-	-	-	1	-	-	-
CO 6	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-
TOTAL	0	6	0	0	6	0	0	0	0	0	0	2	6	0	0
AVERAGE	0	1	0	0	0	1	0	0	0	0	0	1	3	0	0

XVII ASSESSMENT METHODOLOGY DIRECT:

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

XVIII ASSESSMENT METHODOLOGY DIRECT:

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

XIX ASSESSMENT METHODOLOGY INDIRECT:

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

XX MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

COURSE OUTCOMES	Program Outcomes / No. of Key Competencies Matched												PROGRAM SPECIFIC OUTCOMES (PSO'S)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	-	3	-	-	1	-	-	-	-	-	-		-	-	-
CO 2	-	3	-	-	1	-	-	-	-	-	-	-		-	-
CO 3	-	3	-	-	1	-	-	-	-	-	-	2	2	-	-
CO4	-	2	-	-	1	-	-	-	-	-	-	2	-	-	-
CO 5	-	3	-	-	1	-	-	-	-	-	-	-	-	-	-
CO 6	-	2	-	-	1	-	-	-	-	-	-		-	-	-

3 = High; 2 = Medium; 1 = Low

XXI SYLLABUS:

Week-1	BASIC OPERATIONS ON MATRICES
	Review basic operations on matrices by using MATLAB
Week-2	GENERATION OF VARIOUS SIGNALS AND SEQUENCES
	Generation of various signals and sequences such as unit impulse, sinc, gaussian, exponential, sawtooth, triangular and sinusoidal by using MATLAB.
Week-3	OPERATIONS ON SIGNALS AND SEQUENCES
	Operations on signals and sequences such as addition, subtraction, multiplication, scaling, shifting and folding by using MATLAB.
Week-4	GIBBS PHENOMENON
	Verification of Gibbs phenomenon by using MATLAB
Week-5	FOURIER TRANSFORMS AND INVERSE FOURIER TRANSFORM
	Finding the Fourier transform and inverse Fourier transform of given signal/sequence and plotting its magnitude and phase spectrum by using MATLAB.
Week-6	PROPERTIES OF FOURIER TRANSFORMS
	Verify time shifting and scaling, time and differentiation properties of Fourier transforms by using MATLAB.
Week-7	LAPLACE TRANSFORMS
	Finding the Laplace transform of a given signal and locate its zeros and poles in s-plane.
Week-8	Z-TRANSFORMS
	Finding the Z-transform of a given sequence and locate its zeros and poles in s-plane.
Week-9	CONVOLUTION BETWEEN SIGNALS AND SEQUENCES
	Finding convolution between given two signals/sequences by using MATLAB.
Week-10	AUTO CORRELATION AND CROSS CORRELATION
	Finding auto correlation and cross correlation between signals and sequences by using MATLAB.
Week-11	GAUSSIAN NOISE
	Generation of Gaussian noise, computation of its mean, M.S value and its Skew, kurtosis, and PSD, probability distribution function by using MATLAB.
Week-12	WIENER -KHINCHINE RELATIONS
	Verification of Wiener- Khinchine relations using MATLAB.
Week-13	DISTRIBUTION AND DENSITY FUNCTIONS OF STANDARD RANDOM VARIABLES
	Finding distribution and density functions of standard random variables and plot them using MATLAB.
Week-14	WIDE SENSE STATIONARY RANDOM PROCESS

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. Digital Signal Processing, Principles, Algorithms, and Applications, John G. Proakis, Dimitris G. Manolakis, Pearson Education / PHI. 2007..

REFERENCE BOOKS:

1. S.Varadarajan, M.M. Prasada Reddy,M.Jithender Reddy,” Signals and Systems Introduces MATLAB Programs “ I.K International Publishing House Pvt .Ltd,2016.
2. Scott L. Miller, Donald G. Childers,” Probability and Random Process: with Applications to Signal Processing and Communications”, Elsevier ,2004
3. Krister Ahlersten,”An Introduction to Matlab”.BookBoon,2012.

XXII 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	Generate matrices and perform basic operations on matrices using MATLAB.	C0 1	T1-13.2
2	Generate various signals and sequences such as unit impulse, unit step, ramp, sinc and signum.	C0 1	T1 14.5
3	Perform amplitude and time operations on signals and sequences.	C0 1	T1 14.8
4	Verify GIBBS phenomenon.	C0 2	T1 15.5 -15.9
5	Calculate Fourier transform and inverse Fourier transform of given signal and sequence.	C0 3	T1 15.7
6	Verify properties of Fourier transform.	CO 6	T1-11.1 to 11.5
7	Calculate Laplace transform of given signal and locate poles and zeros on S-plane.	CO 3	T1-161 to 16.8
8	Calculate Z transform of given sequence and locate poles and zeros on Z-plane.	CO 3	R44.1
9	Find convolution between given two signals and sequences.	CO 4	R44.2
10	Calculate Auto correlation and Cross correlation between signals and sequences.	CO 5	R44.3
11	Generate Gaussian noise and calculate its mean, mean square, distribution and density functions.	CO 5	R44.6
12	Verify Wiener – Khinchine relationships using MATLAB.	CO 6	R44.10

13	Calculate probability density and distributions functions of a given random variable.	C0 6	R45.6
14	Verify a random process for stationary in wide sense using MATLAB.	C0 6	R45.6

XXIII EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Determine the array matrix using MATLAB software?
2	Find the aperiodic signal if the given input signal is rectangular?
3	How to Add two signals X , Y where $X = [0 \ 1 \ 6 \ 5]$ and Y will be user defined.
4	How to generate the fourier series coefficients when we are giving the half wave rectifier?
5	Determine the differentiation,integration of DTFT?
6	Verify the frequency-shifting property of the DTFT.
7	verify the transfer function using input and impulse response of the system?.
8	perform convolution between the following signals 1. $X(n)=[1 \ -1 \ 4 \]$, $h(n) = [\ -1 \ 2 \ -3 \ 1]$
9	Determine the Auto Correlation and Cross Correlation
10	Detrmine the conditions for Region of convergence in laplace transform?
11	How to add gaussian noise in 1D signal

Signature of Course Coordinator

HOD, ECE



INSTITUTE OF AERONAUTICAL ENGINEERING (Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	ELECTRONICS AND COMMUNICATION ENGINEERING				
Course Title	ELECTRONIC CIRCUIT ANALYSIS				
Course Code	AEC004				
Program	B.Tech				
Semester	IV				
Course Type	Core				
Regulation	R-16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	3	-	-
Course Coordinator	Mr. J. Siva Ramakrishna, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEE002	II	Electrical Circuits
B.Tech	AEC001	III	Electronic Devices and Circuits

II COURSE OVERVIEW:

This course provides design and analysis of small signal low frequency, high frequency, and large signal amplifier circuits. The course covers multistage amplifiers, power amplifiers, and feedback amplifiers. 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
Electronic Circuit Analysis	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 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
45%	Understand
27%	Apply
18%	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 8th and 16th 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 centre. 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	Design and analyse single stage and multi stage Amplifiers.
II	Analyse the frequency response of different types of Amplifiers.
III	Interpret the concept of feedback and classify various types of feedback amplifiers.
IV	Understand the principle of oscillation and design different types of oscillators.

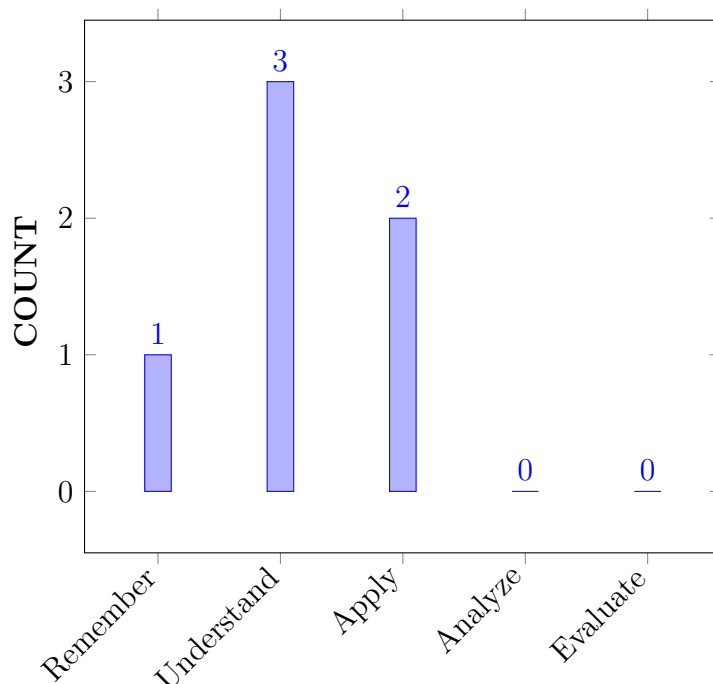
VII COURSE OUTCOMES:

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

CO 1	List the effects of resistance, coupling and bypass capacitors for frequency response of single stage amplifiers.	Remember
CO 2	Explain the concept of transistor amplifiers at high frequency for determining gain and bandwidth.	Understand

CO 3	Develop RC, transformer and direct coupled multi stage amplifiers to find the effect of cascading on gain and bandwidth.	Apply
CO 4	Summarize the concept of tuned amplifiers for determining the resonant frequency and gain.	Understand
CO 5	Demonstrate the conditions required by an amplifier to generate positive and negative feedback amplifiers.	Apply
CO 6	Describe different types of power amplifiers based on position of quiescent point for determining efficiency and power dissipation of class A, class B power amplifiers.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

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 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	
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 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	

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.	1	

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Synthesize and analyze aircraft structures, propulsion, production technologies and computer aided engineering in aeronautical systems including air traffic controls standards	3	Quiz

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 frequency response of single stage amplifier with coupling and bypass capacitors by applying the knowledge of mathematics, engineering fundamentals , and an engineering specialization to the solution of complex engineering problems.	2
	PO 2	Identify, formulate the frequency response of single stage amplifier with coupling and bypass capacitors to analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, science and engineering fundamentals .	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 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 2	PO 1	Build various amplifier circuits using bipolar junction transistor by applying mathematics, science and engineering fundamentals .	3
CO2	PO 3	Design various amplifier circuits using bipolar junction transistor to meet the specified needs with appropriate consideration for the safety, societal, and environmental considerations .	3
	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	2
CO 3	PO 1	Examine (knowledge) various types of amplifier circuits frequency response at low and high frequency using active transistors by applying mathematics, scientific methodologies and engineering fundamentals .	3
	PO 2	Design the amplifier then analyze the low and high frequency response using first principles of mathematics, and engineering sciences .	4
	PO 3	Analysis and design of different amplifiers circuits for various applications for the public safety, cultural, societal, and environmental considerations to solve complex engineering problems .	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	2
	PSO 1	Make use of amplifier circuits to build digital circuit development platform for robotics, embedded systems and signal processing applications.	2
CO 4	PO 1	Understand the operation of transistor amplifiers at high frequency by applying mathematics and engineering fundamentals .	2
	PO 2	Design high frequency amplifier circuits and analyze the designing of practical circuit using first principles of mathematics and engineering sciences .	4

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO4	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	2
	PSO 1	Make use of amplifier circuits to build digital circuit development platform for robotics, embedded systems and signal processing applications.	2
CO 5	PO 1	Demonstrate the working of RC coupled, transformer coupled and direct coupled multi stage amplifiers using transistors by applying the knowledge of mathematics, engineering fundamentals.	3
	PO 2	Identify appropriate method for cascading amplifiers using various coupling schemes like Rc coupling, transformer coupling, and direct coupling circuits using first principles of mathematics and engineering sciences.	3
	PO 3	Identify appropriate method for cascading amplifiers using various coupling schemes like Rc coupling, transformer coupling, and direct coupling circuits using first principles of mathematics and engineering sciences.	3
	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	2
CO 6	PO 1	Understand the conditions required to generate sinusoidal oscillations by applying the knowledge of mathematics, and engineering fundamentals.	2
	PO 2	Identify appropriate method to generate oscillations using transistor amplifiers to build digital circuit development platform for robotics, embedded systems and signal processing applications.	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 and design documentation, make effective presentations, and give and receive clear instructions	2

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	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	2	5	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 2	3	-	3	-	-	-	-	-	-	2	-	-	-	-	-
CO 3	3	4	5	-	-	-	-	-	-	2	-	-	2	-	-
CO 4	2	4	-	-	-	-	-	-	-	2	-	-	2	-	-
CO 5	3	3	3	-	-	-	-	-	-	2	-	-	-	-	-
CO 6	2	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	66.6	50	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 2	100	-	30	-	-	-	-	-	-	40	-	-	-	-	-
CO 3	100	40	50	-	-	-	-	-	-	40	-	-	100	-	-
CO 4	66.6	40	-	-	-	-	-	-	-	40	-	-	100	-	-
CO 5	100	30	30	-	-	-	-	-	-	40	-	-	-	-	-
CO 6	66.6	20	-	-	-	-	-	-	-	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	-	1	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	3	2	2	-	-	-	-	-	-	1	-	-	3	-	-
CO 4	3	2	-	-	-	-	-	-	-	1	-	-	3	-	-
CO 5	3	1	1	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	3	1	-	-	-	-	-	-	-	1	-	-	3	-	-
TOTAL	18	8	4	-	-	-	-	-	-	6	-	-	9	-	-
AVERAGE	3	1.6	1.3	-	-	-	-	-	-	1	-	-	3	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	PO 4	Quiz	✓
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	SINGLE STAGE AMPLIFIERS AND FREQUENCY RESPONSE
	Classification of amplifiers, overview of analysis of a transistor amplifier circuit using h-parameter, Millers theorem and its dual, design of Single stage RC coupled amplifier using bipolar junction transistor, low frequency response of bipolar junction transistor amplifier, analysis at low frequency, effect of coupling and bypass capacitor.
MODULE II	HIGH FREQUENCY RESPONSE OF AMPLIFIER
	The hybrid- π common emitter transistor model, hybrid π conductance and capacitance, effect of coupling and bypass capacitors, common emitter short circuit current gain, current gain with resistive load, alpha, beta cut-off frequencies, gain bandwidth product, emitter follower at high frequencies.
MODULE III	MULTI STAGE AMPLIFIERS AND TUNED AMPLIFIERS
	Multistage amplifier: Different coupling schemes used in amplifiers, RC coupled amplifiers, transformer coupled amplifiers and direct coupled amplifiers, analysis of cascaded RC coupled bipolar junction transistor amplifiers, cascode amplifiers, Darlington pair.
	Tuned amplifiers: introduction, Q - factor, small signal tuned amplifier, effect of cascading single tuned amplifiers on bandwidth, stagger tuned amplifiers, stability of tuned amplifiers.
MODULE IV	FEEDBACK AMPLIFIERS AND OSCILLATORS
	Feedback amplifiers: Concept of feedback, classification of feedback amplifiers, general characteristics of negative feedback amplifiers, analysis of voltage series, voltage shunt, current series and current shunt feedback configurations, problems; Oscillators: Classification of oscillator, conditions for oscillations, RC phase shift oscillator, generalized analysis of LC oscillations, Hartley and Colpitts oscillators, Wien - bridge and crystal oscillators, stability of oscillators
MODULE V	LARGE SIGNAL AMPLIFIERS
	Classification, class A large signal amplifiers, transformer coupled class A audio power amplifiers, efficiency of class A amplifier, class B amplifier, efficiency of class B amplifier, class B push-pull amplifier, complementary symmetry class B push-pull amplifier, distortion in power amplifiers, thermal stability and heat sinks.

TEXTBOOKS

1. Jacob Millman, Christor C Halkias, "Integrated Electronics", Tata McGraw Hill, 1st Edition, 2008.

2. Sedra A.S., K.C. Smith, "Micro Electronic Circuits", Oxford University Press, 6th Edition, 2013.
3. Donald A Neamen, "Electronic Circuits Analysis and Design" , Tata McGraw Hill , 3 rd Edition, 2007.

REFERENCE BOOKS:

1. David A. Bell "Electronic Devices & Circuits" 5th Edition. Oxford university press, 7 th Edition, 2009
2. S.Salivahna, N. Suresh kumar, "Electronic circuit analysis", McGraw-Hill Education, 1 st Edition, 2011.

WEB REFERENCES:

1. https://www.iare.ac.in/sites/default/files/Courses_description/ECA%20Discriptor-30012019.pdf

COURSE WEB PAGE:

1. <https://www.iare.ac.in/?q=courses/electronics-and-communication-engineering-autonomous/electronic-circuit-analysis>

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/electronics-and-communication-engineering-autonomous/eca
CONTENT DELIVERY (THEORY)			
2	Classification of amplifiers.	CO 1	T1-1.1 to 1.4
3	Analysis of CE, CB transistor amplifier circuit using h-parameter.	CO 1	T1-1.1 to 1.4
4	Analysis of CC transistor amplifier circuit using h-parameter.	CO 1	T1-1.1 to 1.4
6	Millers theorem and its dual.	CO 1	T1-1.1 to 1.4
7	Design of Single stage RC coupled amplifier using bipolar junction transistor	CO 1	T1-1.1 to 1.4
8	Low frequency response of bipolar junction transistor amplifier.	CO 2	T1-3.1 to 3.3
9	Analysis of amplifier at low frequency, effect of coupling and bypass capacitor.	CO 2	T1-3.1 to 3.3
12	The hybrid- π common emitter transistor model,	CO 2	T1-2.2 R2-8.1
13	The hybrid- π common emitter transistor model	CO 3	T1-4.1

14	hybrid π conductance and capacitance.	CO 3	T1-4.2to 4.9
17	The effect of coupling and bypass capacitors	CO 3	T1-4.2 to 4.9
20	Common emitter short circuit current gain	CO 3	T1-4.2 to 4.9
21	Current gain with resistive load	CO 3	T1-4.2 to 4.9
22	Alpha, beta cut-off frequencies.	CO 4	T1- 4.10
23	Gain bandwidth product and emitter follower at high frequencies	CO 4	T1- 4.10
24	Emitter follower at high frequencies	CO 4	T1-4.11 to 4.14
28	multistage amplifier: Different coupling schemes used in amplifiers.	CO 3	T1-4.11 to 4.14
29	RC coupled amplifiers, transformer coupled amplifiers and direct coupled amplifiers	CO 3	T1-4.15 to 4.17
30	RC coupled amplifiers, transformer coupled amplifiers and direct coupled amplifiers.	CO 5	T1-4.15 to 4.17
31	Analysis of cascaded RC coupled bipolar junction transistor amplifiers,	CO 5	T1-7.1 to 7.9 R2-17.1
32	Analysis of cascode amplifiers and Darlington pair,	CO 5	T1-7.1 to 7.9 R2-17.1
35	Tuned amplifiers introduction, Q - factor	CO 5	T1-7.1 to 7.9 R2-17.1
36	Small signal tuned amplifier	CO 6	T1-5.1 to 5.7
37	Effect of cascading single tuned amplifiers on bandwidth	CO 6	T1-5.1 to 5.7
38	Stagger tuned amplifiers	CO 6	T1-5.1 to 5.7
39	Stability of tuned amplifiers	CO 6	T1-5.1 to 5.7
41	Concept of feedback	CO 6	T1-5.1 to 5.7
43	Classification of feedback amplifiers	CO 5	T1-6.1 to 6.2 R2-19.1
44	General characteristics of negative feedback amplifiers,	CO 5	T1-6.1 to 6.2 R2-19.1
45	Analysis of voltage series, voltage shunt feedback amplifiers	CO 5	T1-6.1 to 6.2 R2-19.1
46	Analysis of current series and current shunt feedback amplifiers	CO 5	T1-6.1 to 6.2 R2-19.1
49	Classification of oscillators	CO 5	T1-6.1 to 6.2 R2-19.1
50	Conditions for oscillations	CO 5	T1-6.3 to 6.5
51	Analysis of RC phase shift oscillator	CO 5	T1-6.3 to 6.5
52	Analysis of weinbridge oscillator	CO 5	T1-6.3 to 6.5
53	Analysis of Hartley oscillators,	CO 5	T1-9.3 to 9.7
54	Analysis of Colpitts oscillators,	CO 5	T1-9.3 to 9.7
55	Crystal oscillators	CO 5	T1-9.3 to 9.7
56	stability of oscillators	CO 5	T1-9.3
59	Efficiency of class A amplifier, class B amplifier,	CO 6	T1-9.3
60	Complementary symmetry class B	CO 6	T1-9.3

61	Push-pull class B amplifier and distortion in power amplifiers	CO 6	T1-9.3
62	, Thermal stability and heat sinks	CO 6	T1-9.3
PROBLEM SOLVING / CASE STUDIES			
5	Problems on CE, CC and CB amplifiers	CO 1	T1-1.1 to 1.4
7	Problems on CE, CC and CB amplifiers	CO 1	T1-1.1 to 1.4
10	Problems on frequency response of amplifiers	CO 2	T1-2.1
11	Problems on multistage amplifiers	CO 2	T1-2.1
15	Problems on high frequency response of amplifiers	CO 2	T1-2.2 R2-8.1
16	Problems on high frequency response of amplifiers	CO 2	T1-2.2 R2-8.1
18	Problems on hybrid-pi model configuration.	CO 3	T1-5.8 to 5.11
19	Problems on frequency response.	CO 3	T1-4.11 to 4.14
25	Problems on gain bandwidth of amplifier	CO 3	T1-5.8 to 5.11
26	Problems on current gain of high frequency amplifiers.	CO 3	T1-4.1 to 4.9
27	Problems on emitter follower.	CO 3	T1-4.1 to 4.9
33	Problems on Rc coupled, transformer coupled amplifier.	CO 3	T1-4.15 to 4.17
34	Problems on cascode amplifier.	CO 3	T1-4.15 to 4.17
40	Problems on tuned amplifier.	CO 4	T1- 4.10
42	Problems on feedback.	CO 5	T1-7.1 to 7.9 R2-17.1
47	Problems on feedback amplifier.	CO 5	T1-9.3 to 9.7
DISCUSSION ON DEFINITION AND TERMINOLOGY			
48	Definitions on cascade amplifiers	CO 1	T1-1.1 to 1.4
57	Definitions on high frequency response of amplifiers.	CO 3	T1-4.1 to 4.9
58	Definitions on feedback amplifier.	CO 5	T1-7.1 to 7.9 R2-17.1
59	Definitions on oscillators.	CO 5	T1-6.1 to 6.2 R2-19.1
63	Definitions on power amplifiers.	CO 6	T1-9.3 to 9.7
DISCUSSION ON QUESTION BANK			
64	Classification of amplifiers	CO 2	T1-1.1 to 1.4
62	Cascade amplifiers	CO 1	T1-3.1 to 3.9
62	Tuned amplifiers.	CO 2	T1-4.1 to 4.9
62	Feedback amplifiers.	CO 3	T1-5.1 to 5.12
62	Power amplifiers.	CO 4	T1-6.1 to 6.15

Signature of Course Coordinator
Mr. J. Siva Ramakrishna, Assistant 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	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	Analog Communications				
Course Code	AEC005				
Program	B.Tech				
Semester	IV				
Course Type	Core				
Regulation	R-16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Mrs. G.Ajitha, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEC001	III	Electronic Devices and Circuits
B.Tech	AEC003	III	Probability Theory and Stochastic Process

II COURSE OVERVIEW:

Analog communications emphasizes on generation, transmission and reception of audio, video and telephony signals. The course covers representation of signals in time and frequency domain, need of modulation and an effect of noises on the performance of communication systems. Analog communication system principles are used for real world applications of Radio and TV broadcasting systems.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Analog Communications	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 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
60%	Understand
20%	Apply
20%	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).

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 8th and 16th 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.

VI COURSE OBJECTIVES:

The students will try to learn:

I	The skills for analyzing different type's signals in terms of their properties such as energy, power, and correlation and apply for analysis of linear time invariant systems.
II	The generation and detection of Amplitude Modulation (AM), Frequency Modulation (FM), and Phase Modulation (PM) signals.
III	The performance of AM, FM, PM systems in terms of power, bandwidth and SNR (Signal-to-Noise Ratio).

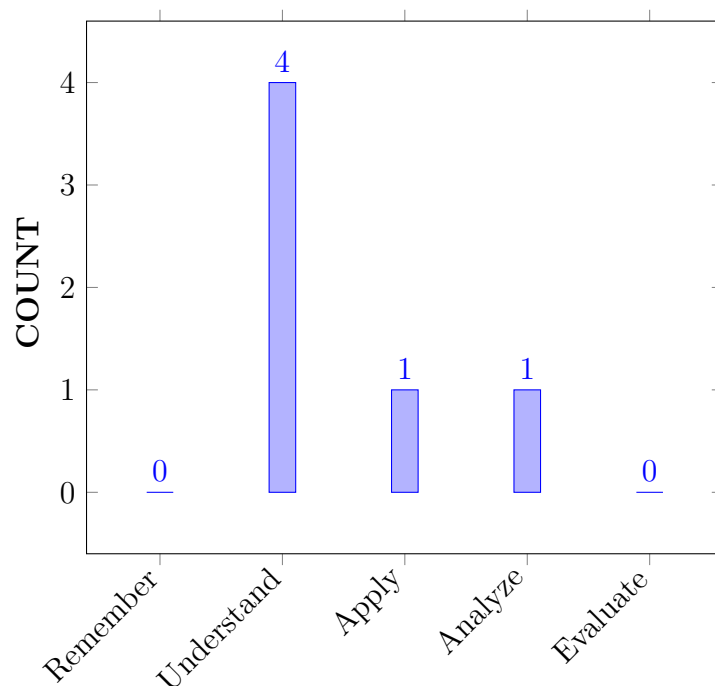
IV	To establish a firm foundation for the understanding of telecommunication systems and evaluate analog communication system in terms of the complexity of the transmitters and receivers.

VII COURSE OUTCOMES:

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

CO 1	Interpret the signals and different mathematical operations, convolution, correlation for analysis of response of LTI system.	Understand
CO 2	Illustrate the basic principles, generation and detection techniques of amplitude modulations for video signal transmission systems.	Understand
CO 3	Outline the generation and detection techniques of frequency modulated waves used for audio signal transmission systems	Understand
CO 4	Compare bandwidth, power requirements, efficiency for AM and FM analog communication systems .	Analyze
CO 5	Make use of the working principles of AM , FM receivers to measure selectivity, sensitivity, fidelity and signal to noise ratio.	Apply
CO 6	Demonstrate the sampling and reconstruction of band limited signals using sampling techniques for digital signal transmission..	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

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

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 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 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:

(COs)	POs / PSOs	Justification for mapping (Students will be able to)	No. of key competencies
CO 1	PO 1	Classify (knowledge) basic signals such as exponential, sinusoidal, impulse, unit step and signum for performing mathematical operations on signals by applying the principles of mathematics, science and engineering fundamentals .	3

	PO 2	Understand the given problem statement and formulate the (complex) engineering problems of convolution and correlation between two signal , translate the information into the graphical form from the provided information and data, develop solutions based on inputs	5
	PO 3	Design convolution and correlation for the customer needs , use creativity , cost constraints and manage design process for the image processing applications with neural networks.	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	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 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
	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	Compare AM and FM analog communication systems and calculate bandwidth, power requirements, efficiency and noise using science and mathematical principles for solving complex engineering problems	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	Design orthogonal modulations schemes required for 5g,6g technologies in terms of bandwidth, power,efficiency for complex Engineering problems and customer needs design system components using creativity by innovative solutions for modern communication technologies	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 5	PO 1	Judge the performance of the working principles and operations of TRF and super heterodyne receivers using mathematics and scientific and engineering methodologies	3
	PO 2	Understand the given problem statement and formulate the (complex) engineering problems of characteristics of a good receiver, translate the information into various parameters from the provided information and data , develop solutions based on inputs	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
	PSO 3	Develop modulator and demodulator for Wired and Wireless Communication Applications.	2
CO 6	PO 1	Understand the sampling theorem for band limited and bandpass signals and reconstruction of samples by filtering methods mathematical principles for solving complex engineering problems.	3

	PO 2	Understand the given problem statement and formulate the (complex) engineering problems of sampling theorem , translate the information into the given parameters from the provided information and data , develop solutions based on inputs	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

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	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	-	-	-	-	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	2	2	2
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	-	-	-	-	100
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
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	-	-	-	-	2
CO 6	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
TOTAL	18	12	4	0	0	0	0	0	0	6	0	0	0	0	8
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	SIGNAL ANALYSIS AND LTI SYSTEMS
	Classification of signals and study of Fourier transforms for standard signals, definition of signal bandwidth; Systems: Definition of system, classification of systems based on properties, linear time invariant system , impulse, step, sinusoidal response of a linear time invariant system, transfer function of a linear time invariant system, distortion less transmission through a linear time invariant system; system bandwidth; Convolution and correlation of signals: Concept of convolution, graphical representation of convolution, properties of convolution; Cross correlation ,auto correlation functions and their properties, comparison between correlation and convolution.

MODULE II	AMPLITUDE AND DOUBLE SIDEBAND SUPPRESSED CARRIER MODULATION
	Introduction to communication system, need for modulation, frequency division multiplexing; Amplitude modulation, definition; Time domain and frequency domain description, single tone modulation, power relations in amplitude modulation waves; Generation of amplitude modulation wave using square law and switching modulators; Detection of amplitude modulation waves using square law and envelope detectors; Double side band modulation: Double side band suppressed carrier time domain and frequency domain description; Generation of double side band suppressed carrier waves using balanced and ring modulators; Coherent detection of double side band suppressed carrier modulated waves; Costas loop; Noise in amplitude modulation, noise in double side band suppressed carrier
MODULE III	SINGLE SIDE BAND MODULATION AND VESTIGIAL SIDE BAND MODULATION
	Frequency domain description, frequency discrimination method for generation of amplitude modulation single side band modulated wave; time domain description; Phase discrimination method for generating amplitude modulation single side band modulated waves; Demodulation of single side band waves. Noise in single side band suppressed carrier; Vestigial side band modulation: Frequency description, generation of vestigial side band modulated wave; Time domain description; Envelope detection of a vestigial side band modulation wave pulse carrier; Comparison of amplitude modulation techniques; applications of different amplitude modulation systems.
MODULE IV	ANGLE MODULATION
	Basic concepts, frequency modulation: Single tone frequency modulation, spectrum analysis of sinusoidal frequency modulation wave, narrow band frequency modulation, wide band frequency modulation, transmission bandwidth of frequency modulation wave, phase modulation, comparison of frequency modulation and phase modulation; Generation of frequency modulation waves, direct frequency modulation and indirect frequency modulation, detection of frequency modulation waves: Balanced frequency discriminator, Foster Seeley discriminator, ratio detector, zero crossing detector, phase locked loop, comparison of frequency modulation and amplitude modulation; Noise in angle modulation system, threshold effect in angle modulation system, pre-emphasis and de-emphasis
MODULE V	RECEIVERS AND SAMPLING THEOREM
	Receivers: Introduction, tuned radio frequency receiver, super heterodyne receiver, radio frequency amplifier, mixer, local oscillator, intermediate frequency amplifier, automatic gain control; Receiver characteristics: Sensitivity, selectivity, image frequency rejection ratio, choice of intermediate frequency, fidelity; Frequency modulation receiver, amplitude limiting, automatic frequency control, comparison with amplitude modulation receiver; Sampling: Sampling theorem, graphical and analytical proof for band limited signals, types of sampling, reconstruction of signal from its samples.

TEXTBOOKS

1. B.P. Lathi, "Signals, Systems and Communications", BS Publications, 5th Edition, 2009.
2. S. S. Haykin, "Communication Systems", Wiley Eastern, 2nd Edition, 2006.
3. 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.

WEB REFERENCES:

1. <https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ee46>

COURSE WEB PAGE:

1. https://lms.iare.ac.in/index?route=course/details&course_id=73

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=73
CONTENT DELIVERY (THEORY)			
2	Introduction to signal and classification of signals.	CO 1	T3 –1.2.4 to 1.4.8
3	Study of Fourier transforms for standard signals	CO 1	TI –1.1 to 2.5
S.No	Topics to be covered	CO's	Reference
4	classification of systems based on properties, linear time invariant	CO 1	T3 –1.1 to 1.1.6
5	Transfer function and response of LTI system	CO 1	T3 –3.2 to 3.3.4
6	Distortion less transmission through a linear time invariant system	CO 1	R1 –3.3, T3- 8.3 to 8.4
7	Concept of convolution and properties of convolution	CO 2	T3 – 3.4

8	Cross correlation ,auto correlation functions and their properties	CO 2	T3 –3.4.1 to3.4.2, T3 –8.2.
9	Comparison between correlation and convolution.	CO 2	T3 –3.5.1 to 3.5.2
10	Introduction to communication system and need for modulation	CO 3	T3 – 4.1 to 4.3.4
11	Time domain and frequency domain description of amplitude modulation	CO 3	T3 -4.4 to 4.4.5, T2 – 2.14
12	Power relations in AM waves	CO 5	T3 –9.1 to 9.5.2
13	Generation of AM waves, square law Modulator, Switching modulator	CO 4	R3 –6.1
14	Detection of AM Waves; Square law detector, Envelope detector	CO 4	R3 –6.2 to 6.4.6
15	Time domain and frequency domain description of DSBSC	CO 3	T2 -6.2 to 6.3
16	Generation of DSBSC Waves, Balanced Modulators, Ring Modulator,	CO 4	T3 – 1.2 to 1.2.3
17	Coherent detection of DSB-SC Modulated waves,	CO 4	T3 –1.2.4 to 1.4.8
18	COSTAS Loop.	CO 4	TI –1.1 to 2.5
19	Time domain and frequency domain description of SSBSC	CO 4	T3 –1.1 to 1.1.6
20	Frequency discrimination method for generation of SSBSC	CO 4	T3 –3.2 to 3.3.4
21	Phase discrimination method for generation of SSBSC	CO 4	R1 –3.3, T3- 8.3 to 8.4
22	Demodulation of SSB Waves	CO 4	T3 – 3.4
23	Time domain and frequency domain description of VSBSC	CO 4	T3 –3.4.1 to3.4.2, T3 –8.2.
24	Generation of VSB Modulated wave	CO 4	T3 –3.5.1 to 3.5.2
25	Envelop detection of a VSB Wave pulse Carrier	CO 4	T3 – 4.1 to 4.3.4
26	Comparison of AM techniques, applications of different AM Systems.	CO 4	T3 -4.4 to 4.4.5, T2 – 2.14

S.No	Topics to be covered	CO's	Reference
27	Frequency modulation basic concepts and Single tone frequency modulation	CO 5	T3 –9.1 to 9.5.2
28	Spectrum Analysis of Sinusoidal FM Wave	CO 5	R3 –6.1
29	Narrow band FM, wide band FM, Constant Average Power.	CO 6	R3 –6.2 to 6.4.6
30	Transmission bandwidth of FM Wave	CO 5	T2 -6.2 to 6.3
31	Generation of FM Waves, Direct FM and indirect FM	CO 6	T3 – 1.2 to 1.2.3
32	Detection of FM waves :Balanced Frequency discriminator ,Phase locked loop	CO 6	T3 –1.2.4 to 1.4.8
33	Noise in AM System	CO 7	TI –1.1 to 2.5
34	Noise in Angle Modulation System	CO 7	T3 –1.1 to 1.1.6
35	Tuned radio frequency receiver,	CO 8	TI –1.1 to 2.5
36	Super hetrodyne receiver, RF section and Characteristics	CO 8	T3 –1.1 to 1.1.6
37	Intermediate frequency, AGC circuits	CO 9	TI –1.1 to 2.5
38	FM receiver, comparison with AM receiver	CO 9	T3 –1.1 to 1.1.6
39	Sampling theorem	CO 10	T3 –3.5.1 to 3.5.2
40	Types of sampling, reconstruction of signal from its samples	CO 10	T3 – 4.1 to 4.3.4
PROBLEM SOLVING/ CASE STUDIES			
41	Fourier transforms for standard signals	CO 1	TI –1.1 to 2.5
42	linear time invariant system	CO 1	TI –1.1 to 2.5
43	Convolution and correlation	CO 2	T3 – 3.4
44	Power, current, voltage relations in AM wave	CO 5	T3 -4.4 to 4.4.5, T2 – 2.14
45	Time domain and frequency domain equations of AM wave	CO 4	R3 –6.2 to 6.4.6
46	Time domain and frequency domain equations of DSBSC.	CO 4	T2 -6.2 to 6.3
47	Time domain and frequency domain equations of SSBSC.	CO 4	T2 -6.2 to 6.3
48	Time domain and frequency domain equations of FM.	CO 6	T3 –9.1 to 9.5.2
49	Bandwidth and power calculation of FM wave	CO 5	R3 –6.1
50	Noise in AM System, DSBSC, SSBSC,FM	CO 7	TI –1.1 to 2.5
51	Super hetrodyne receiver	CO 9	T3 –3.5.1 to 3.5.2
52	Sampling Theorem	CO 10	T3 – 4.1 to 4.3.4

S.No	Topics to be covered	CO's	Reference
DISCUSSION OF DEFINITION AND TERMINOLOGY			
53	Amplitude modulation generation and detection	CO 4	T3 –9.1 to 9.5.2
54	DSBSC ,SSBSC generation and demodulation	CO 4	R3 –6.2 to 6.4.6
55	Angle Modulation	CO 6	T3 –3.5.1 to 3.5.2
56	Receivers	CO 9	T3 – 4.1 to 4.3.4
DISCUSSION OF QUESTION BANK			
57	Amplitude modulation generation and detection	CO 1,2, 3	R4:2.1
58	DSBSC ,SSBSC generation and demodulation	CO 4,11	T4:7.3
59	Angle Modulation	CO 6,7	R4:5.1
60	Receivers	CO 8,11	T1:7.5

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 COMMUNICATIONS ENGINEERING				
Course Title	CONTROL SYSTEMS				
Course Code	AEE009				
Program	B.Tech				
Semester	IV				
Course Type	CORE				
Regulation	R-16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	1.5
Course Coordinator	Ms.L Babitha, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSB11	II	Mathematical Transform Techniques
B.Tech	AEEB11	III	Electrical Machines – I

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 various time and frequency domain analysis. It elaborates the concept of stability and its assessment for linear time invariant systems. This course address the various real time issues and how the control strategies are used in automation areas associates with variety of 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	✓	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
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 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:

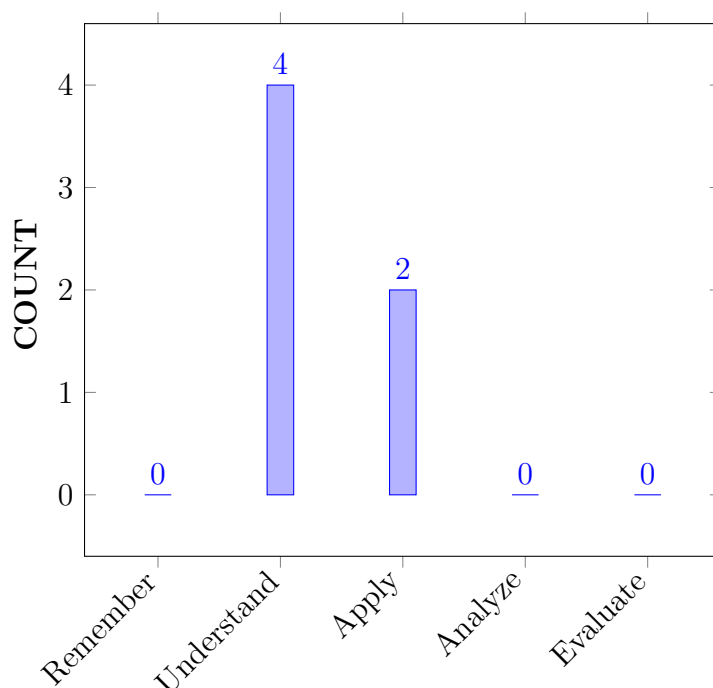
I	The mathematical models of dynamic systems using the concepts of basic sciences.
II	The system performance using time domain and frequency domain analysis for standard inputs.
III	Classification of controllers and compensators as per the desired dynamic response of the system.
IV	The different ways of system representation such as transfer function and state space.

VII COURSE OUTCOMES:

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

CO 1	Relate the different physical and mechanical systems into equivalent electrical analogies using the mathematical form of complex physical systems.	Understand
CO 2	Utilize various reduction techniques for developing the transfer function and steady state error with the standard input signals.	Apply
CO 3	Make use of the time domain analysis to predict transient response specifications for analysing system's stability	Apply
CO 4	Infer the stability of a first and second order systems using frequency domain specifications.	Understand
CO 5	Classify the types of compensators in time domain and frequency domains specifications for increasing the steady state accuracy of the system.	Understand
CO 6	Interpret linear system equations in state-variable form for the analysis of system's dynamic behavior.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

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.	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 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	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.	2	CIE/Quiz/AAT
PO 8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	2	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
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	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	An ability to understand the basic concepts in Electronics and Communication Engineering and to apply them to various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of complex systems.	1	Research Paper / Quiz / AAT
PSO 2	An ability to solve complex Electronics and communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions.	1	Research Paper / Quiz / AAT
PSO 3	An understanding of social-awareness and environmental-wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.	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	Determine the mathematical model of complex systems by analyze complex engineering problems using principles of mathematics and engineering sciences.	7

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 3	Design the equivalent electrical models using force-voltage and force-current analogy by analyze complex engineering problems using principles of mathematics and engineering sciences.	7
	PO 4	Analyze the characteristics of Motors of Field and Armature control by conducting some investigations using technical literature and research based knowledge	5
	PO 6	Understands the concept of open loop and closed loop with examples informed by the contextual knowledge to assess societal engineering practice.	3
	PO 10	Understands the basics of control systems and should be able to communicate effectively on engineering activities	2
	PO 12	Recognize the types of control systems is what we use in daily life through the preparation and ability in personal development.	2
	PSO 3	Understands the operation of open and closed loop control systems to meet the requirements of the employer.	1
CO 2	PO 1	Explain the different complex physical systems with the knowledge of mathematics, science, and engineering fundamentals.	3
	PO 2	Determine the mathematical model of complex systems by analyze complex engineering problems using principles of mathematics and engineering sciences.	6
	PO 3	Design the solution for analyze complex engineering problems using principles of mathematics and engineering sciences.	7
	PO 4	Analyze the behavior of first and second order system with different standard inputs by conducting some investigations using technical literature and research based knowledge	5
	PO 6	Understands the concept of various controllers and how they are applicable to the contextual knowledge to assess societal engineering practice.	3
	PO 8	Knowledge of various controllers ability to use their application to professional ethics and responsibilities and norms of the Engineering practice	3
	PO 10	Understands the basics of controllers and various types of system should be able to communicate effectively on engineering activities	2
	PO 12	Recognize the types of controllers is what we use in daily life through the preparation and ability in personal development.	3
	PSO 1	Design and operate controllers in electrical systems in order to protect the system.	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
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 analyze complex engineering problems using principles of mathematics and engineering sciences.	5
	PO 4	Analyze the nature of stability of the type of system by conducting some investigations using technical literature and research based knowledge	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 concept of time domain analysis and should be able to communicate effectively on engineering activities	2
	PSO 1	Design and operate controllers in electrical systems in order to protect the system.	1
CO 4	PO 1	Understand the concept of frequency response of a system using principles of mathematics, science, and engineering fundamentals.	3
	PO 2	Derive frequency domain specifications and correlation between time and frequency domain framed using basics of mathematics and engineering sciences.	4
	PO 3	Determine the frequency response of a system by analyze complex engineering problems using principles of mathematics and engineering sciences.	7
	PO 4	Analyze the magnitude and phase plot by conducting some investigations using technical literature and research based knowledge	7
	PO 6	Understands the concept of frequency response of a system from the contextual knowledge to assess societal engineering practice.	3
	PO 10	Understands the concept of frequency domain analysis and should be able to communicate effectively on engineering activities	2
	PSO 2	Understands frequency response of a system involving transmission and distribution of Electrical Energy	1
CO 5	PO 1	Understands the concept of compensators and its types using the fundamentals of mathematics, science, and engineering fundamentals.	3
	PO 2	Derive the equation for lead, lag, lead-lag compensators to meet the specifications framed using basics of mathematics and engineering sciences.	5

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 3	Determine the frequency response of a system by analyze complex engineering problems using principles of mathematics and engineering sciences.	7
	PO 4	Analyze the behavior of types of compensators by conducting some investigations using technical literature and research based knowledge	7
	PO 6	Understands the concept of various compensators and how they are applicable to the contextual knowledge to assess societal engineering practice.	2
	PO 8	Knowledge of various compensators ability to use their application to professional ethics and responsibilities and norms of the Engineering practice	3
	PO 10	Understands the basics of compensators and various types of system should be able to communicate effectively on engineering activities	2
	PO 12	Recognize the types of compensators is what we use in daily life through the preparation and ability in personal development.	2
	PSO 1	Design and operate compensators in electrical systems in order to protect the system.	2
	PSO 2	Control the system's power utilization in electrical systems in specific applications of industry and sustainable rural development.	2
CO 6	PO 1	Understands state model of control system using its block diagram using basic knowledge of science and engineering fundamentals.	3
	PO 2	Formulate the state transmission matrix for controllability and observability to evaluate stability of the system framed using basics of mathematics and engineering sciences.	4
	PO 3	Determine the state of stability of a system or a differential linear equation analyze complex engineering problems using principles of mathematics and engineering sciences.	7
	PO 10	Understands the concept of state space analysis and should be able to communicate effectively on engineering activities	2
	PO 6	Understands the concept of state of stability of a system they are application to the contextual knowledge to assess societal engineering practice.	2

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
CO 1	3	7	7	5	-	3	-	-	-	2	-	2	-	-	1
CO 2	3	3	7	5	-	3	-	3	-	2	-	3	2	-	-
CO 3	3	5	5	5	-	3	-	-	-	2	-	-	1	-	-
CO 4	3	4	7	7	-	3	-	-	-	2	-	-	-	1	-
CO 5	3	5	7	7	-	2	-	3	-	2	-	2	2	2	-
CO 6	3	4	7	-	-	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	100	66	9	-	60	-	-	-	20	-	8.3	-	-	14.2
CO 2	100	100	66.7	9	-	60	-	100	-	20.0	-	8.3	40.0	-	-
CO 3	100	100	50	9	-	60	-	-	-	20	-	-	20.0	-	-
CO 4	100	66.7	66.7	100	-	60	-	-	-	20	-	-	-	9.09	-
CO 5	100	66.7	66.7	100	-	40	-	100	-	20.0	-	8.3	40.0	18.2	-
CO 6	100	66.7	66.7	-	-	40	-	-	-	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	2	1	-	2	-	-	-	1	-	1	-	-	1
CO 2	3	3	2	1	-	2	-	1	-	1	-	1	2	-	-
CO 3	3	3	3	1	-	3	-	-	-	1	-	-	1	-	-
CO 4	3	2	2	3	-	3	-	-	-	1	-	-	-	1	-
CO 5	3	2	2	3	-	1	-	1	-	1	-	1	2	2	-
CO 6	3	2	2	-	-	1	-	-	-	1	-	-	-	-	-
TOTAL	18	15	13	9	-	12	-	2	-	6	-	3	5	3	1
AVERAGE	3	2.5	2.0	1.8	-	2	-	1	-	1	-	1	1.5	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:

	Assessment of mini projects by experts	✓	End Semester OBE Feedback

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, AC servomotor, signal flow graph, Mason's gain formula; Time response analysis: Standard test signals, shifted unit step, impulse response, unit step response of first and second order systems, time response specifications, steady state errors and error constants, dynamic error coefficients method, effects of proportional, derivative and proportional derivative, proportional integral and PID controllers.
MODULE III	CONCEPT OF STABILITY AND ROOT LOCUS TECHNIQUE
	Concept of stability: Necessary and sufficient conditions for stability, Routh's and Routh Hurwitz stability criteria and limitations. Root locus technique: Introduction, root locus concept, construction of root loci, graphical determination of 'k' for specified damping ratio, relative stability, 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, calculation of gain margin and phase margin, determination of transfer function, 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, diagonalization, solving the time invariant state equations, state transition matrix and properties, concept of controllability and observability; Compensators: Lag, lead, lead-lag 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

Ms L Babitha, 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 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	Pulse and Digital Circuits				
Course Code	AEC006				
Program	B.Tech				
Semester	IV				
Course Type	Core				
Regulation	R-16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Mr. S Lakshmanachari, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEE002	II	Electrical Circuits
B.Tech	AEC001	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
Pulse and Digital 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
0 %	Remember
50 %	Understand
35 %	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).

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 8th and 16th 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 centre. 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	Be proficient in the use of linear and non linear wave shaping circuits for sinusoidal, pulse and ramp inputs.
II	Construct various multivibrators using transistors and design sweep circuits and sampling gates.
III	Evaluate the methods to achieve frequency synchronization and division using uni-junction transistors, multivibrators and symmetric circuits.

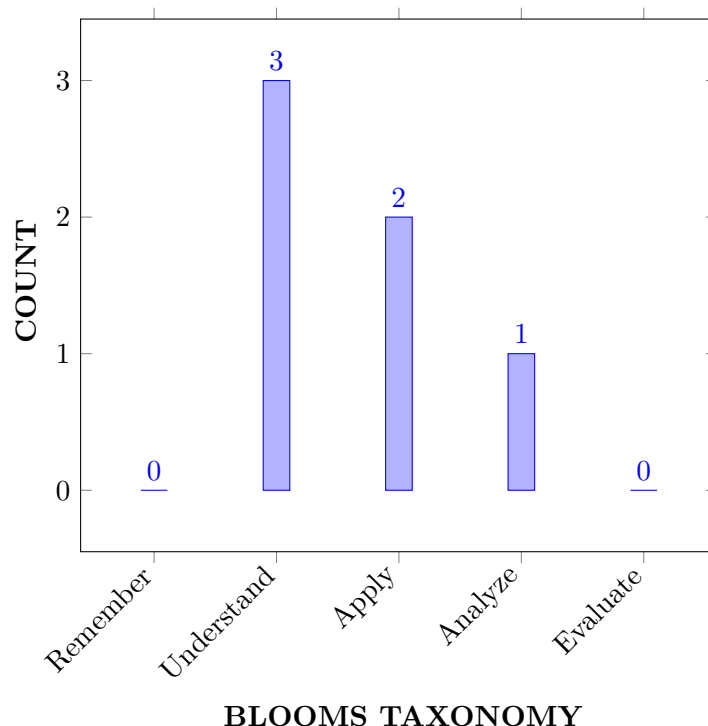
IV	Realize logic gates using diodes and transistors and distinguish between various logic families.

VII COURSE OUTCOMES:

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

CO 1	Analyze the response of linear and non-linear wave shaping circuits for impulse and pulse inputs with different time constants.	Analyze
CO 2	Build bistable, monostable & astable multivibrator circuits using transistors for real time applications.	Apply
CO 3	Apply the operating principles of diodes and transistors for the designing of sampling gates.	Apply
CO 4	Illustrate different methods to generate time base waveforms using Bootstrap and Miller circuits.	Understand
CO 5	Understand the synchronization and frequency division concepts using relaxation devices and sweep circuits.	Understand
CO 6	Summarize the characteristics of digital logic families for designing of digital logic 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.

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
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

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.	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
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	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
	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

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	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 2	PO 1	Design the basic electronic circuits using active transistors by applying mathematics, scientific methodologies 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
	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	Make use of pulse and digital circuits to build embedded software and digital circuit development platform for robotics, embedded systems and signal processing applications.	2
CO 3	PO 1	Demonstrate the working of sampling gates using diodes & transistors and there types by applying the knowledge of mathematics, engineering fundamentals , and an engineering specialization to the solution of complex engineering problems.	2
	PO 2	Understand the problem statement of drawbacks of unidirectional sampling gates then formulate the solution to overcome the drawbacks of unidirectional sampling gates from the provided information and data in reaching substantiated conclusions by the interpretation of results .	5
	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 4	PO 1	Understand different methods to generate time base waveforms using bootstrap and miller circuits by applying the 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 problem statement and formulate methods to generate time base waveforms using bootstrap and miller circuits from the provided information and data in reaching substantiated conclusions by the interpretation of results .	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
CO 5	PO 1	Understand the concept of frequency division, synchronization and pulse synchronization of various relaxation circuits by applying the knowledge of mathematics and engineering fundamentals .	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	2
	PSO 1	Understand the synchronization and frequency division concepts using relaxation devices and sweep circuits for robotics, embedded systems and signal processing applications .	1
CO 6	PO 1	Summarize the characteristics of digital logic families such as propagation delay, fan in, fan out and noise immunity for designing of digital logic circuits by applying the knowledge of engineering fundamentals .	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

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	4	5	-	-	-	-	-	-	2	-	-	-	-	-
CO 2	3	5	5	-	-	-	-	-	-	2	-	-	2	-	-
CO 3	2	5	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 4	2	4	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 5	2	-	-	-	-	-	-	-	-	2	-	-	1	-	-
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	66.6	40	50	-	-	-	-	-	-	40	-		-	-	-
CO 2	100	50	50	-	-	-	-	-	-	40	-	-	100	-	-
CO 3	66.6	50	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 4	66.6	40	-	-	-	-	-	-	-	40	-		-	-	-
CO 5	66.6	-	-	-	-	-	-	-	-	40	-	-	50	-	-
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	-	-	-	-	-	-	1	-		-	-	-
CO 2	3	2	2	-	-	-	-	-	-	1	-	-	3	-	-
CO 3	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	1	-	-	-	-	-	-	-	1	-		-	-	-
CO 5	3	-	-	-	-	-	-	-	-	1	-	-	2	-	-
CO 6	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-
TOTAL	16	6	4	-	-	-	-	-	-	6	-	-	5	-	-
AVERAGE	2.66	1.5	2	-	-	-	-	-	-	1	-	-	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:

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

XVIII SYLLABUS:

MODULE I	WAVE SHAPING CIRCUITS
	Linear wave shaping circuits: High pass RC and low pass RC circuits, response to impulse and pulse inputs with different time constants, high pass RC circuit as a differentiator, low pass RC circuit as an integrator, switching characteristics of diode; Non-linear wave shaping circuits: Clipping circuits, diode clippers, shunt clippers, series clippers, clipping at two independent levels; Clamping circuits: Clamping theorem.
MODULE II	MULTIVIBRATORS
	Multivibrators: Introduction, classification; Bistable multivibrator: Fixed bias, self bias, unsymmetrical triggering, symmetrical triggering; Schmitt trigger: Upper trigger point, lower trigger point, hysteresis, applications of Schmitt trigger; Monostable multivibrator: Collector coupled, triggering of monostable Multivibrator. Astable multivibrator: Collector coupled, voltage to frequency converter.
MODULE III	SAMPLING GATES AND TIME BASE GENERATORS
	Sampling gates: basic operating principle of sampling gate, uni and bi directional sampling gates. Time base generators: General features of a time base signal; Methods of generating a time base waveform: Exponential sweep circuits, sweep circuit using uni junction transistor, Miller sweep circuit and Bootstrap sweep circuit. Bootstrap sweep circuit.
MODULE IV	SYNCHRONIZATION AND FREQUENCY DIVISION
	Synchronization and frequency division: Pulse synchronization of relaxation devices, frequency division with sweep circuits, other astable relaxation circuits, synchronization of astable multivibrator, monostable relaxation circuits as dividers, stability of relaxation dividers; Synchronization of a sweep circuit with symmetrical signals: Sinusoidal synchronization signals and sine wave frequency division with a sweep circuit.
MODULE V	DIGITAL LOGIC FAMILIES
	Bipolar logic families: RTL, DTL, DCTL, HTL, TTL, ECL, MOS, and CMOS logic families, tristate logic; Interfacing of CMOS and TTL families.

TEXT BOOKS

1. Anand Kumar, "Pulse and Digital Circuits, PHI learning", 2nd Edition, 2005.
2. David A. Bell, "Solid State Pulse Circuits", PHI learning, 4th Edition.
3. David J. Comer, "Digital Logic State Machine Design", Oxford University Press, 3rd Edition, 2008.

REFERENCE BOOKS:

1. Ronald J. Tocci, "Fundamentals of Pulse and Digital Circuits", PHI learning, 3rd Edition, 2008.
2. Millman J. Taub, "Pulse, Digital and Switching Waveforms", Tata McGrawHill, 2nd Edition, 2007.

WEB RESOURCES:

1. https://www.iare.ac.in/sites/default/files/Courses_description/PDC%20Discriptior-30012019.pdf

COURSE WEB PAGE:

1. <https://www.iare.ac.in/?q=courses/electronics-and-communication-engineering-autonomous/pulse-and-digital-circuits>

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	Linear wave shaping circuits: Response of high pass RC to step input.	CO 1	T1-1.1 to 1.4
3	Linear wave shaping circuits: Response of high pass RC to square input with different time constants.	CO 1	T1-1.1 to 1.4
4	Responses of low pass RC to step input.	CO 1	T1-1.1 to 1.4
5	Responses of low pass RC to square input with different time constants.	CO 1	T1-1.1 to 1.4
6	High pass RC circuit as a differentiator and low pass RC circuit as an integrator.	CO 1	T1-1.1 to 1.4
7	Switching characteristics of diode; Non-linear wave shaping circuits: shunt clippers.	CO 1	T1-3.1 to 3.3
8	switching characteristics of diode; Non-linear wave shaping circuits: series clippers.	CO 1	T1-3.1 to 3.3
9	Clamping circuits: Clamping theorem.	CO 1	T1-2.2 R2-8.1
10	Classification of multivibrators.	CO 2	T1-4.1
11	Working of Bistable multivibrator.	CO 2	T1-4.2 to 4.9
12	Designing of fixed bias bistable multivibrator.	CO 2	T1-4.2 to 4.9
13	Designing of self bias Bistable multivibrator.	CO 2	T1-4.2 to 4.9
14	Symmetrical and unsymmetrical triggering of Bistable multivibrator.	CO 2	T1-4.2 to 4.9
15	Working of Schmitt trigger.	CO 2	T1- 4.10
16	Upper trigger point, lower trigger point, hysteresis and applications of schmitt trigger.	CO 2	T1- 4.10
17	Design of schmitt trigger.	CO 2	T1-4.11 to 4.14
18	Monostable multivibrator: collector coupled, triggering of monostable multivibrator.	CO 2	T1-4.11 to 4.14
19	Collector coupled Astable multivibrator: voltage to frequency converter.	CO 2	T1-4.15 to 4.17
20	Sampling gates: basic operating principle of sampling gate.	CO 3	T1-4.15 to 4.17
21	Uni-directional sampling gates using diodes.	CO 3	T1-7.1 to 7.9 R2-17.1

S.No	Topics to be covered	CO's	Reference
22	Bi-directional sampling gates using diodes.	CO 3	T1-7.1 to 7.9 R2-17.1
23	Bi-directional sampling gates using transistors.	CO 3	T1-7.1 to 7.9 R2-17.1
24	General features of a time base signal; Methods of generating a time base waveform.	CO 4	T1-5.1 to 5.7
25	Exponential sweep circuits.	CO 4	T1-5.1 to 5.7
26	Sweep circuit using uni junction transistor.	CO 4	T1-5.1 to 5.7
27	Miller sweep circuit.	CO 4	T1-5.1 to 5.7
28	Bootstrap sweep circuit.	CO 4	T1-5.1 to 5.7
29	Pulse synchronization of relaxation devices.	CO 5	T1-6.1 to 6.2 R2-19.1
30	Frequency division with sweep circuits.	CO 5	T1-6.1 to 6.2 R2-19.1
31	Synchronization of astable multivibrator.	CO 5	T1-6.1 to 6.2 R2-19.1
32	Monostable relaxation circuits as dividers.	CO 5	T1-6.1 to 6.2 R2-19.1
33	Stability of relaxation dividers.	CO 5	T1-6.1 to 6.2 R2-19.1
34	Synchronization of a sweep circuit with symmetrical signals.	CO 5	T1-6.3 to 6.5
35	Sinusoidal synchronization signals.	CO 5	T1-6.3 to 6.5
36	Sine wave frequency division with a sweep circuit.	CO 5	T1-6.3 to 6.5
37	Bipolar logic families: RTL, DTL, DCTL.	CO 6	T1-9.3 to 9.7
38	HTL, TTL, ECL.	CO 6	T1-9.3 to 9.7
39	MOS and CMOS logic families.	CO 6	T1-9.3 to 9.7
40	Interfacing of CMOS and TTL families.	CO 6	T1-9.3
PROBLEM SOLVING / CASE STUDIES			
41	Problems on high pass and low pass RC circuits.	CO 1	T1-1.1 to 1.4
42	Problems on shunt and series clipper circuits.	CO 1	T1-2.1
43	Problems on shunt clamper circuits.	CO 1	T1-2.2 R2-8.1
44	Problems on series clamper circuits.	CO 1	T1-2.2 R2-8.1
44	Problems on bootstrap sweep circuit.	CO 4	T1-5.8 to 5.11
45	Problems on Monostable multivibrator.	CO 2	T1-4.11 to 4.14
46	Problems on Miller sweep circuit.	CO 4	T1-5.8 to 5.11
47	Problems on fixed bias and self bias bistable multivibrator.	CO 2	T1-4.1 to 4.9
48	Problems on Astable multivibrator.	CO 2	T1-4.15 to 4.17
49	Problems on schmitt trigger.	CO 2	T1- 4.10
50	Problems on sampling gates.	CO 3	T1-7.1 to 7.9 R2-17.1
DISCUSSION ON DEFINITION AND TERMINOLOGY			
51	Definitions on wave shaping circuits.	CO 1	-
52	Definitions on multivibrators.	CO 2	-

S.No	Topics to be covered	CO's	Reference
53	Definitions on sampling gates and time base generators.	CO 3, CO 4	-
54	Definitions on synchronization and frequency division.	CO 5	-
55	Definitions on digital logic families.	CO 6	-
DISCUSSION ON QUESTION BANK			
56	Wave shaping circuits.	CO 1	-
57	Multivibrators.	CO 2	-
58	Sampling gates and time base generators.	CO 3, CO 4	-
59	Synchronization and frequency division.	CO 5	-
60	Digital logic families.	CO 6	-

Signature of Course Coordinator

HOD, ECE

✓	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).

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 8th and 17th 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.

VI COURSE OBJECTIVES:

The students will try to learn:

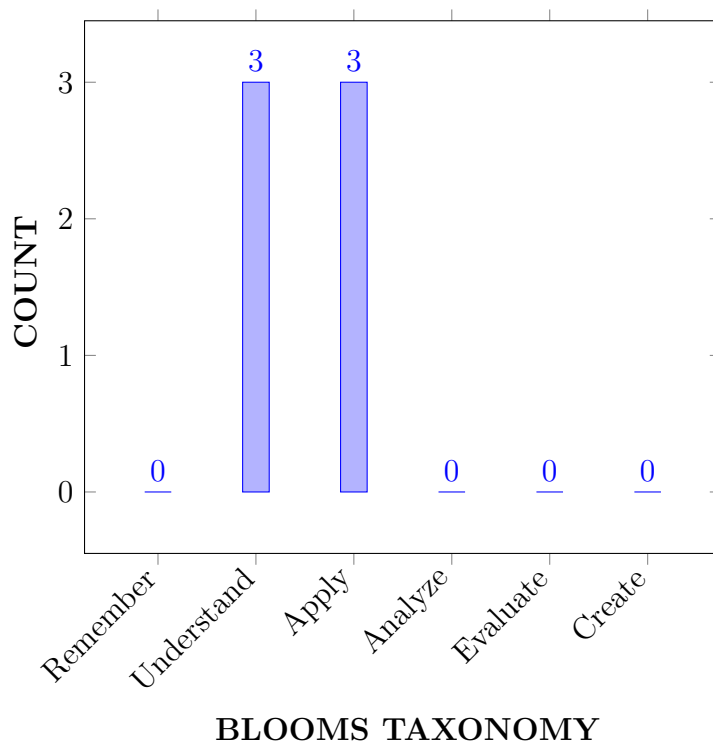
I	The basic concepts required to understand various engineering applications involving electromagnetic fields.
II	The wave propagation characteristics of electromagnetic wave in bounded and unbounded media.
III	The basic theory of transmission lines, appropriate tools (smith chart) to analyze transmission 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	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	-

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	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 using the knowledge of mathematics, Science and engineering fundamentals.	3
	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

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	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
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

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	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% ≤ 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 Z_{min} and Z_{max} ; 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", PHlearning, 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/index?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	Magnetic 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	Inconsistency 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
Ms M Sreevani, Assistant 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	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

ELECTRONICS AND COMMUNICATION ENGINEERING COURSE DESCRIPTION

Course Title	ELECTRONIC CIRCUITS AND PULSE CIRCUITS LABORATORY				
Course Code	AEC102				
Program	B.Tech				
Semester	IV	ECE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	2
Course Coordinator	Mr. S Lakshmanachari, Assistant 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:

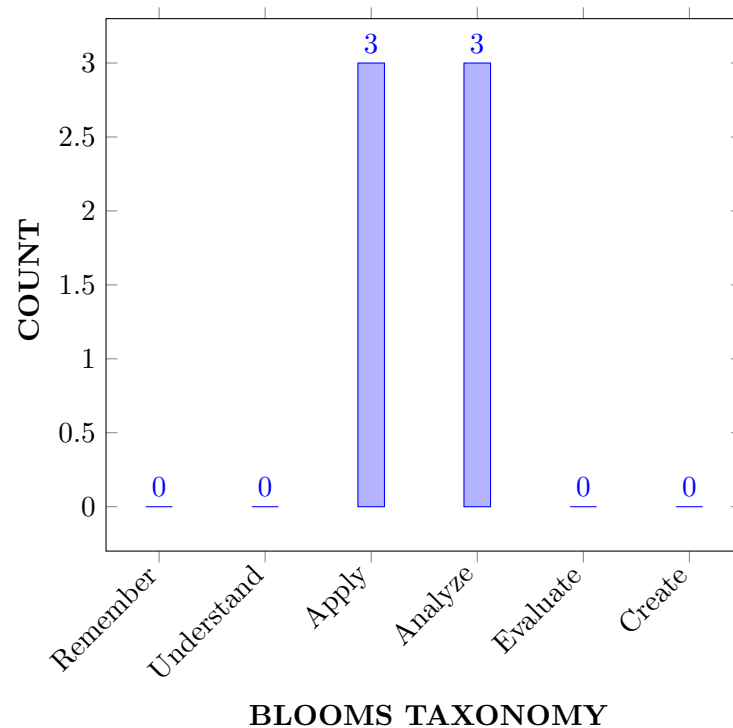
I	The basic amplifier circuits using common emitter and common base configurations.
II	The multivibrator circuits using transistors for real time applications.
III	The principle of oscillation and design of oscillators.
IV	The response of linear and non linear wave shaping circuits for sinusoidal, pulse 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
Mr. S Lakshmanachari, Assistant Professor

HOD,ECE



INSTITUTE OF AERONAUTICAL ENGINEERING (Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTION

Course Title	DIGITAL SYSTEM DESIGN LABORATORY				
Course Code	AEC103				
Program	B.Tech				
Semester	IV	ECE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	2
Course Coordinator	Ms. S Swathi, Assistant Professor				

I COURSE OVERVIEW:

The laboratory strives in exploring the logic design and related fields. Digital logic testers are used to provide students with practical training and familiarize themselves with the various functions of logic gates and using integrated components to complete circuitry functions and develop an interest in digital logic and enlighten them in the abilities of deduction. The lab allows students to conduct actual gate-level experiments on combinational and sequential circuits to increase student interest and develop skills to design digital gates using VHDL.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
B.Tech	AEC002	III	Digital System Design	4

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Digital System Design 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 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.	1	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

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.	2	Lab Experiments / CIE / SEE

3 = High; 2 = Medium; 1 = Low

VIII COURSE OBJECTIVES:

The students will try to learn:

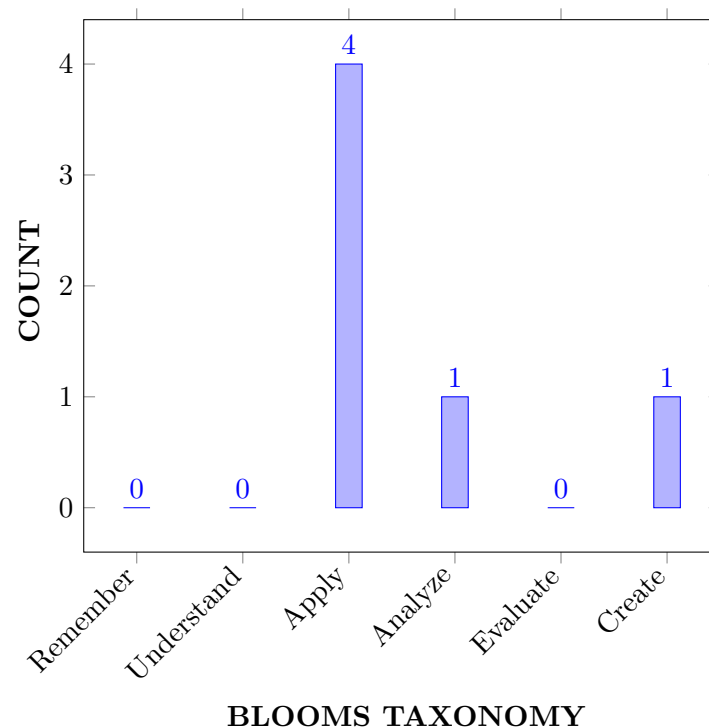
I	Design and simulate the combinational logic circuits using HDL code.
II	Model the sequential circuits and simulate using HDL code.
III	Implementation of basic real time applications and verify the outputs using FPGA.

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	Apply the concept of Boolean algebra to verify the truth table of various 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 SR flip flop, JK flip flop, D flip flop, T flip flops for functional simulation and timing analysis.	analyze
CO 4	Build the universal shift registers, counters using the flip flops..	Apply
CO 5	Examine a finite state machine for detection of sequence.	Apply
CO 6	Design the real time applications like traffic light controller, chess clock controller FSM, elevator operations using FPGA kit.	Create

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	Apply the knowledge of boolean algebra (mathematics, science, engineering fundamentals) to understand the function of logic gates	1
	PO 2	Identify the importance of basic gates in the optimization of conventional Boolean formulas in general and digital circuits	3
	PO 5	Create a program for boolean expressions in VHDL and verify the outputs using the tool.	1
	PO 10	Able to communicate effectively on engineering activities	1
CO 2	PO 1	Understand the knowledge of combinational circuits (mathematics, science, engineering fundamentals) for simulating circuits in data flow, structural and behavioral modelling styles	1
	PO 2	Identify and analyse complex engineering the combinational circuits like adders, encoder/decoders multiplexers/demultiplexers, code converters, ALU (complex engineering problems) using the principles of dataflow, structural, behavioral modelling style (science) and simulate the design to validate the results	5

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 3	Design solutions for combinational circuits(complex engineering problems) like adders, encoder/decoders multiplexers/demultiplexers, code converters, ALU.	3
	PO 5	Simulate the combinational circuits in VHDL using data flow or structural or behavioral models using vivado tool	1
	PO 10	Able to communicate effectively on engineering activities	1
CO 3	PO 2	Analyze(complex engineering) bi-stable elements flip-flops SR flipflop, JK flip flop, D flip dlop, T flip flop and illustrate the excitation tables of different flip flops for memory storage elements.	3
	PO 5	Verify the functional simulation and timing analysis of different outputs using hard description language in Vivado tool .	1
	PO 10	Able to communicate effectively on engineering activities	1
CO 4	PO 1	Apply the knowledge of mathematics, science, engineering fundamentals to design universal shift registers	1
	PO 2	Identify the functionality of (complex engineering problems)to design shift registers and counters using flip flops by applying engineering fundamentals and science	4
	PO 5	Analyze the various flip flops for functional simulation and timing analysis using hard ware description language in Vivado tool .	1
	PO 10	Able to communicate effectively on engineering activities	1
CO 5	PO 2	Illustrate about finite state machine and design FSM for the given sequence by applying principles of mealy/moore machine concepts(science and engineering fundamentals).	3
	PO 3	Design finite state machine(complex engineering problems) using mealey and moore machines which will be used in real time applications.	3
	PO 5	Model the finite state machines and verify functional simulation using hard ware description language in Vivado tool	1
	PO 10	Able to communicate effectively on engineering activities	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PSO 2	Develop the finite state machine by applying the fundamental of mealy and moore models	1
CO 6	PO 2	Identify and formulate for basic real time applications of the digital circuits and design using mathematical principles for solving complex engineering problems	3
	PO 3	Design basic real time applications of the digital circuits like traffic light controller ,chess clock controller, elevator (complex engineering problems)	2
	PO 5	Build the real time applications of digital circuits and simulate using hardware description language in Vivado tool.	1
	PO 9	Function effectively as an apply basic principles to create for apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling the digital circuits lifelong applications such as digital equipment and in many applications where signals are derived from digital circuits	2
	PO 10	Able to communicate effectively on engineering activities	1
	PSO 2	Develop basic real time applications of the digital circuits by applying the fundamental blocks of shift registers.	2

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	1	3	-	-	1	-	-	-	-	1	-	-	-	-	-
CO 2	1	5	3	-	1	-	-	-	-	1	-	-	-	-	-
CO 3	-	3	-	-	1	-	-	-	-	1	-	-	-	-	-
CO 4	1	4	-	-	1	-	-	-	-	1	-	-	-	-	-
CO 5	-	3	3	-	1	-	-	-	-	1	-	-	-	2	-
CO 6	-	4	2	-	1	-	-	-	2	1	-	-	-	2	-

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	33.3	30	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 2	33.3	50	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 3	-	30	30	-	-	-	-	-	-	40	-	-	-	-	-
CO 4	33.3	40	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 5	-	30	30	-	-	-	-	-	-	40	-	-	-	50	-
CO 6	-	40	20	-	-	-	-	-	16	40	-	-	-	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
	1	1	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 1	1	1	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	1	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	-	1	1	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	1	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 5	-	1	1	-	-	-	-	-	-	1	-	-	-	2	-
CO 6	-	2	1	-	-	-	-	-	1	1	-	-	-	2	-
TOTAL	3	9	3	0	0	0	0	0	1	6	0	0	0	4	0
AVERAGE	1	1.5	1	0	0	0	0	0	1	1	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 DIRECT:

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

XVII ASSESSMENT METHODOLOGY INDIRECT:

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

XVIII SYLLABUS:

Week-1	REALIZATION OF A BOOLEAN FUNCTION
	Design and simulate the HDL code to realize three and four variable Boolean functions.
Week-2	DESIGN OF DECODER AND ENCODER
	Design and simulate the HDL code for the following combinational circuits (a) 3 to 8 Decoder 8 to 3 Encoder (With priority and without priority) .
Week-3	DESIGN OF MULTIPLEXER AND DE MULTIPLEXER
	Design and simulate the HDL code for the following combinational circuits (a) Multiplexer (b) De-multiplexer
Week-4	DESIGN OF CODE CONVERTERS
	Design and simulate the HDL code for the following combinational circuits (a) 4- Bit binary to gray code converter (b) 4- Bit gray to binary code converter (c) Comparator
Week-5	FULL ADDER AND FULL SUBTRACTOR DESIGN MODELLING
	Write a HDL code to describe the functions of a full Adder and subtractor Using three modeling styles
Week-6	DESIGN OF 8 BIT ALU
	Design a model to implement 8-bit ALU functionality.
Week-7	HDL MODEL FOR FLIP FLOPS
	Write HDL codes for the flip-flops - SR, D, JK, T Flip flops.
Week-8	DESIGN OF COUNTERS
	Write a HDL code for the following counters (a) Binary counter (b) BCD counter (Synchronous reset and asynchronous reset)
Week-9	HDL CODE FOR UNIVERSAL SHIFT REGISTER.
	Design and simulate the HDL code for universal shift register.
Week-10	HDL CODE FOR CARRY LOOK AHEAD ADDER.
	Design and simulate the HDL code for carry look ahead adder.
Week-11	HDL CODE TO DETECT A SEQUENCE.
	Write a HDL code to detect the sequence 1010101.
Week-12	CHESS CLOCK CONTROLLER FSM USING HDL
	Design a chess clock controller FSM using HDL and simulate the code.
Week-13	TRAFFIC LIGHT CONTROLLER USING HDL
	Design a traffic light controller using HDL and simulate the code.
Week-14	ELEVATOR DESIGN USING HDL CODE.
	Write HDL code to simulate Elevator operations and simulate the code.

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.

Week No	Topics to be covered	CO's	Reference
1	Design and simulate the HDL code to realize three and four variable Boolean functions	CO 1	T1 13.2
2	Design and simulate the HDL code for the following combinational circuits (a) 3 to 8 Decoder (b) 8 to 3 Encoder (With priority and without priority)	CO 2	T1 14.5
3	Design and simulate the HDL code for the following combinational circuits (a) Multiplexer (b) De-multiplexer	CO 2	T1 14.8
4	Design and simulate the HDL code for the following combinational circuits (a) 4- Bit binary to gray code converter (b) 4- Bit gray to binary code converter (c) Comparator	CO 2	T1 15.5 -15.9
5	Write a HDL code to describe the functions of a full Adder and subtractor Using three modeling styles	CO 2	T1 15.17
6	Design a model to implement 8-bit ALU functionality	CO 2	T1 15.16
7	Write HDL codes for the flip-flops - SR, D, JK, T	CO 3	T1 16.1, T1 16.8
8	Write a HDL code for the following counters (a) Binary counter (b) BCD counter (Synchronous reset and asynchronous reset)	CO 4	R1 4.1
9	Design and simulate the HDL code for universal shift register	CO 4	R1 4.2
10	Design and simulate the HDL code for carry look ahead adder	CO 2	R1 4.3
11	Write a HDL code to detect the sequence 1010101	CO 5	R2 4.6
12	Design a traffic light controller using HDL	CO 6	R2 4.10
13	Design a chess clock controller FSM using HDL	CO 6	R2 5.6
14	Write HDL code to simulate Elevator operations	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

Signature of Course Coordinator
Ms. S Swathi, Assistant Professor

HOD,ECE



INSTITUTE OF AERONAUTICAL ENGINEERING (Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	Electronics and Communication Engineering				
Course Title	Integrated Circuits Applications				
Course Code	AEC008				
Program	B.Tech				
Semester	V				
Course Type	Core				
Regulation	R-16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	M Sreevani, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEC001	III	Electronic devices and circuits
B.Tech	AEC002	III	Digital system design
B.Tech	AEC006	IV	Pulse and digital circuits

II COURSE OVERVIEW:

This course introduces the fundamental concepts of operational amplifier, linear and non-linear applications of op-amp and digital Integrated circuits. It focus on process of learning about signal condition, signal generation, instrumentation, timing and control using various IC circuits. It provides the knowledge on comparators, digital IC's for combination and sequential circuit designs and the basis for the next level of course VLSI Design.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Integrated Circuits Applications	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 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
10%	Understand
65%	Apply
10%	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).

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 8th and 17th 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.

VI COURSE OBJECTIVES:

The students will try to learn:

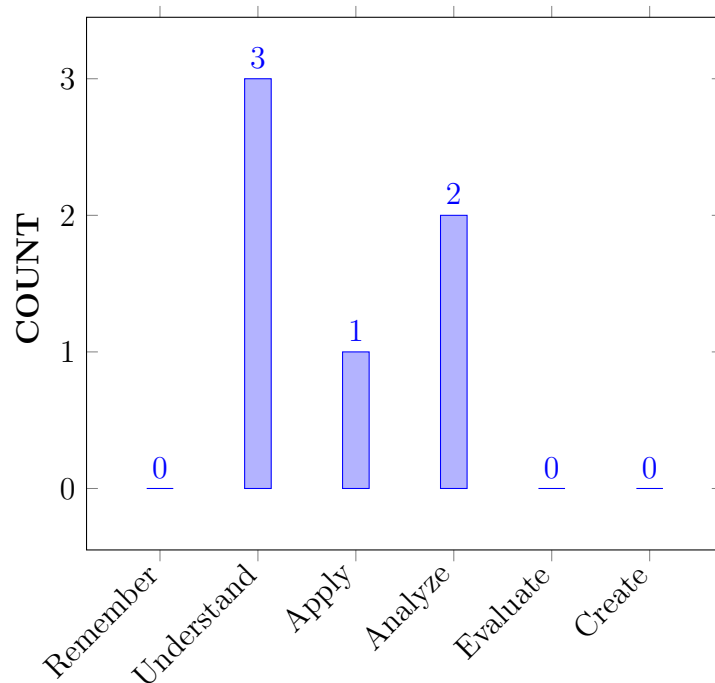
I	The basic building blocks, characteristics and applications of operational amplifier.
II	The functional details of logic families, combinatorial and sequential digital circuits (ICs) used in digital design.
III	Different IC models which are basic for Mixed signal integrated circuits in future.

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 circuits using OPAMP for audio and radio frequency ranges.	Analyze
CO 4	Demonstrate the characteristics, operation and applications of Multi-vibrators using IC555 timer.	Understand
CO 5	Choose an appropriate A/D and D/A converter for signal processing applications.	Apply
CO 6	Analyze the characteristics of sequential and combinational digital integrated circuits for digital circuit design.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

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.	3	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
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 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.
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 10	Speaks orally on basic of opamp characterstics and internal operations of an operational amplifier.	2
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 3	Develop solution to manage data processing and interfacing applications by establishing innovative solutions using data converters .	1
	PO 10	Speaks fluently about the importance of feedback and applications of operational amplifier(Subject matter).	2
	PSO 2	Apply data converters in the field of application specific integrated circuit (ASIC) prototype designs and system on chip (SOC) designs.	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

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies matched.
	PO 3	Develop phase locked loop circuit, based on customer needs for design of tuners, local oscillator, FM modulators and evaluate outcomes of the designs.	2
	PO 10	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.	2
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 3	Develop solution to manage data processing and interfacing applications by establishing innovative solutions using data converters .	1
	PO 10	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.	2
	PSO 2	Apply data converters in the field of application specific integrated circuit (ASIC) prototype designs and system on chip (SOC) designs.	2
CO 5	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

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies matched.
	PO 10	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.	2
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
	PO 3	Design solutions for complex engineering problems such as digital system by doing innovative solution and implementing them using modern tools.	3
	PO 10	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.	2
	PSO 2	Design various digital circuits in application specific integrated circuit (ASIC) and 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	1	-	-	-	-	-	-	2	-	-	-	2	-
CO 3	2	4	2	-	-	-	-	-	-	2	-	-	-	-	-
CO 4	2	7	1	-	-	-	-	-	-	2	-	-	-	2	-
CO 5	2	7	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 6	2	7	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	2	2	2
CO 1	66.7	70	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 2	66.7	70	10	-	-	-	-	-	-	40	-	-	-	100	-
CO 3	66.7	40	20	-	-	-	-	-	-	40	-	-	-	-	-
CO 4	66.7	70	10	-	-	-	-	-	-	40	-	-	-	100	-
CO 5	66.7	70	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 6	66.7	70	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
	3	3	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 1	3	3	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	3	-	-	-	-	-	-	-	1	-	-	-	2	-
CO 3	3	2	1	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	3	1	-	-	-	-	-	-	1	-	-	-	2	-
CO 5	3	3	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	3	3	1	-	-	-	-	-	-	1	-	-	-	2	-
TOTAL	18	17	3	0	0	0	0	0	0	6	0	0	0	6	0
AVERAGE	3	2.83	1	0	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	INTEGRATED CIRCUITS
	Integrated Circuits: Classification of integrated circuits, Package types and temperature ranges; Differential Amplifier: DC and AC analysis of Dual input Balanced output Configuration; Properties of differential amplifier configuration: Dual Input Unbalanced Output, Single Ended Input, Balanced/ Unbalanced Output; DC Coupling and Cascade Differential Amplifier Stages, Level translator. Characteristics of OP-Amps: Op-amp Block Diagram, ideal and practical Op-amp specifications, DC and AC characteristics, 741 op-amp and its features; Op-Amp parameters and Measurement: Input and Output Off set voltages and currents, slew rate, CMRR, PSRR, and Drift.
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, multivibrators, triangular and square wave generators, non- linear function generation, log and anti-log amplifiers.
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, monostable, 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, R-2R ladder DAC, inverted R-2R DAC, and IC 1408 DAC, DAC characteristics; ADC techniques: Integrating, successive approximation, flash converters, A/D characteristics.
MODULE V	DIGITAL IC APPLICATIONS
	Combinational Design Using TTL/ CMOS ICs: Logic delays, TTL/CMOS interfacing, adders, multiplexer, demultiplexer, decoder, encoder; Sequential design using TTL/ CMOS ICs: SR, JK, T, and D flip-flops; Counters: Synchronous and asynchronous counters, decade counter; Registers: Shift registers, universal shift register, Ring counters and Johnson counters.

TEXTBOOKS:

1. D. Roy Chowdhury, "Linear Integrated Circuits", New age international (p) Ltd, 2nd Edition, 2003.
2. Ramakanth A. Gayakwad, "Op-amps and 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.
2. S P Bali — Linear Integrated Circuits, TMH, 1st Edition, 2008.

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=493

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=493
CONTENT DELIVERY (THEORY)			
2	Introduction to Integrated Circuits (ICs)	CO1	T1:2.2 T2:1.2-1.7
3	Basics of operational amplifier	CO1	T1:2.5 R1:3.4
4	Differential amplifier	CO1	T1:2.4
5	DC analysis of differential amplifier	CO1	T2:1.12- 1.13
6	AC analysis of differential amplifier	CO1	T1:3.2
7	Characteristics of Op-amps	CO1	T1:3.3-3.4
8	Level shifter circuit	CO1	T1:2.3 R2:12.7
9	Linear applications of op-amps	CO2	T1:11.1-11.5
10	Non-linear applications of op-Amps:1	CO2	T1:4.8
11	Non-linear applications of op-Amps:2	CO2	T1:7.2
12	Active filters-1	CO3	T2:10.4 R2:7.2
13	Active filters-2	CO3	T1:8.2-8.5
14	Timers	CO4	T1:9.2-9.7
15	555 Timer	CO4	T1:10.1
16	Phase Locked Loop (565 PLL)	CO4	T1:10.2
17	Data converters	CO5	T1:10.3 R2:5.4
18	DAC techniques	CO5	T3:3.12 R2:12.7
19	ADC techniques	CO5	T3:7.2
20	Data converter characteristics.	CO5	T3:8.4
21	Logic families	CO6	T1:2.2 T2:1.2-1.7
22	Logic families characteristics-1	CO6	T1:2.5 R1:3.4
23	Logic families characteristics-2	CO6	T1:2.4
24	Resistor Transistor Logic (RTL)	CO6	T2:1.12-1.13
25	Diode Transistor Logic (DTL)	CO6	T1:3.2
26	High Threshold Logic (HTL) Family	CO6	T1:3.3-3.4

27	Transistor -Transistor Logic (TTL) tristate logic	CO6	T1:2.3 R2:12.7
28	Emitter Coupled Logic (ECL) family	CO6	T1:11.1- 11.5
29	CMOS logic family	CO6	T1:4.8
30	CMOS NAND and NOR Gates	CO6	T1:7.2
31	CMOS combinational circuits	CO6	T1:7.2
32	CMOS sequential circuits	CO6	T2:10.4 R2:7.2
33	CMOS sequential circuits	CO6	T1:8.2-8.5
34	CMOS 40XX series ICs	CO6	T1:9.2-9.7
35	IC 7473, IC 7474.	CO6	T1:10.1
36	IC 74194.	CO6	T1:10.2
37	IC 74LS93, IC 74HC163.	CO6	T1:10.3 R2:5.4
38	IC 74HC190	CO6	T3:3.12 R2:12.7
39	Asynchronous up/down counter	CO6	T3:7.2
40	3 Bit UP/DOWN ripple counter	CO6	T3:8.4
41	4 Bit UP/DOWN ripple counter	CO6	T3:8.4
PROBLEM SOLVING/ CASE STUDIES			
42	Problems on Differential amplifier	CO1	T1:2.2 T2:1.2-1.7
43	Problems on AC analysis of differential amplifier	CO1	T1:2.5 R1:3.4
44	Problems on DC analysis of differential amplifier	CO1	T1:2.4
45	Problems on Operational amplifier	CO1	T2:1.12- 1.13
46	Problems on Characteristics of op-amps	CO1	T1:3.2
47	Problems on Linear applications of op-amps	CO2	T1:3.3-3.4
48	Problems on Non-linear applications of op-Amps	CO2	T1:2.3 R2:12.7
49	Problems on Active filters-1	CO3	T1:11.1-11.5
50	Problems on Active filters-2	CO3	T1:4.8
51	Problems on Timers	CO4	T1:7.2
52	Problems on 555 Timer	CO4	T1:7.2
53	Problems on Data converters	CO5	T2:10.4 R2:7.2
54	Problems on CMOS circuit for a Boolean function.	CO6	T1:9.2-9.7
55	Problems on Sequential circuits using IC 7474	CO6	T1:10.1
DISCUSSION ON DEFINITION AND TERMINOLOGY			
56	Amplifier characteristics: input offset voltage. input offset current, CMRR and slew rate of an op-amp.	CO1	T1:2.2 T2:1.2-1.7
57	Voltage Controlled Oscillator (VCO).	CO4	T1:2.5 R1:3.4
58	Define power supply rejection ratio	CO1	T1:2.4
59	Define frequency response.	CO3	T2:1.12-1.13
60	Define threshold voltage and hysteresis.	CO4	T1:3.2
DISCUSSION ON QUESTION BANK			
61	Derive the output voltage of an op-amp based differential amplifier.	CO1	T1:2.2 T2:1.2-1.7
62	Derive the gain expression for inverting operational amplifier and non-inverting operational amplifier.	CO2	T1:2.5 R1:3.4

63	Explain the operation of astable multivibrator using op amp and derive the expression for frequency of oscillations.	CO4	T1:2.4
64	Explain in brief the principle of operation of successive approximation ADC.	CO5	T2:1.12-1.13
65	Implement BCD to 7 segment display decoder using common cathode using 4:16 decoder.	CO6	T1:3.2

Signature of Course Coordinator
M Sreevani, Assistant 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



INSTITUTE OF AERONAUTICAL ENGINEERING (Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	Electronics and Communication Engineering				
Course Title	Digital Communications				
Course Code	AEC009				
Program	B.Tech				
Semester	V				
Course Type	Core				
Regulation	R-16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Mr G. Kiran Kumar, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEC003	IV	Probability Theory and Stochastic Process
B.Tech	AEC005	V	Analog Communications

II COURSE OVERVIEW:

This course provides the constructional features of digital communication systems, coding and decoding algorithms. It intended to provide the various digital modulation and demodulation techniques for wired and wireless data transmission. Analytical skills to configure secure digital communications for signal and image processing applications.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Digital Communications	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
0%	Remember
33%	Understand
50%	Apply
17%	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).

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 8th and 17th 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.

VI COURSE OBJECTIVES:

The students will try to learn:

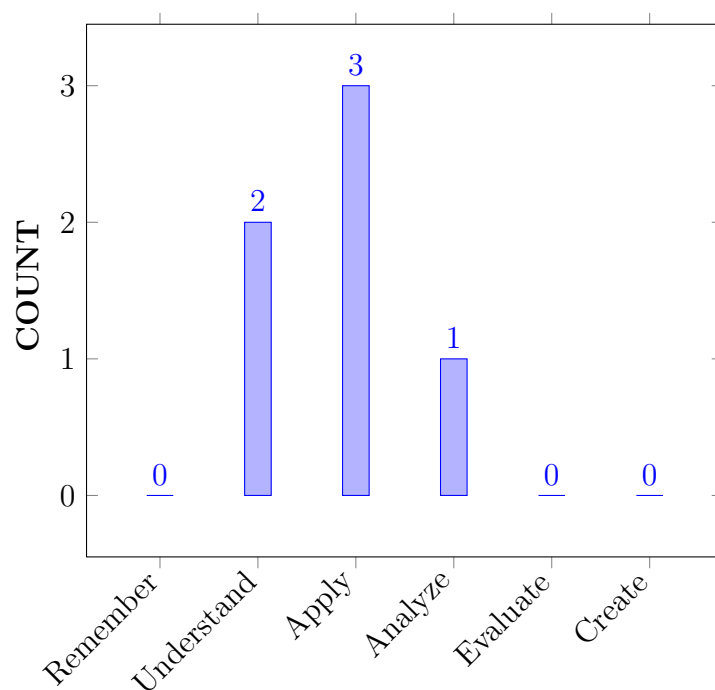
I	The building blocks of digital communication systems such as source coding, channel coding and modulators.
II	The error performance of digital communication system in the presence of noise and other interferences.
III	The applications of spread spectrum techniques in secured digital communication systems.

VII COURSE OUTCOMES:

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

CO 1	Outline the concepts of pulse modulation techniques for binary codeword data.	Understand
CO 2	Identify the pass band data transmission model for digital modulation and demodulation techniques.	Apply
CO 3	Summarize pulse shaping of line codes to mitigate inter symbol interference, cross talk.	Understand
CO 4	Apply information theory and source coding techniques to increase coding efficiency.	Apply
CO 5	Analyze encoding and decoding algorithms for error detection and error corrections in digital communications.	Analyze
CO 6	Build convolutional encoders by using time domain approach and graphical approach.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

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 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	✓	✓	✓	-	-	-	-	-	-	✓	-	-	-	-	✓

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	✓	-	✓	-	-	-	-	-	-	✓	-	-	-	-	-

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 concept of conventional digital communication system and understand various types of pulse analog and digital modulation techniques for signals analysis by applying the principles of mathematics, science, and engineering fundamentals .	3
	PO 2	Understand binary code words (problem statement) and formulate transmission bandwidth problems related to pulse code modulation and delta modulations for the implementation (Solution development) differential pulse code modulation from the provided information and substantiate with the interpretation of variations in the results.	5
	PO 10	Effective presentation and speaking style on the concept of pulse code modulation, demodulation, sampling, quantization and coding (understand) and write subject matter effectively on coding mathematics for obtaining of digital data.	2
CO 2	PO 1	Interpret the process of data transmission in communication systems by applying (mathematics, science) and principles of engineering fundamentals	3
	PO 2	Identify digital modulation techniques (problem statement) and apply formulation to the transmission model 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 (knowledge) on the concept of pulse code modulation, demodulation, sampling, quantization and coding (understand) the pulse digital modulation and demodulation techniques and write subject matter effectively and using signal space diagrams.	2
	PSO 3	Make use of pass band modulation schemes compare signal to noise and figure of merit for wired and wireless communication applications.	1
CO 3	PO 1	Understand various line encoding formats for data transmission of a digital signal over a transmission line by applying the principles of mathematics, science, engineering fundamentals	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 3	Identify inter-symbol interference and cross talk problem in baseband transmission and design pulse shaping filters to reduce inter-symbol interference by identifying cost requirements for innovative solutions .	4
	PO 10	Effective presentation and speaking style (knowledge) on the pulse shaping of line codes to mitigate inter symbol interference, cross talk and write subject matter effectively on cross talk and using optimum filter, raised cosine filters.	2
CO 4	PO 1	Outline average information content in a given messages by applying the principles of mathematics, science, engineering fundamentals	3
	PO 2	Analyze the tradeoff between bandwidth and signal to noise ratio (problem statement) of various communication channels and calculate (formulation) coding efficiency and implement (solution development) source coding techniques from the provided information and substantiate with the interpretation of variations in the results.	5
	PO 3	Develop fixed length and variable length coding procedures (identify) and understand the performance of channels 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 (knowledge) on the concept of information theory, source coding techniques and write subject matter effectively and for average information content in a message.	2
	PSO 3	Understand narrow band and wide band spread spectrum models for wired and wireless communication applications.	1
CO 5	PO 1	Understand error detection and error correction capabilities of linear block codes and convolutional codes by applying the principles of mathematics, science, engineering fundamentals	3
	PO 2	Analyze generator matrix (problem statement) and formulate check bit vectors to implement code vectors from the provided information to interpretation of the results.	5
	PO 3	Make use of syndrome decoding algorithm identify Transmitted and received code vectors for error syndrome to calculate single and multiple bit errors 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

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 (knowledge) on various spread spectrum techniques and write subject matter effectively and in terms of Frequency hopping	2
	PSO 3	Develop error control codes in wired and wireless communication applications.	1
CO 6	PO 1	Understand Understand binary convolutional codes for smaller block of data storage by applying the principles of mathematics, science, engineering fundamentals	3
	PO 3	Construct convolutional encoders(design) and develop state diagram, tree diagram and code trellis diagram to get constraint length and code rate for the representation of system behavior 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 (knowledge) on the error detection and error correction technique technique and write subject matter effectively on and for digital transmission in noisy environment.	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	3	5	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 2	3	5	-	-	-	-	-	-	-	2	-	-	-	-	1
CO 3	3	-	4	-	-	-	-	-	-	2	-	-	-	-	-
CO 4	3	5	5	-	-	-	-	-	-	2	-	-	-	-	1
CO 5	3	5	5	-	-	-	-	-	-	2	-	-	-	-	1
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
CO 1	100	50	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 2	100	50	-	-	-	-	-	-	-	40	-	-	-	-	50
CO 3	100	-	40	-	-	-	-	-	-	40	-	-	-	-	-
CO 4	100	50	50	-	-	-	-	-	-	40	-	-	-	-	50

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	100	50	50	-	-	-	-	-	-	40	-	-	-	-	50
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
CO 1	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	1	-	-	-	-	2
CO 3	3	-	2	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	2	2	-	-	-	-	-	-	1	-	-	-	-	2
CO 5	3	2	2	-	-	-	-	-	-	1	-	-	-	-	2
CO 6	3	-	2	-	-	-	-	-	-	1	-	-	-	-	-
TOTAL	18	8	8	0	0	0	0	0	0	6	0	0	0	0	6
AVERAGE	3	2	2	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	PULSE DIGITAL MODULATION
	Pulse modulation: analog pulse modulation, types of pulse modulation; pulse amplitude modulation (single polarity, double polarity); generation and demodulation of pulse width modulation; generation and demodulation of pulse position modulation. Introduction: elements of digital communication systems, advantages and disadvantages of digital communication systems, applications. pulse digital modulation: elements of pulse code modulation: sampling, quantization and coding; quantization error, non-uniform quantization and companding; differential pulse code modulation, adaptive differential pulse code modulation; delta modulation and its drawbacks; adaptive delta modulation; comparison of pulse code modulation and delta modulation systems; noise in pulse code modulation and delta modulation systems.
MODULE II	DIGITAL MODULATION TECHNIQUES
	Digital Modulation Techniques: Introduction, amplitude shift keying modulator, coherent amplitude shift keying detector, non-coherent amplitude shift keying detector, frequency shift keying, bandwidth and frequency spectrum of frequency shift keying, non-coherent frequency shift keying detector, coherent frequency shift keying detector; phase shift keying, coherent phase shift keying detection. optimal reception of digital signal: baseband signal receiver; probability of error; optimum filter; matched filter, probability of error using matched filter; calculation of probability of error for amplitude shift keying, frequency shift keying, phase shift keying.
MODULE III	BASE BAND TRANSMISSION AND PULSE SHAPING
	Base band transmission: requirements of a line-encoding format, various line encoding formats: unipolar, polar, bipolar; scrambling techniques: BZ8S, HDB3, computation of power spectral densities of various line encoding formats. pulse shaping: inter symbol interference; pulse shaping to reduce inter symbol interference; nyquist criterion; raised cosine filter; equalization; correlative level coding; duo-binary encoding, modified duo –binary coding; Eye diagrams for amplitude shift keying, frequency shift keying; cross talk.
MODULE IV	INFORMATION THEORY AND SOURCE CODING
	Information theory: information, entropy, conditional entropy; mutual information; channel capacity; various mathematical modeling of communication channels and their capacities; hartley shannon law; tradeoff between bandwidth and s/n ratio. source coding: fixed length and variable length source coding schemes, huffman coding; source coding to increase average information per bit; lossy source coding. spread spectrum modulation: use of spread spectrum; direct sequence spread spectrum ; code division multiple access using direct sequence spread spectrum, frequency hopping spread spectrum; pn-sequences: generation and characteristics; synchronization in spread spectrum systems

MODULE V	LINEAR BLOCK CODES AND CONVOLUTION CODES
	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, syndrome calculation and decoding. convolution codes: introduction, encoding of convolution codes; time domain approach; transform domain approach; general approach; state, tree and trellis diagram; decoding using viterbi algorithm; burst error correction: block interleaving and convolution interleaving.

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. John Proakis, “Digital Communications”, TMH, 2nd Edition 1983.
2. B.P.Lathi, “Modern Analog and Digital Communication”, Oxford reprint, 3rd Edition, 2004.
3. Singh, Sapre, “Communication Systems Analog and Digital”, TMH, 2nd Edition, 2004.

WEB REFERENCES:

1. <http://www.igniteengineers.com>
2. <http://www.ocw.nthu.edu.tw>

COURSE WEB PAGE:

1. <https://www.iare.ac.in/?q=courses/electronics-and-communication-engineering-autonomous/digital-communications>

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=188
CONTENT DELIVERY (THEORY)			
2	Pulse modulation, generation demodulation of pulse amplitude modulation	CO 1	T1-5.2 to 5.3
3	Generation demodulation of pulse width modulation, pulse position modulation	CO 1	T1-5.4 to 5.5
4	Elements of digital communication system	CO 1	T1-5.5 to 5.8

5	Pulse code modulation generation and detection.	CO 1	T1-5.8 to 5.9
6	Quantization and companding	CO 1	T1-5.11 to 5.12
9	Differential pulse code modulation generation and detection, adaptive differential pulse code modulation generation and detection	CO 1	T1-5.14 to 5.15
10	Delta modulation, adaptive delta modulation	CO 1	T1-5.16 to 5.16
11	Comparison of pulse code modulation and delta modulation, noise in pulse code modulation and delta modulation systems.	CO 1	T1-5.16 to 5.16
12	Digital modulation techniques ,amplitude shift keying modulator, detector	CO 2	T1-6.1 to 6.3
13	Frequency shift keying modulation and demodulation	CO 2	T1-6.8 to 6.9
15	Binary phase shift keying generation and detection, quadrature phase shift keying modulation and demodulation.	CO 3	T1-6.2 to 6.3
16	Differential phase shift keying transmitter and receiver , differentially encoded phase-shift keying,	CO 2	T1-6.3 to 6.4
18	Optimal reception of digital signal, baseband signal receiver;	CO 2	T1-11.1
19	Probability of error, optimum filter, matched filter	CO 2	T1-11.2 to 11.3
20	Calculation of probability of error for amplitude shift keying modulator.	CO 2	T1-11.2 to 11.3
CONTENT DELIVERY (THEORY)			
21	Calculation of probability of error for frequency shift keying modulation, binary phase shift keying modulation.	CO 2	T1-11.9 to 11.10
22	Requirements of a line encoding format, unipolar, polar coding.	CO 3	R2-7.1 to 7.2
23	Scrambling techniques, binary 8-zero substitution, high-density bipolar order 3.	CO 3	R2-7.4
25	Inter symbol interference, pulse shaping to reduce inter symbol interference	CO 3	R2-7.3
26	Nyquist's criterion, raised cosine filter, equalization;	CO 3	R2-7.3.1 to 7.3.2
27	Duo-binary encoding, modified duo binary coding	CO 3	R2-7.3.3 to 7.3.6
28	Eye diagrams, cross talk.	CO 3	R2-7.6
29	Information theory, entropy, types of entropies	CO 4	T1-13.1 to 13.3
30	Mutual information, channel capacity	CO 4	T1-13.1 to 13.3
32	Fixed length and variable length source coding schemes	CO 4	T1-13.5 to 13.6
33	Huffman coding.	CO 4	T1-13.6 to 13.7
34	Shannon fano coding	CO 4	T1-13.7 to 13.9
37	Lossy source coding, channel coding theorem, hartley shannon law, trade-off between bandwidth and signal to noise ratio.	CO 4	T1-13.8

39	Spread spectrum modulation, direct sequence spread spectrum , frequency-hopping spread spectrum	CO 9	T1-17.1 to 17.2
40	Code division multiple access using direct sequence spread spectrum	CO 4	T1-17.3 to 17.4
41	PN-sequences, generation and characteristics, synchronization in spread spectrum systems.	CO 4	T1-17.6 to 17.7
42	Error control coding, linear block codes	CO 5	T1-13.11
44	Matrix description of linear block codes	CO 5	T1-13.12
45	Error detection and error correction capabilities of linear block codes	CO 5	T1-13.13
46	Hamming codes.	CO 5	T1-13.14
48	Cyclic codes, syndrome calculation	CO 5	T1-13.16 to 13.18
50	Convolution codes	CO 6	T1-13.19
52	Time domain approach; transform domain approach	CO 6	T1-13.19
53	State diagram , tree diagram	CO 6	T1-13.20
54	Trellis diagram, Viterbi algorithm	CO 6	T1-13.20
PROBLEM SOLVING/ CASE STUDIES			
7	Problems on pulse code modulation and delta modulation	CO 2	T1-5.8 to 5.9
8	Problems on sampling, quantization	CO 2	T1-5.5 to 5.8
14	Problems on frequency shift keying	CO 2	T1-6.8 to 6.9
17	Problems on phase shift keying	CO 2	T1-6.2 to 6.3
24	Problems on line coding formats	CO 3	R2-7.1 to 7.2
31	Problems on the entropy of the source	CO 4	T1-13.1 to 13.3
35	Problems on source coding schemes	CO 4	T1-13.5 to 13.6
36	Problems on Huffman coding schemes	CO 4	T1-13.6 to 13.7
38	Problems on mutual information	CO 4	T1-13.1 to 13.3
43	Problems on linear block codes	CO 5	T1-13.13
47	Problems on hamming codes	CO 5	T1-13.16 to 13.18
49	Problems on syndrome decoding	CO 5	T1-13.14
51	Problems on cyclic codes	CO 6	T1-13.16 to 13.18
55	Problems on convolutional codes	CO 6	T1-13.19
56	Problems on tree diagram, trellis diagram.	CO 6	T1-13.20
DISCUSSION ON DEFINITION AND TERMINOLOGY			
57	Definitions on pulse digital modulation	CO 1	T1-5.1 to 5.3
58	Definitions on digital modulation techniques	CO 2	T1-6.1 to 6.3
59	Definitions on base band transmission and pulse shaping	CO 3	R2-7.1 to 7.2
60	Definitions on information theory and source coding	CO 4	T1-13.1 to 13.3
61	Definitions on linear block codes and convolution codes	CO 5	T1-13.11

DISCUSSION ON QUESTION BANK			
62	Pulse digital modulation	CO 1	T1-5.1 to 5.3
63	Digital modulation techniques	CO 2	T1-6.1 to 6.3
64	Base band transmission and pulse shaping	CO 3	R2-7.1 to 7.2
65	Information theory and source coding	CO 4	T1-13.1 to 13.3
66	Linear block codes and convolution codes	CO 5	T1-13.11

Course Coordinator
Mr G.Kiran Kumar, Assistant Professor

HOD,ECE

ANNEXURE - I

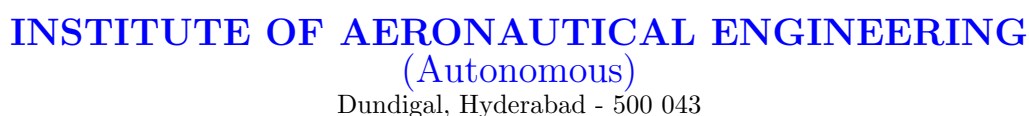
KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

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	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



Department	Electronics and Communication Engineering				
Course Title	Antennas and Propagation				
Course Code	AEC011				
Program	B.Tech				
Semester	V				
Course Type	Core				
Regulation	R-16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Dr V. Kishen Ajay Kumar, Associate Professor				

Level	Course Code	Semester	Prerequisites
B.Tech	AEC007	IV	Electromagnetic Theory and Transmission Lines

Antennas have become increasingly important to our society until now they are indispensable. This course will cover the fundamentals of antenna, concepts of antenna wave propagation, antenna theory, design and measurements and radiation phenomenon of various Very high frequency (VHF), Ultra high frequency (UHF) and Microwave antennas. Antennas are used in numerous applications to determine the range of a wireless RF or microwave system. Antennas are also used near the ocean's surface with higher data rate systems such as satellite communication systems.

Subject	SEE Examination	CIE Examination	Total Marks
Antennas and Propagation	70 Marks	30 Marks	100

✓	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
45	Understand
18	Apply
27	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 8th and 17th 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.

VI COURSE OBJECTIVES:

The students will try to learn:

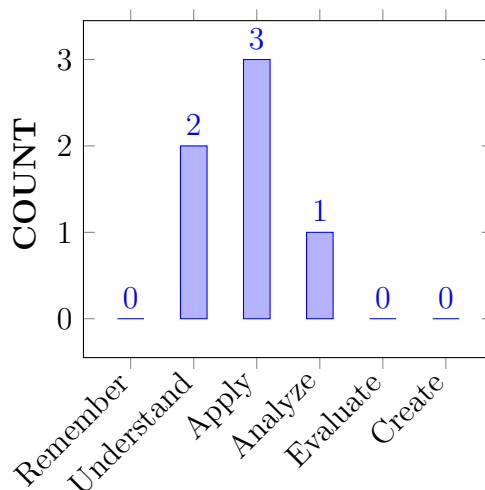
I	The radiation phenomena associated with various types of antennas and understand basic terminology and concepts of antennas along with emphasis on their applications.
II	Analyze the electric and magnetic field emission from various basic antennas with mathematical formulation of the analysis.
III	Explain radiation mechanism of different types of antennas and their usage in real time field.
IV	Justify the propagation of the waves at different frequencies through different layers in the existing layered free space environment structure.

VII COURSE OUTCOMES:

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

CO 1	Compare the basic antenna parameters and antenna theorems using electromagnetic field theory to measure radiation characteristics of antennas.	Understand
CO 2	Illustrate array system of antennas and field analysis under application of currents for the individual antenna elements to increase gain.	Apply
CO 3	Classify the frequency ranges of operation and applications of antennas to achieve greater radiation efficiency over extremely wide bandwidth	Analyze
CO 4	Identify antennas based on frequency using feeding methods for specific applications to improve directional characteristics.	Apply
CO 5	Apply the concepts of radiation mechanism to measure antenna parameters for given specifications.	Apply
CO 6	Summarize modes of radio wave propagation in the atmosphere at VHF and microwave frequencies, infer their characteristics to estimate the parameters of wave propagation.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

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 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 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	Successful Career and Entrepreneurship: An understanding of social awareness and environmental-wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real-world applications using optimal resources as an Entrepreneur.	3	Quiz

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	Write parametric integral expressions for a given current source by applying the principles of science to engineering problems .	2
	PO 2	Identify the fields produced by the current element, 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 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

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PSO 3	Basic knowledge of science and electronics and communication is needed in the design and implementation of complex systems	1
CO 2	PO 1	Knowledge on antenna parameters, engineering and mathematical background is essential to sketch the radiation pattern for arrays of 2 isotropic sources by the principle of pattern multiplication for array antennas.	3
	PO 2	Identify the number of individual elements, formulate the electromagnetic fields equation to the radiation pattern for arrays of 8 isotropic sources by the principle of pattern multiplication for array antennas using principles of mathematics, natural sciences, and engineering sciences .	5
	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
	PSO 3	A good mathematical and engineering fundamental is required to apply them to various areas like embedded systems.	1
CO 3	PO 1	Basic knowledge of science and mathematics is needed to compare various types of antennas at different frequencies.	2
	PO 2	Analyze the complex design considerations of VHF, UHF and microwave antennas. using principles of mathematics, natural sciences, and engineering sciences .	5
	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
	PO 3	Understand microwave, UHF and VHF antennas using various system components and identify solutions that meet the specified needs for the societal and environmental considerations .	2
CO 4	PO 1	Apply the knowledge of science and mathematics to understand the working principles and operation of microwave antennas.	3
	PO 2	Understand various types of feed systems of given parabolic reflector antennas and formulate the design problems from the provided data.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 3	Design parabolic reflector antenna using various research based feeding mechanisms and analyze HPBW, directivity and gain of the paraboloidal antenna and provide valid conclusions based on synthesis of the available data .	5
	PO 4	Analyze the practical design considerations of antennas using research methods including interpretation of data , to provide valid conclusions .	5
	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
	PSO 3	A good mathematical and engineering fundamental is required to apply them to various areas like communication systems.	1
CO 5	PO 1	Basic knowledge of science and mathematics is needed to measure and calculate the optimum values of different antenna parameters.	2
	PO 2	Engineering and mathematical background is essential to formulate the characteristics of antennas and assimilate the techniques for antenna parameter measurements.	2
	PO 3	Illustrate techniques for antenna parameter measurements, design various VHF antennas using research methods and analyze gain, directivity including interpretation of parameters to provide valid conclusions .	5
	PO 4	Recognize the concepts of various antennas and analyze the performance based on antenna parameter measurement techniques.	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	1
	PSO 3	Solve the transmitter and receiver design considerations for modeling and evaluating the antennas for wired and wireless communication applications.	1
CO 6	PO 1	Basic knowledge of science and mathematics is needed to analyze the uniform linear arrays such as broad side array and end fire array.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	Identify different layers of atmosphere using research methods and analyze problems like fading, path loss between two antennas for space wave propagation and validate various parameters of radio wave propagation and interpret the data and provide valid conclusions .	5
	PO 3	Identify different layers of atmosphere using research methods and analyze complex engineering problems between two antennas for sky wave propagation and validate various parameters of sky wave propagation using principles of mathematics .	5
	PO 4	Compare different layers of atmosphere using research methods and analyze complex engineering problems like fading, energy loss between two antennas for space wave propagation, validate various parameters of radio wave propagation and interpret the data and provide valid conclusions .	5
	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

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	6	-	-	-	-	-	-	-	1	-	-	-	-	1
CO 2	3	5	-	-	-	-	-	-	-	1	-	-	-	-	1
CO 3	2	5	2	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	2	5	5	-	-	-	-	-	1	-	-	-	-	1
CO 5	2	2	5	2	-	-	-	-	-	1	-	-	-	-	1
CO 6	2	5	5	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
	66.7	60	-	-	-	-	-	-	-	20	-	-	-	-	50
CO 1	66.7	60	-	-	-	-	-	-	-	20	-	-	-	-	50

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 2	100	50	-	-	-	-	-	-	-	20	-	-	-	-	50
CO 3	66.7	60	20	-	-	-	-	-	-	20	-	-	-	-	-
CO 4	100	20	50	45.5	-	-	-	-	-	20	-	-	-	-	50
CO 5	66.7	20	50	18.2	-	-	-	-	-	20	-	-	-	-	50
CO 6	66.7	50	50	45.5	-	-	-	-	-	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		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3	-	-	-	-	-	-	-	1	-	-	-	-	2
CO 2	3	2	-	-	-	-	-	-	-	1	-	-	-	-	2
CO 3	3	2	1	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	1	2	2	-	-	-	-	-	1	-	-	-	-	2
CO 5	3	1	2	1	-	-	-	-	-	1	-	-	-	-	2
CO 6	3	2	2	2	-	-	-	-	-	1	-	-	-	-	-
TOTAL	18	11	07	10	0	0	0	0	0	6	0	0	0	0	08
AVERAGE	3.0	1.8	1.7	1.6	0	0	0	0	0	1	0	0	0	0	2.0

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	✓	Tech - Talk	-	Certification	-
Laboratory Practices	-	5 Minutes Video / Concept Video	-	Open Ended Experiments	-

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 AND THIN LINEAR WIRE ANTENNAS
	Antenna fundamentals :Introduction, radiation mechanism,single wire,2wires,dipoles,current distribution on a thin wire antenna; Antenna Parameters, radiation patterns, patterns in principal planes, main lobe and side lobes, beam widths, radiation intensity, beam efficiency, directivity, gain and resolution, antenna apertures, aperture efficiency, effective height; Antenna properties based on reciprocity theorem; Thin linear wire antennas: Retarded potentials; Radiation from small electric dipole, Quarter wave monopole and half wave dipole, current distributions, evaluation of field components; power radiated, radiation resistance, beam widths, directivity, effective area and effective height; Natural current distributions, fields and patterns of thin linear center-fed antennas of different lengths; Illustrated problems.
MODULE II	LOOP ANTENNAS AND ANTENNA ARRAYS
	Loop Antennas: Introduction, small loop; Comparison of Far fields of small loop and short dipole; Radiation resistances and directivities of small and large loops. 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; BSA's with non uniform amplitude distributions; General considerations and Binomial arrays; Folded Dipoles and their characteristics;Arrays with parasitic elements,Yagi-Uda array,Helical antennas-Helical geometry, Helix modes, Practical design considerations for monofilar helical antenna in axial and normal modes.
MODULE III	VHF,UHF AND MICROWAVE ANTENNAS
	VHF, UHF and Microwave Antennas: Horn antennas- Types, Fermat's principle, optimum horns, design considerations of pyramidal horns; Illustrative problems; Lens antennas: Introduction, geometry of Non-metallic dielectric lenses, zoning, tolerances, applications; Slot antenna, its pattern, Babinet's principle and complementary antennas, impedance of slot antennas. Microstrip Antennas: Introduction, features, advantages and limitations; Rectangular patch antennas –geometry and parameters, characteristics of microstrip antennas, Impact of different parameters on characteristics.
MODULE IV	REFLECTOR ANTENNAS AND ANTENNA MEASUREMENTS
	Reflector Antennas: Introduction, flat sheet and corner reflectors; Paraboloidal reflectors: Geometry, pattern characteristics, feed methods, reflector types- Related features; 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: Comparison method, absolute and 3-antenna methods.

MODULE V	RADIO WAVE PROPAGATION
	Wave Propagation - I: Introduction, definitions, categorizations , general classifications, different Modes of Wave Propagation; Ground wave propagation: Introduction, plane earth reflections, space and surface waves, 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, Satya Prakashan, Antennas and Wave Propagation, Tech India Publications,1st Edition, 2001.

WEB REFERENCES:

1. [http:// web.stanford.edu/class](http://web.stanford.edu/class)
2. <http://www.electronicagroup.com>
3. <http://www.cpri.in/about-us/departmentsunits/library-and-information-centre/digital-library-links.html>
4. <http://nptel.ac.in/courses/antennas>

COURSE WEB PAGE:

http://lms.iare.ac.in/index?route=course/details&course_id=285

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=285
CONTENT DELIVERY (THEORY)			
2	Introduction, Isotropic radiators, Radian, Steradian, Radiation Pattern	CO 1	T1: 2.1
3	Radiation Intensity, Directivity - Gain, Directivity	CO 1	T1: 2.2-2.8
4	Antenna Efficiency, Antenna Apertures, Effective Area, Relation between maximum aperture and Gain	CO 1	T1: 2.9-2.10
5	Effective Height, Antenna Theorems - Reciprocity Theorem, Applications.	CO 1	T1: 2.12-2.13,21,22
6	Quarter Wave Monopole and Half Wave Dipole, Current Distributions, Field Components, Radiated Power, Radiation Resistance	CO 1	T1: 6.5
12	Loop Antennas- Introduction, Small circular Loop, Comparison of Far Fields of Small Loop and Short Dipole.	CO 1	T1: 6.6
13	Fields from Oscillating dipole	CO 1	T1: 7.1-7.3
14	Antenna Arrays - Point Sources- Definition, Patterns, Arrays of 2 Isotropic Sources – Different Cases	CO 2	T1: 8.6-8.7
15	Principle of Pattern Multiplication, Uniform Linear Arrays- Broadside Arrays	CO 2	T1: 8.1-8.4
16	End-fire Arrays, EFA with Increased Directivity, Derivation of their Characteristics and Comparison	CO 2	T1: 8.5-7.9
19	BSAs with Non-Uniform Amplitude Distributions, General considerations and Binomial Arrays	CO 2	T1: 7.19-7.22
21	Antenna Measurements: Introduction, Concepts – Reciprocity, Near and Far Fields, Coordinate System, Sources of Errors	CO 5	T1: 14.1-14.4

22	Errors Patterns to be Measured, Pattern Measurement Arrangement Directivity Measurement	CO 5	T1: 14.5-14.6
23	Gain Measurements (by Comparison, Absolute and 3-Antenna Methods)	CO 5	T1: 14.7
CONTENT DELIVERY (THEORY)			
24	Directivity and radiation pattern Measurements	CO 5	T1: 9.1-9.10
25	Microstrip Antennas-Introduction, Basic characteristics of micro strip antennas, Feeding Methods	CO 4	T1: 10.1-10.6
26	Methods of Analysis, Rectangular and Circular micro strip antennas	CO 3	R3: 7.1-7.3
27	Reflector Antennas- Introduction, Paraboloidal Reflectors- Geometry, Pattern Characteristics, Feed Methods	CO 4	T1: 5.15
29	Lens Antennas: Introduction, Geometry of Non-metallic Dielectric Lenses ,Zoning, Tolerances	CO 4	T1: 21.1-21.2
32	Arrays with Parasitic Elements, Yagi-Uda Array, Folded Dipoles and their Characteristics	CO 2	T1: 21.5b
33	Helical Antennas-Helical Geometry, Helix modes, Practical Design Considerations for Monofilar Helical Antenna in Axial and Normal Modes	CO 3	R3:11.1-11.3
35	Horn Antennas- Types, Fermat's Principle, Optimum Horns, Design Considerations of Pyramidal Horns, Illustrative Problems.	CO 3	R3:11.4-11.5
38	Wave Propagation - I: Introduction, definitions, categorizations ,different Modes of Wave Propagation; Ground wave propagation: Introduction, plane earth reflections, wave tilt, curved earth reflections	CO 6	R4:1.1
39	Space wave propagation: Introduction, field strength variation with distance and height .	CO 6	R4:2.7
40	Effect of earth's curvature, absorption, super refraction, M-Curves	CO 6	R4:2.2
41	Duct propagation, scattering phenomena Tropospheric propagation	CO 6	R4:3.1
42	Fading and path loss calculations	CO 6	R4:3.5
43	Wave propagation – II: Sky wave propagation: Introduction, structure of ionosphere	CO 6	R4:3.6
44	Refraction and reflection of sky waves by ionosphere, Ray path, critical frequency	CO 6	R4:3.6.1
48	MUF, virtual height and skip distance	CO 6	R4:3.6.2
49	Relation between MUF and skip distance	CO 6	R4:3.6.3
50	LUF, OF, Multi-hop propagation	CO 6	R4:3.14

PROBLEM SOLVING/ CASE STUDIES			
9	Problems on Radiation Resistance and Radiated Power	CO 1	T1: 2.1
10	Problems on Effective aperture	CO 1	T1: 2.2-2.8
11	Problems on Power radiated by half wave dipole	CO 1	T1: 2.9-2.10
17	Problems on End fire array	CO 2	T1: 2.12-2.13,21,22
18	Problems on Multiplication Pattern	CO 2	T1: 4.1-4.3
20	Problems on Broad side array	CO 2	T1: 6.5
28	Problems on Parabolic Reflector	CO 4	T1: 6.6
30	Problems on Lens antenna	CO 4	T1: 7.1-7.3
34	Problems on Helical Antenna	CO 2	T1: 2.1
36	Problems on Horn antenna	CO 3	T1: 2.2-2.8
37	Problems on Yagi- Uda antenna	CO 3	T1: 8.5-7.9
45	Problems on Skip distance	CO 6	R4:3.1
46	Problems on Maximum usable frequency	CO 6	R4:3.6.2
47	Problems on Critical Frequency	CO 6	R4:3.6.3
51	Problems on Field strength	CO 6	R4:3.14
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Antenna Parameters	CO 1	T1: 2.2-2.8
58	Types of Antennas and Applications	CO 2	T1: 2.9-2.10
59	Array Antennas	CO 2	T1: 2.12-2.13,21,22
60	Measurements of Antenna Parameters	CO 5	T1: 14.5-14.6
61	Modes of radio wave propagation	CO 6	R4:3.6
DISCUSSION OF QUESTION BANK			
62	Polarization in antennas	CO 1	T1: 2.2-2.8
63	Gain Measurements	CO 5	T1: 14.5-14.6
64	Paraboloidal Reflectors	CO 5	T1: 6.6
65	Helical Antenna	CO 3	T1: 2.1
66	Parameters of Sky wave propagation	CO 6	R4:3.6.2

Course Coordinator
Dr. V.Kishen Ajay Kumar, 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	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

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):

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:

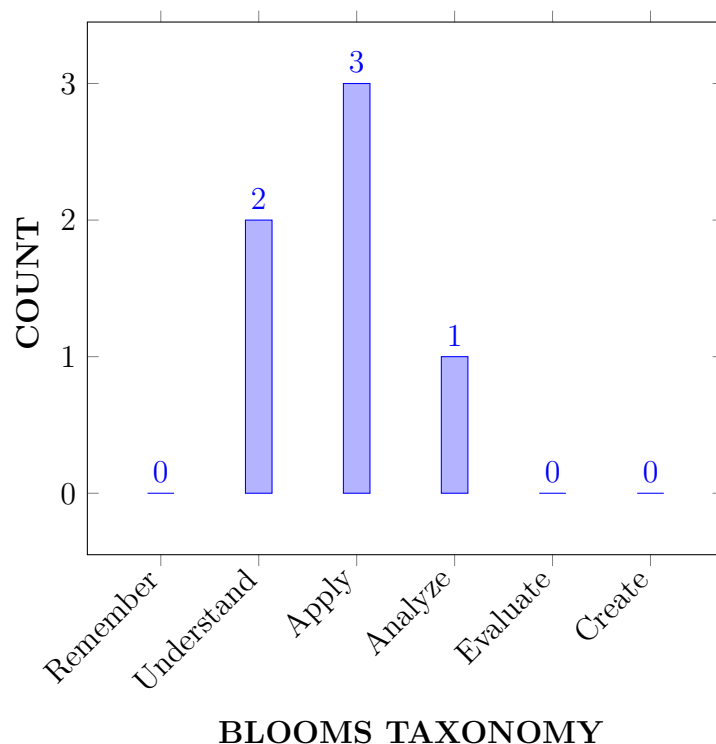
I	The fundamental principles of the VHDL and its constructs used in synthesizable register transfer level (RTL) design implementation of digital logic systems.
II	The concepts of behavioral, dataflow and structural modeling of fundamental digital logic circuits using VHDL.
III	The exposure to various stages of a typical state of the art CAD VLSI tool for simulation, synthesis, place and route, layout and power and clock routing modules.
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	Distinguish the types of logic families, their static and dynamic characteristics for providing the interface between CMOS, TTL and ECL logic.	Analyze
CO 2	Describe the basic language elements, data flow, behavioral and structural modelling constructs of VHDL used for the simulation and synthesis of digital circuits.	Understand
CO 3	Make use of language constructs in three modelling style to implement the VHDL code for combinational ICs.	Apply
CO 4	Implement efficient techniques at circuit level for improving power and speed of combinational circuits like encoders, comparators and barrel shifter.	Apply
CO 5	Choose the latches and flip flops to develop the VHDL model for synchronous and asynchronous sequential circuits.	Apply
CO 6	Identify the types of memories with efficient architectures to improve access times, power consumption.	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 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
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

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 2	Focus on the practical experience of ASIC prototype designs, Virtual Instrumentation and 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 types of logic families, calculation of their electrical characteristics and the interface between various logic families 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 1	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 .	3
	PO 4	Use appropriate logic family in the design of combinational and sequential logic circuits for analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	4
	PO 5	Select and apply appropriate technology to model the complex digital circuits by making use of modern engineering tools .	1
	PO 10	Describe the basic logic families and their electrical properties by giving effective presentations and take clear instructions to implement the combinational and sequential circuits.	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 2	PO 1	Explain the basic language elements in VHDL and data types in VHDL to 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 VHDL with the help of modern engineering tools .	4
	PO 4	Understand the complex engineering problems Use appropriate modeling style of VHDL used 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 modeling style to model the complex digital circuits by making use of modern engineering tools .	1

COURSE OUT COMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
Co 2	PO 10	Describe the basic language elements in VHDL by giving effective presentations and take clear instructions to implement the digital circuits.	1
	PSO 2	Using the basic language elements of VHDL can design a prototype of ASIC , such as PLDs, memory and processors.	1
CO 3	PO 1	Define the language constructs in three modeling styles in VHDL to build the digital circuits in dataflow, behavioral and structural 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
	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 structural modeling in VHDL to build the digital circuits in Structural modeling with the knowledge of mathematics, science and engineering fundamentals .	2
	PO 2	Demonstrate the significance of circuit level modeling and develop the VHDL 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

COURSE OUT COMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 4	PO 3	Understand the customer needs, use creativity and manage design process to model the complex digital circuits making use of structural modeling provided in VHDL 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 the appropriate logic gates as components to model the complex digital circuits.	1
	PO 10	Describe the basic syntax of declaring and initializing the logic gates as components by giving effective presentations and take clear instructions to implement the digital circuits in structural modeling.	1
	PSO 2	Using the logic gates as components can design a prototype of ASIC , such as PLDs, memory and processors.	1
CO 5	PO 1	Define the types of latches and flip flops used for implementing synchronous and asynchronous sequential circuits using knowledge of mathematics, science and engineering fundamentals .	2
	PO 2	Demonstrate the implementation of sequential circuits using latches, flip flops and develop the VHDL description 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 latches and flip flops to model the complex digital circuits by making use of modern engineering tools .	1
	PO 10	Describe the basic structure of latches, flip flops by giving effective presentations and take clear instructions for designing the modules VHDL.	1
	PSO 2	Using the basic latches, flip flops can design a prototype of ASIC , such as PLDs, memory and processors.	1
CO 6	PO 2	Demonstrate the types of memories and compare their architectures to improve their access time and power consumption to identify, formulate and state a problem .	3

COURSE OUT COMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 6	PO 4	Understand the complex engineering problems , use appropriate verilog description in the synthesis of memories for analysis, interpretation of data, and synthesis of the information to provide valid conclusions.	4
	PO 5	Select and apply appropriate design style to model the memories by making use of modern engineering tools	1
	PO 10	Describe the basic memory architectures by giving effective presentations and take clear instructions for synthesizing the sequential circuits.	1
	PSO 2	Using the synthesis of memories 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	3	-	4	1	-	-	-	-	1	-	-	-	1	-
CO 2	2	-	4	5	1	-	-	-	-	1	-	-	-	1	-
CO 3	2	7	-	4	1	-	-	-	-	-	-	-	-	1	-
CO 4	2	4	4	-	1	-	-	-	-	1	-	-	-	1	-
CO 5	2	3	2	-	1	-	-	-	-	1	-	-	-	1	-
CO 6	-	3	-	4	1	-	-	-	-	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	30	-	36.4	100	-	-	-	-	20	-	-	-	50	-
CO 2	66.7	-	40	45.5	100	-	-	-	-	20	-	-	-	50	-
CO 3	66.7	70	-	36.4	100	-	-	-	-	-	-	-	-	50	-

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 4	66.7	40	40	-	100	-	-	-	-	20	-	-	-	50	-
CO 5	66.7	30	20	-	100	-	-	-	-	20	-	-	-	50	-
CO 6	-	30	-	36.4	100	-	-	-	-	20	-	-	-	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 - $0 \leq C \leq 5\%$ – No correlation

2- $40 < C \leq 60\%$ – Moderate.

1- $5 < C \leq 40\%$ – Low/ Slight

3- $60 < C \leq 100\%$ –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	3	-	-	-	-	1	-	-	-	2	-
CO 2	3	-	2	2	3	-	-	-	-	1	-	-	-	2	-
CO 3	3	3	-	1	3	-	-	-	-	-	-	-	-	2	-
CO 4	3	2	2	-	3	-	-	-	-	1	-	-	-	2	-
CO 5	3	1	1	-	3	-	-	-	-	1	-	-	-	2	-
CO 6	-	1	-	1	3	-	-	-	-	1	-	-	-	2	-
TOTAL	15	8	5	5	18	0	0	0	0	5	0	0	0	12	0
AVERAGE	3	1.6	1.67	1.25	3	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:

UNIT-I	CMOS LOGIC AND BIPOLAR LOGIC AND INTERFACING
	Introduction to logic families, CMOS logic, CMOS steady state electrical behavior, CMOS dynamic electrical behavior, CMOS logic families; Bipolar logic, transistor logic, TTL families, CMOS/TTL interfacing, low voltage CMOS logic and interfacing, emitter coupled logic, comparison of logic families, familiarity with standard 74XX and CMOS 40XX series-ICs - specifications.
UNIT-II	THE VHDL HDL AND ITS ELEMENTS
	Design flow, program structure, types and constants, functions and procedures, libraries and packages; The VHDL design elements: Structural design elements, data flow design elements, behavioral design elements, time dimension and simulation synthesis.
UNIT-III	COMBINATIONAL LOGIC DESIGN USING VHDL
	Decoders, encoders, three state devices, multiplexers and demultiplexers, Code Converters, EX-OR gates and parity circuits, comparators, adders and subtractors, ALUs, combinational multipliers. VHDL modes for the above ICs. Design examples (using VHDL) - Barrel shifter, comparators, floating-point encoder, dual parity encoder
UNIT-IV	SEQUENTIAL LOGIC DESIGN
	Latches and flip-flops, PLDs, counters, shift register, and their VHDL models, synchronous design methodology, impediments to synchronous design.
UNIT-V	MEMORIES
	ROMs: Internal structure, 2D-decoding commercial types, timing and applications; Static RAM: Internal structure, SRAM timing, standard SRAMS, synchronous SRAMS; Dynamic RAM: Internal structure, timing, synchronous DRAMS; Familiarity with component data sheets : Cypress CY6116, CY7C1006, specifications.

TEXTBOOKS

1. John F.Wakerly, "Digital Design Principles Practices", PHI/ Pearson Education Asia, 3rd Edition, 2005.
2. J. Bhasker, "VHDL Primer", Pearson Education / PHI, 3 rd Edition. Pearson Higher Education

REFERENCE BOOKS:

1. Charles H. Roth Jr., "Digital System Design Using VHDL", PWS Publications, 1998.
2. Alan B. Marcovitz, "Introduction to Logic Design", TMH, 2 nd Edition, 2005.
3. Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design", TMH, 2003.
4. Cypress Semiconductors Data Book (Download from website).
5. K. Lalkishore, "Linear Integrated Circuit Applications", Pearson Educations 2005.

WEB REFERENCES:

1. <http://equipe.nce.ufrj.br/gabriel/vhdlfpga.html>
2. http://esd.cs.ucr.edu/labs/tutorial/VHDL_page.htm

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)			
2	Introduction to logic families, CMOS logic	C0 1	T1:1
3	OCMOS steady state electrical behavior	C0 1	T1:2.1-2.2
4	CMOS dynamic electrical behavior, CMOS logic families;	C0 1	T1: 2.3-2.10
5	Bipolar logic, transistor logic	C0 1	T1: 3.2 – 3.14
6	TTL families, CMOS/TTL interfacing	C0 1	T1: 4.1 – 4.4
7	low voltage CMOS logic and interfacing	C0 1	T1: 4.5
8	emitter coupled logic, comparison of logic families	C0 1	T1: 4.6 – 4.7
9	familiarity with standard 74XX and CMOS 40XX series-ICs - specifications.	C0 1	T1: 5.2
10	Design flow, program structure	C0 2	T1: 5.3- 5.5
11	types and constants	C0 2	T1: 5.6
12	functions and procedures	C0 2	T1: 6.2 – 6.5
13	The VHDL design elements: Structural design elements	C0 1	T1: 6.6
14	data flow design elements	C0 2	T1: 7.1 – 7.5
15	behavioral design elements	C0 2	T1: 7.6
16	time dimension and simulation synthesis	C0 2	T1: 7.7 – 7.9
17	VHDL Models of Decoders, encoders three state devices	C0 3	T1: 7.10
18	VHDL Models multiplexers and de multiplexer	C0 3	T1: 7.11
19	VHDL Models Code Converters	C0 3	T1: 7.12
20	VHDL Models EX-OR gates and parity circuits	C0 3	T1: 8.2 – 8.8

S.No	Topics to be covered	CO's	Reference
21	VHDL Models comparators, adders and subtractors	C0 3	T1 : 8.9 – 8.11
22	VHDL Models ALUs and combinational multipliers	C0 4	T1: 10.2 – 10.7
23	Design examples (using VHDL) - Barrel shifter, comparators	C0 4	T1: 11.2 – 11.4
24	VHDL Model of floating-point encoder, dual parity encoder	C0 4	T2: 5.1
25	VHDL Model of Latches and flip-flops	C0 5	T2: 5.2
26	VHDL Model of PLDs	C0 5	T2: 5.3
27	VHDL Model of Synchronous counters	C0 5	T2: 5.4
28	VHDL Model of Asynchronous counters	C0 5	T1:1
29	VHDL Model of shift register	C0 5	T1:2.1-2.2
30	synchronous design methodology	C0 5	T1: 2.3-2.10
31	impediments to synchronous design	C0 5	T1: 3.2 – 3.14
32	VHDL Programs	C0 5	T1: 4.1 – 4.4
33	ROMs: Internal structure	C0 6	T1: 4.5
34	2D-decoding commercial types, timing and applications	C0 6	T1: 4.6 – 4.7
35	Static RAM: Internal structure	C0 6	T1: 5.2
36	SRAM timing, standard SRAMS	C0 6	T1: 5.3- 5.5
37	synchronous SRAMS	C0 6	T1: 5.6
38	Dynamic RAM: Internal structure, timing	C0 6	T1: 6.2 – 6.5
39	Dynamic RAM: Internal structure, timing	C0 6	T1: 6.6
40	synchronous DRAMs	C0 6	T1: 7.1 – 7.5
41	Familiarity with component data sheets : Cypress CY6116, CY7C1006, specifications	C0 6	T1: 7.6
PROBLEM SOLVING			
42	8 to 1 multiplexer in dataflow modeling	C0 1	T1: 7.10
43	2 to 4 priority encoder dataflow modeling.	C0 1	T1: 7.11
44	1 to 8 de multiplexer using gate level modeling	C0 2	T1: 7.12
45	D flip flop using NAND gates in gate level modeling	C0 2	T1: 8.2 – 8.8
46	BCD adder module using gate level modeling	C0 2	T1 : 8.9 – 8.11
47	Full adder using 2 half adders in gate level modeling	C0 2	T1: 10.2 – 10.7
48	8 to 3 encoder using gate level modeling.	C0 2	T1: 11.2 – 11.4
49	4-bit binary to gray code converter using gate level modeling.	C0 2	T2: 5.1

S.No	Topics to be covered	CO's	Reference
50	8-bit up-down counter using behavioral modeling	C0 3	T2: 5.2
51	3 to 8 decoder using behavioral modeling	C0 3	T2: 5.3
52	8 to 1 multiplexer using case statement.	C0 4	T2: 5.4
53	4-bit universal shift register in behavioral modeling using case statement.	C0 4	T1:1
54	16-to-1 multiplexer using function	C0 5	T1:2.1-2.2
55	Left/Right shifter.	C0 5	T1: 2.3-2.10
56	101 Moore detectors and also obtain its test bench.	C0 6	T1: 3.2 – 3.14
DISCUSSION ON DEFINITIONS AND TERMINOLOGY			
57	CMOS logic and Bipolar logic and interfacing.	C0 1	T1: 4.5
58	The VHDL and its elements	C0 2	T1: 4.6 – 4.7
59	Combinational logic design using VHDL	C0 3	T1: 5.2
60	Sequential logic design	C0 5	T1: 5.3- 5.5
61	Memories	C0 6	T1: 5.6
DISCUSSION ON TUTORIAL QUESTION BANK			
62	Introduction to verilog HDL.	C0 1	T1: 6.6
63	Gate level modeling	C0 2	T1: 7.1 – 7.5
64	Behavioral modeling	C0 3	T1: 7.6
65	Switch level modelling	C0 5	T1: 7.7 – 7.9
66	Sequential logic	C0 6	T1: 7.10

Course Coordinator
Mrs. S. Swathi, Assistant Professor

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 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

ELECTRONICS AND COMMUNICATION ENGINEERING COURSE DESCRIPTION

Course Title	RESEARCH AND CONTENT DEVELOPMENT				
Course Code	AHS106				
Program	B.Tech				
Semester	V	ECE			
Course Type	Elective				
Regulation	IARE - R16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Dr. B. Surekha Reddy, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

II COURSE OVERVIEW:

Research-based learning (RBL) presents as an alternative learning model that can develop the critical thinking skills. The research-based learning is conducted under constructivism which covers four aspects: learning which constructs students understanding, learning through developing prior knowledge, learning which involves social interaction process, and meaningful learning which is achieved through real-world experience. The major focus is to engage students in the inquiry process where they formulate questions, conduct investigations, apply information and media to learning, and generate products that illustrate learning. The 5E learning cycle adopted for RBL leads students through five phases: Engage, Explore, Explain, Elaborate, and Evaluate which results in greater benefits concerning students ability for scientific inquiry.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Research and Content Development	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.

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

VI COURSE OBJECTIVES:

The students will try to learn:

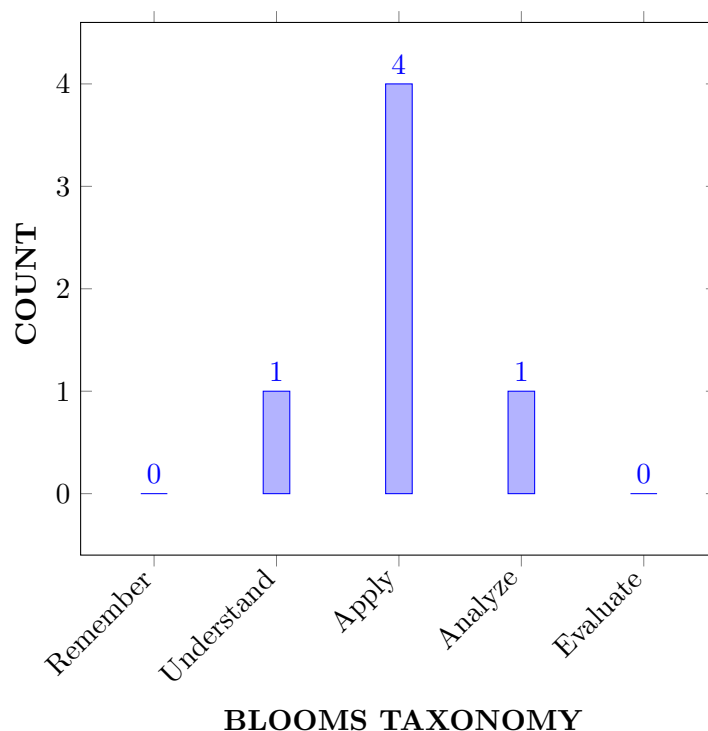
I	Gain a practical understanding of the various methodological tools used for social scientific research.
II	Learn the ethical, political, and pragmatic issues involved in the research process.
III	Improve their ability to develop technical writing.
IV	Identify the overall process of designing a research study from its inception to its report.

VII COURSE OUTCOMES:

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

CO 1	Apply the knowledge of research in finding the gaps from literature survey to formulate new ideas. .	Apply
CO 2	Apply the techniques of data collection and sample design involved with different case studies for solving the research problem.	Apply
CO 3	Analyze the process of testing involved with the survey results for implementing novel models.	Analyze
CO 4	Understand the concepts of formatting styles for different documentation procedures.	Understand
CO 5	Explore the knowledge on multimedia tutorials and blogs for research paper development.	Apply
CO 6	Develop the presentation skills on the literature findings and research methodologies for advanced interacting tools.	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 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 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
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 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.	2	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.	2	Lab Exercises
PSO2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	2	Lab Exercises
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

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	Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.	3
	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

	PO10	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
	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.	2
	PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	3
	PSO2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	3
	PSO3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	3
CO2	PO2	Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.	3
	PO5	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
	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
	PO10	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
CO3	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.	2
	PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	3
	PSO2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	3
	PSO3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	3
	PO2	Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.	3

	PO5	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
	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
	PO10	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
	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.	3
	PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	3
	PSO2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	3
	PSO3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	3
CO4	PO5	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
	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
	PO10	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
	PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	3
	PSO2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	3
	PSO3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	3
CO5	PO5	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
	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

	PO10	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
	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.	2
	PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	3
	PSO2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	3
	PSO3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	3
CO6	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
	PO10	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
	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.	3
	PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	3
	PSO2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	3
	PSO3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	3

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 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	-	-	-	-	-	-	2	1	-	2	3	3	3
CO 2	-	3	-	-	3	-	-	-	2	1	-	2	3	3	3
CO 3	-	3	-	-	3	-	-	-	3	1	-	3	3	3	3
CO 4	-	-	-	-	3	-	-	-	3	3	-		3	3	3
CO 5	-	-	-	-	3	-	-	-	3	3	-	2	3	3	3
CO 6	-	-	-	-	-	-	-	-	3	3	-	-	3	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	LATEX FOR DOCUMENTATION
	Formatting Styles, Inserting table, Bullets and Numbering, Changing Text Direction, Cell alignment, Footnote, Hyperlink, Symbols, Spell Check and Track Changes using LaTeX; Mathematical expressions, Subscripts and superscripts, brackets and parentheses, fractions and binomials, aligning equations, operators, spacing in math mode, integrals, sums and limits, display style in math mode, list of Greek letters and math symbols, mathematical fonts; Prepare class timetable and student marks list using LaTeX;

WEEK II	RESEARCH FORMULATION AND DESIGN
	Motivation and objectives – Research methods vs. Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research. Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research database, development of working hypothesis.
WEEK III	DATA COLLECTION AND SAMPLING DESIGN
	Sources of Data: Primary Data, Secondary Data; Procedure Questionnaire -Survey and Experiments - Design of survey and Experiments- Sampling Merits and Demerits - Control Observations - Procedures - Sampling Errors.
WEEK IV	CONTENT DEVELOPMENT
	Document design and layout; Papers; Articles; E-book formats. Forums; Multimedia tutorials; Wikis; Blogs; Websites
WEEK V	PROOF READING PROCESS AND REPORT WRITING
	Definition, purpose, difference between content and copy, editing, competing priorities, elements of structure, style and appearance, evaluation, overall organizing, clarity of expression, grammatical accuracy, correctness of layout; Meaning of Interpretation, technique of Interpretation, precaution in Interpretation; Significance of report writing, different steps in writing report, layout of the research report, types of reports, oral presentation, mechanics of writing a research report, precautions for writing research reports, conclusions.

TEXTBOOKS

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, “An Introduction to Research Methodology”, RBSA Publishers. U.K., 2002.
2. Kothari, C.R, “Research Methodology: Methods and Techniques”. New Age International. 418p, 1990.
3. Stefan Kottwitz , “ LATEX Beginner’s Guide”, Packt Publishing Limited, 2011.

REFERENCE BOOKS:

1. Meenakshi Raman, Sangeeta Sharma, “Technical Communication”, Oxford Publishers, 1st Edition, 2004.
2. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, ESS Publications. 2 volumes.

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 to Research Methodology, Documentation and Content Development	CO 1	T1: 1.2
2	Topic selection, Research Formulation and Design for writing working paper by students.	CO 1	T2: 3.5
3	Data Collection and Sampling Design exercises for writing working paper by students	CO 2	T1: 3.4

4	Data Collection and Sampling Design exercises for writing working paper by students	CO 2	T2: 2.2
5	Abstract Writing by using LATEX software.	CO 3	T1: 2.4
6	Writing a Working Paper using LATEX software (Introduction)	CO 3	T3: 4.5
7	Writing a Working Paper using LATEX software (Literature Survey with References)	CO 3	T3: 4.6
8	Report Submission and Seminar of Working Paper (till Literature Survey only)	CO 3	T2: 5.1
9	Writing a Working Paper using LATEX software (Research Methodology)	CO 4	T2: 5.2
10	Writing a Working Paper using LATEX software (Research Methodology)	CO 4	T1: 7.1
11	Writing a Working Paper using LATEX software (Results and Discussion).	CO 4	T1:7.2
12	Writing a Working Paper using LATEX software (Results and Discussion)	CO 5	T1:7.3
13	Writing Working Paper using LATEX software (Conclusion)	CO 5	T1:7.3
14	Proof reading exercises on Working Paper	CO 6	T1:7.3
15	Plagiarism Analysis and Paraphrasing Exercises on Working Paper	CO 6	T2:7.3
16	Report Submission and Seminar on Full Length Working Paper	CO 6	T2:7.3

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Integration of knowledge and skills from various areas through more complex investigations and multi-disciplinary projects.
2	Autonomous learning encouraged through independent research of unstructured problems
3	Teamwork, which helps prepare students for a social environment
4	Self-evaluation and self-criticism, against self-competency, trying to see beyond their own ideas and knowledge

Signature of Course Coordinator
Dr. B. Surekha Reddy, Assistant Professor

HOD,ECE



INSTITUTE OF AERONAUTICAL ENGINEERING (Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING COURSE DESCRIPTION

Course Title	Digital Communication Laboratory				
Course Code	AEC105				
Program	B.Tech				
Semester	V	ECE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1
Course Coordinator	Mr Nune Naresh Chary, Assistant Professor				

I COURSE OVERVIEW:

This lab course gives the hands on experience in elements of digital communication systems. The design of various coding techniques, pulse analog and digital modulations to analyse signal to noise ratio, bit error rate, power and bandwidth for digital communication systems. This lab is useful in the digital signal processors in secured communication systems, multimedia communications and data storage applications.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEC009	V	Digital Communications
B.Tech	AEC005	IV	Analog Communications

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Digital Communications 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 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
2	2	2	2	2	10

2. Programming Based

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

VI COURSE OBJECTIVES:

The students will try to learn:

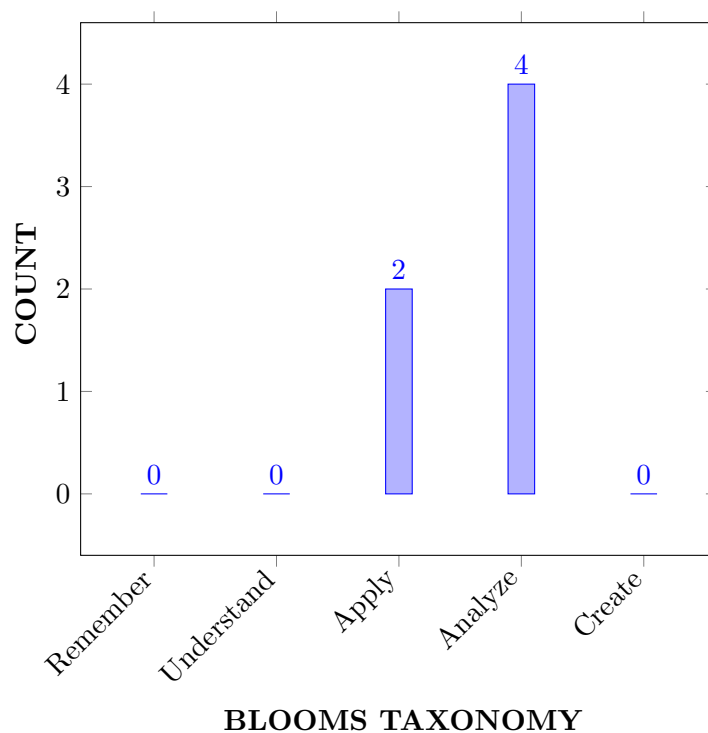
I	The Elements of digital communication systems to convert continuous time signals into discrete time signals.
II	The pulse analog modulation techniques, generation and detection of digital modulation techniques.
III	The time and frequency domain analysis of the signals in communication system by using MATLAB tools.

VII COURSE OUTCOMES:

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

CO 1	Examine sampling theorem for processing of different signals such as low pass signals, band-limited signals and bandpass signals. .	Analyze
CO 2	Classify the pulse modulation and demodulation methods for encoded data in analog to digital conversion.	Analyze
CO 3	Apply the concept of pulse code modulation and demodulation for the equivalent sequence of binary code word data.	Analyze
CO 4	Categorize the digital modulation techniques used for transfer a digital bit stream over an analog channel at a high frequency.	Analyze
CO 5	Determine bit rate in delta modulation and demodulation process for the no. of bits per sample are transmitted.	Apply
CO 6	Develop frequency domain description of different digital modulation techniques for spectral characteristics analysis.	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 analyse 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	1	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	Day -to- Day evaluation sheets

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.	1	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	Identify (Problem analysis) sampling rate and sampling time interval in analog to digital signal conversion using principles of mathematics, natural sciences, and engineering sciences	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	4
CO 2	PO 2	Identify (Problem analysis) pulse modulation techniques and convert analog signal into discrete signals using principles of mathematics, natural sciences, and engineering sciences.	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	4
CO 3	PO 5	Create, select, and apply appropriate techniques to 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.	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	4
CO 4	PO 2	Identify (Problem analysis) digital modulation techniques with reference to 0 and 1 as binary input and to reduce ambiguity using principles of mathematics, natural sciences, and engineering sciences	2
	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
	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
CO 5	PO 2	Identify (Problem analysis) the bit rate of delta modulation and demodulation with reference to 0 and 1 as binary input using principles of mathematics, natural sciences, and engineering sciences	2
	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

	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
	PSO 3	Make use of High Frequency Structure Simulator (HFSS) to design DPSK for Wired and Wireless Communication Applications.	1
CO 6	PO 2	Identify (Problem analysis) spectrum analysis for different modulations using principles of mathematics, natural sciences, and engineering sciences.	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	4

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	2			3	
CO 2	2			3	
CO 3		2		3	
CO 4	2		2	3	
CO 5	2		2	3	1
CO 6	2			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	SAMPLING THEOREM – VERIFICATION
	Verification of sampling theorem for under, perfect, over sampling cases.
WEEK II	PULSE AMPLITUDE MODULATION AND DEMODULATION
	Generation of Pulse Amplitude modulation and demodulation using hardware and matlab.
WEEK III	PULSE WIDTH MODULATION AND DEMODULATION
	Generation of Pulse width modulation and demodulation using hardware and matlab.
WEEK IV	PULSE POSITION MODULATION AND DEMODULATION
	Generation of pulse position modulation and demodulation using hardware and matlab.
WEEK V	PULSE CODE MODULATION AND DEMODULATION
	Generation of pulse code modulation and demodulation using hardware and understanding the concept analog to digital conversion.
WEEK VI	DIFFERENTIAL PULSE CODE MODULATION AND DEMODULATION
	Generation of differential pulse code modulation and demodulation using hardware.
WEEK VII	DELTA MODULATION AND DEMODULATION
	Generation of delta modulation and demodulation using hardware.
WEEK VIII	FREQUENCY SHIFT KEYING
	Generation of Frequency shift keying modulation and demodulation using hardware.
WEEK IX	PHASE SHIFT KEYING
	Generation of Phase shift keying modulation and demodulation using hardware.
WEEK X	DIFFERENTIAL PHASE SHIFT KEYING
	Generation of Differential Phase shift keying modulation and demodulation using hardware
WEEK XI	AMPLITUDE SHIFT KEYING
	Generation of Amplitude Shift Key modulation and demodulation using hardware.
WEEK XII	QUADRATURE PHASE SHIFT KEYING
	Generation of QPSK modulation and demodulation using hardware
WEEK XIII	MATLAB for QPSK and SIMULINK for DPSK.
	Understand frequency domain description of Quadrature Phase Shift Keying and Differential Phase shift keying.
WEEK XIV	STUDY OF THE SPECTRAL CHARACTERISTICS OF AMPLITUDE MODULATION
	Understand frequency domain description of Amplitude Modulation.

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.

REFERENCE BOOKS:

1. John Proakis, "Digital Communications", TMH, 2nd Edition 1983.
2. B.P.Lathi, "Modern Analog and Digital Communication", Oxford reprint, 3rd Edition, 2004.
3. Singh, Sapre, "Communication Systems Analog and Digital", TMH, 2nd Edition, 2004.

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	Verification of sampling theorem for under, perfect, over sampling cases.	CO 1	T1: 2.3
2	Generation of Pulse Amplitude modulation and demodulation using hardware and matlab.	CO 2	T1: 3.1
3	Generation of Pulse width modulation and demodulation using hardware and matlab.	CO 4	T1: 3.11
4	Generation of pulse position modulation and demodulation using hardware and matlab.	CO 4	T1: 4.8
5	Generation of pulse code modulation and demodulation using hardware and understanding the concept analog to digital conversion.	CO 3	T2: 2.8
6	Generation of differential pulse code modulation and demodulation using hardware.	CO 4	T2: 3.5
7	Generation of delta modulation and demodulation using hardware.	CO 5	T2: 4.6
8	Generation of Frequency shift keying modulation and demodulation using hardware.	CO 4	R1: 2.1
9	Generation of Phase shift keying modulation and demodulation using hardware.	CO 4	R1: 2.8
10	Generation of Differential Phase shift keying modulation and demodulation using hardware.	CO 4	R1: 3.1
11	Generation of Amplitude Shift Key modulation and demodulation using hardware.	CO 4	R2:2.1
12	Generation of QPSK modulation and demodulation using hardware	CO 4	R2:2.6
13	Understand frequency domain description of Quadrature Phase Shift Keying and Differential Phase shift keying	CO 6	R2:3.2
14	Understand frequency domain description of Amplitude Modulation	CO 6	R2:4.1

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Design a sampling circuit with 5 V p-p amplitude and 100 Hz sine wave and remove aliasing effect..
2	Design PAM transmission of voice signal with $W = 3KHz$. Calculate transmission bandwidth if $f_s = 8KHz$ and $\tau = 8KHz$.
3	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 $\Delta = 0.1$.
4	Design a PCM circuit with IC CD4016, LM324, 7493, 7400 and Feed 2Vpp, 100Hz unipolar sine wave as the analog input (Set dc level at 2V to obtain a signal that varies between +1V and +3V). Make sure that the input peak voltage never exceeds the peak DAC output.
5	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
Mr. Nune Naresh Chary, Assistant Professor

HOD,ECE



INSTITUTE OF AERONAUTICAL ENGINEERING (Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	ELECTRONICS AND COMMUNICATION ENGINEERING				
Course Title	INTEGRATED CIRCUITS APPLICATIONS LABORATORY				
Course Code	AEC106				
Program	B.Tech				
Semester	V	ECE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	2
Chief Coordinator	Ms M Sreevani, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
B.Tech	AEC008	V	Integrated Circuits Applications	3

II 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.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Integrated Circuits 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.

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:

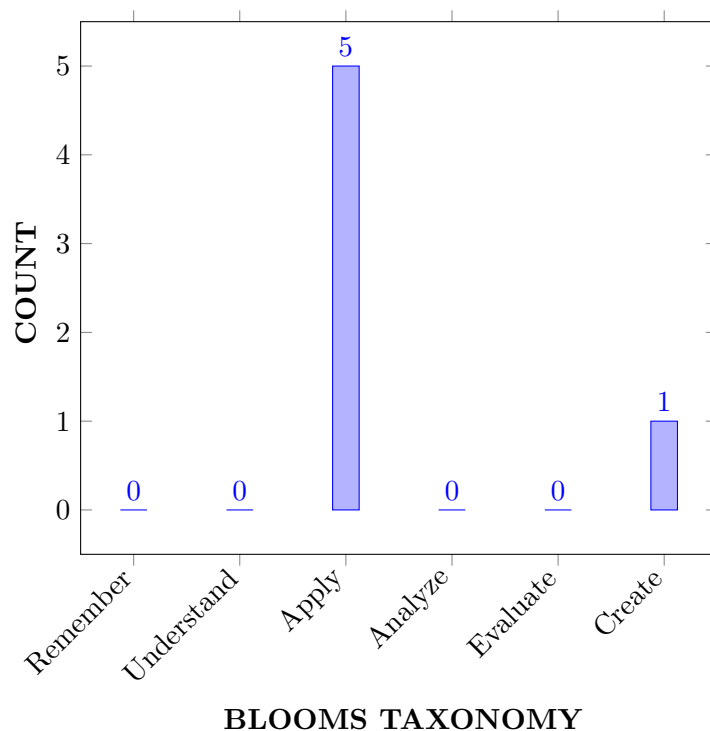
I	The experiments on design of Linear and Digital Integrated circuits using operational amplifier and digital ICs.
II	The design and implementation of analog circuits and gain the hands-on experience on the various building blocks of digital circuits.
III	The IC based real-time applications in the fields 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 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 feedback 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
	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

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies matched.
	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 and 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
	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

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies matched.
	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 specific integrated circuit (ASIC) and system on chip (SOC) designs.	1

XI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	PO 1, PO 2	SEE Exams	PO 1, PO 2, PO 5	Seminars	PO1, PO12	Assignments	-
Laboratory Practices	PO 2, PO 3, PO 5	Student Viva		Mini Project	-	Certification	
Term Paper	-	5 Minutes Video	-	Open Ended Experiments	-	-	-

XII ASSESSMENT METHODOLOGY INDIRECT:

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

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

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

XIV 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 BAND-PASS FILTERS
	To design and verify the operation of the Active low pass and High pass using IC 741.
Week-4	ASTABLE MULTIVIBRATORS AND SCHMITT TRIGGER USING 555
	To design and construct an Astable multivibrators and Schmitt trigger using IC 555.
Week-5	MONOSTABLE MULTIVIBRATORS 555
	To design and construct Monostable multivibrators using IC 555 .
Week-6	SCHMITT TRIGGER USING 555
	To design and construct schmitt trigger using NE555 Timer.
Week-7	PLL USING IC 565
	Verifying characteristics of PLL
Week-8	INSTRUMENTATION AMPLIFIER.
	To design and verify the operation of instrumentation amplifier using IC 741.
Week-9	MULTIPLEXER AND DEMULTIPLEXER
	Verify Functionality of multiplexer and demultiplexer.
Week-10	ENCODER AND DECODER
	Verify Functionality of encoder and decoder.
Week-11	REALISATION OF DIFFERENT FLIP-FLOPS USING LOGIC GATES
	Verify Functionality of flip-flop.
Week-12	4 BIT COUNTERS
	Verify Functionality of counters.
Week-13	REALISATION OF SHIFT REGISTERS
	Verify Functionality of shift register
Week-14	DECADE COUNTER
	Verify Functionality of decade counter

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, 3rd Edition, 2003.
3. John F. Wakerly, "Digital Design Principles and Practices", Prentice Hall, 3rd Edition, 2005.

REFERENCE BOOKS:

1. Salivahanan, "Linear Integrated Circuits and Applications", TMH, 1st Edition, 2008

XV COURSE PLAN:

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

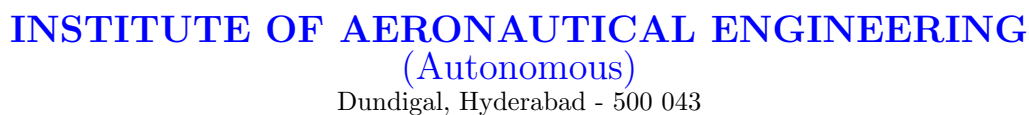
Week No	Topics to be covered	CO's	Reference
1	To find voltage gain of inverting, Non-inverting and Differential Amplifiers using IC 741.	CO 1	T1:11.1-11.5
2	To find the frequency response of integrator and differentiator for different inputs using IC 741.	CO 1	T1:11.1-11.5
3	To find the frequency response of second order Active Lowpass, High-pass And Bandpass Filters using IC 741.	CO 2	T1:4.8 , T1:7.2
4	To design and construct an Astable multivibrators and Schmitt trigger using IC 555.	CO 2	T1:4.8 , T1:7.2
5	To design and construct Monostable multivibrators using IC 555.	CO 3	T2:10.4 , R2:7.2
6	To design and construct schmitt trigger using NE555 Timer.	CO 3	T2:10.4 , R1:7.2
7	To verify characteristics of PLL.	CO 4	T2:10.4 , R1:7.2
8	To design and verify the operation of instrumentation amplifier using IC 741.	CO 1	T1:8.2-8.5
9	To verify Functionality of multiplexer and demultiplexer.	CO 6	T1:11.1-11.5
10	To verify Functionality of encoder and decoder.	CO 6	T1:10.1 , T1:10.2
11	To verify Functionality of flip-flop.	CO 6	T1:11.1-11.5
12	To verify Functionality of counters.	CO 6	T3:3.12 , R1:12.7
13	To verify Functionality of shift register.	CO 6	T3:3.12 , R1:12.7
14	To verify Functionality of decade counter.	CO 6	T3:3.12 , R1:12.7

XVI 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



Department	Electronics and Communication Engineering				
Course Title	Digital Signal Processing				
Course Code	AEC012				
Program	B.Tech				
Semester	VI				
Course Type	Core				
Regulation	R-16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Dr. S China venkateswarlu, Professor				

Level	Course Code	Semester	Prerequisites
B.Tech	AECB14	III	Signals and Systems

The course is intended to provide representation of discrete-time signals and systems, and their analysis using fourier and z-transforms. The notion of discrete fourier transform is introduced, followed by an overview of fast algorithms for its computation. The methods for spectral analysis of discrete-time signals are discussed next, principal methods for design of FIR and IIR filters, followed by multi-rate signal processing and finite word length effects. While this course deals largely with the theory of DSP, we will use a powerful software package, MATLAB, to look at applications of this theory, particularly fourier analysis and digital filter design.

Subject	SEE Examination	CIE Examination	Total Marks
Digital Communications	70 Marks	30 Marks	100

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	✗	MOOC
✗	Open Ended Experiments	✗	Seminars	✗	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 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
25%	Understand
50%	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).

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 8th and 16th 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 / Alternative Assessment Tool (AAT):

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). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

VI COURSE OBJECTIVES:

The students will try to learn:

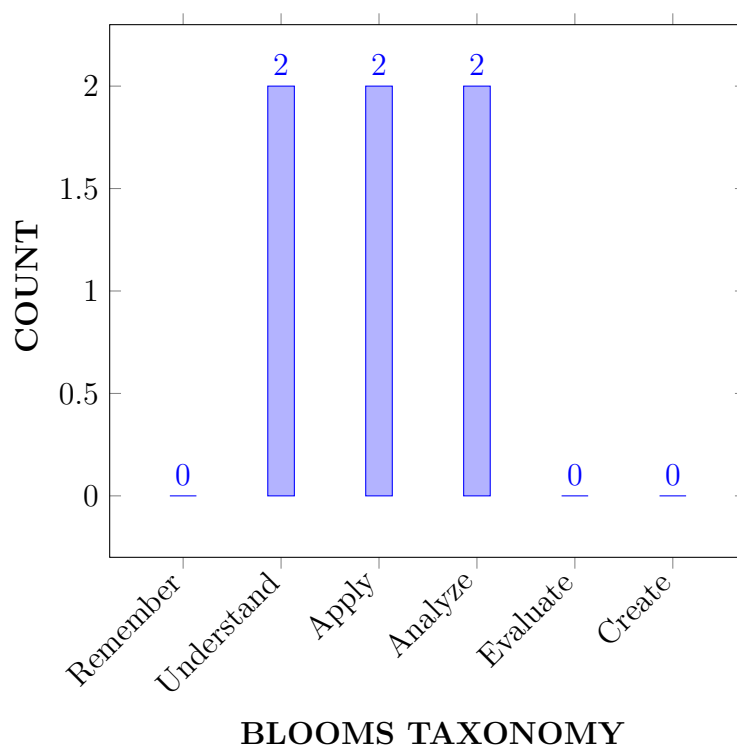
I	To provide background and fundamental material for the analysis and processing of digital signals and to familiarize the relationships between continuous-time and discrete-time signals and systems.
II	To study fundamentals of time domine, frequency domine and z- domine analysis and to discuss the inter-relationships of these analytic method and to study the designs and structures of digital (IIR and FIR) filters from analysis to synthesis for a given specifications.
III	To acquaint in FFT algorithm, multi-rate signal processing techniques and finite word length effects. To introduce a few real-world signal processing applications.

VII COURSE OUTCOMES:

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

CO 1	Illustrate the realization of LTI systems using discrete time signals and systems	Understand
CO 2	Construct the decimation-in-time and decimation-in-frequency fast fourier transforms for reducing computational complexity of DFT.	Apply
CO 3	Implement FIR and IIR filters using digital filter transformation techniques.	Apply
CO 4	Analyze the performance characteristics of IIR and FIR filters using MATLAB.	Analyze
CO 5	Interpret the multi rate signal processing methods for interfacing the digital systems with different sampling rates.	Understand
CO 6	Examine errors in analog to digital conversion for tolerating finite word length effects.	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.	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.	3	SEE/CIE/Quiz /AAT
PO 3	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 5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction analysis and interpretation of data, and synthesis of the information to provide valid conclusions and modeling to complex engineering activities with an understanding of the limitations.	3	Design 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 digital signal processing applications	2	Lectures and assignments.

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.Understand the response of LTI system by applying the principles of mathematics and science for the solution of complex engineering problem.	3
	PO 2	Understand the basic convolution problem statement and translate convolution sum by using overlap add and over lap save method. Analyze complex engineering problems by applying optimized realization of digital filters then Validate and interpret the results.	4
CO 2	PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals to solve the fast fourier transform of discrete signals.	3
	PO 2	Formulate and analyze (Problem analysis) complex Engineering problems and apply fast fourier transform of discrete sigals using first principles of engineering mathematics, design butterfly diagram and interpret the results in terms of computational complexity.	6

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 3	PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals to understand finite impulse response and infinite impulse filters.	3
	PO 2	Identify the given problem statement and formulate the required steps and implement (complex) of IIR and FIR digital filters from the provided information and data . Validate one filter design with other design in reaching substantiated conclusions by the interpretation of results .	6
	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 .	4
	PSO 1	Apply filter transformation methods to convert digital filters from analog filters	1
CO 4	PO 1	Basic knowledge of science and mathematics is needed to understand FIR and IIR filters characteristics and then apply design techniques.	3
	PO 2	Identify the problem statement of digital filters provided with data specification. Implement IIR and FIR filter design and concluded by the interpretation of results.	4
	PO 3	Design solutions for complex digital filters by considering of basic filter designs and modify the design system components and specifications to achieve (engineering objective) digital signal processing applications	2
	PO 5	Problems on digital filter design can be formulated and analyzed in MATLAB Tool	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 (knowledge) concept of poly phase filter by applying the fundamental concepts of mathematical principles and Engineering and Science of mathematical principles .	1
	PO 2	Identify the problem statement of poly phase filter provided with data specification. Make use of multi rate signal processing concepts in the design of system components poly phase filters and phase shifters to establish innovative solutions for complex engineering problems	6
	PSO 1	Apply finite word length effects for multi rate signal processing applications.	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
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 problem statement of finite word length effects while implementing signal processing techniques (analyze complex engineering problems) on digital signal processor (engineering sciences). conclusions by the interpretation of results.	6

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	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	6	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	6	4	-	-	-	-	-	-	-	-	-	1	-	-
CO 4	3	4	2	-	1	-	-	-	-	-	-	-	1	-	-
CO 5	1	6	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 6	3	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
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	100.0	40.0	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	100.0	60.0	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	100.0	60.0	40.0	-	-	-	-	-	-	-	-	-	50.0	-	-
CO 4	100.0	40.0	20.0	-	100	-	-	-	-	-	-	-	50.0	-	-
CO 5	33.3	60.0	40.0	-	-	-	-	-	-	-	-	-	50.0	-	-
CO 6	100.0	60.0	-	-	-	-	-	-	-	-	-	-	-	-	-

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	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	3	2	-	-	-	-	-	-	-	-	-	2	-	-
CO 4	3	2	1	-	3	-	-	-	-	-	-	-	2	-	-
CO 5	1	3	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 6	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	16	16	3	-	3	-	-	-	-	-	-	-	6	-	-
AVERAGE	2.67	2.67	1.5	-	3	-	-	-	-	-	-	-	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 mini projects 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 & 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 & 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 & 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.

COURSE WEB PAGE:

1. <http://www.ebooks directory.com>
2. <http://Campus guides.lib.utah.edu>

XIX COURSE PLAN:

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

S.No	Topics to be covered	Course Out-comes	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	Discrete time signal definition; signal classification; Elementary signals;	CO 1	T1:2.1-2.3
3	Transformation of elementary signals; concept of digital frequency;	CO 1	T1:2.4,7.5
5	Linear time invariant (LTI) system; properties of the LTI system;	CO 1	T1:2.7,7.3
8	Time domain analysis of discrete time systems; impulse response;	CO 1	T1:2.8
10	The convolution sum; methods of evaluating the convolution sum;	CO 2	T1:3.2 R1:3.1-3.2
11	Filtering using overlap-save and overlap-add method	CO 2	T1:4.2
14	Realization of digital filters: concept of IIR and FIR filters;	CO 3	T1:8.1 R2:4.5
15	Realization structures for IIR and FIR filters using direct form-I and direct form-II, cascade, lattice and parallel.	CO 3	T1:8.3-8.7
18	Introduction to discrete time fourier transform (DTFT); discrete fourier transform definition;	CO 4	T1:8.7-8.9
19	Properties of DFT;	CO 4	T1:10.2.1-2.3
20	Linear and circular convolution using DFT;	CO 4	T1:10.2.4 R2:7.6
21	Fast-fourier-transform (FFT): direct computation of DFT;	CO 4	T1:11.1-11.5
22	Need for efficient computation of the DFT (FFT algorithms)	CO 4	T1:11.4
23	Radix-2 FFT algorithm for the computation of DFT and IDFT using decimation-in-time	CO 5	T1:11.9

24	Decimation-in-frequency algorithms for FFT	CO 5	T1:9.4-9.6
25	General radix-N FFT.	CO 5	T1:9.7-9.10
32	Analog filters: butterworth filters	CO 6	T1:12.1-12.3
33	Chebyshev type-1 & type-2 filters;.	CO 6	T1:12.3,7.3
34	Chebyshev type-2 filters	CO 6	T1:12.4
37	Analog transformation of prototype LPF to HPF	CO 6	T1:12.3-12.5
38	Analog transformation of prototype LPF to BPF/BSF.	CO 6	T1:12.6
39	Analog transformation of prototype LPF to BSF.	CO 6	T1:12.7 R1:3.1
40	Transformation of analog filters into equivalent digital filters using impulse invariant method	CO 7	T1:7.2
41	Bilinear transform method;	CO 7	T1:12.8 R2:4.5
42	Matlab programs of IIR and FIR filters	CO 8	T1:12.9-12.10
43	Design of linear phase FIR filters windowing	CO 9	T1:12.11-12.12
44	and frequency sampling methods;	CO 9	T1:12.13-12.14
45	Equiripple linear phase FIR filters;	CO 9	T1:12.15 R2:7.6
46	Parks-McClellan algorithm and remez algorithm;	CO 9	T1:12.16-12.17
47	Least-mean-square error filter design;	CO 9	T1:13.1 R2:8.1
48	Design of FIR differentiators;.	CO 10	T1:13.2 R2:8.2
49	Matlab programs of FIR filters;	CO 10	T1:13.3 R2:8.3
50	Comparison of FIR & IIR	CO 10	T1:13.4 R2:8.4
51	Multirate signal processing; decimation; interpolation;	CO 11	T1:13.5 R2:8.5
52	Polyphase structures for decimation and interpolation filters; Structures for rational sampling rate conversion;.	CO 11	T1:13.6 R2:8.6
53	Applications of multirate signal processing for design of phase shifters, interfacing of digital systems with different sampling rates, sub band coding of speech signals.	CO 11	T1:14.1 R3:7.1
54	Analysis of finite word length effects: representation of numbers; ADC quantization noise, coefficient quantization error,	CO 11	T1:14.2 R3:7.2
55	Product quantization error, truncation & rounding errors; limit cycle due to product round-off error; Round-off noise power;	CO 11	T1:14.3 R3:7.3
56	Limit cycle oscillations due to overflow in digital filters; principle of scaling; pead band effects	CO 11, CO 12	T1:14.4 R3:7.4
PROBLEM SOLVING/ CASE STUDIES			
6	Operation on signals	CO 1	T2:1.12
7	System characteristics	CO 1	T1:2.2
9	Time domain analysis of discrete time systems, Impulse response	CO 1	T2:1.12

12	Linear convolution,circular convolution	CO 2	T1:3.2
13	Overlap add method,overlap save method	CO 2	T1:3.2
16	Realization structures of digital filters direct form I&II	CO 3	T1: 9.2-9.3
17	Realization structures of digital filters cascade and parallel form	CO 3	T1: 9.2-9.3
26	Discrete Fourier Transform(DFT)	CO 4	T1: 7.2
27	DFT properties	CO 4	T1: 7.2
28	IDFT	CO 4	T1: 7.2
29	DIT FFT	CO 5	T1: 8.1
30	DIF FFT	CO 5	T1: 8.1
31	Inverse FFT	CO 5	T1: 8.1
35	IIR Filters-butterworth filters	CO 6	T1: 10.3
36	IIR Filters- chebyshev type-1 filters	CO 6	T1: 10.3
57	Finite word length effects	CO 11	T1: 10.3
DISCUSSION OF DEFINITION AND TERMINOLOGY			
58	System characteristics, impulse response	CO1	T2:1.12
59	DFT and FFT	CO4,CO5	T1:7.2, T1:8.1
60	IIR and FIR filters	CO 6	T1:10.2,T1:10.3
61	Multi rate signal processing	CO8,CO9	T1:11.6
62	Finite word length effects	CO 10	T1:9.4-9.6
DISCUSSION OF QUESTION BANK			
63	System characteristics,time domain analysis,convolution sum	CO1,CO2	T2:1.12, T1:3.2
64	Realization structures	CO 3	T1: 9.2-9.3
65	DFT and FFT	CO4,CO5	T1:7.2, T1:8.1
66	IIR and FIR filters	CO 6	T1:10.2,T1:10.3
67	Multirate signal processing	CO8,CO9	T1: 11.6

Signature of Course Coordinator
Dr. S China venkateswarlu, 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	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	Microprocessors and Microcontrollers				
Course Code	AEC013				
Program	B.Tech				
Semester	VI				
Course Type	Core				
Regulation	R-16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Ms B. Lakshmi Prasanna, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEC002	III	Digital System Design
B.Tech	AEC010	V	Computer organization

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	✓	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
10%	Remember
50 %	Understand
30 %	Apply
10 %	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).

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 8th and 17th 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

VI COURSE OBJECTIVES:

The students will try to learn:

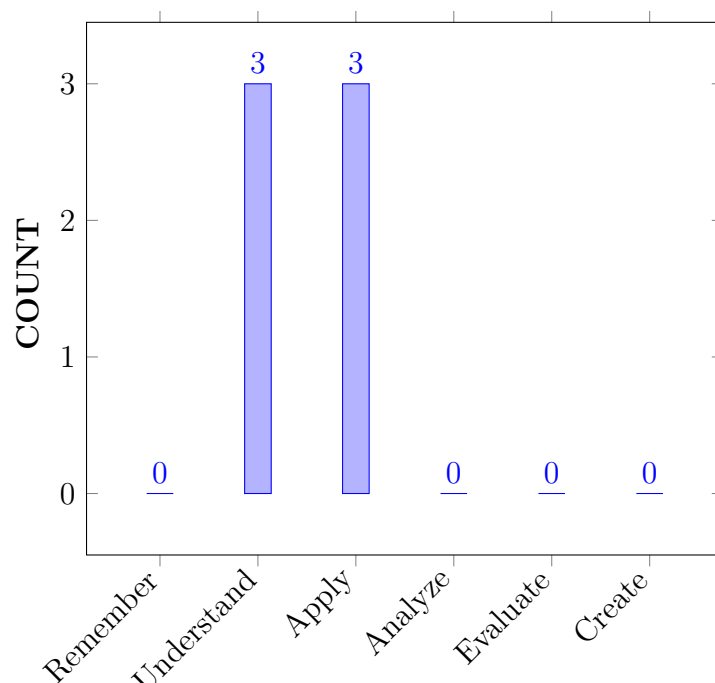
I	The signal descriptions along with functional architecture and hardware interfacing skills using microprocessors and microcontrollers.
II	The instruction set and logic to build assembly language programs for arithmetic, logic and automated electronic systems.
III	The essential concepts of development 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	Outline the functional components of microprocessors and microcontrollers for understanding the operation of architectures.	Understand
CO 2	Make use of addressing modes and instruction set of target microprocessors and microcontrollers for writing an assembly language programs to perform a task.	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 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 microprocessor and microcontroller based applications using necessary input and output devices.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

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 , 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	2	SEE, CIE, AAT , QUIZ

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.	1	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 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	2	2	2
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
	PO 10	Explain the functional components of microprocessors and microcontrollers by giving effective presentations and receive clear instructions for understanding the operation of architectures.	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
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 microcontrollers microcontrollers by giving effective presentations and receive clear instructions for writing an assembly language programs to perform a task .	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 and receive clear instructions 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 microcontrollers by giving effective presentations and receive clear instructions using interrupt controller.	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 microprocessor and microcontroller based applications using necessary input and output devices and give effective presentations and receive clear instructions.	1
	PSO 1	Develop microprocessor and microcontroller based applications in the fields of robotics 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 MAP-PING:

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	-	-	-	-	-	-	-	-	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	2	2	2
CO 1	100	-	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 2	100	30	30	-	-	-	-	-	-	20	-	-	100	-	-
CO 3	100	40	30	-	-	-	-	-	-	20	-	-	-	-	-
CO 4	-	30	30	-	-	-	-	-	-	20	-	-	-	-	-
CO 5	-	40	40	-	-	-	-	-	-	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	2	2	2
CO 6	100	60	60	-	-	-	-	-	-	20	-	-	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	-	-	-	-	-	-	-	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
X	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	8086 MICROPROCESSORS
	Register organization of 8086, Architecture, signal description of 8086, physical memory organization, general bus operation, I/O addressing capability, special purpose activities Minimum mode, maximum mode of 8086 system and timings, machine language instruction formats, addressing mode of 8086, instruction set of 8086, assembler directives and operators.
MODULE II	PROGRAMMING WITH 8086 MICROPROCESSOR
	Machine level programs, programming with an assembler, Assembly language programs, introduction to stack, stack structure of 8086/8088, interrupts and interrupt service routines. Interrupt cycle of 8086, non-mask able interrupt and mask able interrupts, interrupt programming.
MODULE III	INTERFACING WITH 8086/88
	Semiconductor memory interfacing, dynamic RAM interfacing, interfacing i/o ports, PIO 8255 modes of operation of 8255, interfacing to D/A and A/D converters, stepper motor interfacing, control of high power devices using 8255. Programmable interrupt controller 8259A, the keyboard /display controller 8279, programmable communication interface 8251 USART, DMA Controller 8257.
MODULE IV	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 V	SYSTEM DESIGN USING MICROCONTROLLER
	8051 Timers/Counters, Serial data communication and its programming, 8051 interrupts, Interrupt vector table, Interrupt programming. Real world interfacing of 8051 with external memory, expansion of I/O ports, LCD, ADC, DAC, stepper motor interfacing.

TEXTBOOKS

1. A.K Ray, K. M. Bhurchandani, “Advanced Microprocessors and Peripherals” Tata McGraw-Hill Education, 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, 2 nd Edition, 2009.
3. Douglas V. Hall, —Microprocessors and Interfacing Programming and Hardware||, TMGH, 2 nd Edition, 1994.

REFERENCE BOOKS:

1. Kenneth J. Ayala, —The 8051 Microcontroller||, Thomson Learning, 3 rd 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, 2 nd Edition, 2012.

WEB REFERENCES:

1. <http://www.nptel.ac.in/downloads/106108100/>
2. <http://www.the8051microcontroller.com/web-references>
3. <http://www.iare.ac.in>

COURSE WEB PAGE:

1. <https://www.iare.ac.in/?q=courses/electronics-and-communication-engineering-autonomous/microprocessors-and-microcontrollers>

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/electronics-and-communication-engineering-autonomous/microprocessors-and-microcontrollers
CONTENT DELIVERY (THEORY)			
2	Register organization of 8086 microprocessor	CO 1	T1:1.1 R2:1.3
3	Flag Register of 8086 Microprocessor	CO 1	T1:1.1 R2:1.2.2
4	Architecture and signal description of 8086 microprocessor	CO 1	T1:1.2 R2:1.1,6.1
5	Physical memory organization of 8086 microprocessor	CO 1	T1:1.4 R2:2.3
7	General bus operation, I/O addressing capability and special purpose activities	CO 1	T1:1.5,1.6,1.7
8	Operation of 8086 microprocessor in minimum mode with read and write timing diagrams	CO 1	T1:1.8 R2:6.3
9	Operation of 8086 microprocessor in maximum mode with read and write timing diagrams	CO 1	T1:1.9 R2:6.4
10	Machine language instruction formats	CO 2	T1:2.1 R2:3.1
11	Addressing modes of 8086 Microprocessor	CO 2	T1:2.2 R2:1.4
12	Instruction Set Of 8086 Microprocessor: Data transfer instructions	CO 2	T1:2.3 R2:3.2
13	Instruction Set Of 8086 Microprocessor: Arithmetic and Logical instructions	CO 2	T1: 2.3 R2:3.4,3.5
14	Instruction Set Of 8086 Microprocessor: Program control transfer instructions	CO 2	T1: 2.3 R2:3.3

15	Instruction Set Of 8086 Microprocessor: Machine Control Instructions and Flag manipulation instructions	CO 2	T1: 2.3 R2:3.7
16	Instruction Set Of 8086 Microprocessor: Shift and rotate instructions	CO 2	T1: 2.3 R2:3.6
17	Instruction Set Of 8086 Microprocessor: String instructions	CO 2	T1: 2.3 R2:4.1
18	Assembler Directives and operators	CO 2	T1:2.4 R2:2.2
19	Machine level programs, programming with an assembler	CO 2	T1:3.1,3.2,3.3 R2:2.1
24	Introduction to stack and stack structure of 8086/8088 microprocessor	CO 1	T1:4.1,4.2
25	Interrupts and Interrupt service routines	CO 4	T1:4.3 R2:8.1
26	Interrupt cycle of 8086 microprocessor, non- mask able interrupt and mask able interrupts	CO 4	T1:4.4,4.5,4.6 R2:8.2
27	Interrupt programming	CO 4	T1:4.7
28	Interfacing I/O ports	CO 3	T1:5.3
29	Pin diagram and Architecture 8255 PPI	CO 3	T1:5.4 R2:9.2
30	Operating modes of 8255 PPI	CO 3	T1:5.5 R2:9.3
31	A/D and D/A converters	CO 6	T1:5.6,5.7 R2:9.8,9.9
33	Stepper motor interfacing	CO 6	T1:5.8 R2:9.11
34	Control of high power devices using 8255 PPI	CO 6	T1:5.9
35	Pin configuration of 8259 PIC	CO 4	T1:6.2 R2:10.3
36	Architecture of 8259 PIC	CO 4	T1:6.2 R2:10.3
38	Keyboard /display controller 8279	CO 6	T1:6.3 R2:10.2
40	Programmable communication interface 8251 USART	CO 5	T1:6.4 R2:11.3
42	DMA Controller 8257	CO 3	T1:7.1 R2:11.6
43	Internal architecture and pin configuration of 8051 microcontroller	CO 1	T1:17.2 R2:20.1
44	Addressing modes of 8051 microcontroller	CO 2	T1:17.3
45	Instruction set of 8051 microcontroller	CO 2	T1:17.8 R2:19.9
46	Bit addressable features and I/O Port structures	CO 1	T1:17.4 R2:19.10
48	8051 Timers/Counters	CO 1	T1:17.5 R2:20.3,20.4
49	Serial data communication and its programming	CO 5	T1:17.6 R2:20.6
50	8051 interrupts, Interrupt vector table	CO 4	T1:17.7 R2:20.5

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	Programming with 8086 microprocessor	CO 1, CO 2, CO 4	T1, R2
56	Interfacing with 8086/88	CO 2, CO 3, CO 4, CO 5, CO 6	T1, R2
57	8051 microcontroller	CO 1, CO 2,	T1, R2

58	System design using microcontroller	CO 3, CO 4, CO 5, CO 6	T1, R2
DISCUSSION OF QUESTION BANK			
59	8086 Microprocessor	CO 1, CO 2	T1, R2
60	Programming with 8086 microprocessor	CO 1, CO 2, CO 4	T1, R2
61	Interfacing with 8086/88 microprocessor	CO 2, CO 3, CO 4, CO 5	T1, R2
62	8051 microcontroller	CO 1, CO 2	T1, R2
63	System design using microcontroller	CO 3, CO 4, CO 5	T1, R2

Signature of Course Coordinator
Ms B. Lakshmi Prasanna, Assistant 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	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

✓	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 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
8%	Remember
33%	Understand
42 %	Apply
17%	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	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 17th 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
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

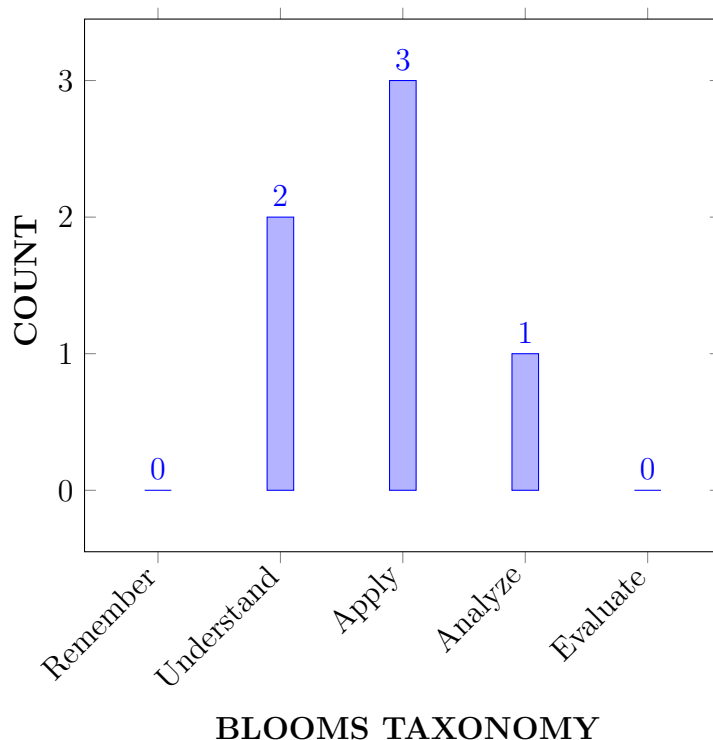
I	The performance characteristics and working principle of analog and digital instruments for measuring electrical quantities.
II	The analysis of various signals by using oscilloscopes and signal analyzers which have built in signal generators
III	The measurement of unknown resistive and reactive components by using various 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 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 tfor 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.	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

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 2	Focus on the practical experience of ASIC prototype designs, Virtual Instrumentation and SOC designs	3	SEE/ CIE / AAT
PSO 3	Build the Embedded hardware design and software programming skills for entry level job positions to meet the requirements of employers.	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
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	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	Formulate and analyze (Problem analysis) complex Engineering problems for measurement of electrical parameters using first principles of mathematics and Engineering sciences	4
	PO 3	Understand the customer needs, use creativity and manage design process in realization of measuring instruments for measuring analog and digital values and evaluate outcomes .	3
	PO 10	Effective presentation and speaking style on building blocks of an instrument and write subject matter effectively on working principle of D' Arsonval movement.	2
	PSO 2	Illustrate the concept analog and digital meters to measure voltage, current and resistance by using virtual instrumentation.	1
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	Identify, Formulate and analyze (Problem analysis) complex engineering problems for the measurement using principles of electrostatic deflection sensitivity in Oscilloscopes using review research literature and mathematics and Engineering sciences .	6
	PO 3	Understand customer needs, manage the design various Oscilloscopes for in realization of measuring signal parameters and evaluate outcomes of the circuit .	4
	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 2	Develop the model of oscilloscopes to analyze the real time signals.	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

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	Review research literature, conclusions using first principles of engineering sciences Describe the working of multi-function signal generators (Complex problem analysis).	4
	PO 3	Develop signal generator circuit based on customer needs for design of multi-function signal generators and evaluate outcomes of the design.	3
	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 2	Develop the model of signal generators to perform the real time signals.	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	Compare the working functionality of two analyzers by formulate, review research literature	3
	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 2	Develop the model of signal analyzers to examine the real time signals with the harmonic components.	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
	PO 2	Identify, formulate and Analyze AC and DC bridge circuits and compare them by its applications using first principles of mathematics and Engineering sciences.	4
	PO 3	Understand customer needs, manage the design AC and DC bridge circuits on requirement and evaluate outcomes of the circuit.	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
	PSO2	Understand the performance of a bridge using practical experience to analyze Virtual Instrumentation	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

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	Identify, formulate, review research literature using first principles of engineering sciences illustrate Transducers and classify them according to their application) (complex engineering problems) .	5
	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.	4
	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 using all active and passive Transducers	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	4	3	-	-	-	-	-	-	2	-	-	-	1	-
CO 2	3	6	4	-	-	-	-	-	-	2	-	-	-	2	-
CO 3	3	4	3	-	-	-	-	-	-	2	-	-	-	2	-
CO 4	3	3	-	-	-	-	-	-	-	2	-	-	-	2	-
CO 5	3	4	3	-	-	-	-	-	-	2	-	-	-	2	-
CO 6	3	5	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
	100	40	30	-	-	-	-	-	-	40	-	-	-	50	-
CO 1	100	40	30	-	-	-	-	-	-	40	-	-	-	50	-
CO 2	100	60	40	-	-	-	-	-	-	40	-	-	-	100	-
CO 3	100	40	30	-	-	-	-	-	-	40	-	-	-	100	-
CO 4	100	30	-	-	-	-	-	-	-	40	-	-	-	100	-
CO 5	100	40	30	-	-	-	-	-	-	40	-	-	-	100	-
CO 6	100	50	40	-	-	-	-	-	-	40	-	-	-	-	66.7

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	0	0	0	0	0	0	2	0	0	0	2	0
CO 2	3	2	2	0	0	0	0	0	0	2	0	0	0	3	0
CO 3	3	2	1	0	0	0	0	0	0	2	0	0	0	3	0
CO 4	3	2	0	0	0	0	0	0	0	2	0	0	0	3	0
CO 5	3	1	1	0	0	0	0	0	0	2	0	0	0	3	0
CO 6	3	2	2	0	0	0	0	0	0	2	0	0	0	0	3
TOTAL	18	11	8	0	0	0	0	0	0	12	0	0	0	14	3
AVERAGE	3	1.8	1.4	0	0	0	0	0	0	2	0	0	0	2.8	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:

UNIT 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.
UNIT 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.
UNIT 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
UNIT 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.
UNIT 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. Helbins, 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 2	T1:7.19-7.28,R2:4.7-4.13

S.No	Topics to be covered	CO's	Reference
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
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

S.No	Topics to be covered	CO's	Reference
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	UNIT-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	UNIT-II: Oscilloscopes	CO 2	T1:7.1-7.32
59	UNIT-III: Signal Generators and Wave Analyzers	CO 3,4	T1:8.1-8.10,9.1-9.6
60	UNIT-IV: AC and DC Bridges	CO 5	T1:11.1.-11.18
61	UNIT-V: Transducers	CO 6	T1:13.1-13.25
DISCUSSION OF QUESTION BANK			
62	UNIT-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	UNIT-II: Oscilloscopes	CO 2	T1:7.1-7.32
64	UNIT-III: Signal Generators and Wave Analyzers	CO 3,4	T1:8.1-8.10,9.1-9.6
65	UNIT-IV: AC and DC Bridges	CO 5	T1:11.1.-11.18
66	UNIT-V: Transducers	CO 6	T1:13.1-13.25

Course Coordinator
Mr.Mohd.Khadir, Assistant Prfoessor

HOD,ECE

ANNEXURE - I

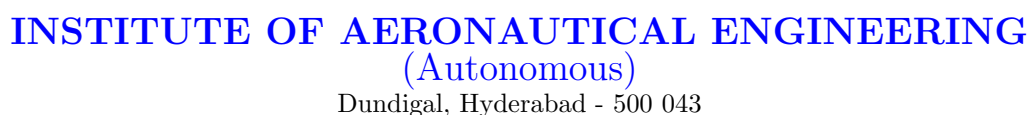
KEY COMPETENCIES FOR ASSESSING PROGRAM OUTCOMES

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



Department	Electronnics and Communication Engineering				
Course Title	Cellular and Mobile Communications				
Course Code	AEC520				
Program	B.Tech				
Semester	VI				
Course Type	Professional Elective-III				
Regulation	R-16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mr B.Santhosh Kumar, Assistant Professor				

Level	Course Code	Semester	Prerequisites
B.Tech	AEC005	IV	Analog Communications
B.Tech	AEC009	V	Digital Communications

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.

Subject	SEE Examination	CIE Examination	Total Marks
Cellular and Mobile Communications	70 Marks	30 Marks	100

✓	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 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
17%	Remember
49%	Understand
34%	Apply

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 8th and 17th 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

VI COURSE OBJECTIVES:

The students will try to learn:

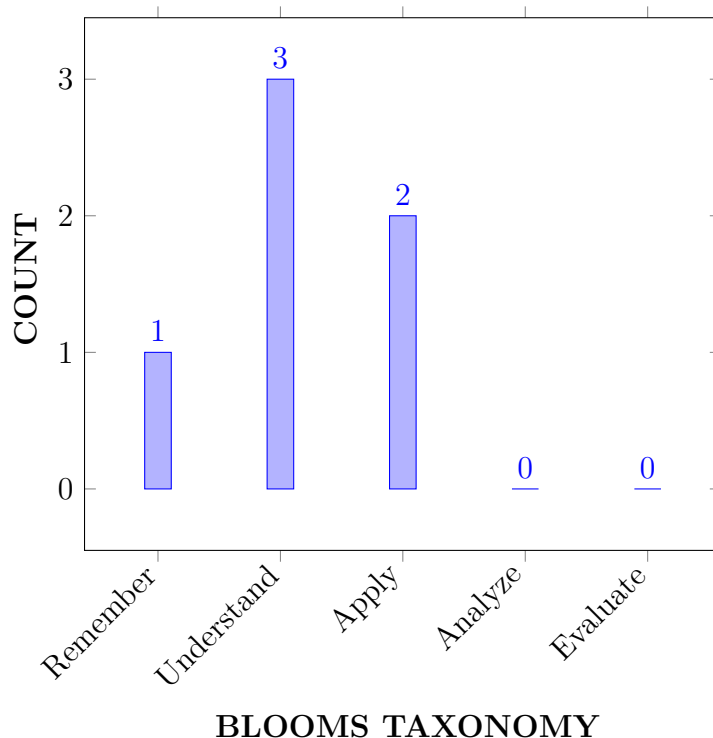
I	The cellular mobile system, cell coverage, cell site and mobile antennas system for interference reduction.
II	The wireless system standard applications for the Global System for Mobile Communications, Code Division Multiple Access and Time Division Multiple Access technologies.
III	The advanced intelligent network for wireless communications and future public land mobile telecommunications.

VII COURSE OUTCOMES:

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

CO 1	Demonstrate the cellular mobile system design concepts to improve the Signal to noise ratio and cell coverage	Understand
CO 2	Utilize the omni directional and directional antennas to improve the channel capacity and interference reduction for improving the design parameters.	Apply
CO 3	Find the Co-channel and non co-channel interferences and their parameters to improve the system capacity.	Remember
CO 4	Illustrate the importance of Handoff for preventing loss of interruption of services to a caller.	Understand
CO 5	Make use of the Numbering and grouping, setup access and paging channels for low traffic in the mobile and land originating calls.	Apply
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:

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.	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

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	–	–
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	Research papers /Project

3 = High; 2 = Medium; 1 = Low

XI 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	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	5	-	-	-	-	-	-	-	-	-	-	-	-	2
CO 4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	2	-	2	-	-	-	-	-	-	-	-	-	-	-	2
CO 6	3	5	-	-	-	-	-	-	-	-	-	-	-	-	1

XII 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	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	100	-	20	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	67	50	-	-	-	-	-	-	-	-	-	-	-	-	100
CO 4	67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	67	-	20	-	-	-	-	-	-	-	-	-	-	-	100
CO 6	100	50	-	-	-	-	-	-	-	-	-	-	-	-	50

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

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
	P02	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
CO 2	PO1	Understand the concept of frequency reuse channels, deduce the co-channel interference reduction factor.	3
	PO3	Outline the concept of frequency channels and desired C/I in an omni directional antenna system.	2

CO 3	PO1	Remember concepts of cell coverage for signal and traffic.	2
	PO2	Compare the co-channel and non co-channel interferences, antenna system and their parameters.	5
	PSO3	Understand impairments due to multipath fading channel and be able simulate standard stochastic channel models for various environments.	2
CO 4	PO1	Illustrate the concepts of signal reflects in flat and hilly terrain and phase difference between direct and reflected paths.	2
CO 5	PO1	Interpret current and proposed cellular technologies	2
	PO3	Analyze various methodologies to improve the channel capacity and reduce the interferences	2
	PSO3	Interpret current and proposed cellular technologies	2
CO 6	PO1	Utilize the advanced wireless technologies for future wireless networks .	3
	PO2	Illustrate the concepts of signal reflects in flat and hilly terrain and phase difference between direct and reflected paths.	5
	PSO3	Able to work in advanced research wireless and mobile cellular networks.	1

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

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
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	5	-	-	-	-	-	-	-	-	-	-	-	-	2
CO 4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	2	-	2	-	-	-	-	-	-	-	-	-	-	-	2
CO 6	3	5	-	-	-	-	-	-	-	-	-	-	-	-	1

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	2	2	2
CO 1	100	40	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	100	-	20	-	-	-	-	-	-	-	-	-	-	-	-

CO 3	67	50	-	-	-	-	-	-	-	-	-	-	-	-	100
CO 4	67	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	67	-	20	-	-	-	-	-	-	-	-	-	-	-	100
CO 6	100	50	-	-	-	-	-	-	-	-	-	-	-	-	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	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	2	-	-	-	-	-	-	-	-	-	-	-	-	3
CO 4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	1	-	-	-	-	-	-	-	-	-	-	-	3
CO 6	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2
TOTAL	18	5	2	-	-	-	-	-	-	-	-	-	-	-	8
AVERAGE	3	1.66	1	-	-	-	-	-	-	-	-	-	-	-	2.66

XVII 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	-	-	-	-	-

XVIII ASSESSMENT METHODOLOGY INDIRECT:

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

XIX 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.
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.
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

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/details](https://lms.iare.ac.in/index?route=course/details) course id 127

XX 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, Frequency Reuse.	CO 1	T1-3.2-3.3
3	Channel Assignment Strategies, Handoff Strategies.	CO 1	T1-3.3-3.4
4	Prioritizing Handoffs, Practical Handoff Considerations	CO 2	T1-3.3-3.4
5	Interference and system capacity -Co channels Interference and system capacity	CO 2	T1-3.5
6	Channel planning for Wireless Systems.	CO 2	T1-4.2
7	Trunking and Grade of Service	CO2	T1-4.4
8	Brewster Angle, Reflection from prefect conductors	CO 2	T1-4.2
9	Reflection: Reflection from dielectrics	CO 2	T1-4.6
10	The Three Basic Propagation Mechanisms, Reflection-Reflection from Dielectrics	CO 3	T1-4.7

11	Scattering and outdoor propagation models	CO 2	T1-4.10
12	Longley-Ryce model and okumura Model,	CO 3	T1-4.10.6
13	Indoor propagation models-partition losses (Same Floor) and partition losses between floors	CO 3	T1-4.11
14	Ericsson multiple break point model and attenuation factor model,	CO 3	T1-4.2
15	Small-scale fading and multipath	CO 3	T1-5.1.1
16	Factors influencing small scale fading	CO 2	T1-5.1.1
17	Relationship between bandwidth and received power	CO 4	T1-5.1.1
18	Spread spectrum sliding correlator channel sounding and parameters of mobile multipath channels	CO 2	T1-5.2
19	Coherence bandwidth and doppler spread and coherence time, types of small - Scale fading.	CO 3	T1-5.3
20	Fading effects due to multipath time delay spread	CO 3	T1-5.3.2
21	Slow fading, statistical models for multipath fading channels	CO 2	T1-5.3.3,5.4
21	Clarkes model for flat fading	CO 6	T1-5.4.2
22	Ground Reflection (Two-Ray) Model, Diffraction-Fresnel Zone Geometry	CO 3	T1-5.5
23	Level crossing and fading statistics, two-ray Rayleigh fading model.	CO 3	T1-5.11
24	Small scale multipath measurements	CO 4	T1-5.11
25	Fading effects due to Doppler Spread-Fast fading	CO 3	T1-5.11
26	Two-ray Rayleigh fading model	CO 3	T1-5.11
27	Fundamentals of equalization	CO 4	T1-7.1,7.2
28	Training a generic adaptive equalizer	CO 3	T1-7.3,7.4
29	Non-linear equalization	CO 2	T1-7.6,7.7
30	Decision feedback equalization (DFE) and maximum likelihood sequence estimation equalizer (MLSE)	CO 3	T1-7.7.2
31	Algorithms for adaptive equalization	CO 2	T1-7.8
32	Derivation of selection diversity improvement	CO 4	T1-7.8.1,8.2
33	Derivation of maximal ratio combining improvement, practical space diversity consideration	CO 4	T1-7.10,11
34	Diversity techniques	CO 3	T1-7.10.2-3
35	Polarization diversity and RAKE receiver.	CO 4	T1-7.10.3

36	Introduction to wireless networks	CO 5	R3-P184
37	WLAN topologies and WLAN standard IEEE 802.11	CO 5	R3-P185
38	Comparison of IEEE802.11 a,b,g and n standards	CO 6	R3-P191
39	IEEE 802.16 and its enhancements	CO 6	R3-P190
40	Wireless PANs, Hipper LAN, WLL.	CO 5	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 3	T1-4.6
47	Problems on phase difference between direct and reflected paths	CO 3	T1-5.3.2
48	Problems on path loss slope	CO 3	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 3	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 6	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

Course Coordinator
Mr B.Santhosh Kumar, Assistant 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	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

✓	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 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
40 %	Apply
10 %	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), 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	05	05	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.

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
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

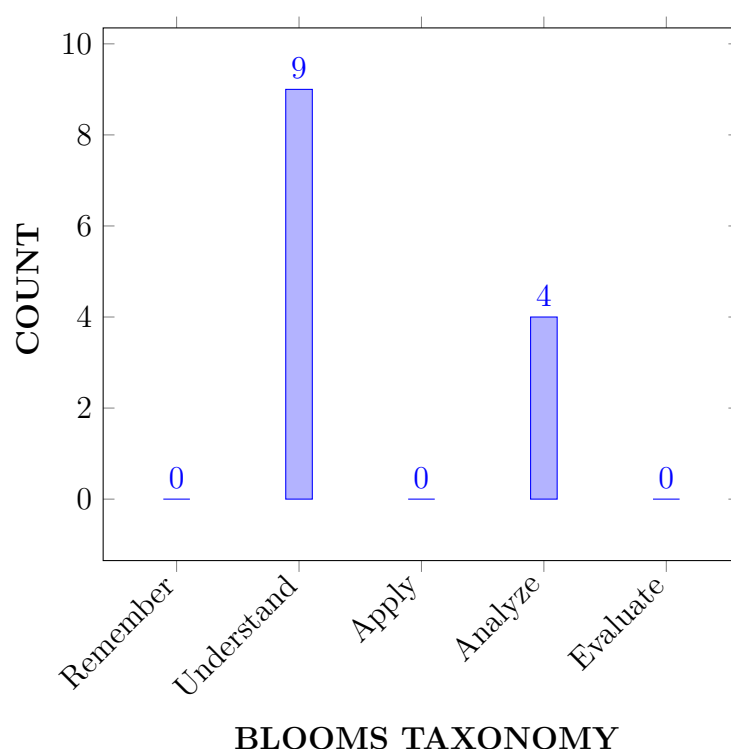
I	The principle and operation of radar systems and radar range equation for communication.
II	The use of Doppler frequency shift to detect moving target in stationary clutter , continuous wave radar system in altimeter applications.
III	The types of radar receivers, transmitter systems and effect of noise on radar signal detection.

VII COURSE OUTCOMES:

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

CO 1	Demonstrate the principle and operation of Radar using Radar Range Equation to calculate transmitted power.	Understand
CO 2	Analyze the principle of FM-CW radar and use it in FM- CW altimeter to measure range and Doppler frequency of the target	Analyze
CO 3	Illustrate the concept of blind speeds, range gated Doppler filters and moving target indicator with Pulse Doppler radar for detection of moving targets.	Understand
CO 4	Choose the appropriate matched filters in Radars receivers to maximize signal to noise ratio	Apply
CO 5	Describe Radar displays and duplexers for transmission and display the data on the screen	Understand
CO 6	Examine the Tracking radar principles, different types of angle trackingfor obtaining Target position	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.	2	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 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
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 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	-

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 basic principle of radar System with the help of Block diagram (knowledge) using the principles of science and mathematics for engineering problems .	3
	PO 10	Communicate effectively on the factors affecting the radar performance using radar range equation to calculate Transmitter power.	2
CO 2	PO 1	Understand the principle of frequency modulated –continuous wave radar using the principles of science and mathematics for engineering problems .	2
	PO 2	Analyze the concept and apply it for altimeter applications Use research-based knowledge and of data to provide valid conclusions .	2
	PO 10	Communicate effectively the concept using effective presentations	2
CO 3	PO 1	understand the principle of moving target indicator radar and Pulse Doppler radar using the principles of science and mathematics for engineering problems	2
	PO 4	Differentiate the two radars for moving target indication and clutter rejection Design solutions for complex engineering problems for the public safety environmental considerations	1
	PO 10	Communicate effectively the concept of moving target indicator using effective presentations	2
CO 4	PO 1	Understand the concept of matched filters in Radars receivers using the principles of science and mathematics for engineering problems)	2
	PO 4	Explain the concept of matched filters in Radars receivers Identify, formulate, review research using first principles of engineering sciences .	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 10	Communicate effectively the concept of matched filters in Radars receivers	2
	PSO 3	Analyze the concept to measure received signal power using High frequency structure simulator Use research-based knowledge and of data to provide valid conclusions.	2
CO 5	PO 1	Understand (knowledge) the concepts display devices and duplexers by applying the principles of mathematics, science to the solutions of complex engineering problems	3
	PO 3	Desin display devices and receviers usin complex engineering solutions to meet specified needs with appropriate consideration for the public health and safety	1
	PO 10	Communicate effectively the concept of display devices and duplexers using effective presentations	2
	PSO 3	Analyze the concept of display devices and duplexers for wireless communication applications	2
CO 6	PO 1	(Understand) the Tracking radar principles, different types of angle tracking using the principles of science and mathematics for engineering problems)..	2
	PO 2	Identify, formulate, review research the Tracking radar principles, different types of angle tracking	2
	PO 4	Use research-based knowledge analysis and interpretation of data of target echo signal for obtaining the Target position	2
	PO 10	Communicate effectively the concept of Tracking radar principles using effective presentations	1
	PSO 3	Make use of High frequency structure simulator (HFSS) for evaluating the Tracking radar principles for wired and wireless communication applications	2

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAP- PING:

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	2	2	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 3	2	-	-	1	-	-	-	-	-	2	-	-	-	-	-
CO 4	2	-	-	3	-	-	-	-	-	2	-		-	-	2
CO 5	3	-	1	-	-	-	-	-	-	2	-	-	-	-	2
CO 6	2	2	-	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	-	-	-	-	-	-	-	-	-	30		-	-	-
CO 2	66.7	20	-	-	-	-	-	-	-	-	40	-	-	-	-
CO 3	66.7	-	10	-	-	-	-	-	-	-	30	-	-	-	-
CO 4	66.7	-	-	27.3	-	-	-	-	-	-	30		-	-	100
CO 5	100	-	10	-	-	-	-	-	-	-	30	-	-	-	100
CO 6	66.7	20	-	18.2	-	-	-	-	-	-	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	-	-	-	-	-	-	-	-	1	-		-	-	-
CO 2	2	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	2	-	-	1	-	-	-	-	-	1	-	-	-	-	-
CO 4	2	-	-	3	-	-	-	-	-	1	-		-	-	3
CO 5	3	-	1	-	-	-	-	-	-	1	-	-	-	-	3
CO 6	2	2	-	2	-	-	-	-	-	1	-		-	-	3
TOTAL	14	4	1	6	0	0	0	0	0	6	0	0	0	0	9
AVERAGE	2.11	2.0	1.0	2.0	0	0	0	0	0	1.0	0	0	0	0	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	FUNDAMENTALS OF RADAR
	Introduction; radar frequencies and applications; Maximum unambiguous range; Radar wave forms; Radar equation; Radar block diagram and operation; Basic pulsed radar system; Moving target indication; Prediction of range performance; Minimum detectable signal; Receiver noise and SNR; Radar cross section of targets; Cross section fluctuations, transmitter power, PRF and range ambiguities; system losses, related problems.
MODULE II	CW AND FREQUENCY MODULATED RADAR
	Doppler Effect, CW Radar: Block Diagram; Isolation between transmitter and receiver; Non-zero IF receiver, receiver bandwidth requirements, applications of CW radar, illustrative problems; FM-CW radar, range and Doppler measurement, block Diagram and characteristics (Approaching/ Receding Targets), FM-CW altimeter, multiple frequency CW radar .
MODULE III	MOVING TARGET INDICATION AND PULSE DOPPLER RADAR
	Introduction to Doppler and moving target indication radar, principle and block diagram of moving target indication, power amplifier transmitter, delay line cancellers, filter characteristics, blind speeds, double cancellation, staggered pulse repetition frequencies, MTI radar parameters, moving target detector; limitations to MTI performance, non-coherent MTI. Pulse doppler radar; radar Equation for pulsed radar; moving target indication versus pulse doppler radar .
MODULE IV	TRACKING RADAR AND RADAR DETECTION IN NOISE
	Introduction, single target tracking: range, Doppler and angle measurement, track while scan, angle tracking: sequential lobing, conical scan, monopulse; Tracking radar: Amplitude comparison monopulse (one- and two coordinates), phase comparison monopulse, tracking in range, acquisition and scanning patterns, comparison of trackers. matched filter receiver, response characteristics and derivation, correlation function and cross-correlation receiver, efficiency of non matched filters, matched filter with non-white noise.
MODULE V	RADAR RECEIVERS
	Noise figure and noise temperature; Displays: Types; Duplexers, branch type and balanced type, circulators as duplexers; Introduction to phased array antennas: Basic concepts, radiation pattern, beam steering and beam width changes, series versus parallel feeds, applications, advantages and limitations

TEXTBOOKS

1. Merrill I Skolnik, "Introduction to Radar Systems", TMH Special Indian Edition, 2nd Edition, 2007.

REFERENCE BOOKS:

1. Merrill I Skolnik , "Radar Handbook", McGraw-Hill Professional Publishing, 3rd Edition, 2008

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)			
2	Radar frequency bands and Applications; Radar Range equation	CO 1	T1: 1.1-1.3
3	Pulse Radar: Block diagram and Operation; Maximum unambiguous range	CO 1	T1: 1.4-1.6
4	Receiver Bandwidth, SNR; Probability of False alarm	CO 2	T1:2.1-2.2
5	Probability of Target Detection, Integration of echo pulses- SNR improvement	CO 2	T1:2.3-2.4
6	Radar Cross Section (RCS) of targets	CO 1	T1:2.7-2.12
7	RCS fluctuation models, transmitter power, PRF and Range ambiguities; system losses	CO 1	T1:2.7-2.12
8	system losses	CO 1	T1:2.7-2.12
9	Moving Targets and Doppler Frequency	CO 4	T1:3.1-3.2
10	CW Radar: Introduction, Block Diagram, Isolation between transmitter and receiver, Non-zero IF receiver,	CO 4	T1:3.3-3.4
11	Non-zero IF receiver	CO 4	T1:3.5-3.6
12	Frequency Modulated CW radar: Range and Doppler measurement, Mathematical Analysis,	CO 4	T1:3.7-3.8
13	Block Diagram and characteristics, FM-CW altimeter	CO 4	T1:3.6-3.7
14	multiple frequency CW radar	CO 4	T1:3.8-3.9
15	Moving target indication (MTI) on A scope	CO 5	T1:4.1-4.4
16	butterfly effect, MTI using delay line canceller (DLC) Doppler measurement using Pulse radar, MTI radar .	CO 5	T1:4.5-4.8
17	Doppler measurement using Pulse radar, MTI radar .	CO 5	T1:4.9-4.10
18	Range gated doppler filters, MTI radar parameters	CO 6	T1:5.1-5.3
19	moving target detector; MTI radar performance: Parameter Definitions,	CO 6	T1:4.1-4.10
19	limitations to MTI performance	CO 6	T1:4.1-4.10
20	Search and Tracking radars, track while scan (TWS) radar, Angle/Bearing Tracking: Sequential Lobing	CO 6	T1:5.1-5.2

21	Conical scan, Monopulse methods; Monopulse Tracking	CO 6	T1:5.3-5.4
22	Amplitude comparison, Phase comparison, Bearing errors	CO 6	T1:5.5-5.6
23	Glint Noise and Frequency Agility, Tracking in range, Acquisition,	CO 6	T1:5.7-5.8
24	Comparison of trackers	CO 6	T1:5.8-5.10
25	Tracking with Surveillance Radar	CO 6	T1:5.9-5.10
26	MF response characteristics; Correlation Receiver	CO 3	T1:10.1- 10.3
27	Efficiency of non matched filters,	CO 3	T1:10.4- 10.5
28	Matched filter with non-white noise	CO 6	T1:10.6- 10.7
29	Automatic Detection of radar signals	CO 6	T1:10.8- 10.9
30	Tapped Delay Line (TDL) detection, CFAR receiver	CO 6	T1: 10.8 T1: 13.1-13.2
31	Radar Clutter: Land and Sea clutter	CO 5	T1: 10.8 T1: 13.3-13.4
32	Advantages and Disadvantages of Magnetron Oscillator	CO 5	T1:6.1-6.3
33	Klystron Amplifier, Traveling wave tube (TWT) Amplifier	CO 5	T1:6.4-6.6
34	SHybrid Linear-Beam Amplifier	CO 5	T1:6.1-6.6
35	Crossed-Field Amplifiers	CO 5	T1:6.1-6.6
36	Receiver Noise Figure (NF)	CO 5	T1:9.1-9.5 T1: 8.1-8.3
37	NF of Mixers	CO 6	T1:9.1-9.5
38	Basics of Radar Displays and Duplexers	CO 4	T1:9.1-9.5
39	Phased array antennas: Current and Radiation pattern	CO 4	T1:9.1-9.3 T1: 8.1-8.3
40	Beam steering and effects	CO 4	T1:9.4-9.5 T1: 8.3-8.4
41	Basics of Antenna feeds and Phase shifters	CO 5	T1:9.6-9.7 T1: 8.5-8.8
PROBLEM SOLVING/ CASE STUDIES			
42	Radar Range equation	CO 2	T1-4.3.1-4.3.1
43	Maximum unambiguous range	CO 2	R4- 6.8-6.9 R4- 6.14- 6.15
44	Pulse Radar	CO 2	T1-4.4- 4.5
45	Cut off frequency of rectangular waveguide	CO 3	T1 -4.6
46	CW Radar	CO 4	T1-10.1.1- 10.1.2
47	FM-CW Radar	CO 4	T1-7.1-7.3
48	Doppler measurement using Pulse radar	CO 4	T1-8.1-8.3
49	MTI Radar	CO 5	R4-7.2
50	delay line canceller (DLC)	CO 5	R4- 7.13
51	Tracking radars	CO 5	T1-8.5-8.6
52	Klystron Amplifier	CO 5	T1-8.6-8.7

53	Receiver Noise Figure (NF)	CO 6	T1-9.1-9.3
54	Crossed-Field Amplifiers	CO 5	T1-11.4
55	Phased array antennas	CO 5	T1-11.5
56	Antenna feeds and Phase shifters	CO 6	T1-11.5
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Introduction	CO 2	T1-4.3.1-4.3.1
58	CW and frequency modulated radar	CO 5	R4- 7.13
59	Moving Target Indication and Pulse Doppler radar	CO 6	T1-9.1-9.3
60	Tracking radar and radar detection in noise	CO 6	T1-9.4-9.6
61	Radar Transmitters and Receivers	CO 6	T1-11.5
DISCUSSION OF QUESTION BANK			
62	Introduction lines	CO 2	T1-4.3.1-4.3.1
63	CW and frequency modulated radar	CO 5	R4- 7.13
64	Moving Target Indication and Pulse Doppler radar	CO 6	T1-9.1-9.3
65	Tracking radar and radar detection in noise	CO 6	T1-9.4-9.6
66	Radar Transmitters and Receivers	CO 6	T1-11.5

Signature of Course Coordinator
Ms P.Annapurna Assistant Professor

HOD,ECE



INSTITUTE OF AERONAUTICAL ENGINEERING (Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	ELECTRONICS AND COMMUNICATION ENGINEERING				
Course Title	SATELLITE COMMUNICATION				
Course Code	AEC522				
Program	B.Tech				
Semester	VI				
Course Type	Core				
Regulation	R-16				
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	AEC009	V	Digital Communications

II COURSE OVERVIEW:

Satellites form an essential part of telecommunications worldwide. This course will cover the fundamentals of satellite communications, LEO satellites, MEO satellites, GEO satellites, and orbits. Transponders on communication satellites, link budget calculations, multiple access techniques and the propagation of radio waves through the earth's atmosphere. This course also covered the growth of VSAT systems and internet packet communications in satellite

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Satellite 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). 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
%	Remember
50%	Understand
33.3%	Apply
16.7%	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 8th and 17th 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, METE (Modeling and Experimental Tools in Engineering), MOOCs etc.

VI COURSE OBJECTIVES:

The students will try to learn:

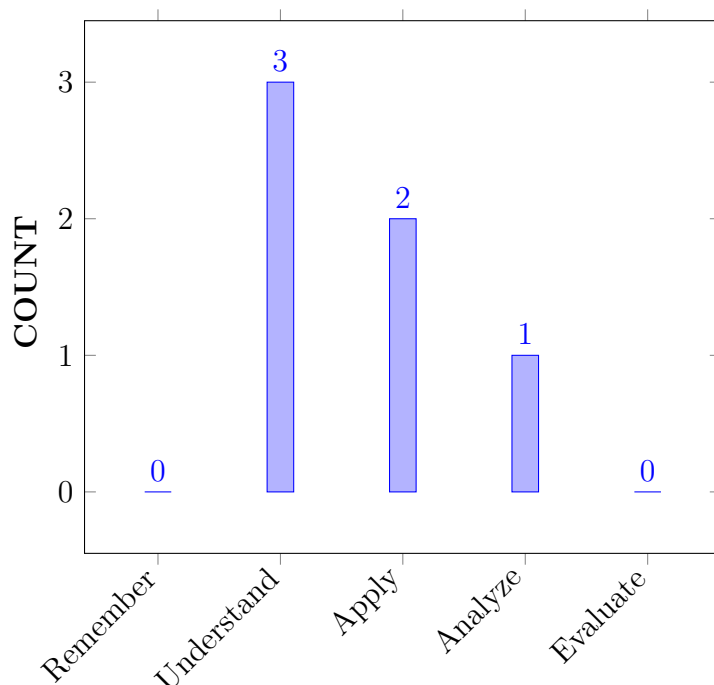
I	The basics of orbital mechanics, the types of satellite orbits, the location of ground stations, and the look angles from ground stations to the satellite
II	Organization of communications between a satellite and a ground station (TTC and M, payload, data and channels), basic analysis of link budget and examples of calculations.
III	The application of the satellite communication in the fields of multi spectral remote sensing, resource management and mineral exploration

VII COURSE OUTCOMES:

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

CO 1	Outline the concept of orbital mechanics and satellite systems for characterized the different types of earth orbits	Understand
CO 2	Organize the functions of major satellite subsystems and satellite uplink / downlink for controlling and tracking the satellite	Apply
CO 3	Analyze the satellite uplink / downlink to achieve the required C/N ratio using basic transmission theory	Analyze
CO 4	Interpret the technique of earth stations to simultaneously share the resources of the same transponder using multiple access systems	Understand
CO 5	Extend the earth station technology to a VSAT terminal to operate into a single transponder using TDM/PSK technology	Understand
CO 6	Apply the satellite packet switching technology and error control coding for digital satellite links	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

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 / 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 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

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	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	✓	✓	-	✓	-	-	-	-	-	✓	-		-	-	-
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 concept of altitude by applying the Scientific, mathematical principles and own engineering discipline.	3
	PO 2	Identify the different types of earth orbits, formulate their altitudes by reviewing research literature, analyze complex engineering problems, interpret and validate the results with the basics of engineering science.	5
	PO 10	Communicate orally on altitude and write effective reports on orbital mechanics	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 2	PO 1	Understand the functions of a satellite subsystems and satellite link by applying the mathematical principles and own engineering discipline	3
	PO 2	Review the functions of subsystems, formulate the appropriate command code for controlling and tracking by reviewing research literature, analyze complex engineering problems, interpret and validate the results with the basics of engineering science	5
	PO 4	Recognize (knowledge) the importance of telemetry, tracking and command system in station keeping understand the corresponding context of the engineering knowledge, the command subsystem controls the satellite operation (technical uncertainty) by receiving the decoding command codes from the earth station and analyze the command codes	5
	PO 10	Communicate orally on satellite subsystems and write effective reports on tracking	2
	PSO 3	Make use of High Frequency Structure Simulator(HFSS) for designing the tracking antenna	1
CO 3	PO 1	Understand the basic satellite link analysis by applying the scientific, mathematical principles and own engineering discipline	3
	PO 2	Identify the importance of C/N ratio in satellite uplink and downlink, formulate the C/N ratio by reviewing research literature, analyze complex engineering problems, interpret and validate the results with the basics of engineering science	5
	PO 4	Recognize (knowledge) the effect of C/N ratio in satellite link analysis, understand the corresponding context of the engineering knowledge , free space loss and atmospheric absorption (technical uncertainty) in both uplink and downlink, analyze the C/N ratio by applying the transmission theory	5
	PO 10	Communicate orally on satellite link analysis and write effective reports on C/N ratio	2
CO 4	PO 1	Understand the multiple access of satellite communications and interference by applying the mathematical principles and own engineering discipline	3
	PO 2	Identify the importance of C/N ratio in satellite uplink and downlink, formulate the C/N ratio 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.
	PO 4	Recognize (knowledge) the effect of interference in satellite link, understand the corresponding context of the engineering knowledge, adjacent channel, intermodulation and intersymbol interference (technical uncertainty) in both uplink and downlink, analyze the non-linear characteristic of power amplifiers in transponders applying the out-of-band rejection of the satellite output multiplexer	5
	PO 10	Communicate orally on multiple access of satellite communications	1
CO 5	PO 1	Understand the performance of earth station technology in terms of figure of merit by applying the mathematical principles and own engineering discipline	3
	PO 2	Review the different types of VSAT networks by research literature , analyze complex engineering problems , interpret and validate the results with the basics of engineering science	5
	PO 10	Communicate orally on the performance of earth station technology and write effective reports on VSAT networks	2
	PSO 3	Make use of High Frequency Structure Simulator (HFSS) for designing the earth station antenna	1
CO 6	PO 1	Understand the concept of satellite packet switching for data traffic and error correction coding in digital satellite communication systems applying the mathematical principles and own engineering discipline	3
	PO 2	Review the various correction codes like block codes and convolutional codes by research literature , analyze complex engineering problems , interpret and validate the results with the basics of engineering science	5
	PO 10	Communicate orally on the importance of error control codes and write effective reports on data traffic	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	5	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 2	3	5	-	5	-	-	-	-	-	2	-	-	-	-	1
CO 3	3	5	-	5	-	-	-	-	-	2	-	-	-	-	-
CO 4	3	5	-	5	-	-	-	-	-	2	-	-	-	-	-
CO 5	3	5	-	-	-	-	-	-	-	2	-	-	-	-	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	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	100	50	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 2	100	50	-	45.4	-	-	-	-	-	40	-	-	-	-	50
CO 3	100	50	-	45.4	-	-	-	-	-	40	-	-	-	-	-
CO 4	100	50	-	45.4		-	-	-	-	40	-	-	-	-	-
CO 5	100	50	-	-	-	-	-	-	-	40	-	-	-	-	50
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
CO 1	3	2	-	-	-	-	-	-	-	1	-	-	-	3	
CO 2	3	2	-	2	-	-	-	-	-	1	-	-	-	-	2
CO 3	3	2	-	2	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	2	-	2	-	-	-	-	-	1	-	-	-	-	-
CO 5	3	2	-	-	-	-	-	-	-	1	-	-	-	-	2
CO 6	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
TOTAL	18	12	-	6	-	-	-	-	-	6	-	-	-	-	4
AVERAGE	3	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	COMMUNICATIONS SPACECRAFT AND ORBITS
	Overview of present and future trends of satellite communications introduction to satellite systems: low earth orbit (LEO), medium earth orbit (MEO), geo synchronous earth orbit (GEO), geostationary earth orbit (GEO); Orbital mechanics: orbital elements, locating the satellite with respect to the earth, coverage angle, slant range, inclined orbits, orbital perturbations due to earth's oblateness and moon and sun, eclipse of GEO satellite, sun transit outage
MODULE II	SPACE SEGMENT
	Placement of a communication satellite in GEO satellite sub systems: telemetry, tracking and command system, power system, satellite antenna equipment, communications subsystem and transponders, TWT amplifier operation, satellite frequency bands and allocations; Satellite link: basic transmission theory, system noise temperature and G/T ratio, basic link analysis, design of satellite links for a specified C/N with and without frequency Re-use , link budget; Propagation effects: introduction, atmospheric absorption, cloud attenuation, troposphere and ionospheric scintillation and low angle fading; Effects of rain: rain induced attenuation, rain induced cross polarization interference
MODULE III	COMMUNICATION SATELLITE ACCESS SYSTEMS
	Multiple Access: Frequency division multiple access (FDMA), Time division multiple access (TDMA), frame structure, burst structure, satellite switched TDMA, on-board processing, demand assignment multiple access (DAMA), types of demand assignment, characteristics. Code division multiple access (CDMA) / Spread spectrum multiple access (SSMA); direct sequence CDMA (DS-CDMA) or DS spread spectrum transmission and reception, adjacent channel interference, inter modulation, handover, satellite diversity
MODULE IV	EARTH STATION AND VSAT SYSTEMS TECHNOLOGY
	Earth Station: Transmitters, receivers, antennas, tracking systems, terrestrial interface, power test methods, lower orbit considerations; VSAT (Very Small Aperture Terminal) Systems: overview of VSAT systems, VSAT network architecture, access control, and multiple access selection. NGSO constellation design: orbits, coverage, frequency bands, delay and throughput, non geostationary orbit (NGSO) constellation design and problems
MODULE V	SATELLITE PACKET COMMUNICATION
	Message transmission by FDMA: M/G/1 queue, message transmission by TDMA, pure aloha, satellite packet switching, slotted aloha, packet reservation, tree algorithm, error control for digital satellite links, error control coding, block codes, convolution codes, implementation of error detection on satellite links. Overview of future satellite communication systems, introduction to satellite laser communication, data relay communication satellites, satellite mobile services, applications

TEXTBOOKS

1. Dennis rodgy —Satellite Communications, 4th Edition, 2004.
2. Pratt. Bostian, Allnutt, —Satellite Communications, Wiley India, 2nd Edition, 2006.
3. G´erard Maral, —Satellite Communication Systems, 1993.
4. Tri T. Ha, Digital Satellite Communications 2nd edition, TMH, 1990.

REFERENCE BOOKS:

1. Rappaport T.S., —Wireless communications, 2nd Edition, Pearson Education, 2010.
2. Bruce Elbert, —Introduction to Satellite Communications, 1987.
3. M Richharia, Satellite Communication Systems 2nd edition, MacMillan, 2005.

WEB REFERENCES:

1. <https://nptel.ac.in/courses/117/105/117105131/>

COURSE WEB PAGE:

1. <https://lms.iare.ac.in/?q=node/1264>

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=node/1264
CONTENT DELIVERY (THEORY)			
2	Describe the overview of present and future trends of satellite communications	CO 1	T2 – 1.3 to 1.4
3	Introduction to low earth orbit (LEO), medium earth orbit (MEO).	CO 1	TI – 3.8
4	Geo synchronous earth orbit (GEO), Geostationary earth orbit (GEO) systems	CO 1	TI – 3.8
6	Orbital mechanics: orbital elements, locating the satellite with respect to the earth	CO 1	T2–2.1
9	Coverage angle, Slant range, Inclined orbits	CO 1	T2–2.2
10	Orbital perturbations due to earth's oblateness and moon and sun	CO 1	T2–2.3 to2.4
11	Eclipse of GEO satellite, Sun transit outage	CO 1	T2–2.5 to2.6
12	Placement of a communication satellite in GEO	CO 2	T2–3.1
13	satellite sub systems: Telemetry, tracking and command system	CO 2	T2–3.2
14	Power system, satellite antenna equipment	CO 2	T2–3.3

15	Communications subsystem and transponders	CO 2	T2-3.4
16	TWT amplifier operation	CO 2	T2-3.5
17	Satellite frequency bands and allocations	CO 2	T2-4.1
18	Satellite link: Basic transmission theory, system noise temperature and G/T ratio	CO 3	T2-4.2 to 4.3
20	Basic link analysis, design of satellite links for a specified C/N with and without frequency re-use	CO 3	T2-4.4
23	Link budget: Propagation effects: introduction, atmospheric absorption	CO 3	T2-4.5 to 4.7
24	Cloud attenuation, troposphere and ionospheric scintillation and low angle fading	CO 3	T2-8.1 to 8.2
25	Effects of rain: Rain induced attenuation, rain induced cross polarization interference	CO 3	T2-8.3 to 8.4
26	Multiple Access: Frequency division multiple access (FDMA)	CO 4	T2-6.1
27	Time division multiple access (TDMA), frame structure, burst structure, satellite switched TDMA, on-board processing	CO 4	T2-6.2 to 6.3
28	Demand assignment multiple access (DAMA), types of demand assignment, characteristics	CO 4	T2-6.4 to 6.5
29	Code division multiple access (CDMA) / spread spectrum multiple access (SSMA): Direct sequence CDMA (DS-SS) or DS spread spectrum transmission and reception	CO 4	T2-6.8
30	Adjacent channel interference, inter modulation, handover, satellite diversity	CO 4	T2-10.1
31	Earth station: transmitters, receivers, antennas	CO 5	T2:10.2-10.3
32	Tracking systems, terrestrial interface, power test methods, lower orbit considerations	CO 5	T2:10.4-10.5
33	Very small aperture terminal systems: overview of VSAT systems, VSAT network architecture	CO 5	T2-9.1 to 9.3
34	Access control, and multiple access selection	CO 5	T2-9.4 to 9.5
35	NGSO constellation design: orbits, coverage, frequency bands, delay and throughput	CO 6	T2:10.4-10.5
36	Geostationary orbit (NGSO) constellation design	CO 6	T2-10.6
37	Message transmission by FDMA: M/G/1 queue	CO 6	T4-8.2
38	Message transmission by TDMA, pure aloha, satellite packet switching	CO 6	T4-8.3 to 8.4

39	Slotted aloha, packet reservation, tree algorithm	CO 6	T4—8.5 to 8.7
40	Error control for digital satellite links: error control coding, block codes	CO 6	T2—7.3 to7.5
42	Convolution codes	CO 6	T2—7.6
44	Overview of future satellite communication systems	CO 6	R3—12.3
45	Introduction to satellite laser communication	CO 6	R3—12.4
46	Satellite mobile services, applications	CO 6	R3—12.5
PROBLEM SOLVING/ CASE STUDIES			
5	Radius of the orbit	CO 1	TI – 3.8
7	Velocity of the satellite	CO 2	TI – 3.8
8	Apogee height, semi major axis and semi minor axis	CO 2	T2-2.1
19	Received power	CO 3	T2-3.4
20	System noise temperature	CO 4	T2-4.2 to 4.3
21	G/T ratio of the earth station	CO 4	T2-4.2 to 4.3
22	C/N ratio	CO 4	T2-4.4
41	Block codes	CO 6	T2—7.3 to7.5
43	Convolution codes	CO 6	T2—7.6 to7.7
DISCUSSION OF DEFINITION AND TERMINOLOGY			
46	Kepler's laws	CO 1	T2 – 1.3 to 1.4
47	Orbital elements	CO 2	TI – 3.8
48	Telemetry, tracking, command and monitoring system	CO 2	T2-3.2
49	Multiple access system	CO 4	T2-6.1
50	VSAT	CO 5	T2-9.1 to9.3
DISCUSSION OF QUESTION BANK			
51	Orbital mechanics	CO 1	TI:3.8, T2:2.1-2.2 T2:2.3-3.1
52	Satellite subsystems	CO 2	T2:3.2-4.1 T2:4.2-4.7
53	Link analysis	CO 3	T2:6.1-6.8 T2:10.1
54	Multiple Access	CO 4	T2:10.2-10.5 T1:9.1-10.6
55	NGSO constellation design	CO 5,6	T4:8.2-8.7 T2:7.3-7.6

Signature of Course Coordinator

HOD,ECE

COURSE DESCRIPTION

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
0%	Remember
70%	Understand
10%	Apply
20%	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).

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 8th and 17th 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.

VI COURSE OBJECTIVES:

The students will try to learn:

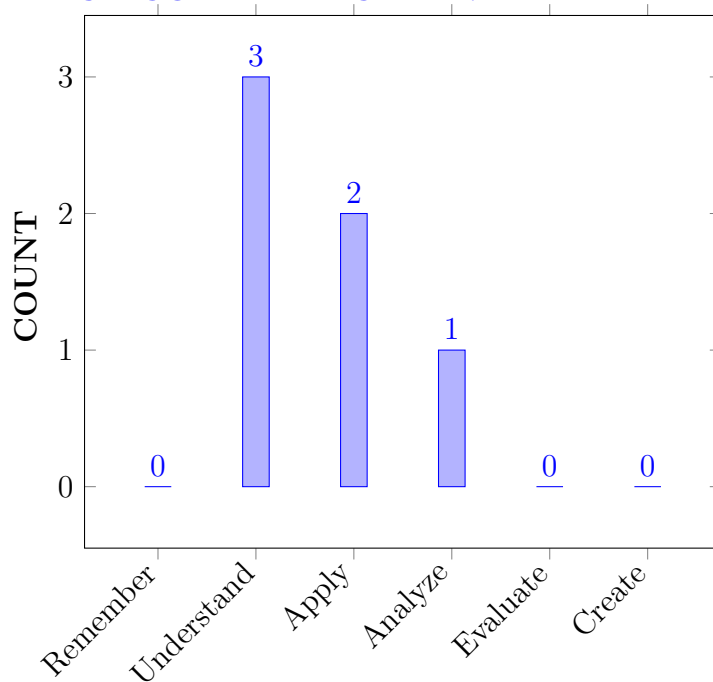
I	The concepts of frequency reuse, handoff, multipath channels and multiple access techniques used in wireless communication systems.
II	The process of fading mechanism, types of equalizers and diversity techniques.
III	The wireless network standards together with network protocols.

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



BLOOMS TAXONOMY

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.	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 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.	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 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 understanding wireless system 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 channel capacity and co-channel interference for considering design parameters.	2
	PO 2	Finding the channel interference and review the fading operations by analyzing complex engineering problems	3
	PO 4	Knowledge of the channel interference characteristics and ability to apply modeling techniques of fading operations by analyzing engineering problems	5
	PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large.	1
	PSO 3	Illustrate the concept of channel capacity for wireless communication .	1
CO 3	PO 1	Illustrate the radio wave propagation (knowledge) used in propagation mechanisms by applying the principles of mathematics and science for solving complex engineering problems .	2
	PO 2	Understand the radio wave propagation and formulate to the propagation mechanisms using principles of mathematics and engineering science .	3
	PO 4	Knowledge of the wave propagation characteristics and ability to apply modeling techniques of fading operations by analyzing engineering problems	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 complex Engineering activities with the Engineering community and with society at large.	1
	PSO 3	Illustrate the concept of radio wave propagation for wireless communication .	1
CO 4	PO 1	Analyze (knowledge) the channel path loss models and transmission operations by analyzing complex engineering problems using the principles of mathematics, engineering science .	2
	PO 2	Understand the channel path loss models problem statement and finding the solution implementation of fading operations by analyzing complex engineering problems	3
CO 5	PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large.	1
	PO 1	Identify parameters of mobile multipath channels for solving complex engineering problems generates by applying mathematics, science and engineering fundamentals .	3
	PO 4	Knowledge of the multipath characteristics and ability to apply modeling techniques of fading operations by analyzing engineering problems	5
	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 multiple access (knowledge) for specifying multiple users over a single channel.	2
	PO 2	Identify the parameters of multiple access schemes problem statements using mathematics principles .	2
	PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large.	1

Note: For Key Competencies Refer Annexure

XIII TTOTAL 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	3	-	5	-	-	-	-	-	1	-	-	-	-	1
CO 3	2	3	-	5	-	-	-	-	-	1	-	-	-	-	1
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	2	2	2
CO 1	33.3	-	-	-	-	-	-	-	-	20	-		-	-	-
CO 2	66.6	30.0	-	45.5	-	-	-	-	-	20	-	-	-	-	50
CO 3	66.6	30.0	-	45.5	-	-	-	-	-	20	-	-	-	-	50
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 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 perfect conductors, ground reflection (Two-Ray) mode; Diffraction Fresnel zone geometry, knife-edge diffraction model, multiple knife-edge diffraction, scattering, outdoor propagation models; Longley-Ryze 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	CELLULAR SYSTEM DESIGN FUNDAMENTALS
	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	Cellular system design fundamentals	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	Cellular system design fundamentals	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



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

Course Title	IDEATION AND PRODUCT DEVELOPMENT				
Course Code	AEC201				
Program	B.Tech				
Semester	V	ECE			
Course Type	Elective				
Regulation	IARE - R16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Dr. D Srikar, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

II COURSE OVERVIEW:

Ideation and product development lab mainly focuses on the creation of concrete solutions to specific problems. This is particularly challenging when the solution and its elements are entirely unknown. In so-called top-down approaches, the development focus is on the desired features of the new product rather than on already existing solutions or their elements. Both methods from product development, such as creativity techniques, and methods from lightweight design, such as physical surrogate modeling, help to explore the unknown and find a way to new solutions to complex problems. For complex problems, it is often important to consider the entire system by adopting a holistic and interdisciplinary view. In both lightweight design and in product development, all relevant requirements on a product, all aspects of feasibility and constraints on realization, and all interactions of all system components have to be taken into account.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Research and Content Development	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.

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

VI COURSE OBJECTIVES:

The students will try to learn:

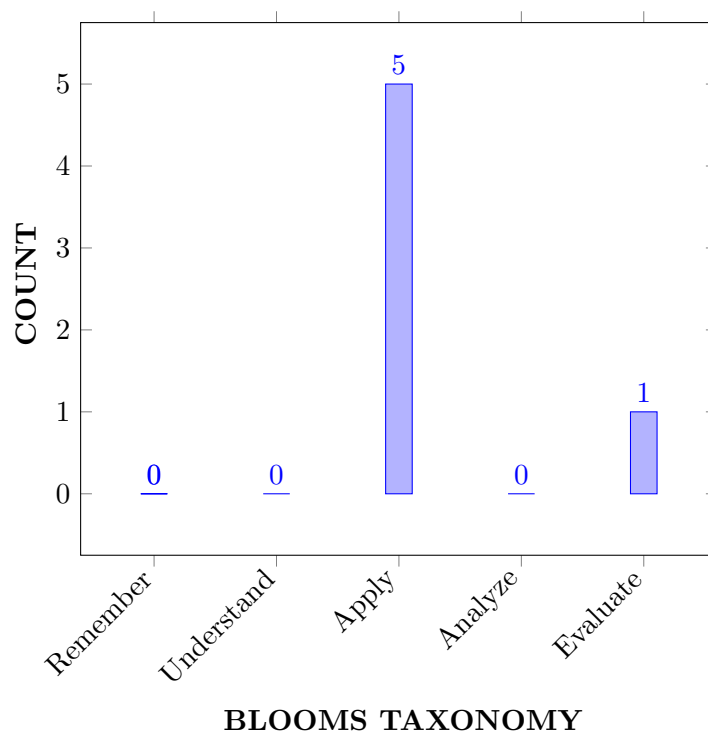
I	To develop next generation Entrepreneurs and Creative Leaders to resolve live challenges.
II	To understand about the future needs of industries.
III	To transform innovative ideas into successful businesses.
IV	To use a range of creative thinking tools to develop Out of the Box Ideas.
V	To develop Breakthrough Innovators and Dynamic Thinkers.

VII COURSE OUTCOMES:

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

CO 1	Develop knowledge and skills from various areas through more complex and multidisciplinary projects to select a research topic. .	Apply
CO 2	Organize the collected evidences to make quantitative, qualitative and statistical analysis for finding the research problem.	Apply
CO 3	Solve unstructured problems that need research as an individual or as a member/leader in diverse teams to discern which information is reliable and which is not.	Apply
CO 4	Make use of a software tool by running simulations rigorously to get the desired output for the research problem found.	Apply
CO 5	Assess the outputs achieved by making judgments about information and validity of ideas for confirming the quality of work based on a set of criteria.	Evaluate
CO 6	Build a hardware prototype to test and analyze the product designed for an application.	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.	2	Lab exercises/ 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 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/ 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 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 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
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 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.	2	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.	2	Lab Exercises
PSO2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	2	Lab Exercises

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

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 mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems.	3
	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
	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.	2
CO 2	PO 2	Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.	1
	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.	1
	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
	PO10	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
	PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems..	3
	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.	1

CO 3	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
	PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	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 and design documentation, make effective presentations, and give and receive clear instructions.	2
CO 4	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
	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 .	3
	PO10	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
	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.	3
	PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	3
	PSO2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	3
	PSO3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	3
CO 5	PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems.	2
	PO 2	Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.	1
	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.	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 and design documentation, make effective presentations, and give and receive clear instructions.	3

	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.	2
CO 6	PO 2	Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.	1
	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.	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 and design documentation, make effective presentations, and give and receive clear instructions.	3
	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.	2

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 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	11	9	8
CO 1	3	-	-	2	-	-	-	-	-	2	-	-	-	-	-
CO 2	-	1	1	2	-	-	-	-	-	2	-	-	-	-	-
CO 3	3	-	1	2	-	-	-	-	-	2	-	-	-	-	-
CO 4	-	-	-	2	3	-	-	-	-	3	-		3	3	3
CO 5	2	1	-	1	-	-	-	-	-	3	-	2	-	-	-
CO 6	-	1	-	1	-	-	-	-	-	3	-	2	-	-	-

XII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	PO 2, PO 9, PO 12	SEE Exams	PO 2, PO 9, PO 12	Seminars	-
Laboratory Practices	PO 2, PO 5, PO 9, PO 12, PSO1, PSO2	Student Viva	PO 2, PO 5, PSO2, PSO3	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 TO PRODUCT DEVELOPMENT
	Product development -Examples of product development process-theories and methodologies-Product development teams- Product development planning process-Technical and business concerns. Understanding customer needs-Customer satisfaction -gathering customer needsOrganising and prioritizing customer needs.
WEEK II	ESTABLISHING PRODUCT FUNCTION
	Functional decomposition, Modeling process, Function trees, Creating function structure, Augmentation, Functional common basis.
WEEK III	PRODUCT TEARDOWN AND EXPERIMENTATION
	Teardown process, Teardown methods, Post teardown reporting- Applications of product teardown.

WEEK IV	BENCHMARKING AND ESTABLISHING ENGINEERING SPECIFICATIONS
	Benchmarking approach, examples, Support tools, Setting product specifications-Product portfolios architecture types, theory, platforms. Product architecture - Types and examples, Product modularity, Modular design and methods.
WEEK V	GENERATING, SELECTION AND EMBODIMENT OF CONCEPTS
	Concept generation process, methods Basic and advanced-Morphological analysis, Concept selection process, Factors, Design evaluation, Information quality, Feasibility-Basic and advanced methods, Concept embodiment: General process, advanced methods Modeling of product metrics: Model selection, Model preparation, Mathematical modeling, Construction of product models.

TEXTBOOKS

1. Product Design: Techniques in Reverse engineering New Product development. K Otto K Wood. Prentice Hall, 2001. ISBN 0-13-0212271-7 TCD Shelf Mark. HL-236-568.
2. Invention by design: how engineers get from thought to thing, Petroski H. Cambridge, Mass., London, Harvard University Press, 1996. ISBN 0674463676. TCD Shelf Mark. HL-201-280.
3. Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, Tim Brown, Harper Business, 2009, ISBN 978-0061766084.
4. Creative Confidence: Unleashing the Creative Potential Within Us All, Tom David Kelley, Crown Business, 2013, ISBN 978-0385349369.

REFERENCE BOOKS:

1. Kevin N. Otto and Kristin L. Wood - Product Design Pearson Education 2001
2. Smith, Preston G., Reinertsen Donald G. (1991) Developing products in half the time, Van Nostrand Reinhold, New York.

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	Successful team formation and management	CO 3	T1: 1.3
2	Introduction to user-centred design	CO 1	T2: 2.4
3	Ideation and use of personas and POVs	CO 2	T1: 3.2
4	Need finding	CO 2	T2: 2.5
5	Embedded Microcontrollers for consumer products	CO 6	T1: 3.3
6	Human factors in engineering design	CO 2	T3: 4.2
7	Critical Experience and Critical Function Prototyping	CO 4	T3: 4.5
9	Dark Horse and Funky' prototyping	CO 5	T4: 5.1
10	Rapid prototyping and manufacturing	CO 6	T4: 6.5
11	User testing	CO 6	T1:6.1
12	Use of video/electronic media for communication	CO 6	T1:6.4

13	Start-ups and entrepreneurship	CO 6	T1:6.5
14	Intellectual Property	CO 6	T1:6.6

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Integration of knowledge and skills from various areas through more complex investigations and multi-disciplinary projects.
2	Autonomous learning encouraged through independent research of unstructured problems
3	Teamwork, which helps prepare students for a social environment
4	Self-evaluation and self-criticism, against self-competency, trying to see beyond their own ideas and knowledge

Signature of Course Coordinator
Dr. D Srikar, Assistant Professor

HOD,ECE



INSTITUTE OF AERONAUTICAL ENGINEERING (Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	ELECTRONICS AND COMMUNICATION ENGINEERING				
Course Title	DIGITAL SIGNAL PROCESSING LABORATORY				
Course Code	AEC107				
Program	B.Tech				
Semester	VI	ECE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	2	1
Course Coordinator	Dr.B Ravi Kumar, Associate Professor				

I COURSE OVERVIEW:

This course provides practical hands on exposure to mathematical operations on linear time invariant systems. It covers analysis of signals by fast Fourier transform algorithms, implementation of IIR filters in MATLAB using various digital transformation techniques such as Butterworth and bilinear transformation techniques. Implementation of FIR filters in MATLAB using window methods and frequency sampling method. The significant applications of digital signal processing are done by sampling rate conversion.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECB17	IV	Signals and systems laboratory

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Digital signal processing 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
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 analysis of signals in frequency domain by using DFT and FFT algorithms.
II	The designing of IIR and FIR filters using transformation techniques by using MATLAB tool.
III	IIR and FIR Filter Implementation using DSP Kits.

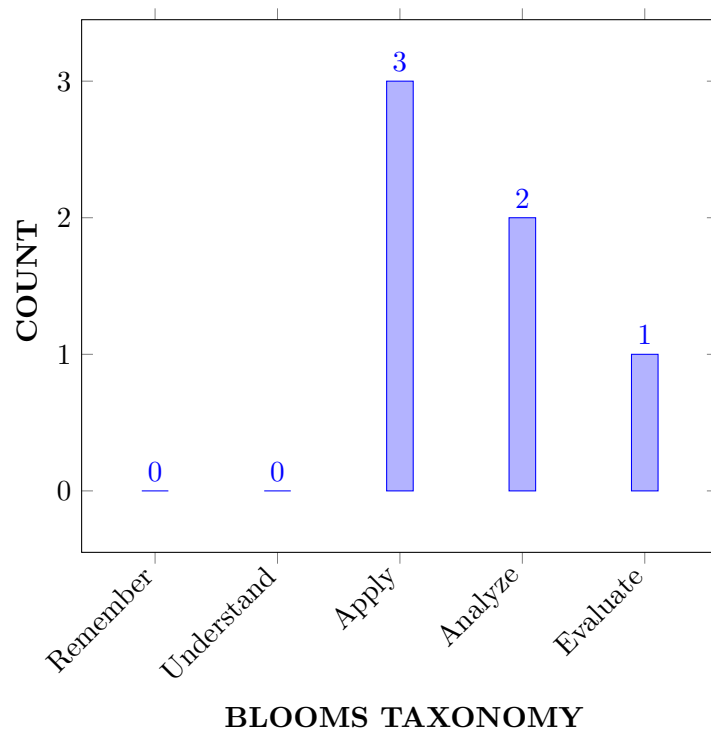
VII COURSE OUTCOMES:

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

CO 1	Examine the overlap add and overlap save convolution methods for long duration sequence .	Apply
CO 2	Compute the FFT algorithms for reducing computational complexity of discrete Fourier transform.	Apply

CO 3	Implement digital FIR and IIR filters using digital transformation technique.	Analyze
CO 4	Analyse the DTMF tone generation and detection using Goertzel algorithm .	Analyze
CO 5	Apply decimation and interpolation methods for sampling rate conversion.	Apply
CO 6	Design the IIR and FIR Filter algorithms using DSP Kits .	Create

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 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 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 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.	4
	PO 5	Apply the concept of convolution for finding the response of LTI system using MATLAB tool.	1
	PO 10	Demonstrate the ability to communicate effectively in Design and implementation for spectral analysis of discrete signals and make effective Interpretation. .	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 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.	6
	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
	PO 10	Demonstrate the ability to communicate effectively in Design and implementation for reducing computational complexity of discrete Fourier transform and make effective Interpretation.	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 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.	6

	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
	PO 10	Demonstrate the ability to communicate effectively in Design and implementation using different methods and make effective Interpretation.	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 .	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 .	4
	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
	PO 10	Demonstrate the ability to communicate effectively in Design and implementation for the generation and detection of dual-tone multi-frequency (DTMF) signaling and make effective Interpretation.	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 .	4
	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

	PO 10	Demonstrate the ability to communicate effectively in Design and implementation for interfacing the digital systems with different sampling rates and make effective Interpretation.	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 .	6
	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
	PO 10	Demonstrate the ability to communicate effectively in Design and implementation for designing real time embedded signal processing applications and make effective Interpretation.	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 10	PSO 1
CO 1	3	4	1	1	
CO 2	4	6	1	1	1
CO 3	4	6	1	1	
CO 4	4	4	1	1	1
CO 5	4	4	1	1	
CO 6	4	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	LINEAR CONVOLUTION VS CIRCULAR CONVOLUTION
	Generation of linear convolution without using built in function and the function conv in MATLAB Generation of circular convolution without using built in function in MATLAB.
WEEK II	DFT AND IDFT
	Compute the Discrete Fourier Transform and IDFT with and without fft and ifft in MATLAB.
WEEK III	OVERLAPADD AND OVERLAP-SAVE METHODS
	Implementation of Linear convolution using DFT (Overlapadd and Overlap-Save methods).
WEEK IV	DIT-FFT ALGORITHM
	Implementation of Decimation-in-time radix-2 FFT algorithm.
WEEK V	DIF-FFT ALGORITHM
	Implementation of Decimation-in-frequency radix-2 FFT algorithm.
WEEK VI	IIR DIGITAL FILTER USING BUTTERWORTH METHOD AND BILINEAR TRANSFORMATION
	Implementation of IIR digital filter using Butterworth method and bilinear transformation.
WEEK VII	IIR Digital Filter Using Chebyshev (Type I And II) Method
	Implementation of IIR digital filter using Chebyshev (Type I and II) method.
WEEK VIII	FIR DIGITAL FILTER USING WINDOWS
	Implementation of FIR digital filter using window (Rectangular, Hamming, Hanning, Bartlett) methods.
WEEK IX	FIR DIGITAL FILTER USING FREQUENCY SAMPLING METHOD
	Implementation of FIR digital filter using frequency sampling method.
WEEK X	OPTIMUM EQUIRIPPLE FIR DIGITAL FILTER
	Implementation of optimum equiripple FIR digital filter using window methods.
WEEK XI	DTMF TONE GENERATION AND DETECTION
	DTMF Tone Generation and Detection Using Goertzel Algorithm.
WEEK XII	SAMPLING RATE CONVERSION
	Implementation of sampling rate conversion by decimation, interpolation and a rational factor using MATLAB.
WEEK XIII	SINE WAVE GENERATION
	a) Implementation of DFT b) Sine wave generation using lookup table with values generated from MATLAB.
WEEK XIV	IIR AND FIR FILTERS USING DSP KITS
	IIR and FIR Filter Implementation using DSP Kits.

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. Robert J. 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 1	T1: 7.2
3	Overlap-add and overlap-save methods	CO 1	T1: 2.3.4
4	DIT-FFT algorithm	CO 2	T1: 8.1
5	DIT-FFT algorithm	CO 2	T1: 8.2
6	IIR digital filter using Butterworth method and bilinear transformation	CO 3	T1: 10.3
7	IIR digital filter using Chebyshev (Type I and II) method	CO 3	T1: 10.3
8	FIR digital filter using windows	CO 4	T1: 10.2
9	FIR digital filter using frequency sampling method	CO 4	T1: 10.3
10	Optimum equiripple FIR digital filter	CO 4	T1: 10.4
11	DTMF tone generation and detection	CO 5	T3:6.6
12	Sampling rate conversion	CO 5	T1: 11.6
13	Sine wave generation	CO 5	T1:2.1-2.2
14	IIR and FIR filters using DSP kits	CO 6	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
Dr.B.Ravi Kumar, Associate Professor

HOD,ECE



INSTITUTE OF AERONAUTICAL ENGINEERING (Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING COURSE DESCRIPTION

Course Title	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY				
Course Code	AEC108				
Program	B.Tech				
Semester	VI	ECE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	2
Course Coordinator	Ms. B Lakshmi Prasanna, 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 facilitate 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.

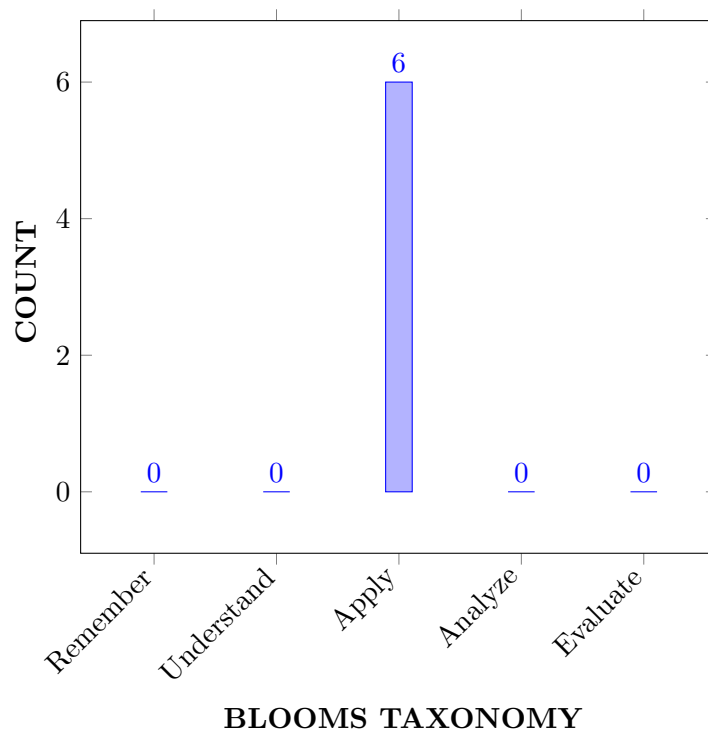
VII COURSE OUTCOMES:

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.	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	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

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	Day to Day Evaluation/ 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 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 software) for writing, compiling and running an assembly language programs on training boards to build embedded system applications .	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	Utilize embedded software and digital circuit platforms perform code conversions which are commonly used in various embedded applications .	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	Utilize embedded software and digital circuit platforms to perform data transfer in various Embedded applications .	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	Make use of embedded software to perform data conversion in various embedded applications .	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	Utilize embedded software and digital circuit platforms to build robotic applications 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 software and digital circuit platforms to create processor or controller based solutions in Embedded applications.	2

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 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

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	DESIGN A PROGRAM USING WIN862
	Design and develop an Assembly language program using 8086 microprocessor and to show the following aspects. (a)Programming (b)Execution (c)Debugging To Demonstrate the win 862 software and Trainer kit for 8086 Microprocessor
WEEK II	16 BIT ARITHMETIC AND LOGICAL OPERATIONS
	Write an ALP program to perform 16 Bit arithmetic and logical operations using WIN862 software
WEEK III	MULTIBYTE ADDITION AND SUBTRACTION
	(a) Write an ALP program to perform multi byte addition and subtraction (b) Write an ALP program to perform 3*3 matrix multiplication and addition

WEEK IV	PROGRAMS TO SORT NUMBERS
	(a) Write an ALP program to perform ascending order using 8086 (b) Write an ALP program to perform descending order using 8086
WEEK V	PROGRAMS FOR STRING MANIPULATIONS OPERATIONS
	(a) Write an ALP program to insert or delete a byte in the given string (b) Write an ALP program to search a number/character in a given string (c) Write an ALP program to move a block of data from one memory location to the other (d) Write an ALP program for reverse of a given string.
WEEK VI	CODE CONVERSIONS
	(a) Write an ALP program to convert packed BCD to Unpacked BCD (b) Write an ALP program to convert packed BCD to ASCII (c) Write an ALP program to convert hexadecimal to ASCII
WEEK VII	INTERFACING STEPPER MOTOR
	(a) Write an ALP program to rotate stepper motor in clockwise direction (b) Write an ALP program to rotate stepper motor in anti clockwise direction
WEEK VIII	INTERFACING ADC and DAC DEVICES
	(a) Write an ALP program to convert analog to digital using 8086 (b) Write an ALP program to convert digital to analog using 8086
WEEK IX	INTERFACING KEYBOARD TO 8086
	Write an ALP program to interface keyboard to 8086
WEEK X	SERIAL AND PARALLEL COMMUNICATION
	(a) Parallel communication between two microprocessors using 8255 (b) Serial communication between two microprocessor kits using 8251
WEEK XI	INTERFACING TRAFFIC LIGHT CONTROLLER AND TONE GENERATOR
	(a) Write a program to interface traffic light controller (b) Write an ALP program to interface tone generator
WEEK XII	ARITHMETIC AND LOGICAL OPERATIONS USING 8051
	Write an ALP program to perform 16 Bit arithmetic and logical operations using 8051 microcontroller
WEEK XIII	TIMER/COUNTER
	Write an ALP Program and verify Timer/Counter using 8051
WEEK XIV	INTERFACING KEYBOARD TO 8051
	Write an ALP program to interface keyboard to 8051

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.

XV COURSE PLAN:

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

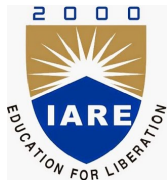
S.No	Topics to be covered	CO's	Reference
1	Design a program using WIN862	CO 1/ CO 2	T1: 3.3
2	16 bit arithmetic and logical operations	CO1/ CO2	T1: 3.4
3	Multibyte addition and subtraction	CO1/ CO2	T1: 3.4
4	Programs to sort numbers	CO1/ CO2	T1: 3.4
5	Programs for string manipulations operations	CO1/ CO2/ CO3	T1: 3.4
6	Code conversions.	CO1/ CO2	T1: 3.4
7	Interfacing stepper motor to 8086 microprocessor	CO1/ CO6	T1: 5.8
8	Interfacing ADC and DAC devices	CO1/ CO4/ CO6	T1: 5.6, 5.7
9	Interfacing keyboard to 8086 microprocessor	CO1/ CO6	T1: 6.3
10	Serial and Parallel communication	CO1/ CO3/ CO6	T1: 6.4
11	Interfacing traffic light controller and tone Generator to 8086 microprocessor	CO1/ CO6	T1: 6.5, 6.6
12	Arithmetic and logical operations using 8051 microcontroller	CO1/ CO2	R1: 4,5
13	Timer/Counter operations	CO1/ CO5/ CO6	R1: 2
14	Interfacing keyboard to 8051 microcontroller	CO1/ CO6	R1: 8

XVI 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
Ms. B Lakshmi Prasanna, Assistant Professor

HOD,ECE



INSTITUTE OF AERONAUTICAL ENGINEERING (Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING

COURSE DESCRIPTION

Department	ELECTRONICS AND COMMUNICATION ENGINEERING				
Course Title	INSTRUMENTATION LABORATORY				
Course Code	AEC109				
Program	B.Tech				
Semester	VI ECE				
Course Type	Core				
Regulation	IARE-R16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	2	1
Course Coordinator	Ms K.S.Indrani, Assistant Professor, ECE				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
B.Tech	AEC002	III	Digital System Design	3

II COURSE OVERVIEW:

The Laboratory Virtual Instrument Engineering Workbench (LabVIEW) is a development environment designed by National Instruments that creates graphic-based programs called virtual instruments (VIs) that simulate actual laboratory instruments. The course imparts the basic knowledge about the software based tools for the development of virtual instruments in real world data acquisition and measurement systems. The course seeks to provide a hands-on environment and uses a number of VI-programming.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Instrumentation 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.

1. Experiment Based:

Preparation	Performance	Calculations and Graph	Results and Error Analysis	Viva	Total
2	2	2	2	2	10

2. Programming Based:

Preparation	Performance	Calculations and Graph	Results and Error Analysis	Viva	Total
-	-	-	-	-	-

VI COURSE OBJECTIVES:

The students will try to perform:

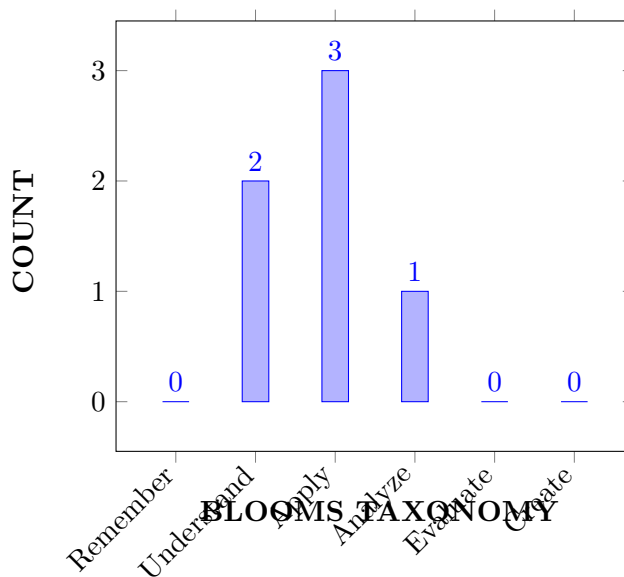
I	The concept of virtual instrumentation and to develop basic VI programs using loops, case structures etc. including its applications in image, signal processing and motion control.
II	LabVIEW tool to design basic operations and data acquisition using myDAQ and myRIO cards.
III	Prototype model for distribute stand-alone applications using LabVIEW.

VII COURSE OUTCOMES:

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

CO No	Course Outcomes	Knowledge Level (Bloom's Taxonomy)
CO 1	Build the arithmetic and logical operations based applications using the LabVIEW graphical programming environment.	Apply
CO 2	Apply single and multiple-loop design patterns for application functionality.	Apply
CO 3	Analyze data log waveform graphs for system monitoring, processing and controlling.	Analyze
CO 4	Demonstrate the formula node in LabVIEW for signal processing, image processing etc.	Apply
CO 5	Design data acquisition systems using myDAQ and myRIO data cards.	Understand
CO 6	Illustrate the data acquisition and interfacing concepts using a state-of-the-art software platform such as National Instrument's LabVIEW.	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 (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 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 the logic in Labview environment and validate the result of the circuit .	2
	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

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 (complex) engineering problems into model, translate the information and implement using loop designs based on the functionality of the circuit, validate the output of the circuit in reaching substantiated conclusions by the interpretation of results .	5
	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 model 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 and validate the output of the circuit in reaching substantiated conclusions by the interpretation of results .	4
	PO 10	Explain fluently about the data log waveforms of the system with(technical knowledge).	1
CO 4	PO 1	Summarize the formula node in Labview for signal processing and image processing environment 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 model and prototype systems from the provided information and data, develop solutions based on the formula node in Labview, validate the output by using various controlling operations.	7
	PO 3	Develop circuits , based on customer needs for design of various fields and evaluate outcomes of the designs .	5
	PO 4	Use research based knowledge and research method including experimental design using Labview for signal processing and image processing and (synthesize the information to validate conclusions).	5
	PO 5	Use Virtual instrumentation tools for signal processing and image processing applications.	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies matched.
	PO 10	Outline fluently about the importance importance of formulae node in Labview (Subject matter).	1
	PSO 2	Design VLSI signal processing applications in Labview environment.	1
CO 5	PO 1	Demonstrate different 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 based on the functionality of the data translation, validate the data converters in reaching substantiated conclusions by the interpretation of results .	7
	PO 3	Develop solution to manage data processing and interfacing applications by establishing innovative solutions using data converters .	5
	PO 4	Use research based knowledge and research method including experimental design using as data acquisition using my RIO and my DAQ and (synthesize the information to validate conclusions).	5
	PO 5	Use latest tools data cards like my RIO and my DAQ for data acquisition systems.	1
	PO 10	Communicate effectively about usage of data acquisition systems of my RIO and my DAQ cards.	1
	PSO 2	Acquire knowledge on datacards usage in order to use in ASIC and SOC designs .	1
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 system using labview, validate the design in reaching substantiated conclusions 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 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 experiment using virtual instrumentation lab and analyze the result .(Subject matter) .	5
	PO 5	Outline fluently about the importance of phase locked loop,voltage controlled oscillator and applications of operational amplifier(Subject matter).	1
	PO 10	Explain orally the internal operation and applications of digital IC with the technical knowledge	1
	PSO 2	Design , various digital circuits in application specific integrated circuit (ASIC) and system on chip (SOC) designs.	1

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	2	2	2
CO 1	2	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	2	5	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	2	5	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	2	7	5	5	1	-	-	-	-	1	-	-	-	1	-
CO 5	2	7	5	5	1	-	-	-	-	1	-	-	-	1	-
CO 6	2	7	5	5	1	-	-	-	-	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	20	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 2	66.7	50	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 3	66.7	50	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 4	66.7	70	50	45	100	-	-	-	-	20	-	-	-	50	-
CO 5	66.7	70	50	45	100	-	-	-	-	20	-	-	-	50	-
CO 6	66.7	70	50	45	100	-	-	-	-	20	-	-	-	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
	3	1	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 1	3	1	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	3	2	2	3	-	-	-	-	1	-	-	-	2	-
CO 5	3	3	2	2	3	-	-	-	-	1	-	-	-	2	-
CO 6	3	3	2	2	3	-	-	-	-	1	-	-	-	2	-
TOTAL	18	14	6	6	9	0	0	0	0	6	0	0	0	6	0
AVERAGE	3	2.3	2	2	3	0	0	0	0	1	0	0	0	2	0

XVI ASSESSMENT METHODOLOGY DIRECT:

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

XVII ASSESSMENT METHODOLOGY INDIRECT:

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

XVIII SYLLABUS:

Week-1	OPEN AND RUN A VIRTUAL INSTRUMENT
	Open the front panel and block diagram in Lab VIEW software.
Week-2	BASIC ARITHMETIC OPERATIONS BOOLEAN OPERAT
	Designing a program to perform Addition, Subtraction , Multiplication and Division operations, and Developing a program to perform AND, OR, NOT, NAND, NOR,XOR and XNOR operations using Lab VIEW.
Week-3	SUM OF n NUMBERS USING "FOR LOOP" FACTORIAL OF A GIVE NUMBER USING FOR LOOP
	Designing a program to find the sum of n numbers using FOR loop and De-signing a program to perform the factorial of a given number using FOR loop.
Week-4	SUM OF n NATURAL NUMBERS USING WHILE LOOP FAC-TORIAL OF A GIVE NUMBER USING WHILE LOOP
	Designing a program to find the sum of n natural numbers using WHILE loop and Designing a program to perform the factorial of a given number using WHILE loop.
Week-5	CONVERT °C TO °F, CREATE A SUBVI
	Designing the program to convert °C to °F and Create a SubVI.
Week-6	ARRAY MAXIMUM AND MINIMUM
	To design and construct Mono stable multi vibrators using IC 555.
Week-7	ANALYZING AND LOGGING DATA BY USING WAVE FORM
	Designing a program to analyze and logging the data.
Week-8	BUNDLE AND UNBUNDLE CLUSTER
	Designing a program to bundle and unbundle a cluster.
Week-9	APPLICATION USING FORMULA NODE & DISCRETE CO-SINE TRANSFORM
	Designing a program to create a sine wave using formula node and to perform discrete cosine transform on the given signal.
Week-10	FLAT AND STACKED SEQUENCE
	Designing a program to perform functions using flat and stacked sequence.
Week-11	DATA ACQUISITION THROUGH VIRTUAL INSTRUMENTA-TION
	Acquire the data from the sensors by using MY DAQ and MY RIO.
Week-12	DEVELOPING VOLTMETER USING DAQ CARDS
	Designing a program to Develop voltmeter by using DAQ CARDS .
Week-13	DEVELOPING SIGNAL GENERATOR USING DAQ CARDS
	Designing a program to develop signal generator by using DAQ cards
Week-14	REAL TIME TEMPERATURE CONTROL USING VIRTUAL IN-STRUMENTATION.
	Designing a program for real time temperature control by using virtual instru-mentation.

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. 4. Sanjay Gupta, —Virtual Instrumentation using LABVIEW||, McGraw-Hill Education, 2nd edition, 2010.

XIX 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	Open the front panel and block diagram in Lab VIEW software.	CO 2	T1:11.1-11.5
2	Designing a program to perform Addition, Subtraction , Multiplication and Division operations, and Developing a program to perform AND, OR, NOT, NAND, NOR,XOR and XNOR operations using Lab VIEW.	CO 2	T1:11.1-11.5
3	Designing a program to find the sum of n numbers using FOR loop and Designing a program to perform the factorial of a given number using FOR loop.	CO 3	T1:4.8 , T1:7.2
4	Designing a program to find the sum of n natural numbers using WHILE loop and Designing a program to perform the factorial of a given number using WHILE loop.	CO 4	T1:4.8 , T1:7.2
5	Designing the program to convert °C to °F and Create a SubVI.	CO 4	T2:10.4 , R2:7.2
6	Designing a program to find the maximum and minimum variable from an array.	CO 4	T2:10.4 , R1:7.2
7	Designing a program to analyze and logging the data.	CO 7	T2:10.4 , R1:7.2
8	Designing a program to bundle and unbundle a cluster.	CO 8	T1:8.2-8.5
9	Designing a program to create a sine wave using formula node and to perform discrete cosine transform on the given signal.	CO 9	T1:11.1-11.5

10	Designing a program to perform functions using flat and stacked sequence.	CO 10	T1:10.1 , T1:10.2
11	Acquire the data from the sensors by using MY DAQ and MY RIO.	CO 11	T1:11.1-11.5
12	Designing a program to Develop voltmeter by using DAQ CARDS .	CO 12	T3:3.12 , R1:12.7
13	Designing a program to develop signal generator by using DAQ cards.	CO 12	T3:3.12 , R1:12.7
14	Designing a program for real time temperature control by using virtual instrumentation.	CO 12	T3:3.12 , 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.

Signature of Course Coordinator

HOD,ECE



INSTITUTE OF AERONAUTICAL ENGINEERING (Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	Electronics and Communication Engineering				
Course Title	Microwave Engineering				
Course Code	AEC015				
Program	B.Tech				
Semester	VII				
Course Type	CORE				
Regulation	R-16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Ms P Annapurna, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEC007	IV	Electromagnetic Theory and Transmission Lines
B.Tech	AEC011	V	Antennas and 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 introduces passive and active microwave devices, filters, amplifiers, mixers, couplers and power dividers that constitute wireless communication systems between the antenna and the signal processor. The applications include cellular communications, high-speed digital and analog circuits, wireless networks and radar.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
MICROWAVE ENGINEERING	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 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
9.1%	Remember
55.5%	Understand
27.3%	Apply
12.2%	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).

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 8th and 17th 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.

VI COURSE OBJECTIVES:

The students will try to learn:

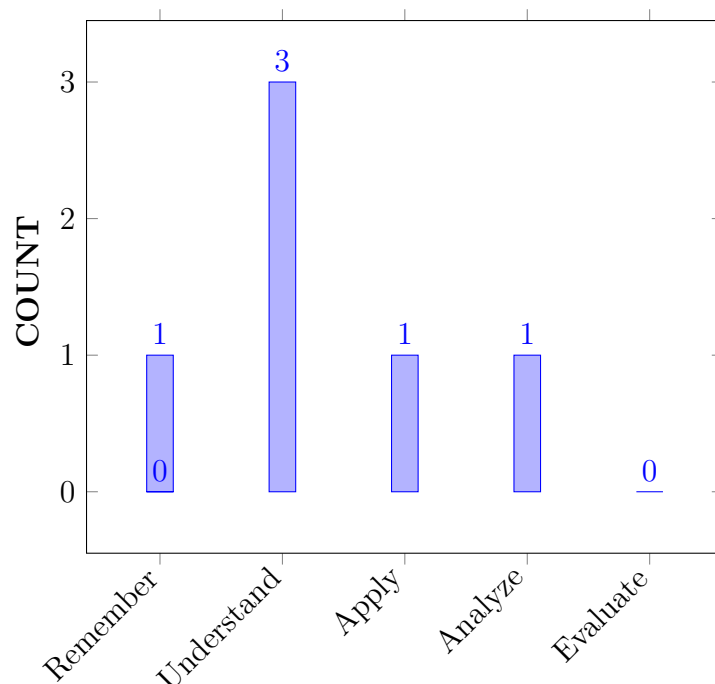
I	The fundamental concepts of wave guide components and electromagnetic wave propagation for microwave communication using Maxwell's equations.
II	The generation of microwave signals to measure different parameters using microwave test bench.
III	The real time applications of microwave engineering in radars, defense, navigation, remote sensing, satellite communications etc.

VII COURSE OUTCOMES:

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

CO 1	Recall the concepts of transmission lines and waveguides to derive the field components of wave equations in Rectangular modes.	Remember
CO 2	Illustrate the principle of waveguide components which are used to couple microwave power from the waveguide system to make the relation between input and output power	Understand
CO 3	Apply the concept of S-Matrix to measure output power in microwave components such as E-plane Tee, H-plane Tee, Magic –Tee and directional couplers	Apply
CO 4	Demonstrate the operation of microwave tubes, solid state devices for the generation and transmission of the microwave frequencies	Understand
CO 5	Describe avalanche transit time devices of different modes for determining the noise figure, operating frequency range and output power .	Understand
CO 6	Analyze microwave test bench setup to measure microwave parameters at microwave frequency	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

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, 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

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
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, 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, 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 patch and smart antennas for wire and wireless communication applications	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.
CO1	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 principles of science and engineering fundamentals to complex engineering problems	3
	PO 10	Communicate effectively on the concepts of transmission lines and waveguides (knowledge) to derive the field components of wave equations i.e TE,TM and TEM modes	1
CO2	PO 1	Illustrate the principle of waveguide components which are used (Knowledge) by analyzing complex engineering problems to measure different parameters by using the principles of mathematics and engineering science.	4
	PO 2	Formulate and analyze (Problem analysis) complex Engineering problems for the for measuring different parameters including design of experiments, analysis of complex problems	5
	PO 10	Communicate effectively on the concepts of measuring different wave guide parameters	1
CO3	PO 1	Recall the concepts of power dividers and couplers (knowledge) and obtain the expressions by applying the principles of mathematics, engineering science for complex engineering problems.	4
	PO 2	Formulate and analyze (Problem analysis) complex Engineering problems for Determining the s-parameters on power dividers using first principles of mathematics and Engineering sciences	4
	PO 4	Analyze the microwave components to evaluate the s-parameters on power dividers and couplers (knowledge) methods including design of experiments, analysis of complex problems	3
	PO 10	Communicate effectively on the concepts of microwave power for Determining the s-parameters on power dividers	1
CO4	PO 1	Extend the concept of limitations of conventional tubes to microwave tubes for analyzing the microwave solid state devices (Knowledge) by applying the principles of mathematics, engineering science for complex engineering problems.	4
	PO 10	Communicate effectively on concept of limitations of conventional tubes to microwave tubes for analyzing the microwave solid state devices	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO5	PO 1	Describe the Avalanche Transit time devices of solid sate devices (Knowledge) for determining the Noise figure, Operating frequency range , output power and efficiency by analyzing complex engineering problems using the principlesof mathematics, engineering science.	4
	PO 2	Formulate and analyze (Problem analysis) complex Engineering problems for detection, generation and amplification of semiconductor devices using first principles of mathematics and Engineering sciences.	3
	PO 10	Communicate effectively on the concepts of detection, generation and amplification of solid state microwave devices.	1
CO6	PO 1	Calculate the measurements of microwavepower, attenuation, frequency, VSWR and impedance using microwave Test bench setup by applying mathematics and engineering science for engineering problems.	3
	PO 10	Communicate effectively on the concepts of measurements of microwave components using testbench	1
	PSO 3	Make use of High Frequency Structure Simulator(HFSS) for wire and 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	2	2	2
CO 1	3	-	-	-	-	-	-	-	-	1	-		-	-	-
CO 2	4	5	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	4	4	-	3	-	-	-	-	-	1	-	-	-	-	-
CO 4	4	-	-	-		-	-	-	-	1	-		-	-	-
CO 5	4	3	-	-	-	-	-	-	-	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	2	2	2
CO 1	100	-	-	-	-	-	-	-	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	2	2	2
CO 2	100	50	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 3	100	40	-	27.3	-	-	-	-	-	20	-	-	-	-	-
CO 4	100	-	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 5	100	30	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 6	100	-	-	-	-	-	-	-	-	20	-	-	-	-	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
	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	3	2	-	1	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 5	3	1	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	3	-	-	-	-	-	-	-	-	1	-	-	-	-	3
TOTAL	18	5	0	1	0	0	0	0	0	6	0	0	0	0	3
AVERAGE	3	1.7	0	1	0	0	0	0	0	1	0	0	0	0	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	WAVEGUIDES
	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; Illustrative problems; Cavity resonators: Types of cavity resonators; Rectangular cavity resonator: Dominant modes and resonant frequencies, illustrative problems.
MODULE II	WAVEGUIDE COMPONENTS AND APPLICATIONS
	Coupling mechanisms: Probe, loop, coupling to a cavity resonator, waveguide discontinuities, waveguide irises, tuning screws and posts, matched loads; Waveguide attenuators; Waveguide phase shifters; waveguide multiport junctions: E plane Tee, H plane Tee, Magic Tee, applications of Magic Tee, hybrid ring; Ferrites: Faraday rotation principle, gyrator, isolator, circulator.
MODULE III	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 IV	MICROWAVE SOLID-STATE DEVICES
	Microwave solid-state devices: Microwave tunnel diode; Transferred electron devices: Gunn-effect diodes, RWH theory, modes of operations; Avalanche transit time devices: IMPATT diode, TRAPATT diode, BARITT diode, Pin diodes, varactor diodes, crystal detectors.
MODULE V	MICROWAVE MEASUREMENTS
	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.

TEXTBOOKS

1. Samuel Y. Liao, —Microwave Devices and Circuits, Pearson, 3rd Edition, 2003.
2. Herbert J. Reich, J.G. Skolnik, 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, 4th Edition, 1955.

REFERENCE BOOKS:

1. R.E. Collin, "Foundations for Microwave Engineering" IEEE Press, John Wiley, 2nd Edition, 2002.
2. Peter A. Rizzi, "Microwave Engineering Passive Circuits" PHI, 3rd Edition, 1999.
3. M.L. Sisodia, G.S. Raghuvanshi, "Microwave Circuits and Passive Devices" Wiley Eastern Ltd., New Age International Publishers Ltd, 1st Edition, 1995.
4. Microwave and Radar Engineering – M. Kulkarni, Umesh Publications, 1998.

WEB REFERENCES:

1. <https://nptel.ac.in/courses/112105171/1>

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
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)			
2	Introduction, microwave spectrum and bands, applications of microwaves	CO 1	T1-0.1-0.4
3	Types of waveguides, field equations in rectangular waveguide	CO 1	T1-4.1.1-4.1.3
4	Field components of TM waves for rectangular waveguide	CO 1	T1-4.1.6-4.1.7
5	Field components of TE waves for rectangular waveguide	CO 1	T1-4.1.6-4.1.7
6	Modes of TM and TE waves in rectangular waveguide	CO 1	T1-4.1.4
7	Cut off frequency of rectangular waveguide	CO 1	T1-4.3.1-4.3.1
8	Wave impedance in rectangular waveguide	CO 1	R4- 6.8-6.9 R4- 6.14- 6.15
9	Dominant mode and degenerate modes	CO 1	T1-4.4- 4.5
10	Mode characteristics of phase velocity, group velocity, wavelength and impedance relations	CO 1	T1 -4.6
11	Cavity resonators	CO 1	T1 - 9.1
12	Coupling mechanisms	CO 1	T1 - 9.2- 9.3
13	Waveguide discontinuities	CO 1	T1 - 9.4.1
14	Waveguide irises, tuning screws and posts, matched loads	CO 2	T1 - 9.4.2-9.4.3
15	Waveguide attenuators	CO 3	T1-9.5
16	Waveguide multiport junctions- E plane Tee Junction	CO 3	T1-10.1.1-10.1.2
17	Waveguide multiport junctions- H plane Tee Junction	CO 3	T1-7.1-7.3

18	Waveguide multiport junctions- E-H plane Tee Junction	CO 3	T1-8.1-8.3
19	Ferrites: Faraday rotation principle	CO 2	R4-7.2
20	Limitations of conventional tubes at microwave frequencies	CO 4	R4 -7.5-7.9
21	Klystron: Velocity modulation process	CO 4	R4- 7.13
22	Reflex Klystron: Velocity modulation	CO 4	T1-8.5-8.6
23	Helix Traveling Wave tube: Slow wave structures	CO 4	T1-8.6-8.7
24	Microwave cross field tubes (M type)- Magnetrons	CO 4	T1-9.1-9.3
25	Microwave solid-state devices: Microwave tunnel diode	CO 5	T1-9.4-9.6
26	Transferred electron devices: Gunn-effect diodes	CO 5	T1-9.4-9.6
27	RWH theory	CO 6	T1-9.4-9.6
28	Avalanche transit time devices: IMPATT diode	CO 5	T1-10.2-10.4
29	Avalanche transit time devices: TRAPATT diode	CO 5	T1-10.2-10.4
30	BARITT diode	CO 5	T1-10.2-10.4
31	Pin diodes	CO 5	T1-10.5-10.6
32	Varactor diodes, crystal detectors	CO 5	T1-10.7
33	Description of microwave bench	CO 6	T1-11.2
34	Different blocks in microwave bench and their features	CO 6	T1-11.2
35	Microwave power measurement	CO 6	T1-11.4
36	Measurement of attenuation	CO 6	T1-11.5
37	Frequency standing wave measurements	CO 6	T1-11.5
38	Measurement of low and high VSWR	CO 6	T1-11.6
39	Measurement of Cavity Q	CO 6	T1-11.7
40	Measurement of Impedance	CO 6	T1-11.8
41	Measurement of Phase shift	CO6	T1-11.9
PROBLEM SOLVING/ CASE STUDIES			
42	Phase velocity, group velocity, wavelength and impedance relations	CO 1	T1-4.3.1-4.3.1
43	Field components of TM waves for rectangular waveguide	CO 1	R4- 6.8-6.9 R4- 6.14- 6.15
44	Field components of TE waves for rectangular waveguide	CO 1	T1-4.4- 4.5
45	Cut off frequency of rectangular waveguide	CO 1	T1 -4.6
46	Waveguide multiport junctions- E plane Tee Junction	CO 3	T1-10.1.1-10.1.2
47	Waveguide multiport junctions- H plane Tee Junction	CO 3	T1-7.1-7.3
48	Waveguide multiport junctions- E-H plane Tee Junction	CO 3	T1-8.1-8.3
49	Ferrites: Faraday rotation principle	CO 4	R4-7.2
50	Output power in Klystron	CO 4	R4- 7.13
51	Output power in Reflex Klystron	CO 4	T1-8.5-8.6
52	Helix Traveling Wave tube: Slow wave structures	CO 4	T1-8.6-8.7
53	Microwave cross field tubes (M type)- Magnetrons	CO 4	T1-9.1-9.3
54	Microwave power measurement	CO 6	T1-11.4

55	Measurement of attenuation	CO 6	T1-11.5
56	Measurement of low and high VSWR	CO 6	T1-11.5
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Waveguides	CO 1	T1-4.3.1-4.3.1
58	Waveguide components and applications	CO 2	R4- 7.13
59	Microwave linear beam and cross field tubes (O-type and M-type)	CO 4	T1-9.1-9.3
60	Microwave solid-state devices	CO 5	T1-9.4-9.6
61	Microwave measurements	CO 6	T1-11.5
DISCUSSION OF QUESTION BANK			
62	Waveguides	CO 1	T1-4.3.1-4.3.1
63	Waveguide components and applications	CO 2	R4- 7.13
64	Microwave linear beam and cross field tubes (O-type and M-type)	CO 4	T1-9.1-9.3
65	Microwave solid-state devices	CO 5	T1-9.4-9.6
66	Microwave measurements	CO 6	T1-11.5

Signature of Course Coordinator
P.Annapurna,Assistant Professor

HOD,ECE

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
✓	Open Ended Experiments	✓	Seminars	✓	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 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), 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	05	05	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.

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 Videos	Assignment	Tech-talk	Seminar	Open Ended Experiment
20%	30%	30%	10%	10%

VI COURSE OBJECTIVES:

The students will try to learn:

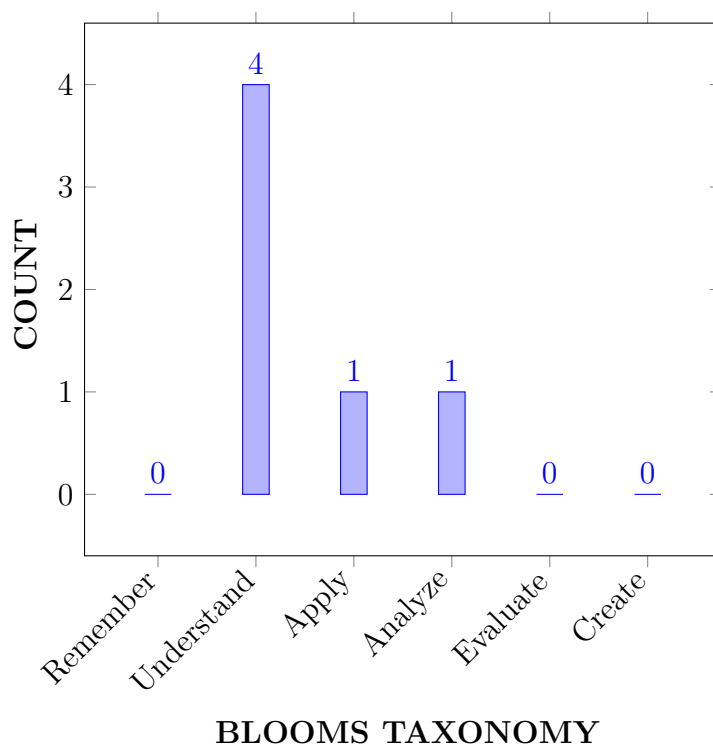
I	The fundamental concepts of embedded computing, embedded C, RTOS and embedded software tools for implementing embedded systems.
II	Embedded software development tools for debugging and testing of embedded applications, architectures of ARM and SHARC processors.
III	Interfacing with external environments 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	Analyze 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	Understand 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.	2	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	3	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 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.	3	AAT / Projects

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.	2	Seminars / 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	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	2
CO2	PO 1	Apply the integration of sensors, actuators and on-chip peripherals of microcontroller architectures for prototype design by applying engineering fundamentals.	1
	PO 2	Understand the given the embedded application problem statement and finding the solution implementation of prototype embedded system design by analyzing complex engineering problems.	6
	PO 3	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.	6

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO2	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.	6
	PO 5	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.	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
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 science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1
	PO 10	Describe the principles of RTOS and the methods used for saving memory and power giving effective presentations and take clear instructions Use Keil Integrated Development Environment by giving effective presentations and take clear instructions in real time environments.	1
	PSO1	Formulate and Evaluate the embedded applications in the field of Intelligent Embedded and Semiconductor technologies.	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	Understand the given the embedded application problem statement and finding the solution implementation of embedded applications using tools by analyzing complex engineering problems.	5
	PO 3	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.	5
	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 embedded software development tools to provide valid conclusions.	6

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 4	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 engineering fundamentals.	1
	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
	PSO2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	1
CO6	PO 1	Model a embedded application prototype using embedded C by applying engineering fundamentals.	1
	PO 2	Understand the problem statement of embedded prototype design in global engineering applications in complex problem analysis using mathematics.	5
	PO 3	Design solutions of embedded applications in global engineering applications for complex Engineering problems that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations.	6
	PO 10	Describe 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	2	2	2
CO 1	3	-	-	-	-	-	-	-	-	1	-	-	2	-	-
CO 2	1	6	6	6	1	-	-	-	-	1	-	-	-	-	-
CO 3	1	-	-	-	-	-	-	-	-	1	-	-	2	-	-
CO 4	3	5	5	6	1	-	-	-	-	1	-	-	-	-	-
CO 5	1	-	-	-	-	-	-	-	-	1	-	-	-	1	-
CO 6	1	5	6	-	-	-	-	-	-	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	-	-	100	-	-
CO 2	33.3	60	60	54.5	100	-	-	-	-	20	-	-	-	-	-
CO 3	33.3	-	-	-	-	-	-	-	-	20	-	-	100	-	-
CO 4	100	50	50	54.5	100	-	-	-	-	20	-	-	-	-	-
CO 5	33.3	-	-	-	-	-	-	-	-	20	-	-	-	50	-
CO 6	33.3	50	60	-	-	-	-	-	-	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	-	-	3	-	-
CO 2	1	3	3	3	3	-	-	-	-	1	-	-	-	-	-
CO 3	1	-	-	-	-	-	-	-	-	1	-	-	3	-	-
CO 4	3	2	2	2	3	-	-	-	-	1	-	-	-	-	-
CO 5	1	-	-	-	-	-	-	-	-	1	-	-	-	2	-
CO 6	1	2	3	-	-	-	-	-	-	1	-	-	-	-	-
TOTAL	10	7	8	5	6	-	-	-	-	6	-	-	6	2	0
AVERAGE	1.66	1.16	1.33	0.83	1	-	-	-	-	1	-	-	1	0.33	0

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
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
✓	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	INTRODUCTION TO EMBEDDED C AND APPLICATIONS
	C looping structures, register allocation, function calls, pointer aliasing, structure arrangement, bit fields, unaligned data and endianness, inline functions and inline assembly, portability issues; Embedded systems programming in C, binding and running embedded C program in Keil IDE, dissecting the program, building the hardware; Basic techniques for reading and writing from I/O port pins, switch bounce; Applications: Switch bounce, LED interfacing, interfacing with keyboards, displays, D/A and A/D conversions, multiple interrupts, serial data communication using embedded C interfacing.
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	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://lms.iare.ac.in/index?route=course/detailscourseid = 228](https://lms.iare.ac.in/index?route=course/detailscourseid=228)

COURSE WEB PAGE:

1. [https://lms.iare.ac.in/index?route=course/playercourseid = 228sectionid = 729lessonid = 7135](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	Introduction to embedded C,C looping structures.	CO 2	T3-1.3
11	Register allocation, Function calls, and pointer aliasing.	CO 2	T3-2.4
12	Structure arrangement, Bit fields, unaligned data and endianness.	CO 2	T3-2.5
13	Inline functions and inline assembly, portability issues.	CO 2	T3-2.6
14	Embedded systems programming in C, binding and running embedded C program in Keil IDE	CO 2	T3-2.7
15	Embedded C program in Keil IDE, dissecting the program, building the hardware	CO 2	T3-2.8
16	Basic techniques for reading and writing from I/O port pins, switch bounce	CO 2	T3-2.9
17	Applications: Switch bounce, LED interfacing.	CO 2	R2-3.1
18	Interfacing with keyboards, displays	CO 2	R2-3.2
19	D/A and A/D conversions, multiple interrupts.	CO 2	R2-3.3
20	Serial data communication using embedded C interfacing.	CO 2	R2-3.4
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	Introduction to embedded c and applications	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	Introduction to embedded c and applications	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
Mrs. P. Ganga Bhavani, Assistant Professor

HOD,ECE

COURSE DESCRIPTION

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
0%	Remember
50 %	Understand
15 %	Apply
35 %	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 8th and 17th 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.

VI COURSE OBJECTIVES:

The students will try to learn:

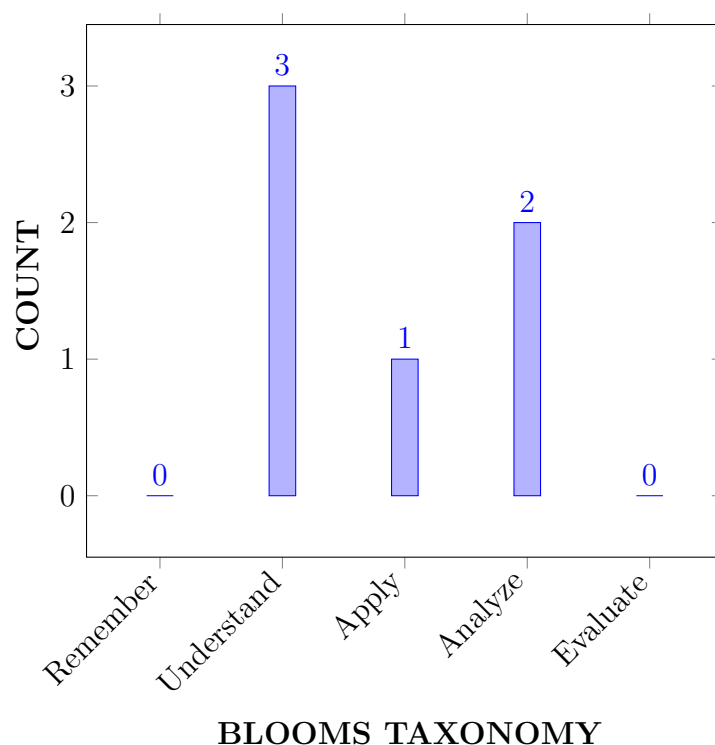
I	The Principles of hierarchical VLSI design from the metal oxide semiconductor transistor up to the system level and fabrication.
II	The Data path subsystems incorporating into a VLSI chip with contemporary techniques for achieving high-speed, low-power and low area overhead.
III	The Chip design through 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	Outline the effects of scaling on MOS circuits for area, delay, power and fabrication flow with constant voltage or field or combined modelling.	Understand
CO 2	Describe inverters, complex gates and dynamic CMOS circuits for power consumption, distortion and speed of operation.	Understand
CO 3	Build the stick diagrams, layouts of MOS circuits using lambda, absolute and Euler physical design rules.	Apply
CO 4	Distinguish the structure, implementation approaches on full custom and semicustom design for speed, cost, reconfiguration and reliability parameters.	Analyze
CO 5	Explain data path subsystems containing arithmetic logic units, parity generators, comparators and memories using stick diagrams and layouts.	Understand
CO 6	Construct simulation, synthesis and design verification of logic circuits using the key elements of VLSI design flow.	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.	2	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 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.	3	SEE, CIE, AAT

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.	-	-

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 trends in technology (knowledge) it's effect on various gate parameters such as area, maximum operating frequency, channel resistance, gate capacitance and time delay by applying the principles of mathematics, science and engineering fundamentals	3
	PO 2	Formulate and analyze (problem analysis) complex Engineering problems for MOSFET scaling 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	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

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 10	Describe inverters, complex gates and dynamic CMOS circuits for power consumption, distortion and speed of operation with clarity	1
CO 3	PO 1	Build the stick diagrams, layouts of MOS circuits (knowledge) by following design rules with mathematics, science and engineering fundamentals	3
	PO 4	Design layout of transistors from stick diagram using experimental design and analysis	2
	PO 10	Explain the stick diagrams, layouts of MOS circuits using lambda, absolute and Euler physical design rules with clarity	1
CO 4	PO 1	Distinguish the structure, implementation approaches (knowledge) for full custom and semicustom design on the basis of speed, cost and reconfiguration and time to market parameters by applying mathematics, science and engineering fundamentals	3
	PO 3	Design solutions for complex engineering problems and full custom and semi custom system components using digital system by doing innovative solution and implementing them using modern tools such as cadence software, mentor graphics , synopsis.	3
	PO 4	Examine full custom and semi custom logic circuits with design of experiments, analysis and interpretation of data	2
	PO 10	Explain structure, implementation approaches on full custom and semicustom design for speed, cost, reconfiguration and reliability parameters with clarity	1
	PSO 2	Focus on the practical experience of ASIC prototype and SOC designs with emphasis on of speed, cost, and reconfiguration and time to market parameters.	2
CO 5	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 4	Design various data path subsystems using research-based knowledge and research methods including design of experiments.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 10	Explain data path subsystems containing arithmetic logic units, parity generators, comparators and memories using stick diagrams and layouts. with clarity	1
CO 6	PO 1	Discuss simulation, synthesis and design verification (knowledge) using scientific principles and methodology of VLSI design engineering	2
	PO 2	Formulate and analyze (validation) complex engineering designs for analog and mixed signal using first principles of mathematics and engineering sciences	5
	PO 3	Design solutions for complex engineering problems and design system components using digital system by doing innovative solution and implementing them using modern tools such as cadence software, mentor graphics , synopsis.	3
	PO 4	Examine sequential and combinational logic circuits with design of experiments, analysis and interpretation of data	2
	PO 10	Prepare for Tech talks and concept video presentations keeping in view of latest trends in technology with clarity.	1
	PSO 2	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.	2

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	2	2	2
CO 1	3	3	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	2	4	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	3	-	-	2	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	-	3	2		-	-	-	-	1	-	-	-	2	-
CO 5	3	5	-	2	-	-	-	-	-	1	-	-	-	-	-
CO 6	2	5	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	30	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 2	66	40	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 3	100	-	-	20	-	-	-	-	-	20	-	-	-	-	-
CO 4	100	-	30	20	-	-	-	-	-	20	-	-	-	100	-
CO 5	100	50	-	20	-	-	-	-	-	20	-	-	-	-	-
CO 6	66	50	30	20	-	-	-	-	-	20	-	-	-	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	1	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	3	-	-	1	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	-	1	1	-	-	-	-	-	1	-	-	-	3	-
CO 5	3	2	-	1	-	-	-	-	-	1	-	-	-	-	-
CO 6	3	2	1	1	-	-	-	-	-	1	-	-	-	3	-
TOTAL	18	7	2	8	-	-	-	-	-	6	-	-	-	6	-
AVERAGE	3	1.7	1	2	-	-	-	-	-	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	MOSFETS

	Fundamentals of MOSFETs; Weak and strong inversion conditions; Threshold voltage concept in MOSFETs; Current - voltage characteristics of a MOSFET; MOSFET parasitics; Trends and projections in VLSI design and technology; Scaling in MOS devices; Effects in scaling of MOS devices; BiCMOS technologies; CMOS nanotechnology.
MODULE II	VLSI DESIGN STYLES
	NMOS, PMOS and CMOS fabrication Flow; Noise Margin; Inverter Threshold Voltage; NMOS inverter design and characteristics; CMOS inverter design and properties; Delay and power dissipation; Parallel and series equivalent circuits; Pass transistor; Various pull ups; Bi-CMOS inverters
MODULE III	VLSI PHYSICAL DESIGN
	Stick Diagrams; Physical design rules: 2 micro m and lambda CMOS design rules for wires, contacts and transistors; Layout design; Euler's rule for physical design. VLSI Interconnects; Reliability issues in CMOS VLSI; Latching; Electromigration.
MODULE IV	LOGIC DESIGN AND IMPLEMENTATION STRATEGIES
	Gate Level Design: Complex gates; Switch logic; Transmission gates; Static and dynamic CMOS design; Time delays; Driving large capacitive loads; Wiring capacitances; Fan-in and Fan-out; Choice of layers implementation strategies full custom and semi custom design; Standard cell design and cell libraries; Programmable logic devices; CPLDs; FPGA building block architectures; FPGA interconnect routing procedures; Speed and area tradeoff.
MODULE V	SUB SYSTEM DESIGN
	Data Path Sub Systems: Sub system design; Shifters; Adders; ALUs; Multipliers; Parity generators; Comparators; Zero/one detectors; Counters Array Subsystems: SRAM; DRAM; ROM; Serial access Memories; Static and dynamic latches and registers; Timing issues; Clock strategies; Low power memory Circuits; Synchronous and asynchronous circuit design..

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, Addison Wesley, 1993. ISBN: 978-81-317-1942-8
2. M.J. Smith, "Application Specific Integrated Circuits", Addison 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://lms.iare.ac.in/index?route=course/details> and course_id = 231

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=231
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.	CO1	T1-2.2
5	Effect of transconductance, output conductance and figure of merit on performance characteristics of MOS.	CO1	T1-2.12
6	PASS transistors , NMOS inverter design and impedance ratios of Nmos inverter.	CO2	R1-4.7
7	Alternative forms of Pull –up's, CMOS inverter design and properties	CO2	R1-2.5.3
8	Various forms of Bi-CMOS inverters	CO2	T1-2.6
9	Processing steps of VLSI Design	CO6	T1-3.1, 3.2.
10	Introduction to Stick Diagrams; Physical design rules	CO3	T1-3.4,3.5
11	Introduction to Lambda based design rules	CO3	T1-3.3
12	Double metal MOS process rules, 2µm design rules, Contact cuts	CO3	T1-3.4,3.5
13	Euler's rule for physical design	CO3	T1-3.3
14	Scaling in MOS circuits	CO1	R1-4.8
15	Model and effects of scaling	CO1	R1-4.8
16	VLSI Interconnects, Reliability issues in CMOS VLSI	CO4	R1-4.5
17	Trends and projections in VLSI design and technology, CMOS Nano technology	CO1	R1-4.7
18	Sheet Resistance and area capacitance of MOS layers	CO1	T1-2.13,
19	Inverter Time delays, Driving large capacitive loads	CO2	T1-6.3
20	Propagation Delays, Wiring capacitances; Fan-in and Fan-out	CO2	T1-6.2
21	Gate level design: complex gates, Switch logic-	CO2	T1-4.11
22	Transmission gates ,Other forms of CMOS logic such as Pseudo –nMOS	CO2	T1-4.10, 4.11
23	Architecture Dynamic CMOS,clocked CMOS	CO2	R1-6.3.7
24	Architecture of CMOS domino; n-p CMOS	CO2	R1-6.3.2

25	Design Approach – PROM, PLA and PAL	CO4	T3 -7.7
26	Internal block description of FPGA	CO4	T3
27	Internal block description of CPLD	CO4	T3
28	Different types FPGA interconnect routing procedures; Performance tradeoff	CO4	R1-6.3.4
29	implementation strategies: full custom	CO4	R1-6.6.7
30	implementation strategies: semi custom design	CO4	R1-8.1,8.2
31	Comparison of FPGA and CPLD	CO4	T3
32	Comparison of Full custom and semi custom designs	CO4	R1-6.6.7
33	Design modules in subsystems ,basics of shifters	CO5	R1-6.3.4
34	Architecture of Ripple carry, Carry Look Ahead, Carry select Adders	CO5	R1-6.6.7
35	Architecture of Manchester carry chain ,ALUs.	CO5	R1-8.1,8.2
36	Architectures of Multipliers	CO5	R1-8.9
37	Architectures of Parity generators; Comparators; Zero/one detectors;	CO5	R1-8.4
38	Design of Asynchronous and Synchronous Counters	CO5	R1-8.3,8.5
39	Memory operation of SRAM, DRAM, ROM	CO5	R1-9.1,9.2, 9.3
40	Memory operation of Floating gate concepts and Flash Memories, Serial access Memories.	CO5	T3-7.2,7.3
PROBLEM SOLVING/ CASE STUDIES			
41	Finding drain current, drain to source resistance, transconductance	CO1	R1-2.5.3
42	Finding electrical properties of MOS based on different parameters	CO1	T1-2.6
43	Finding the shift in characteristics based on impedance ratio and beta ratios	CO2	T1-2.10
44	Design of stick diagrams	CO3	T1-3.1, 3.2.
45	Design of Layout of MOS transistor	CO3	T1-3.4,3.5
46	Design using Euler's physical design	CO3	T1-3.3
47	Calculation of resistance and capacitance of layers	CO3	T1-1.1-1.3,1.4
48	Calculation of Delay with respect to circuit	CO2	T1-1.7,1.8
49	Design of complex gate and transmission gate designs	CO2	T1-2.5,2.9
50	Design of shifter circuits	CO5	R1-8.1,8.2
51	Design of adders	CO5	R1-8.9
52	Design of multipliers	CO5	R1-8.4
53	Look up tables and FPGA design	CO5	R1-6.3.2
54	Design of PROM	CO5	R1-6.3.4
55	Design of PLA,PAL	CO4	R1-6.6.7
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	MOS transistor fundamental and basic electrical properties	CO1	T1-1.1-1.3,1.4
57	Stick diagram ,layout, scaling of MOS circuits	CO3	T1-3.1, 3.2
58	Delay of MOS circuits, gate level circuit design	CO2	T1-4.6
59	Adders, multipliers, memory units	CO5	R1-8.1,8.2
60	Architectures of Programmable logical devices and testing	CO4	R1-6.3.2

DISCUSSION ON QUESTION BANK			
61	MOS transistor fundamental and basic electrical properties	CO1	T1
62	VLSI design styles, Stick diagram ,layout, scaling of MOS circuits	CO3	T1
63	Basic circuit concepts and gate level design	CO2	R1
64	Data path subsystems	CO5	R2
65	Programmable logical devices	CO4	R1

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



INSTITUTE OF AERONAUTICAL ENGINEERING (Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	ELECTRONICS AND COMMUNICATION ENGINEERING				
Course Title	DIGITAL IMAGE PROCESSING				
Course Code	AEC508				
Program	B.Tech				
Semester	VII				
Course Type	PROFESSIONAL ELECTIVE - II				
Regulation	R-16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
Course Coordinator	Dr. B. Surekha Reddy, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
UG	AEC003	III	Probability Theory and Stochastic Process
UG	AEC009	V	Digital Communications

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	✓	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
✓	Quiz	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
10%	Remember
70%	Understand
20%	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	05	05	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.

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
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

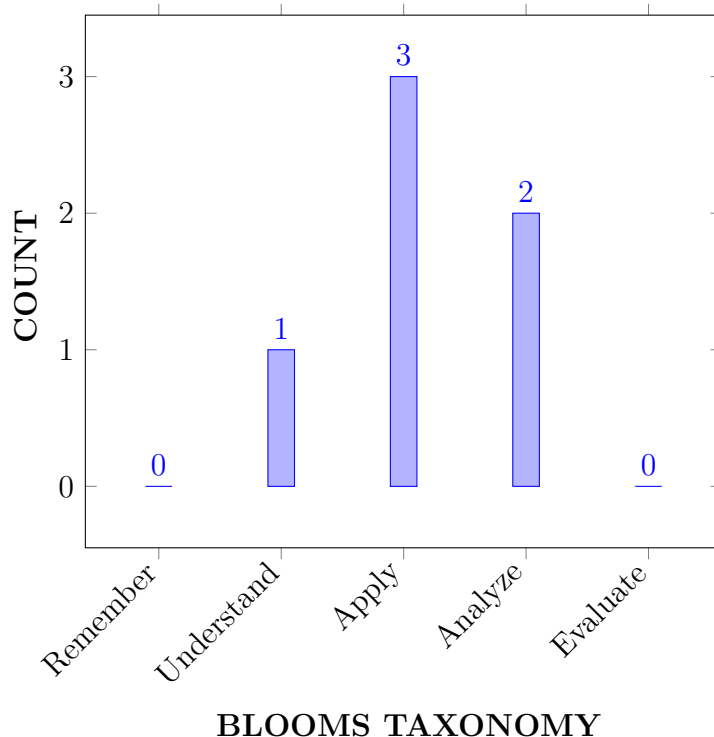
I	The fundamental concepts of digital image processing methods and techniques.
II	The image enhancement, image segmentation and compression techniques in spatial and frequency domains.
III	The algorithms to solve image processing problems to meet design specifications of various applications of image 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	Analyze the image restoration in the spatial and frequency domains to deal with noise models for removing degradation from given image.	Analyze
CO 5	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
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.	3	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 have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.		

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	2
	PO 10	Effective presentation and Speaking Style on sampling and quantization and write Subject Matter Effectively the difference between analog and digital images.	4
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.	4
	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.	2
	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.	5

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	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.	7
	PO 10	Effective presentation and Speaking Style on histogram processing Write Subject Matter Effectively on manipulation technique of an digital image.	4
	PO 12	Recognize the need for the image segmentation in different image applications and ability to improve the enhancement algorithms in the broadest context of technological advancements.	6
	PSO 1	Design of experiments with project development and execution modern tools such as MATLAB with image processing tool box, python, CV2.	6
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.	2
	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.	4
	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	3
	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.	3
	PO 10	Effective presentation and Speaking Style and write on image segmentation techniques.	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 12	Recognize the need for image Segmentation technique, and broadest context of technological change in digital image and advanced engineering concepts.	6
	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.	5
	PO 10	Present effectively and Clarity source encoder and write effectively subject matter on decoder techniques.	4
	PO 12	Recognize the ability of image restoration algorithms for life-long learning in the broadest context of image processing.	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	2	-	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 2	3	5	-	-	-	-	-	-	-	2	-	-	2	-	-
CO 3	2	2	5	7	-	-	-	-	-	2	-	6	2	-	-
CO 4	2	5	5	4	-	-	-	-	-	2	-	-	2	-	-
CO 5	3	3	-	-	-	-	-	-	-	2	-	6	2	-	-
CO 6	3	5	-	-	-	-	-	-	-	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	66.6	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	0.0
CO 2	100	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.0	0.0	0.0	100	0.0	0.0
CO 3	66.6	20.0	50.0	63.6	0.0	0.0	0.0	0.0	0.0	40.0	0.0	50.0	100	0.0	0.0
CO 4	66.6	50.0	50.0	36.3	0.0	0.0	0.0	0.0	0.0	40.0	0.0	0.0	100	0.0	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
CO 5	100	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.0	0.0	50.0	100	0.0	0.0
CO 6	100	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.0	0.0	33.3	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	2	3	-	-	-	-	-	1	-	2	3	-	-
CO 4	3	2	2	1	-	-	-	-	-	1	-	-	3	-	-
CO 5	3	1	-	-	-	-	-	-	-	1	-	2	3	-	-
CO 6	3	2	-	-	-	-	-	-	-	1	-	1	-	-	-
TOTAL	18	8	4	4	-	-	-	-	-	6	-	5	12	-	-
AVERAGE	3	1.6	2	2	-	-	-	-	-	1	-	1.6	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:

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

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 RESTORATION
	Image restoration degradation model, algebraic approach to restoration. Inverse filtering, least mean square filters, constrained least square restoration, interactive restoration.
MODULE IV	IMAGE SEGMENTATION
	Image segmentation detection of discontinuities, edge linking and boundary detection, threshold, region oriented segmentation 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.
MODULE V	IMAGE COMPRESSION
	Image compression: Redundancies and their removal methods, fidelity criteria, image compression models, source encoder and decoder, error free compression, lossy compression, JPEG 2000 standard.

TEXTBOOKS

1. R.C. Gonzalez & R.E. Woods, Digital Image Processing, Addison Wesley/ Pearson education, 2nd Edition, 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, Wiley, 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>

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 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 1	T1:2.4-2.5
6	2D-FFT and properties	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	Haar transform, Slant transform	CO 2	T1:3.1-3.6
9	Hoteling transform, Walsh transform	CO 2	T1:3.1-3.6
10	Hoteling transform, Walsh transform	CO 2	T1:3.1-3.6
11	Discrete cosine transform, Hadamard 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	Understand 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	Understand median filter processing	CO 3	T1:3.1-3.8; R2: 7.4-7.5
18	Spatial domain high pass filtering	CO 3	T1:3.1-3.8; R2: 7.4-7.5
19	Histogram equalization	CO 3	T1:3.1-3.8; R2: 7.4-7.5
20	Apply the Histogram processing technique for image enhancement	CO 3	T1:3.1-3.8; R2: 7.4-7.5
21	Understand filtering in frequency domain	CO 4	T1:4.1-4.6
22	Obtaining frequency domain filters from spatial filters	CO 4	T1:4.1-4.6
23	Generating filters directly in the frequency domain	CO 4	T1:4.1-4.6
24	Low pass (smoothing) filter in frequency domain.	CO 4	T1:4.1-4.6
25	High pass (sharpening) filter in frequency domain	CO 4	T1:4.1-4.6
26	Introduction to Image segmentation	CO 5	T1:10.1-10.6
27	Detection of discontinuities	CO 5	T1:10.1-10.6
28	Edge linking and boundary detection	CO 5	T1:10.1-10.6
29	Threshold techniques for image segmentation	CO 5	T1:10.1-10.6
30	Understand region oriented segmentation	CO 5	T1:10.1-10.6 ; T1:9.1-9.6
31	Morphological image processing, dilation and erosion	CO 5	T1:10.1-10.6; T1:9.1-9.6
32	Understand structuring element decomposition, the Strel function, erosion;	CO 5	T1:9.1-9.6
33	Combining dilation and erosion: Opening and closing	CO 5	T1:9.1-9.6
34	The hit and miss transformation	CO 5	T1:9.1-9.6
35	Introduction to Image compression	CO61	T1:8.1-8.3 ; R2: 7.4-7.5

36	Redundancies and their removal methods	CO 6	T1:8.1-8.3; R2: 7.4-7.5
37	Fidelity criteria, image compression models	CO 6	T1:8.1-8.3; R2: 7.4-7.5
38	Understand source encoder and decoder	CO 6	T1-8.1-8.1.7
39	Error free compression	CO 6	T1-8.1-8.1.7
40	Lossy compression & JPEG 2000 standard	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, Hotelling 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
Dr. B. Surekha Reddy, Assistant Professor

HOD,ECE

✓	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 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
5%	Remember
50%	Understand
20 %	Apply
15%	Analyze
10%	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	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 17th 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
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

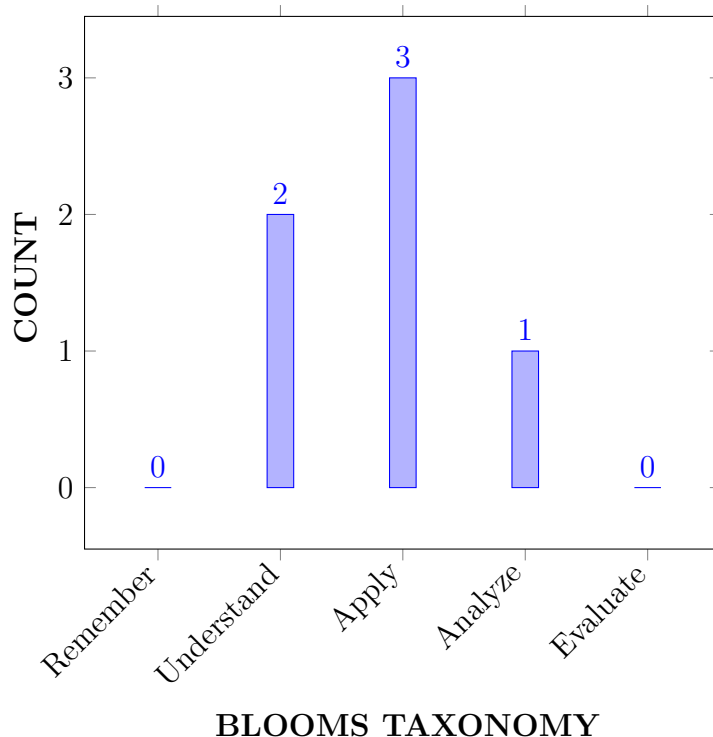
I	The fundamental concepts of research frame work and its methodologies to conduct research work.
II	The design and implementation of quantitative and qualitative research methods given the nature of the research problem.
III	The ethical issues in educational research, including data analysis in using quantitative and qualitative research.
IV	The knowledge and ideas through writing well-developed research reports.

VII COURSE OUTCOMES:

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

CO 1	Describe the role of research and research frame work in several fields of applied economics, scientific, business and industry.	Understand
CO 2	Illustrate the formulation of the research hypotheses using dependent and independent variables for testing of research identified problem.	Understand
CO 3	Build a suitable research design, selecting appropriate research method and resources to analysis the data of specified research problem.	Apply
CO 4	Analyze the scaling and sampling techniques for measurement of data in the research for quantitative and qualitative data.	Analyze
CO 5	Classify the various techniques of data processing and data analysis which includes statistical tools and graphical methods for present the results.	Apply
CO 6	Utilize the American Psychological Association format, ethical issues through knowledge and ideas for writing well-developed research reports	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	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
PO 8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice	1	Tech Talk/ Conept VideosT
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	Tech Talk/ Conept Videos
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/ Conept Videos

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 2	Focus on the practical experience of ASIC prototype designs, Virtual Instrumentation and SOC designs	1	AAT
PSO 3	Build the Embedded hardware design and software programming skills for entry level job positions to meet the requirements of employers.	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	✓	✓	✓	✓	-	-	-	-	✓	✓	-	-	-	✓	-
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 role of research in several fields of applied economics, scientific, business and industry by applying the principles of engineering, science to complex engineering problems	3
	PO 2	Problem or opportunity identification, problem definition, formulation the hypothesis to determining a problem using Information and data collection.	3
	PO 3	Design solutions for complex Engineering problems and use techniques of research process and data collection that meet the specified needs with appropriate consideration for the purpose for all aspects of the problem constraints and apply economics, scientific, business and industry	4
	PO 4	Ability to work with technical uncertainty and Identify the problem in several fields of applied economics, scientific, business and industry using methods and techniques Understanding of appropriate codes of practice and industry standards and Awareness of quality issues and ability to identify, classify	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 Research process in research problem and write Subject Matter Effectively the research problem identification.	4
CO 2	PO 1	Demonstrate the formulation of the research hypotheses using principles of Scientific principles and methodology	2
	PO 2	Problem or opportunity identification, problem definition, formulation the research hypothesis and methodology to determining a problem using Information and data collection	3
	PO 10	Formulation of the research hypotheses using Reference , Speaking Style	3
CO 3	PO 1	Discuss the various types of resources for the data collection (knowledge) by applying the scientific principles and methodology , other disciplines to support the study of engineering discipline to collection the data	2
	PO 2	Understand the given the research problem statement and problem definition finding the solution implementation of research design using literature review by problem formulation and abstraction.	4
	PO3	Research design is the arrangement of conditions Using creativity to establish innovative solutions for collection and analysis of data and apply economics, scientific, business and industry.	4
	PO 4	Ability to work with technical uncertainty and find the Methods of data collection using literature review and information resources in research design using particular materials understand and approach to research problem.	4
	PO 10	Research design is the arrangement of conditions using. Reference , Speaking Style and clarity and for collection and analysis of data	3
	PSO 3	Make use of research methods and techniques for the research design to meet the requirements and desire for higher studies in the field of research design process	2
CO 4	PO 1	Demonstrate the scaling and sampling measurement using principles of Scientific principles and methodology	3
	PO 2	Understand the given the research problem statement identification, definition and finding the solution implementation of scaling measurement, sampling design using literature review by problem formulation and abstraction.	4
	PO 3	Questionnaire in survey Using creativity to establish innovative solutions for open- and- closed- ended questions and apply economics, scientific, business and industry.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 4	Ability to work with technical uncertainty and find the Questionnaire in survey using technical literature review and sampling design , open- and- closed- ended questions using particular materials.	3
	PO 10	Questionnaire in survey using Reference , Speaking Style and clarity and open- closed- ended questions	3
CO5	PO1	concepts of processing and analysis using principles of Scientific principles and methodology editing, coding, classification and tabulation methods using science and methodology	3
	PO 2	Problem or opportunity identification, problem definition, formulation and data collection ,translation of the data processing and validation of data analysis	6
	PO 4	Ability to work with technical uncertainty and find the results data using data processing and data analysis using particular materials(statistical tools)	3
CO6	PO 1	Demonstrate the report generation and APA format using engineering discipline to support study of engineering discipline.	3
	PO2	Interpretation of results and documentation while generating a report based on APA format.	2
	PO 3	Professional codes of ethics, high degree of trust and integrity, believing to follow ethical issues in conducting research	3
	PO8	Identification of ethical issues related to conduct research and a commitment to protecting the rights for research studies.	1
	PO 9	Teams are used during the classroom periods; in the hands- on labs on report generation and Instruction on effective teamwork and project management and while generating a report based on APA format.	3
	PO 10	Effective presentation and Speaking Style, Reference on report generation and write Subject Matter Effectively on validity and reliability evidence in report writing using APA format.	3
	PO12	Ongoing learning feasibility and practicality of research methodology Project management professional certification and Continued personal development for a proposed project.	3
	PSO3	Feasibility and practicality of research methodology entry level job positions to meet the requirements of employers.	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	2	3	4	4	-	-	-	-	-	2	-	-	-	1	-
CO 2	2	3	-	-	-	-	-	-	-	3	-	-	-	-	-
CO 3	2	4	4	4	-	-	-	-	-	3	-	-	-	0	2
CO 4	3	4	2	3		-	-	-	-	3	-		-	2	-
CO 5	3	6	3	-	-	-	-	-	-	-	-	-	-	2	-
CO 6	3	2	3	-	-	-	-	1	3	3	-	3	-	-	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
	66.7	30	40	36.3	-	-	-	-	-	40	-		-	50	-
CO 1	66.7	30	40	-	-	-	-	-	-	60	-	-	-	0	-
CO 2	66.7	40	40	36.3	-	-	-	-	-	60	-	-	-	0	100
CO 3	100	40	20	27.7		-	-	-	-	60	-		-	100	-
CO 4	100	60	30	-	-	-	-	-	-	40	-	-	-	100	-
CO 5	100	20	30	-	-	-	-	33.3	30	60	-		-	-	100
CO 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
	3	1	2	1	0	0	0	0	0	2	0	0	0	2	0
CO 1	3	1	2	0	0	0	0	0	0	3	0	0	0	0	0
CO 2	3	2	2	1	0	0	0	0	0	3	0	0	0	0	2
CO 3	3	2	1	1	0	0	0	0	0	3	0	0	0	3	0
CO 4	3	3	1	0	0	0	0	0	0	3	0	0	0	2	0
CO 5	3	1	1	0	0	0	0	1	1	3	0	0	0	0	2
CO 6															
TOTAL	18	10	9	4	0	0	0	1	1	17	0	0	0	7	4
AVERAGE	3	1.7	1.5	1	0	0	0	1	1	2.8	0	0	0	2.8	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:

UNIT I	INTRODUCION TO RESEARCH AND PHILOSOPHIES
	Introduction to research: The role of research, research process overview; Philosophies and the language of research theory building: Science and its functions, what is theory, the meaning of methodology.
UNIT II	A RESEARCHER PROBLEMS AND HYPOTHESES
	Thinking like a researcher: Understanding concepts, constructs, variables, and definitions; Problems and hypotheses: Defining the research problem, formulation of the research hypotheses, the importance of problems and hypotheses.
UNIT III	RESEARCH DESIGN AND DATA COLLECTION
	Research design: Experimental and no experimental research design, field research, and survey research. Methods of data collection: Secondary data collection methods, qualitative methods of data collection, and survey methods of data collection.
UNIT IV	ATTITUDE MEASUREMENT , SCALING AND SAMPLING TECHNIQUES
	Attitude measurement and scaling: Types of measurement scales; Questionnaire designing, reliability and validity; Sampling techniques: The nature of sampling, probability sampling design, non-probability sampling design, and determination of sample size.
UNIT V	PROCESSING AND ANALYSIS OF DATA,ETHICAL ISSUES
	Processing and analysis of data ; Ethical issues in conducting research; Report generation, report writing and APA format; Title page, abstract, introduction, methodology, results, discussion, references, and appendices.

TEXTBOOKS

1. Bryman, Alan, Bell, Emma, "Business Research Methods", Oxford University Press, 3rd Edition, 2011.
2. C R Kothari, "Research Methodology", New Age International Publishers, 2nd Edition, 2004.

3. Rubin, Allen, Babbie, Earl, "Essential Research Methods for Social Work", Cengage Learning Inc., USA, 2009

REFERENCE BOOKS:

1. Chawla, Deepak, Sandhi, Neena, "Research Methodology: Concepts and Cases", Vikas Publishing House Pvt. Ltd. Delhi, 2011.
2. Neuman W.L., "Social Research Methods: Qualitative and Quantitative Approaches", Pearson Education, 2008.

WEB REFERENCES:

1. <https://nptel.ac.in/courses/112105171/1>

COURSE WEB PAGE:

1. <https://lms.iare.ac.in/index?route=course/playercourse id=230section id=552lesson id=5559>

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 2	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
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	UNIT-I: INTRODUCCION TO RESEARCH AND PHILOSOPHIES	CO 1	T1:1.1-19,2.1-2.8,3.1-3.8,4.1-4.25,5.1-5.10
58	UNIT-II: A RESEARCHER PROBLEMS AND HYPOTHESES	CO 2	T1:7.1-7.32
59	UNIT-III: RESEARCH DESIGN AND DATA COLLECTION	CO 3,4	T1:8.1-8.10,9.1-9.6
60	UNIT-IV: ATTITUDE MEASUREMENT , SCALING AND SAMPLING TECHNIQUES	CO 5	T1:11.1.-11.18
61	UNIT-V: PROCESSING AND ANALYSIS OF DATA,ETHICAL ISSUES	CO 6	T1:13.1-13.25
DISCUSSION OF QUESTION BANK			
62	UNIT-I: INTRODUCCION TO RESEARCH AND PHILOSOPHIES	CO 1	T1:1.1-19,2.1-2.8,3.1-3.8,4.1-4.25,5.1-5.10
63	UNIT-II: A RESEARCHER PROBLEMS AND HYPOTHESES	CO 2	T1:7.1-7.32
64	UNIT-III: RESEARCH DESIGN AND DATA COLLECTION	CO 3,4	T1:8.1-8.10,9.1-9.6
65	UNIT-IV: ATTITUDE MEASUREMENT , SCALING AND SAMPLING TECHNIQUES	CO 5	T1:11.1.-11.18
66	UNIT-V: PROCESSING AND ANALYSIS OF DATA,ETHICAL ISSUES	CO 6	T1:13.1-13.25

Course Coordinator
Mr.Mohd.Khadir, Assistant Prfoessor

HOD,ECE

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

ELECTRONICS AND COMMUNICATION ENGINEERING COURSE DESCRIPTION

Course Title	MICROWAVE ENGINEERING LABORATORY				
Course Code	AEC110				
Program	B.Tech				
Semester	VII	ECE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	2
Course Coordinator	Ms. P Annapurna, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEC011	V	Antennas and Propagation
B.Tech	AEC015	VII	Microwave Engineering

II COURSE OVERVIEW:

The Microwave Engineering Laboratory delivers the necessary hardware support in the area of RF and Microwave Engineering. It focuses on the principles and advanced applications of Microwaves by measuring the characteristics of Microwave components using Microwave bench setup to analyze and simulate various Microwave devices. This is used in real-time applications in the fields of communication systems and home-based automation systems.

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 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	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.

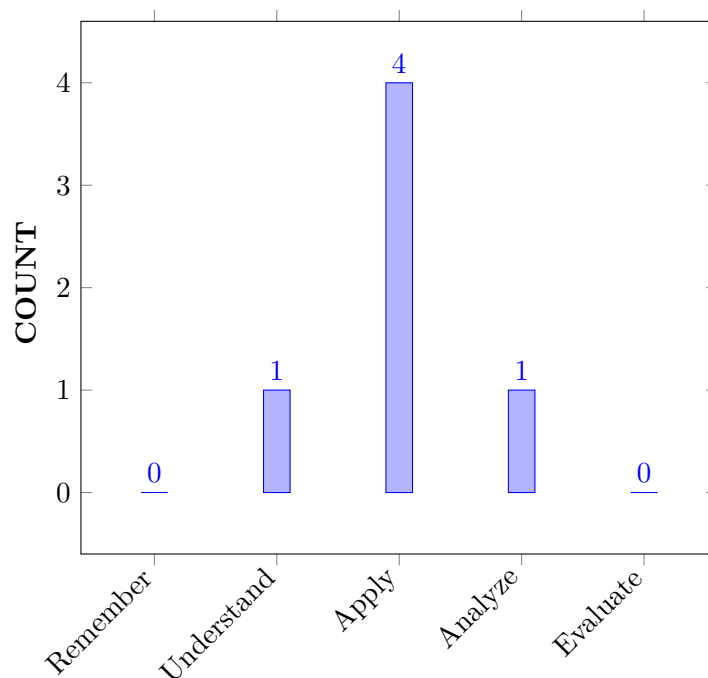
VII COURSE OUTCOMES:

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	Calculate the V-I characteristics of Gunn diode to find out threshold voltage using Gunn bench setup.	Apply
CO 4	Relate the guided wave length with free space and cutoff wave lengths using frequency meter.	Apply

CO 5	Calculate the S-parameters for various microwave components components and Voltage Standing Wave Ratio of unknown load to measure characteristics of microwave devices using microwave test bench	Apply
CO 6	Analyze the polar pattern of Horn antenna to find out the antenna parameters using test setup and High Frequency Software Simulator.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

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	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.	3	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	3	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	2	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	3	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.	3	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 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 / 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 1	Apply the knowledge of mathematics, science, engineering fundamentals to summarise the Waveguide components and their specifications	3
	PO 2	Understand (Problem analysis) the operation microwave bench set up using review research literature , and analyze complex engineering problems reaching substantiated conclusions using first principles engineering sciences.	2
	PO 9	Function effectively as an individual, and as a member or leader to summarise the Waveguide components and their specifications	2
	PO 10	Communicate effectively on Waveguide components and their specifications .	1
CO 2	PO 1	Apply the knowledge of mathematics, science, engineering fundamentals to observe the characteristics of Reflex klystron	3
	PO 2	Identify, formulate, review research literature and analyze the characteristics of Reflex klystron .	1

	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	Function effectively as an individual, and as a member to obtain the readings .	2
	PO 10	Communicate effectively on Reflex klystron and their specifications	1
CO 3	PO 1	Understand (Problem analysis) the operation of gunn diode using review research literature , and analyze complex engineering problems reaching substantiated conclusions using first principles engineering sciences.	2
	PO 2	Identify, formulate, review the characteristics of Gunn diode and find out its Threshold voltage using first principles of mathematics, natural sciences, and engineering sciences .	2
	PO 3	Observe (Design) the characteristics of Gunn diode and find out its Threshold voltage using Design solutions for complex engineering problems that meet the specified needs with appropriate consideration.	2
	PO 9	Function effectively as an individual, and as a member to obtain the readings .	3
	PO 10	Communicate effectively on Gunn diode and their specifications	1
CO 4	PO 1	Apply the knowledge of mathematics, science, engineering fundamentals to observe three different wavelengths to get the solution of complex engineering problems .	2
	PO 2	Identify, formulate, review the characteristics of different types of wavelengths.	2
	PO 3	Compare three different wavelengths and obtain relation between them using Design solutions for complex engineering problems that meet the specified needs with appropriate consideration	2
	PO 9	(Team work)Individual and team work: Function effectively as an individual, and as a member to obtain the readings .	3
	PO 10	Communicate effectively on Gunn diode and their specifications	1
CO 5	PO 1	Apply the knowledge of mathematics, science, engineering fundamentals to obtain the microwave junction and S-Parameters characteristics .	2
	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 Design solutions for complex engineering problems that meet the specified needs with appropriate consideration.	2
	PO 9	(Team work)Individual and team work: Function effectively as an individual, and as a member to obtain the readings .	3
	PO 10	Communicate effectively on microwave junction and S-Parameters characteristics	1
CO 6	PO 1	Apply the knowledge of mathematics, science, engineering fundamentals to obtain the wave impedance .	2
	PO 2	Understand the (Problem analysis) concept of wave impedance using review research literature , and analyze complex engineering problems reaching substantiated conclusions using first principles engineering sciences.	2
	PO 3	Obtain the wave impedance of a matched load using Design solutions for complex engineering problems that meet the specified needs with appropriate consideration.	2
	PO 5	By using modern tool as HFSS to obtain the wave impedance	3
	PO 9	(Team work)Individual and team work: Function effectively as an individual, and as a member to obtain the readings .	2
	PO 10	Communicate effectively on wave impedance measurement	1
	PSO 1	Evaluate the unknown impedance of a given load to find out difference between resistance and reactance circles using smith chart use Create and apply appropriate techniques and modern Engineering and IT tools including complex Engineering activities with an understanding of the limitations.	3

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 3	PO 5	PO 9	PO 10	PSO 1
CO 1	3	2			2	1	
CO 2	3	1	2		2	1	
CO 3	2	2	2		3	1	
CO 4	2	2	2		3	1	
CO 5	2	2	2		3	1	
CO 6	2	2	2	3	2	1	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	STUDY OF MICROWAVE COMPLONENTS
	To study the different wave guide components in the microwave bench setup.
Week-2	MEASUREMENT OF FREQUENCY AND GUIDE WAVELENGTH
	To measure the frequency of a microwave source and demonstrate relationship among guide dimensions, free space wavelength and guide wave length.
Week-3	MODE CHARACTERISTICS OF REFLEX KLYSTRON
	To study the characteristics of Reflex Klystron oscillator, finding the mode numbers and efficiencies of different modes .
Week-4	GUNN DIODE CHARACTERISTICS
	To study the characteristics of Gunn diode oscillator.
Week-5	ATTENUATION MEASUREMENT
	To measure attenuation and insertion loss of a fixed and variable attenuator.
Week-6	DIRECTIONAL COUPLER CHARACTERISTICS
	To measure coupling factor, insertion loss, isolation and directivity of a Directional coupler
Week-7	MEASUREMENT OF IMPEDANCE OF GIVEN LOAD
	To measure the unknown impedance of given load using bench set up.
Week-8	SCATTERING PARAMETERS OF H-PLANE TEE AND E-PLANE TEE
	To find the scattering parameters of a three port H-Plane Tee And E-PlaneTEE.
Week-9	MEASUREMENT OF VSWR
	To measure the low and high VSWR's of matched terminals.
Week-10	MEASURMENT OF SCATTERING PARAMETERS OF MAGIC TEE
	To find the scattering parameters of a four port Magic Tee.
Week-11	CIRCULATOR CHARACTERISTICS
	To measure the isolation and insertion loss of a three port circulator.
Week-12	GAIN AND RADIATION PATTERN OF HORN ANTENNA
	Develop a Hello World application using Google App Engine.
Week-13	MEASUREMENT OF PHASE SHIFT
	To measure the Phase shift between two components in the microwave bench setup.
Week-14	ISOLATOR CHARACTERISTICS
	To measure the isolation and insertion loss of an isolator.

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.

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	Study of Microwave Components.	CO 1	R1
2	Measurement of frequency and guide wave length	CO 4	R1,R2
3	Mode characteristics of reflex klystron.	CO 2	R1,R2
4	Gunn diode characteristics	CO 3	R1,R2
5	Attenuation measurement	CO 4	R1,R2
6	Directional coupler characteristics	CO 5	R1,R2
7	Measurement of impedance of given load.	CO 8	R1,R2
8	Scattering parameters of h-plane tee and e-plane tee	CO 5	R1,R3
9	Measurement of VSWR	CO 6	R1,R3
10	Measurment of s-parameters of magic tee.	CO 5	R1,R3
11	Circulator characteristics.	CO 5	T1-17.1 to 17.6
12	Gain and radiation pattern of horn antenna.	CO 7	R1,R3
13	Measurement of phase shift.	CO 4	R1,R2
14	Isolator characteristics.	CO 5	R1,R2

XVI 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
Ms. P Annapurna, Assistant Professor

HOD,ECE



INSTITUTE OF AERONAUTICAL ENGINEERING (Autonomous)

Dundigal, Hyderabad - 500 043

Electronics and Communication Engineering

COURSE DESCRIPTION

Course Title	EMBEDDED SYSTEMS LABORATORY				
Course Code	AEC111				
Program	B.Tech				
Semester	VII				
Course Type	core				
Regulation	R16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	3
Course Coordinator	Mrs. P. Ganga Bhavani, Assistant Professor				

I COURSE OVERVIEW:

This laboratory course builds on the lecture course "Embedded Systems" which is mandatory for all students of electronics and communication engineering. The course aims at practical experience with the programming of different I/O devices using embedded C and keil tool .

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEC013	VI	Microprocessors and Microcontrollers

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Embedded Systems Laboratory	70 Marks	30 Marks	100

IV 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:

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 exam 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:

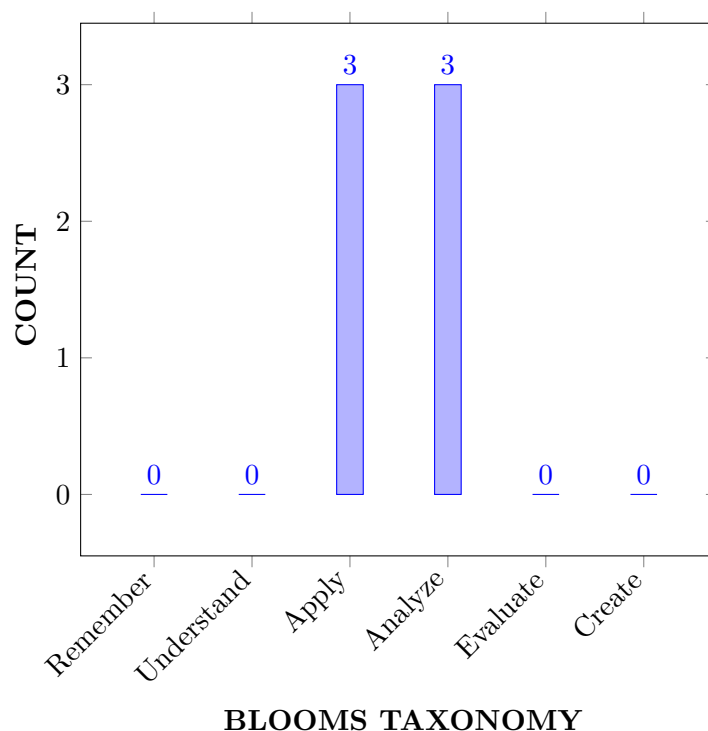
I	Demonstrate Keil IDE tool for development of Embedded system.
II	Program the interfacing of various devices with 8051 using Embedded C.
III	Develop program for implementation of interrupts and serial communications.

VII COURSE OUTCOMES:

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

CO 1	Demonstrate the tool chain for Keil IDE (Embedded Systems Development Tool Chain) using LED Blinking Program.	Apply
CO 2	Build the program to interface LED, LCD, Switch and seven segment display with 8051 to display the data.	Apply
CO 3	Analyze the program to transfer data from microcontroller to PC by using serial communication.	Analyze
CO 4	Examine the program to interface sensor and motor with 8051 microcontrollers to measure the temperature and motor directions.	Analyze
CO 5	Analyze the interfacing connections of analog to digital converter (ADC) and digital to analog converter (DAC) with 8051 microcontrollers.	Analyze
CO 6	Build the program to interface relay and interrupt with 8051 for industrial and control room's 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.
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 related 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	2	Lab related 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 related 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 related 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	Lab related Exercises/ 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	Lab related 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	-	-	2	-	3	-	-	-	1	1	-	-	2	-	-
CO 2	-	3	2	-	-	-	-	-	1	1	-	-	1	-	-
CO 3	-	-	-	-	3	-	-	-	1	1	-	-	-	-	-
CO 4	-	2	2	-	-	-	-	-	1	1	-	-	-	-	-
CO 5	-	-	2	-	3	-	-	-	1	1	-	-	2	-	-
CO 6	-	-	2	-	3	-	-	-	1	1	-	-	1	-	-

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 3	Demonstrate the tool chain for Keil IDE to the design solutions for complex engineering problems and design system components.	7
	PO 5	Select and apply appropriate techniques, resources, and modern engineering and IT tools like Keil IDE for simulation of embedded system circuits.	1
	PO 9	Demonstrate the tool chain for Keil IDE to function effectively as an individual, and as a member in teams	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 and design documentation, make effective presentations, and give and receive clear instructions.	1
	PSO1	Build embedded software platform for embedded systems and signal processing applications using Keil IDE tool.	1
CO 2	PO 2	Understand the given problem statement and develop appropriate arithmetic and logical instructions to provide basic solution to the required experiment.	7
	PO 3	Design simple solutions for complex engineering problems and design system Embedded Systems components or processes that meet the specified needs with appropriate consideration for the public health and environmental considerations.	7
	PO 9	Apply delay program to toggle the LED with 250 ms delay, interface LCD, Switch and seven segment display to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	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 and design documentation, make effective presentations, and give and receive clear instructions.	1
	PSO1	Build Embedded Software and Digital Circuit Development platform to interface LCD and seven segment display with 8051 for Robotics, Embedded Systems and Signal Processing Applications.	1
CO 3	PO 5	Classify different types of serial communications then identify the suitable method to transfer data from microcontroller to PC.	1
	PO 9	Analyze the program to transfer data from microcontroller to PC by using serial communication as a member or leader in diverse teams.	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 and design documentation, make effective presentations, and give and receive clear instructions.	1
CO 4	PO 2	Understand the given problem statement and develop appropriate arithmetic and logical instructions to provide basic solution to the required experiment.	7
	PO 3	Design simple solutions for complex engineering problems and design system Embedded Systems components or processes that meet the specified needs with appropriate consideration for the public health and environmental considerations.	7
	PO 9	Function effectively as an individual, and as a member in teams to interface sensor and motor with 8051 microcontrollers to measure the temperature and motor directions.	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 and design documentation, make effective presentations, and give and receive clear instructions.	1
CO 5	PO 3	Design simple solutions for complex engineering problems and design system Embedded Systems components or processes that meet the specified needs with appropriate consideration for the public health and environmental considerations.	7
	PO 5	Select, and apply appropriate techniques to convert the given analog signal to digital signal and display over LCD display.	1
	PO 9	Function effectively as an individual, and as a member in teams to analyze ADC and DAC converters.	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 and design documentation, make effective presentations, and give and receive clear instructions.	1
	PSO1	Understand the interfacing of analog to digital converter (ADC) and digital to analog converter (DAC) with 8051 microcontroller for embedded systems applications.	1
CO 6	PO 3	Design simple solutions for complex engineering problems and design system Embedded Systems components or processes that meet the specified needs with appropriate consideration for the public health and environmental considerations.	7
	PO 5	Apply the program to interface relay with 8051 for industrial and control room's applications by apply appropriate techniques to complex engineering activities with an understanding of the limitations.	1
	PO 9	Function effectively as an individual, and as a member in teams to interface relay and interrupt with 8051	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 and design documentation, make effective presentations, and give and receive clear instructions.	1
	PSO1	An ability to understand the basic concepts of relay and to apply them to various areas, like Electronics, Communications, Signal processing, industries, Embedded systems etc., in the design and implementation of complex systems.	1

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	2	2	2
CO 1	-	-	7	-	1	-	-	-	2	1	-	-	1	-	-
CO 2	-	7	7	-	-	-	-	-	2	1	-	-	1	-	-
CO 3	-	-	-	-	1	-	-	-	2	1	-	-	-	-	-
CO 4	-	7	7	-	-	-	-	-	2	1	-	-	-	-	-
CO 5	-	-	7	-	1	-	-	-	2	1	-	-	1	-	-
CO 6	-	-	7	-	1	-	-	-	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
CO 1	-	-	70.0	-	100	-	-	-	16.6	20.0	-	-	50.0	-	-
CO 2	-	70.0	70.0	-	-	-	-	-	16.6	20.0	-	-	50.0	-	-
CO 3	-	-	-	-	100	-	-	-	16.6	20.0	-	-	-	-	-
CO 4	-	70.0	70.0	-	-	-	-	-	16.6	20.0	-	-	-	-	-
CO 5	-	-	70.0	-	100	-	-	-	16.6	20.0	-	-	50.0	-	-
CO 6	-	-	70.0	-	100	-	-	-	16.6	20.0	-	-	50.0	-	-

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	0	0	3	0	3	0	0	0	1	1	0	0	2	0	0
CO 2	0	3	3	0	0	0	0	0	1	1	0	0	2	0	0
CO 3	0	0	0	0	3	0	0	0	1	1	0	0	0	0	0
CO 4	0	3	3	0	0	0	0	0	1	1	0	0	0	0	0
CO 5	0	0	3	0	3	0	0	0	1	1	0	0	2	0	0
CO 6	0	0	3	0	3	0	0	0	1	1	0	0	2	0	0
TOTAL	0	6	15	0	12	0	0	0	6	6	0	0	8	0	0
AVERAGE	0	1	2.5	0	2.0	0	0	0	1	1	0	0	1.33	0	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	-
Mini 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:

WEEK I	DEVELOP PROGRAM USING KEIL IDE TOOL
	Design and develop a reprogrammable embedded computer using 8051 microcontrollers and to show the following 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
	a) Program to interface seven segment display using 89V51RD2 b) Program to toggle LED's using simple INTERRUPT
WEEK VII	SERIAL COMMUNICATION INTEFACING
	Program for serial communication between Microcontroller to PC communication the data should be transfer from microcontroller to PC terminal window using 89V51RD2.
WEEK VIII	SERIAL COMMUNICATION INTEFACING
	Program for serial communication between PC to Microcontroller communication the data should be transfer from PC to Microcontroller terminal window using 89V51RD2
WEEK IX	INTERFACING WITH TEMPERATURE SENSOR
	Program to develop necessary interfacing circuit to read data from I) 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 MULTIPLE 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 observe the analog output in CRO.
WEEK XIV	INTERFACE RELAY
	Program to interface Relay with P89V51RD2 using transistor.
WEEK XV	INTERRUPT
	Program to toggle LED'S using simple INTERRUPT.

TEXTBOOKS

1. Shibu K. V, Introduction to Embedded Systems, Tata Mc Graw Hill Education Private Limited, 2nd Edition, 2009.
2. Raj Kamal, Embedded Systems: Architecture, Programming and Design, Tata McGrawHill Education, 2nd Edition, 2011.

REFERENCE BOOKS:

1. Lyla B Das, Embedded Systems, 1st Edition, Pearson Education, 2012.
2. Michael J. Pont, Embedded C, Pearson Education, 2nd Edition, 2008.
3. Frank Vahid, Tony Givargis., Embedded System Design, John Wiley and sons, 3rd Edition, 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
1	Design and develop a reprogrammable embedded computer using 8051 microcontrollers and to show the following 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.	CO 1	T1-2.1 to 2.7
2	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	CO 2	T1-20.1 to 20.2

3	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.	CO 2	T1-8.1 to 8.2
4	Program to interface LCD data pins to port P1 and display a message on it using P89V51RD2	CO 2	T1-8.3 to 8.7
5	Program to 4*4 interface keypad. Whenever a key is pressed, it should be displayed on LCD	CO 2	T1-10.1 to 10.10
6	Program to interface seven segment display using 89V51RD2, Program to toggle LEDS using simple INTERRUPT	CO 2	T1-10.11 to 10.13
7	Program for serial communication between Microcontrollers to PC communication the data should be transfer from microcontroller to PC terminal window using 89V51RD2.	CO 5	T1-11.1 to 11.5
8	Program for serial communication between PC to Microcontroller communication the data should be transfer from PC to Microcontroller terminal window using 89V51RD2	CO 6	T1-11.1 to 11.5
9	Program to develop necessary interfacing circuit to read data from temperature sensor and process using P89V51RD2, the data has to display terminal window.	CO 3	T1 –11.12
10	Program to interface Stepper Motor to rotate the motor in clockwise and anticlockwise directions.	CO 4	T1-10.11 to 10.13
11	Program to verify run 2 to 3 tasks simultaneously on P89V51RD2 SDK. Use LCD interface, LED interface, Serial communication, Relay using transistor.	CO 2	T1-17.1 to 17.6
12	Program to interface ADC,DAC device with P89V51RD2 and display value on LCD and logic analyzer respectively.	CO 5	T1-14.1 to 14.3

XX EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Program to blink all the alternative LEDs of Port1 with 100 ms in 8051 Microcontroller..
2	Design and write the common cathode display codes to display even numbers from 0 to 9 on seven segment display.
3	Embedded C program for 8051 microcontroller to rotate the stepper motor 360° clockwise by half step sequence and 360° anticlockwise by full step sequence.
4	Embedded C program to display the sine wave at the output of digital to analog converter (DAC).
5	What are embedded systems and its applications?
6	What is the use of Keil IDE software?
7	What is the use of flash magic?
8	Program to toggle the odd number of bits of Port, P1 continuously with 250 ms delay.
9	Program to toggle the P0.5 bit with 500 ms delay.

10	Program to toggle the even number of bits of Port, P1 continuously with 100 ms delay.
11	What are the components of embedded systems?
12	What are the languages used in embedded systems?
13	What are the differences between microprocessor and microcontroller?
14	Explain the features of 8051 microcontroller.
15	What are the differences between Harvard Architecture and von Neumann Architecture?
16	With 12 MHz clock frequency how many instructions (of 1 machine cycle and 2 machine cycle) can execute per second?
17	What are Special Function Registers (SFR)?
18	What are the differences between bit addressable and byte address in microcontroller 8051?
19	Are all the bits of flag register used in 8051?
20	List the interrupts available in 8051 microcontroller.
21	What are the different types of seven segment displays?
22	Compute the codes to display odd numbers from 0 to 9 numbers on common cathode seven segment display.
23	Compute the codes to display even numbers from 0 to 9 numbers on common cathode seven segment display.
24	Give the reason behind the motor name as stepper motor or step motor.
25	On which factors the Step angle of the stepper motor depends?
26	Explain the term: Full step operation, Half step operation.
27	What is analog to digital converter (ADC)?
28	List out the features of analog to digital converter, ADC0808?
29	What is the necessity of analog to digital converter (ADC) in real life?
30	Explain the necessity of interfacing in real life?
31	What is digital to analog converter (DAC)?
32	List out the features of digital to analog converter, DAC0808?
33	Explain the necessity of interfacing digital to analog converter (DAC) with 8051 microcontroller?
34	List out the different applications of relays?
35	Explain the interfacing of relay with 8051 microcontroller?
36	List out the different types of serial communications?
37	Define baud rate in serial communication?
38	Explain the different types of data transfer methods?
39	Explain the uses of LM35 temperature sensor?
40	40 What will happen if we supply a voltage of 250V to the VCC of the LM35 temperature sensor?

Signature of Course Coordinator
Mrs. p. Ganga Bhavani, Assistant Professor

HOD,ECE



INSTITUTE OF AERONAUTICAL ENGINEERING (Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRONICS AND COMMUNICATION ENGINEERING COURSE DESCRIPTION

Course Title	VLSI DESIGN LABORATORY				
Course Code	AEC112				
Program	B.Tech				
Semester	VII	ECE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Dr. V.Vijay, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECB07	III	Digital System Design
B.Tech	AECB19	III	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.

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 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
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:

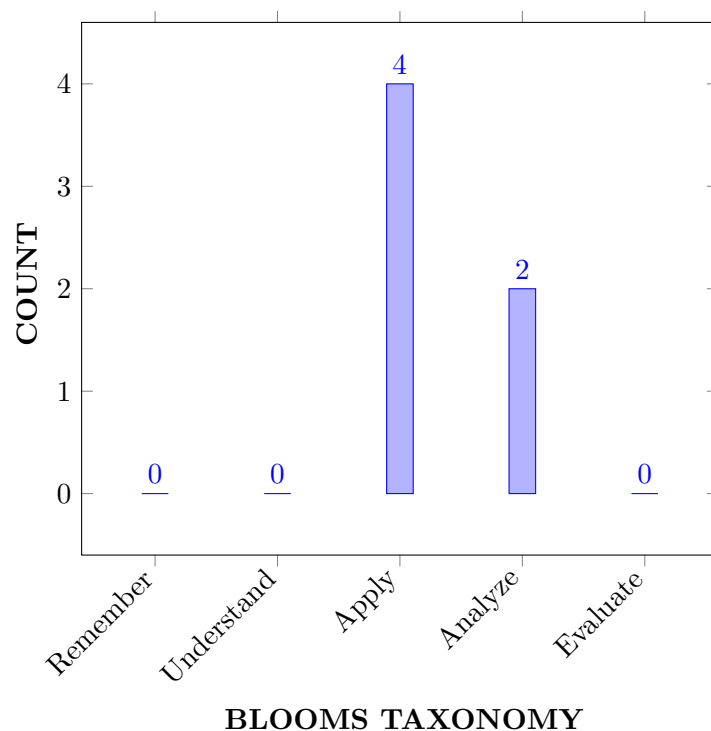
I	Modern tools for functional level to physical layout with verification at intermediate stages in the VLSI design flow in top-down approach.
II	Design and simulations of analog, digital and mixed circuits for optimum values of area over head, power and time delay.
III	The Chip design through a practical approach using advanced modern tools such as vivado and cadence for front end & back end.

VII COURSE OUTCOMES:

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

CO 1	Calculate the static, dynamic and noise margin parameters of CMOS inverter using the output and transfer characteristics of MOSFETs.	Apply
CO 2	Analyze complex gates, switch logic and transmission gates for performance optimization of distortion, power consumption and circuit delays.	Analyze
CO 3	Build 4 X 1 multiplexer and ring oscillator using multiplexer & inverter circuit symbols with necessary inter connections.	Apply
CO 4	Examine the conditions for optimum performance of latches and registers with the knowledge of digital system design.	Analyze
CO 5	Calculate bandwidth, gain, and common mode rejection ratio parameters for differential, MOSFET and casode amplifiers.	Apply
CO 6	Build the stick diagrams, layouts of MOS circuits using design rule checks (DRC) and verification.	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		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 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 Teamwork: 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	Discussions
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	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 Exercises

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	Identify the conditions practically for improved performance of inverters 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 inverter from the provided information and data in reaching substantiated conclusions by the interpretation of results in the Laboratory.	4
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 & transmission gates from the provided information and data in reaching substantiated conclusions by the interpretation of results in the Laboratory.	3
CO 3	PO 1	Design multiplexers (knowledge) consisting of transmission gates & 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 & pass gates using first principles of mathematics and Engineering sciences .	5
CO 4	PO 1	Design latches (knowledge) 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
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
	PO 2	Formulate and analyze (Problem analysis) complex Engineering problems for Differential, MOSFET and casode amplifiers (knowledge) using first principles of mathematics and Engineering sciences .	5
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 .	8
	PO 10	Build the stick diagrams, layouts of MOS circuits (knowledge) by following design rules with engineering sciences .	2
	PO 12	Build the stick diagrams, layouts of MOS circuits (knowledge) by following design rules with engineering sciences .	3
	PSO 2	Using Euler equation of motion derive the Bernoulli equation to analyze complex fluid flow problems using principles of mathematics and engineering sciences .	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	2	2	2
CO 1	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	1	5	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	1	5	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	5	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	2	5	-	-	1	-	-	-	8	2	-	3	-	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	40	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	66	30	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	33	50	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	33	50	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	100	50	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	66	50	-	-	100	-	-	-	66	40	-	37	-	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	-	-	-	2	-	-	2	-	-	-
CO 2	-	3	-	2	-	-	-	-	2	-	-	2	-	-	-
CO 3	-	3	-	-	-	-	-	-	2	-	-	2	-	-	-
CO 4	-	3	-	2	-	-	-	-	2	-	-	2	-	-	-
CO 5	-	3	-	-	-	-	-	-	2	-	-	2	-	2	-
CO 6	-	3	-	-	-	-	-	-	2	-	-	2	-	2	-

TOTAL	0	18	0	4	3	0	0	0	6	0	0	6	0	4	0
AVERAGE	0	3	0	2	3	0	0	0	2	0	0	2	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:

WEEK I	MOSFET
	To plot the (i) output characteristics (ii) Transfer characteristics of an n-channel and p-channel MOSFET.
WEEK II	CMOS INVERTER
	To design and plot the static (VTC) and dynamic characteristics 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	4X1 MULTIPLEXER
	To design and plot the characteristics of a 4x1 digital 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 a simple 5 transistor differential amplifier. Measure gain, ICMR, and CMRR.
WEEK IX	NMOS INVERTER AND CMOS INVERTER
	To design 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 amplifiers.
WEEK XII	COMMON DRAIN AMPLIFIER
	Analysis of Frequency response of Common drain amplifiers.
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 characteristics 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 3	T1:3.11
3	To design and plot the output characteristics of a 3-inverter ring oscillator	CO 3	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 2	T1:4.8
5	To design and plot the characteristics of a 4x1 digital multiplexer using pass transistor logic..	CO 3	T1:5.5
6	To design and plot the characteristics of a positive and negative latch based on multiplexers.	CO 3	T1:5.6

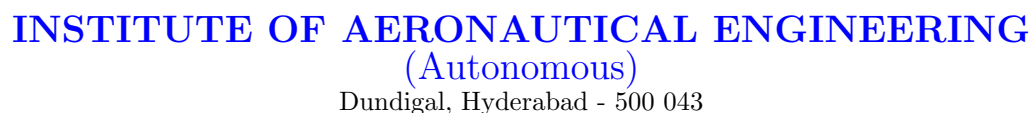
7	To design and plot the characteristics of a master-slave positive and negative edge triggered registers based on multiplexers..	CO 3	R3: T1:8.3
8	Design and simulation of a simple 5 transistor differential amplifier. Measure gain, ICMR, and CMRR.	CO 5	T1:8.3
9	To design layout of NMOS and CMOS inverter..	CO 6	T1:9.2
10	To design the layout of 2-input NAND, NOR gates..	CO 6	T1:9.3
11	Analysis of Frequency response of Common source amplifiers.s.	CO 5	T1:10.6
12	Analysis of Frequency response of Common drain	CO 5	T1:10.7
13	Design and Simulation of Single Stage Cascode Amplifier.	CO 5	T1:10.7
14	Design and Simulation of Basic Current Mirror, Cascode Current Mirror Amplifier	CO 5	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
Dr.V.Vijay, Associate Professor

HOD, ECE



Department	Electronics and Communication Engineering				
Course Title	Digital Signal Processors and Architecture				
Course Code	AEC507				
Program	B.Tech				
Semester	VIII				
Course Type	Professional Elective-III				
Regulation	R-16				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mr. K.Chaitanya, Assistant Professor				

Level	Course Code	Semester	Prerequisites
B.Tech	AEC012	VI	Digital Signal Processing
B.Tech	AEC013	VI	Microprocessors and Microcontrollers

This course enables the architecture, memory management of single instruction and multiple data, very large instruction word and TMS processors for the implementation of discrete fourier transform and fast fourier transform algorithms. It focuses on memory organization, external bus interfacing signals, parallel input/output interface, interrupts, direct memory access, finite impulse response, infinite impulse response filters. In built peripherals of TMS processor used in applications of communication equipment, image processing, control systems and consumer electronic devices.

Subject	SEE Examination	CIE Examination	Total Marks
Digital Signal Processors and Architecture	70 Marks	30 Marks	100

✓	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
25%	Understand
50%	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).

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 8th and 17th 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.

VI COURSE OBJECTIVES:

The students will try to learn:

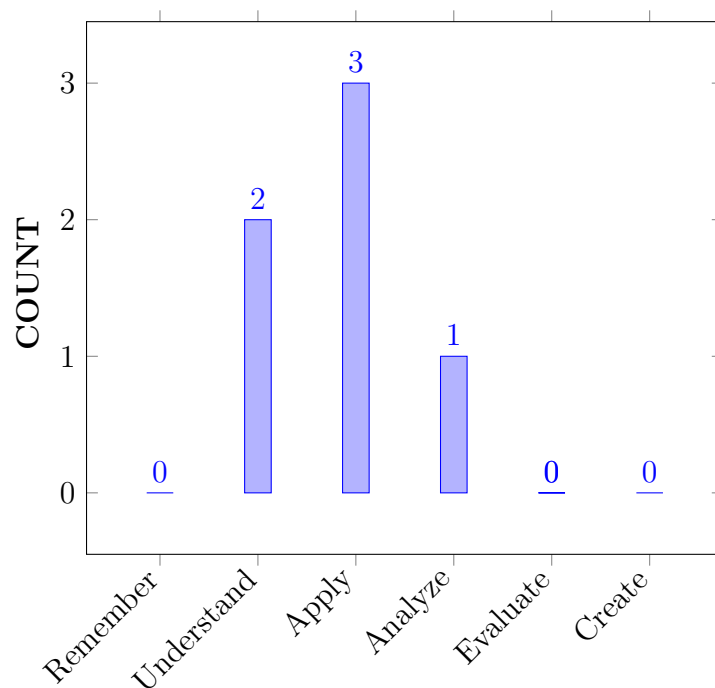
I	The architectures of digital signal processors and design aspects of digital signal processing algorithms.
II	The memory and external input/output peripheral interface with programmable DSP processor.
III	The realization of digital filters and fast fourier transform algorithms of the signal spectrum on host DSP processor.
IV	The programming skills using code composer studio environment for TMS320C54XX processor.

VII COURSE OUTCOMES:

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

CO 1	Describe the floating point and fixed-point arithmetic number representation systems for processing signal in digital signal processor.	Understand
CO 2	Illustrate the concepts of programmable digital signal processors with control instructions, interrupts and pipeline operations.	Understand
CO 3	Demonstrate the instruction sets and addressing modes of TMS320C54XX processor by implementing assembly language programs.	Apply
CO 4	Make use of memory and input/output peripherals to interface the programmable DSP devices for increasing time response of a system.	Apply
CO 5	Analyze the IIR and FIR filters on programmable digital signal processors using Q15 Format	Analyze
CO 6	Compute decimation-in time - FFT and decimation-in-frequency - FFT for reducing computational complexity of DFT.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



BLOOMS TAXONOMY

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	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
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	SEE / CIE / Quiz / AAT

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	2	Day -to- Day evaluation sheets

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Make use of high frequency structure simulator 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	Explain the concepts of floating point and fixed-point arithmetic number representation systems of digital signal processor with knowledge of the principles of science and mathematics for engineering problems.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	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
CO 2	PO 1	Demonstrate the benefits of single instruction multiple data and very large instruction word architectures of programmable DSPs with knowledge of the principles of science and mathematics for engineering problems .	2
	PO 4	Analyze various benefits of single instruction multiple data and very large instruction word architectures of programmable DSPs.	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	4
CO 3	PO 1	Explain instruction sets of TMS320C54XX processor to write simple assembly language programs using engineering fundamentals .	2
	PO 4	Use research-based knowledge and research methods to write simple assembly language programs .	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	4
	PSO 1	Design the assembly language programs for TMS320C54XX processor using engineering fundamentals .	2
CO 4	PO 1	Understand memory and input/output peripherals with the knowledge of mathematics and engineering fundamentals .	2
	PO 4	Analyze and interface the programmable DSP devices for increasing time response of a system using research-based knowledge and research methods .	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	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
CO 5	PO1	Explain the IIR and FIR filters on programmable digital signal processors using the knowledge of mathematics and engineering fundamentals .	2
	PO 2	Analyze IIR and FIR filters on programmable digital signal processors using Q15 format with first principles of mathematics.	1
	PO 4	Solve complex engineering problems in designing IIR and FIR filters on programmable digital signal processors by using the principles of engineering fundamentals .	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	4
	PSO 1	Realize an IIR and FIR filters on programmable digital signal processors using appropriate formulas and engineering fundamentals .	2
CO 6	PO 1	Explain radix-2 decimation-in time-FFT and decimation-in-frequency-FFT on fixed point DSPs using engineering fundamentals .	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	4
	PSO 1	Find the complex sequence using radix-2 decimation-in time-FFT and decimation-in-frequency-FFT on fixed point DSPs using engineering fundamentals .	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	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO 2	2	-	-	1	-	-	-	-	-	3	-	-	-	-	-
CO 3	2	-	-	1	-	-	-	-	-	3	-	-	2	-	-
CO 4	2	-	-	2	-	-	-	-	-	3	-	-	-	-	-
CO 5	2	1	-	1	-	-	-	-	-	3	-	-	2	-	-
CO 6	2	-	-	-	-	-	-	-	-	3	-	-	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	-	-	-	-	-	-	-	-	60	-	-	-	-	-
CO 2	66.6	-	-	9.1	-	-	-	-	-	60	-	-	-	-	-
CO 3	66.6	-	-	-	-	-	-	-	-	60	-	-	100	-	-
CO 4	66.6	-	-	18.2	-	-	-	-	-	60	-	-	-	-	-
CO 5	66.6	10	-	9.1	-	-	-	-	-	60	-	-	100	-	-
CO 6	66.6	-	-	-	-	-	-	-	-	60	-	-	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	-	-	-	-	-
CO 2	3	-	-	1	-	-	-	-	-	3	-	-	-	-	-
CO 3	3	-	-	-	-	-	-	-	-	3	-	-	3	-	-
CO 4	3	-	-	2	-	-	-	-	-	3	-	-	-	-	-
CO 5	3	1	-	1	-	-	-	-	-	3	-	-	3	-	-

CO 6	3	-	-	-	-	-	-	-	-	3	-	-	3	-	-
TOTAL	18	1	-	4	-	-	-	-	-	18	-	-	9	-	-
AVERAGE	3	1	-	1.5	-	-	-	-	-	3	-	-	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	INTRODUCTION TO DIGITAL SIGNAL PROCESSING
	Introduction: Digital signal-processing system, discrete Fourier Transform (DFT) and fast Fourier transform (FFT), differences between DSP and other microprocessor architectures; Number formats: Fixed point, floating point and block floating point formats, IEEE-754 floating point, dynamic range and precision, relation between data word size and instruction word size; Sources of error in DSP implementations: A/D conversion errors, DSP computational errors, D/A conversion errors, Q-notation.
MODULE II	ARCHITECTURE OF PROGRAMMABLE DSPs
	Multiplier and multiplier accumulator, modified bus structures and memory access in PDSPs, multiple access memory, multiport memory, SIMD, VLIW architectures, pipelining, special addressing modes in PDSPs, on-chip peripherals.
MODULE III	OVERVIEW OF TMS320C54XX PROCESSOR
	Architecture of TMS320C54XX DSPs, addressing modes, memory space of TMS320C54XX processors. Program control.
	Instruction set and programming, on-chip peripherals, interrupts of TMS320C54XX processors, pipeline operation.
MODULE IV	INTERFACING MEMORY AND I/O PERIPHERALS TO PDSPs
	SMemory space organization, external bus interfacing signals, memory interface, parallel I/O interface, programmed I/O, interrupts and I/O, direct memory access (DMA).

MODULE V	IMPLEMENTATIONS OF BASIC DSP ALGORITHMS
	The Q-notation, convolution, correlation, FIR filters, IIR filters, interpolation filters, decimation filters, an FFT algorithm for DFT filters computation of the signal spectrum.

TEXTBOOKS

1. Avtar Singh and S. Srinivasan, "Digital Signal Processing , Thomson Publications", 1st Edition,2004.
2. Lapsley,S. Chandet al., "DSP Processor Fundamentals, Architectures and Features, ", PHI learning,1st Edition, 2000.
3. B. Ventakaramani, M. Bhaskar, "Digital Signal Processors Architecture Programming and Applications", Tata McGraw-Hill,1st Edition,2006.

REFERENCE BOOKS:

1. Jonatham Stein, "Digital Signal Processing", John Wiley,1st Edition,2000.
2. Sen M. Kuo WoonSergGan, "Digital Signal Processors Architectures, Implementation and Application", Pearson Practice Hall,1st Edition ,2013.
3. K Padmanabhan, R. Vijayarajeswaran, Ananthi. S, "A Practical Approach to Digital Signal Processing", New Age International,1st Edition ,2006.
4. Ifeachor E. C., Jervis B. W, "Digital Signal Processing: A practical approach", Pearson Practice Hall,2nd Edition ,2002.
5. Peter Pirsch, "Architectures for Digital Signal Processing", John Weily,1st Edition ,2007.

WEB REFERENCES:

1. <https://books.google.co.in/books/about/DigitalSignalProcessors.html?id=2A2-v3raKEC>

COURSE WEB PAGE:

1. https://www.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			
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=courseslist/74
CONTENT DELIVERY (THEORY)			
2	Introduction to digital signal processing	CO 1	T3:2.1

3	Discrete Fourier Transform (DFT)	CO 1	T3:2.1
4	Fast Fourier Transform (FFT)	CO 1	T3:1.2
7	Differences between DSP and other micro processor architectures	CO 1	T3:1.1,1.2.2
8	Number formats: fixed point, floating point and block floating point formats	CO 1	T3:1.4
9	Number formats: fixed point, floating point and block floating point formats	CO 1	T3:1.3,1.8, 1.9
10	IEEE-754 floating point	CO 1	T3:2.1
11	Dynamic range and precision	CO 1	T3:2.2
12	Relation between data word size and instruction word size	CO 1	T3:2.3
13	Sources of error in dsp implementations	CO 1	T3:2.4 T1:5.1-5.20
14	A/D conversion errors	CO 1	T3:2.4 T1:5.1-5.20
15	DSP computational errors	CO 1	T3:2.4 T1:5.1-5.20
16	D/A conversion errors, Q-notation	CO 1	T3:5.4
17	Multiplier and multiplier accumulator	CO 1	T3:5.5
18	Modified bus	CO 1	T1:9.19 T3: 5.8
19	Memory access in PDSPs	CO 2	T3:5.7,5.6
20	Multiple access memory	CO 2	T3:5.1
21	Multiport memory	CO 2	T1-8.1, T1-8.7
22	SIMD architecture	CO 2	T3:6.4.3 T1:14.9,14.48
23	VLIW architectures	CO 2	T3:6.4,6.4 4
24	Pipelining	CO 2	R3:2.1
25	Special addressing modes in PDSPs	CO 2	R3:2.1
26	Special addressing modes in PDSPs	CO 3	T3:1.2
27	On-chip peripherals	CO 3	T3:1.1
28	On-chip peripherals	CO 3	T3:1.4
29	Architecture of TMS320C54XX DSPs	CO 3	T3:1.3,1.8, 1.9
30	Addressing modes	CO 3	T3:2.1
31	Memory space of TMS320C54XX processors	CO 3	T3:2.2
32	Program control and instruction set	CO 3	T3:2.3
33	Instruction set and programming	CO 4	T3:2.4T1:5 .1-5.20
34	On-chip peripherals	CO 4	T3:2.4, T1:5 .1-5.20
35	Interrupts of TMS320C54XX processors	CO 3	T3:2.4T1:5 .1-5.20

36	Interrupts of TMS320C54XX processors	CO 3	T3:2.4T1:5 .1-5.20
37	Pipeline operation.	CO 3	T3:2.4T1:5 .1-5.20
38	Memory space organization	CO 4	T3:5.4
39	External bus interfacing signal	CO 4	T3:5.5
40	Memory interface	CO 4	T2:3.1
41	Parallel I/O interface	CO 4	T2:3.1
42	Programmed I/O	CO 4	T2:3.2
43	Interrupts and I/O	CO 4	T2:3.3
44	Direct memory access (DMA)	CO 4	T2:5.1
45	The Q-notation, convolution and correlation	CO10	T2:6.1,6.6,7.1 7.6, 8.1 -8.3
46	FIR filters	CO 5	T:6.1 to 6.6,7.1 to 7.6,
47	IIR filters	CO 5	T2:3.6
48	Interpolation filters, decimation filters	CO 5	T2:3.4
49	FFT algorithm for DFT filters	CO 6	T2:3.6,3.4 R5:24.5- 24.7
55	Computation of the signal spectrum.	CO 6	T2:3.6,3.4 R5:24.5- 24.7
PROBLEM SOLVING / CASE STUDIES			
5	Problems on Discrete Fourier Transform (DFT)	CO 1	T3:2.1
6	Problems on Fast Fourier Transform (FFT)	CO 6	T3:1.2
50	Problems on the Q-notation	CO 5	T3:1.3,1.8, 1.9
51	Problems on FIR filters	CO 5	T:6.1 to 6.6,7.1 to 7.6,
52	Problems on IIR filters	CO 5	T2:3.6
53	Problems on interpolation filters and decimation filters	CO 5	T2:3.4
54	Problems on FFT algorithm for DFT filters	CO 5	T2:3.6,3.4 R5:24.5- 24.7
DISCUSSION ON DEFINITION AND TERMINOLOGY			
56	Introduction to digital signal processing	CO 1	T3:2.1
57	Architecture of programmable DSPs	CO 2	T1-8.1, T1-8.7
58	Overview of TMS320C54xx processor	CO 3	T3:1.3,1.8, 1.9
59	Interfacing memory and I/O peripherals to PDSPs	CO 4	T2:3.1
60	implementations of basic dsp algorithms	CO 6	T2:3.6,3.4 R5:24.5- 24.7
DISCUSSION ON QUESTION BANK			
61	Introduction to digital signal processing	CO 1	T3:2.1
62	architecture of programmable DSPs	CO 2	T1-8.1, T1-8.7

63	Overview of TMS320C54xx processor	CO 3	T3:1.3,1.8, 1.9
64	Interfacing memory and i/o peripherals to PDSPs	CO 4	T2:3.1
65	Implementations of basic DSP algorithms	CO 6	T2:3.6,3.4 R5:24.5- 24.7

Course Coordinator
Mr. K.Chaitanya, Assistant 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	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