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

COURSE DESCRIPTION

<table>
<tr><td>Department</td><td colspan="5">ELECTRICAL AND ELECTRONICS ENGINEERING</td></tr>
<tr><td>Course Title</td><td colspan="5">ENGLISH</td></tr>
<tr><td>Course Code</td><td colspan="5">AHSC01</td></tr>
<tr><td>Program</td><td colspan="5">B. Tech</td></tr>
<tr><td>Semester</td><td colspan="5">I</td></tr>
<tr><td>Course Type</td><td colspan="5">Foundation</td></tr>
<tr><td>Regulation</td><td colspan="5">UG-20</td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>2</td><td>-</td><td>2</td><td>-</td><td>-</td></tr>
<tr><td>- Course Coordinator</td><td colspan="5">Dr. M.Sailaja, Associate Professor</td></tr>
</table>

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

II COURSE OVERVIEW:

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

III MARKS DISTRIBUTION:

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

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

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

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

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

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

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

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

VI COURSE OBJECTIVES:

The students will try to learn:

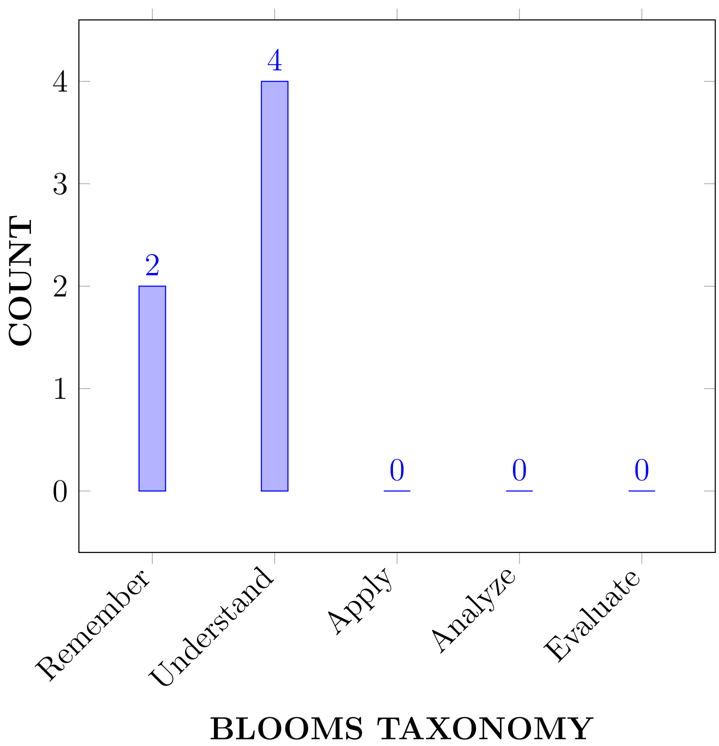
I	Standard pronunciation, appropriate word stress, and necessary intonation patterns for effective communication towards achieving academic and professional targets.
II	Appropriate grammatical structures and also using the nuances of punctuation tools for practical purposes.
III	A critical aspect of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

VII COURSE OUTCOMES:

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

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

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

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

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

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

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	-	-
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	-	-
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.	-	-

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 10	Discuss the heeds of functional grammar and punctuation tools in speaking and writing by generating the clarity of an audio text.	5
CO 2	PO 10	Illustrate essential aspects of grammar as well as punctuation marks for speaking or writing towards a discussion on a topic to give the clarity.	5
CO3	PO 10	Choose suitable grammatical structures and punctuation marks at speaking and writing areas maintaining clarity at professional platform.	5
CO4	PO 10	Interpret the grammatical knowledge and punctuation marks systematically towards providing the clarity in speaking and writing.	5
CO5	PO 10	Demonstrate the role of grammar and punctuation marks understanding the meaning between the sentences as well as paragraphs in speaking or writing for a clarity.	5
CO6	PO 10	Describe the clarity of grammatical usage and the obligation of punctuation marks in speaking and writing.	5

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

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

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

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

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

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

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

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

XVI ASSESSMENT METHODOLOGY-DIRECT:

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

XVII ASSESSMENT METHODOLOGY-INDIRECT:

	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

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

TEXTBOOKS

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

REFERENCE BOOKS:

1. 1. Norman Whitby, Business Benchmark: Pre-Intermediate to Intermediate – BEC Preliminary, Cambridge University Press, 2nd Edition,2008.

2. Devaki Reddy, Shreesh Chaudhary, Technical English, Macmillan, 1st Edition,2009.

3. Rutherford, Andrea J, Basic Communication Skills for Technology, Pearson Education,2nd Edition, 2010.

4. Raymond Murphy, Essential English Grammar with Answers, Cambridge University Press, 2nd Edition,2010.

5. Dr. N V Sudershan, President Kalam's Call to the Nation, Bala Bharathi Publications, Secunderabad, 1st Edition,2003

XIX COURSE PLAN:

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

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

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

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

Signature of Course Coordinator **HOD**

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COURSE DESCRIPTION

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<tr><td>Department</td><td colspan="5">ELECTRICAL AND ELECTRONICS ENGINEERING</td></tr>
<tr><td>Course Title</td><td colspan="5">LINEAR ALGEBRA AND CALCULUS</td></tr>
<tr><td>Course Code</td><td colspan="5">AHSC02</td></tr>
<tr><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>Semester</td><td colspan="5">I</td></tr>
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<tr><td>3</td><td>1</td><td>4</td><td>-</td><td>-</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Mr. P Shantan Kumar, Assistant Professor</td></tr>
</table>

I COURSE PRE-REQUISITES:

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

II COURSE OVERVIEW:

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

III MARKS DISTRIBUTION:

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

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

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

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

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

Continuous Internal Assessment (CIA):

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

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

Continuous Internal Examination (CIE):

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

Alternative Assessment Tool (AAT)

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

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

VI COURSE OBJECTIVES:

The students will try to learn:

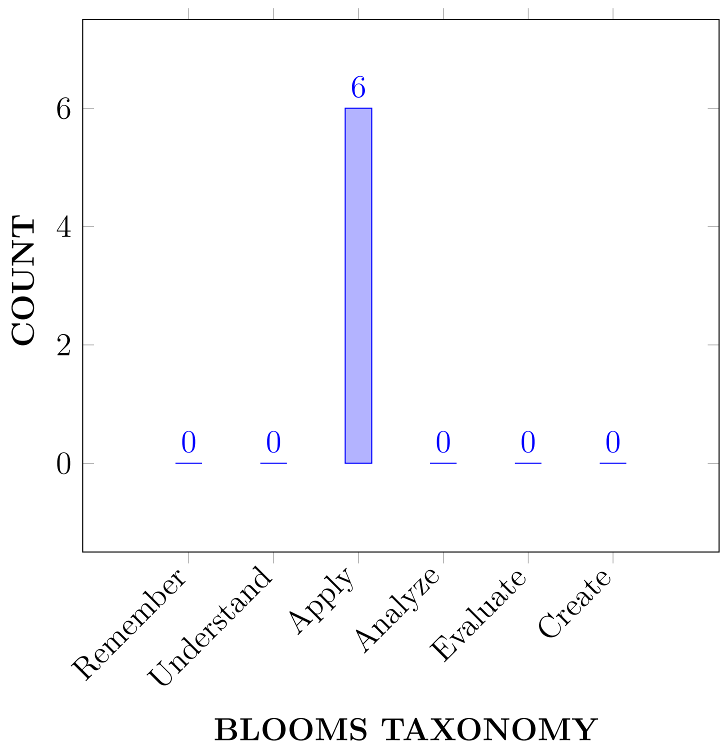
I	The principles of Eigen value analysis and linear transformations, Matrix rank finding methods.
II	The calculus of functions of several variables and the concept of maxima-minima for a three-dimensional surface.
III	The analytical methods for solving higher order differential equations with constant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

VII COURSE OUTCOMES:

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

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

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

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

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

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

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

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involving Power generation, Transmission, Distribution and Utilization.	-	-
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	-	-

PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.	-	-

3 = High; 2 = Medium; 1 = Low

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

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

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

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

CO 5	PO 1	**Determine**the solution of **complex engineering problems** modeled by Second and higher order linear differential equations with constant coefficients by using substitution method and method of variation of parameters.	2
	PO 2	**Model** the problem with the help of ordinary differential equations, prepare precise **statement** of the problem and apply method of variation of parameters and other analytical methods to **develop the solution** and **interpret, validate** the results through proper **documentation**	6
CO 6	PO 1	**Build** the Fourier series expansion **for the complex engineering problems** modeled by given periodic, even and odd functions in various intervals with the help of Fourier coefficients formulae **(principles of mathematics).**	2
	PO 2	**Model** the problem with the help of suitable periodic functions, prepare precise **statement** of the problem and apply Fourier series expansions to **develop the solution** and **interpret, validate** the results through proper **documentation**	6

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

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

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

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

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

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

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

1 - $5\% < C \leq 40\%$ – Low/ Slight

2 - $40\ \% < C < 60\%$ –Moderate

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

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

XVI ASSESSMENT METHODOLOGY DIRECT:

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

XVII ASSESSMENT METHODOLOGY-INDIRECT:

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

XVIII SYLLABUS:

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

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

TEXT BOOKS

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

REFERENCE BOOKS:

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

WEB REFERENCES:

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

COURSE WEB PAGE:

1. lms.iare.ac.in

XIX COURSE PLAN:

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

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

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

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

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

Signature of Course Coordinator **HOD, EEE**

Mr. P Shantan Kumar, Assistant Professor

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

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTION

Course Title	**ENGINEERING PHYSICS**				
Course Code	AHSC03				
Program	B.Tech				
Semester	I	AE/CE/ECE/EEE/ME			
Course Type	Foundation				
Regulation	IARE - UG 20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	4	3	1.5
Course Coordinator	Ms.Sujani Singavarapu, Assistant Professor				

I COURSE PRE-REQUISITES:

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

II COURSE OVERVIEW:

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

III MARKS DISTRIBUTION:

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

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	PPT	✓	Chalk & Talk	x	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 CIA examinations or the marks scored in the make-up examination.

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

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

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. 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.

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 below.

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

VI COURSE OBJECTIVES:

The students will try to learn:

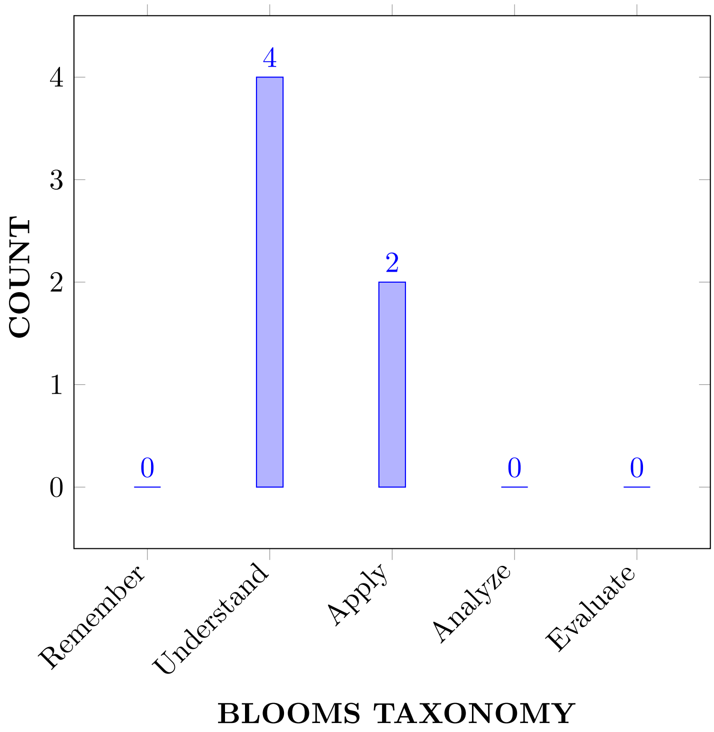
I	Basic formulations in wave mechanics for the evolution of energy levels and quantization of energies for a particle in a potential box with the help of mathematical description.
II	Fundamental properties of semiconductors including the band gap, charge carrier concentration, doping and charge carrier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

VII COURSE OUTCOMES:

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

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

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

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

Program Outcomes	
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

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

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Design, Develop,Fabricate and commission the electrical systems involved in power generation,transmission,distribution and utilization.	1	Laboratory experiments

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH POs, PSOs:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSOs		
	PO 1	PO 2	PO 3	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	**Outline** drawbacks of classical mechanics,basic principles of dual nature of matter wave,derive mathematical equation of matter waves and come to conclusion of quantization of energy used in quantum dots.	3
	PO 2	**Explain** the given **problem statement** and **formulate** quantum confinement problems related to particle enclosed in small dimension from the provided **information** and **data** in reaching substantial conclusions by the **interpretation of results**	4
	PSO 3	**Make use of** the knowledge of **quantum mechanics in experimental tools.**	1

CO 2	PO 1	**Illustrate** the charge transport mechanism in intrinsic and extrinsic semiconductors using energy level diagrams,calculate their charge carrier concentration and use those expressions to integrate with other engineering disciplines.	3
	PO 2	**Explain** the given problem statement and formulate mobility and conductivity aspects of a material from the provided information and data in reaching substantial conclusions **by the interpretation** of **Hall coefficient value.**	4
	PO 4	**Identify** the use of semiconductors under study and their conduction mechanism for the **research based knowledge** and **technological development.**	2
	PSO 1	**Make use of** the knowledge of intrinsic and extrinsic semiconductors **in the design and development of electrical systems.**	1
CO 3	PO 1	**Compare** the concepts of LASER and normal light in terms of mechanism and **working principles** for **applications** in different fields and **scientific practices.**	3
CO 4	PO 1	**Explain** functionality of components in optical fiber communication **system** by using the **basics** of signal propagation, attenuation and dispersion.	3
	PO 2	**Identify the given problem** and **formulate** expressions for acceptance angle and numerical aperture with the given **information and data** by applying principles of information propagation through optical wave guides.	4
CO 5	PO 1	**Outline** the **scientific principles** of light and its propagation evolution of different theories, and use the principles of wave motion and superposition using **mathematical principles** to understand the interference and diffraction phenomena in light	3
	PO 4	**Explain** from **technical literature the knowledge of the equipment** on which scientists performed experiments to understand the superposition of light and pattern formation by relating it to conditions for constructive and destructive interference.	2
CO 6	PO 1	**Outline** the basic **scientific principles** of force and characteristics of a simple harmonic oscillator to understand the forces acting on given oscillator to arrive at equations of damped,forced oscillators and wave equations using basic **mathematical principles**	3

	PO 2	**Explain** how damping and forced oscillations happen in a system and **identify the problems** and advantages for different conditions of damping.	4

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

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

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO:

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

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

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

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

1-5 $<C \leq 40\%$ – Low/ Slight

2 - $40\% < C < 60\%$ –Moderate

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

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

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	PO 1,PO 2, PO 4	SEE Exams	PO 1,PO 2, PO 4	Seminars	-
Term Paper	-	Concept Video	PO 1,PO 2, PO 4	Open Ended Experiments	-
Tech Talk	PO 1, PO 2, PO 4,	Assignments	-		

XVII ASSESSMENT METHODOLOGY INDIRECT:

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

XVIII SYLLABUS:

MODULE I	**QUANTUM MECHANICS**
	Introduction to quantum physics, De-broglie's hypothesis, Wave-particle duality, Davisson and Germer experiment, Time-independent Schrodinger equation for wave function, Physical significance of the wave function, Schrodinger equation for one dimensional problems–particle in a box.
MODULE II	**INTRODUCTION TO SOLIDS AND SEMICONDUCTORS**
	Introduction to classical free electron theory and quantum theory, Bloch's theorem for particles in a periodic potential (Qualitative treatment), Kronig-Penney model (Qualitative treatment), classification: metals, semiconductors, and insulators. Intrinsic and extrinsic semiconductors, Carrier concentration, Dependence of Fermi level on carrier-concentration and temperature, Hall effect
MODULE III	**LASERS AND FIBER OPTICS**
	Characteristics of lasers, Spontaneous and stimulated emission of radiation, Metastable state, Population inversion, Lasing action, Ruby laser, He-Ne laser and applications of lasers. Principle and construction of an optical fiber, Acceptance angle, Numerical aperture, Types of optical fibers (Single mode, multimode, step index, graded index), Optical fiber communication system with block diagram and Applications of optical fibers .
MODULE IV	**LIGHT AND OPTICS**
	Principle of superposition of waves, Young's double slit experiment, Fringe width, Newton's rings. Fraunhofer diffraction from a single slit, double slit (extension to N slits) and diffraction grating experiment.
MODULE V	**HARMONIC OSCILLATIONS AND WAVES IN ONE DIMENSION**
	Simple harmonic oscillator, Damped harmonic oscillator, Forced harmonic oscillator. Transverse waves and Longitudinal wave equation, Reflection and transmission of waves at a boundary, Harmonic waves.

TEXTBOOKS

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

REFERENCE BOOKS:

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

XIX COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	
CONTENT DELIVERY (THEORY)			
2	Introduction to quantum physics- Black body radiation, Planck's law, Photoelectric effect, Compton effect	CO 1	T1:6.1 R1:1.12.1,
3	De-Broglie's hypothesis,	CO 1	T1:6.3 R1:1.16
4	Wave-particle duality -Matter wave concept	CO 1	T1:6.2 R1:1.13.1
5	Davisson and Germer experiment	CO 1	T1:6.4.1 R1:1.13.2
6	Time-independent Schrodinger equation for wave function	CO 1	T1:6.6 R1:1.13.3
7	Born interpretation of the wave function	CO 1	T1:6.6.1 R1:1.17.1
8	Schrodinger equation for one -dimensional problems– particle in a box.	CO 1	T1:6.7 R1:1.17.3
9	Introduction to classical free electron theory & quantum theory.	CO 2	T1:7.2 R1:1.17.3
10	Bloch's theorem for particles in a periodic potential,	CO 2	T1:7.4 R1:2.3
11	Kronig-Penney model (Qualitative treatment)	CO 2	T1:7.5 R1:2.3
12	Types of electronic materials: metals, semiconductors, and insulators	CO 2	T1:7.6,7.7 R1:2.6.2
13	Intrinsic semiconductors - concentration of electrons in conduction band.	CO 2	T1:8.3.1 R1:2.8
14	Intrinsic semiconductors - concentration of holes in valence band	CO 2	T1:8.3.2 R1:2.9.2
15	Extrinsic semiconductors- Carrier concentration in N-Type	CO 2	T2:8.5 R1:2.10
16	Extrinsic semiconductors- Carrier concentration in P-Type	CO 2	T1:8.6 R1:2.10
17	Dependence of Fermi level on carrier-concentration and temperature	CO 2	T1:8.5,8.6 R1:2.10.2
18	Hall effect	CO2	T1:8.9 R1:2.32

19	Introduction and characteristics of LASER	CO 3	T1:12.1. R1:8.2
20	Spontaneous and stimulated emission of radiation,Meta stable state, Population inversion, Lasing action	CO 3	T1:12.2 R1:8.3.3
21	Ruby laser,He-Ne laser	CO 3	T1:12.3,12.8 R1:8.7.2
22	Applications of LASER	CO 3	T1:12.8.12.9 R1:8.7.2
23	Principle and construction of an optical fiber	CO 4	T1:13.2 R2:12.24
24	Acceptance angle, Numerical aperture	CO 4	T1:13.2 R3:12.25
25	Types of optical fibers (Single mode, multimode, step index, graded index)	CO 4	T1:13.3 R3:3.2
26	Optical fiber communication system with block diagram	CO 4	T1:13.7 R3:3.2
27	Applications of optical fibers .	CO 4	T1:13.12 R1:8.10
28	Principle of Superposition of waves	CO 5	T4:4.3 R1:8.11.1
29	Young's double slit experiment	CO 5	T4:4.7 R1:8.11.2
30	Newton's rings	CO 5	T4:4.14 R1:8.12.1
31	Fraunhofer diffraction from a single slit	CO 5	T4:4.19 R1:8.12.2
32	Fraunhofer diffraction from a Double slit	CO 5	T4:4.21 R1:8.20
33	Fraunhofer diffraction from diffraction grating	CO 5	T4:4.22 R1:8.19
34	Simple Harmonic Oscillators	CO 6	T4:2.3 R1:8.77
35	Damped harmonic oscillator	CO 6	T4:2.8,2.9 R1:7.2
36	Forced mechanical oscillators	CO 6	T4:2.14 R1:7.7
37	Impedance, Steady state motion of forced damped harmonic oscillator	CO 6	T4:2.17 R1:7.8
38	Transverse wave on a string, the wave equation on a string	CO 6	T4:3.3 R1:7.9.2
39	Longitudinal waves and the wave equation	CO 6	T4:3.7 R1:7.9.1
40	Reflection and transmission of waves at a boundary	CO 6	T4:3.4 R1:7.10

41	Harmonic waves	CO 6	T4:3.6 R1:7.11, 11.1
	PROBLEM SOLVING/ CASE STUDIES		
1	De-Broglie hypothesis-wavelength expression	CO 1	T1:6.3 R1:1.161
2	Schrodinger equation for one dimensional problems–particle in a box.	CO 1	T1:6.6 R1:1.161
3	Physical significance of the wave function	CO 1	T1: 6.6.1 R1:1.161.
4	Carrier concentration	CO 2	T1:8.3-6, R1:2.8,2.10
5	Fermi level	CO 2	T1:8.5,8.6 R1: 2.10
6	Hall Effect	CO 2	T1:8.9, R1: 2.32
7	Lasers	CO 3	T1: 12.3 R3:12.26
8	Acceptance angle & Numerical aperture	CO 4	T1: 13.2 R3:12.26
9	Refractive indices of core and cladding, fractional refractive index change	CO 4	T1: 13.3 R3:12.26
10	Youngs double-slit	CO 5	T4: 4.7 R1:8.12.1
11	Fringe width	CO 5	T4: 4.7 R1:8.12.1
12	Newton rings	CO 5	T4: 4.14 R1:8.12.1
13	Diffraction grating	CO 5	T4: 4.22 R1:8.12.1
14	Simple Harmonic Oscillator	CO 6	T4:2.3 R1: 8.78
15	Harmonic waves	CO 6	T4:3.6 R1: 7.9.3
	DISCUSSION OF DEFINITION AND TERMINOLOGY		
1	Quantum mechanics	CO 1	T1:6.1-6.7 R1:1.161.
2	Introduction to Solids and Semiconductors	CO 2	T1:7.2-7, 8.3-9 , R1: 2.8, 2.10
3	Lasers and Fiber Optics	CO 3, CO 4	T1: 12.1-12.9,13.2-13.12 R3:12.26

4	Light and Optics.	CO 5	T4: 4.3-4.22 R1:8.12.1
5	Harmonic Oscillations and Waves in One Dimension	CO 6	T4:2.3-3.7 R1: 8.78, 7.9.3
DISCUSSION OF QUESTION BANK			
1	Module 1	CO 1	T1:6.1-6.7 R1:1.161.
2	Module 2	CO 2	T1:6.1-6.7 R1: 2.8, 2.10
3	Module 3	CO 3, CO 4	T1: 12.1-12.9,13.2-13.12 R3:12.26
4	Module 4	CO 5	T4: 4.3-4.22 R1:8.12.1
5	Module 5	CO 6	T4:2.3-3.7 R1: 8.78, 7.9.3

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

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

COURSE DESCRIPTION

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

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC01	I	NIL

II COURSE OVERVIEW:

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

III MARKS DISTRIBUTION:

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

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

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

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

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

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

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

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

VI COURSE OBJECTIVES:

The students will try to learn:

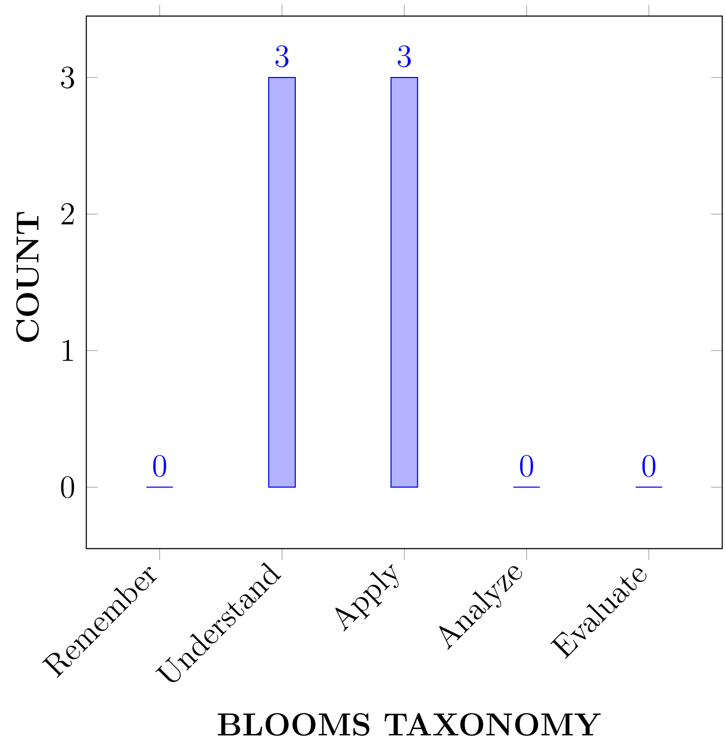
I	**Acquire programming skills in core Python**
II	**Acquire Object-oriented programming skills in Python.**
III	**Develop the skill of designing graphical-user interfaces (GUI) in Python.**
IV	**Develop the ability to write database applications in Python.**
V	**Acquire Python programming skills to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

VII COURSE OUTCOMES:

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

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

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

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

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

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

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	3	Tech talk /Open ended experiments
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer	3	Tech talk /Open ended experiments

3 = High; 2 = Medium; 1 = Low

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

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

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

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

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

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

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

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

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

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

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

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

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

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

XVI ASSESSMENT METHODOLOGY-DIRECT:

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

XVII ASSESSMENT METHODOLOGY-INDIRECT:

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

XVIII SYLLABUS:

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

TEXTBOOKS:

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

REFERENCE BOOKS:

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

COURSE PLAN:

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

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

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

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

Course Coordinator
B Dilip Chakravarty

HOD CSE(CS)

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

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

I COURSE OVERVIEW:

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

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

III MARKS DISTRIBUTION:

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

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

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

Continuous Internal Assessment (CIA):

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

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

Continuous Internal Examination (CIE):

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

1. **Sofware based**

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

2. **Programming Based**

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

VI COURSE OBJECTIVES:

The students will try to learn:

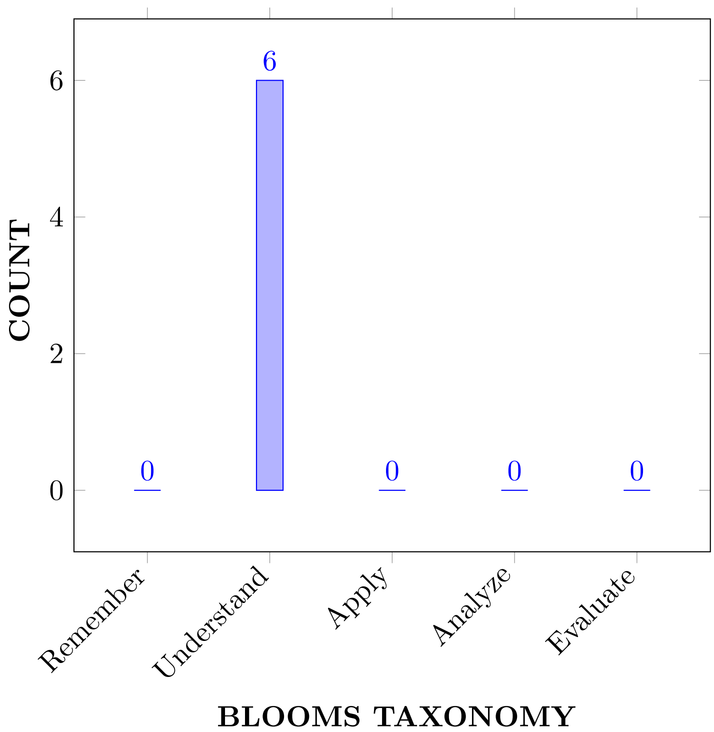
I	Facilitate computer-assisted multi-media instructions to make possible individualized and independent language learning.
II	The critical aspect of speaking and reading for interpreting in-depth meaning of the sentences.
III	Use language appropriately for social interactions such as public speaking,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

VII COURSE OUTCOMES:

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

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

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

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

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	-	-
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	-	-
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.	-	-

3 = High; 2 = Medium; 1 = Low

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

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

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

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

XII ASSESSMENT METHODOLOGY DIRECT:

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

XIII ASSESSMENT METHODOLOGY INDIRECT:

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

XIV SYLLABUS:

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

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

TEXTBOOKS

1. ENGLISH LANGUAGE AND COMMUNICATION SKILLS: LAB MANUAL

REFERENCE BOOKS:

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

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

XV COURSE PLAN:

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

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

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

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

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

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

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTION

Course Title	**PHYSICS LABORATORY**				
Course Code	AHSC05				
Program	B.Tech				
Semester	I	EEE			
Course Type	FOUNDATION				
Regulation	IARE - UG 20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Mr. K Saibaba, Assistant Professor				

I COURSE OVERVIEW:

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

II COURSE PRE-REQUISITES:

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

III MARKS DISTRIBUTION:

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

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

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

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

Continuous Internal Assessment (CIA):

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

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

Continuous Internal Examination (CIE):

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

A. Experiment Based

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

B. Programming Based

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

VI COURSE OBJECTIVES:

The students will try to learn:

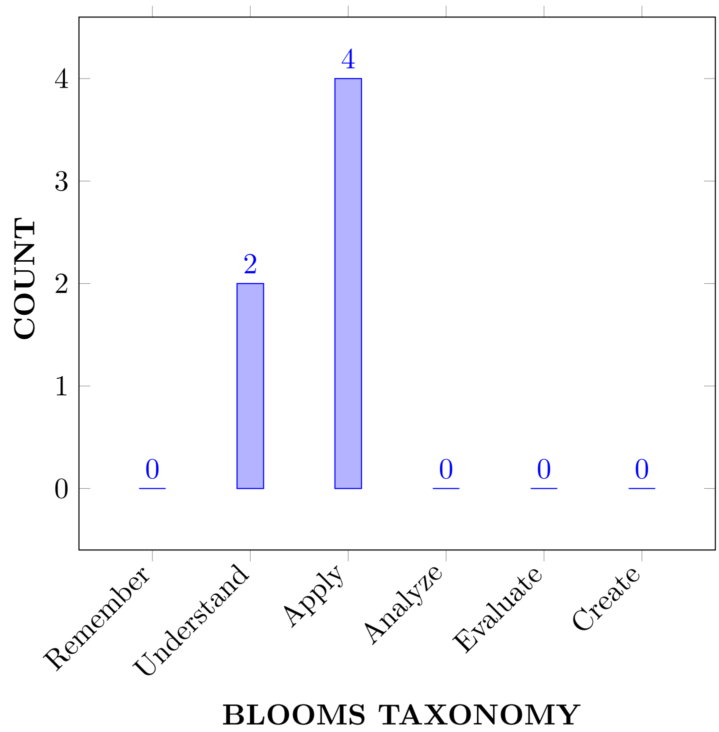
I	To familiarize with the lab facilities, equipment, standard operating procedures.
II	About the different kinds of functional electric and magnetic materials which paves a way for them to use in various technical and engineering applications.
III	The analytical techniques and graphical analysis to study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

VII COURSE OUTCOMES:

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

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

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

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

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer	1	Laboratory experiments and Surveys

3 = High; 2 = Medium; 1 = Low

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

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

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

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

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

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

3 = High; 2 = Medium; 1 = Low

XII ASSESSMENT METHODOLOGY DIRECT:

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

XIII ASSESSMENT METHODOLOGY INDIRECT:

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

XIV SYLLABUS:

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

TEXTBOOKS

1. 1 CL Arora, "Practical Physics", S Chand and Co.,New Delhi, 3rd Edition,2012.

2. 2 Vijay Kumar, Dr. T. Radha krishna, "Practical Physics for Engineering Students", S M Enterprises, 2nd Edition, 2014.

REFERENCE BOOKS:

1. 1 CF Coombs,"Basic Electronic Instrument Handbook", McGraw - HillBookCo.,1972.

2. 2 CH Bernardand CD Epp, John Wiley and Sons, " Laboratory Experiments in College Physics" Inc.,NewYork,1995.

XV COURSE PLAN:

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

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

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

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

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

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

ELECTRICAL AND ELECTRONICS ENGINEERING
COURSE DESCRIPTION

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

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

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSC02	I	-

III MARKS DISTRIBUTION:

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

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

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

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

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

Continuous Internal Assessment (CIA):

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

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

Continuous Internal Examination (CIE):

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

1. **Experiment Based**

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

2. **Programming Based**

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

VI COURSE OBJECTIVES:

The students will try to learn:

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

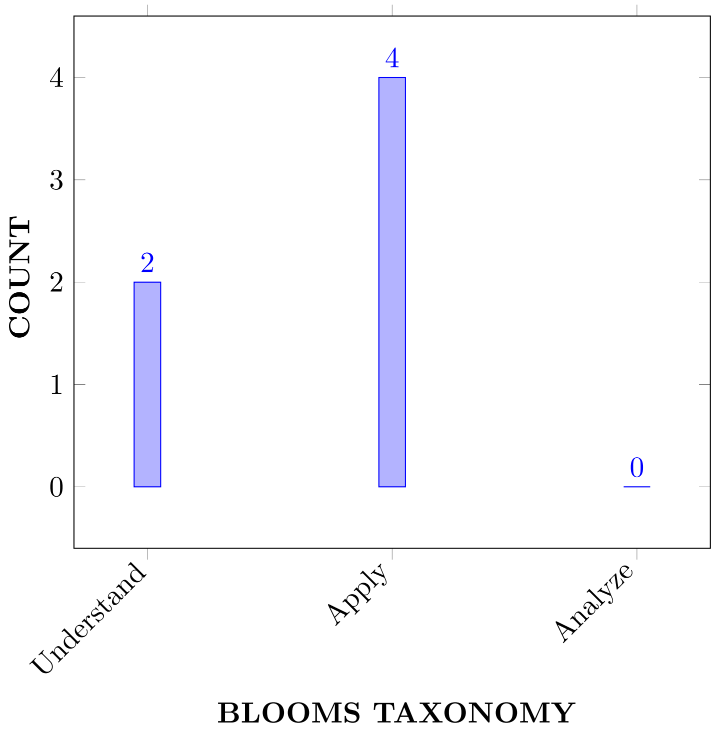
VII COURSE OUTCOMES:

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

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

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

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

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

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	3	Lab Exercises
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	3	Lab Exercises
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.	3	Lab Exercises

3 = High; 2 = Medium; 1 = Low

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

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

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

	PO 3	Understand the given problem statement and formulate (complex) engineering system **for developing a modular approach in solving problems that meet specified needs**.	2
	PO 5	Make use of functions **for creating the concept of code reusability**.	3
	PSO 3	Understand the concept of modularity by implementing different user defined and built functions **from real world problems to visualize the data to analyze the complexity.**.	3
CO 6	PO 1	Apply the knowledge of **engineering fundamentals**, and an **Mathematics and Engineering fundamentals principles to create a object oriented model on real time problems**.	3
	PO 3	Apply object oriented and modular concepts on **solving real world problems** reaching **and reusable conclusions**.	3
	PSO 3	Use built in functions in Python **for solving modular and reusable real time problems**.	3

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

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

XII ASSESSMENT METHODOLOGY DIRECT:

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

XIII ASSESSMENT METHODOLOGY INDIRECT:

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

XIV SYLLABUS:

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

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

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

TEXTBOOKS

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

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

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

XV COURSE PLAN:

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

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

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

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

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

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

ELECTRICAL AND ELECTRONICS ENGINEERING
COURSE DESCRIPTION

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

I COURSE PRE-REQUISITES:

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

II COURSE OVERVIEW:

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

III MARKS DISTRIBUTION:

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

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

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

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

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

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

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

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

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

VI COURSE OBJECTIVES:

The students will try to learn:

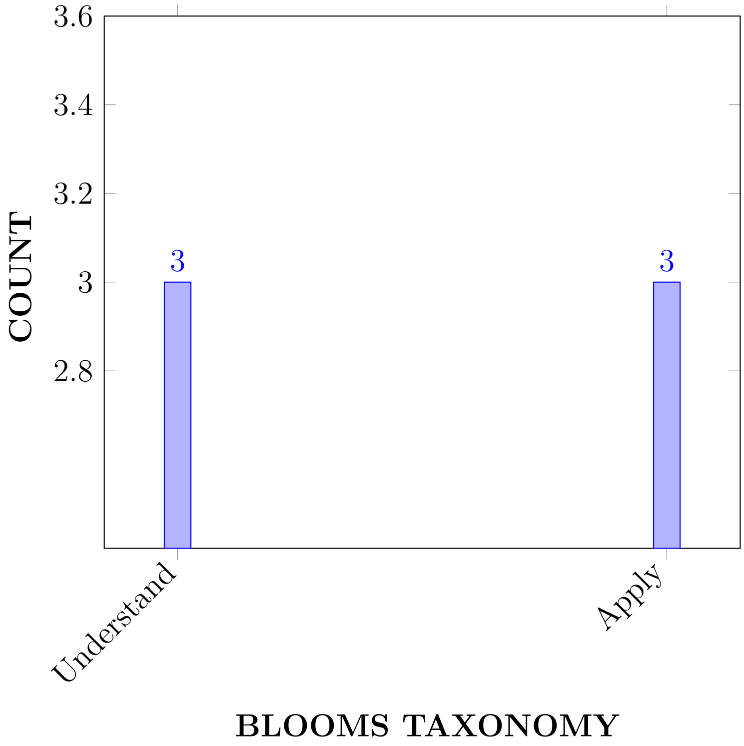
I	The concepts of electrochemical principles and causes of corrosion in the new development and breakthroughs efficiently in engineering and technology.
II	The different parameters to remove causes of hardness of water and their reactions towards the complexometric method.
III	The polymerization reactions with respect to mechanisms and its significance in industrial applications.
IV	The significance of green chemistry to reduce pollution in environment by using natural resources.

VII COURSE OUTCOMES:

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

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

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

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

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

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

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

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization..	-	-
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	-	-
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer. .	-	-

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 (COs)	POs / PSOs	Justification for mapping (Students will be able to)	No. of key competencies
CO 1	PO 1	**Explain** the operation of electrochemical systems in batteries, corrosion process in metals for protecting the metals from corrosion by using **principles of** science for solving **engineering problems**.	2

CO 2	PO 1	**Choose** different electrodes for finding pH of unknown solutions by applying **mathematical** expressions of cell potential by using **principles of science** and mathematics for solving **engineering** problems	3
	PO 2	**Identify** the problem **formulation and abstraction** for calculating electrode potential under non standard conditions by applying Nernst equation from the provided **information.**	2
CO 3	PO 1	**Explain** different treatment methods to produce soft water from raw water for solving **engineering problems** by applying the **principles of science.**	2
	PO 2	**Identify** the problem and formulate for finding the hardness of water in terms of CaCO3 equivalents with given **information and data** by applying **principles of science.**	2
CO 4	PO 1	**Illustrate** different types of polymerization reactions for synthesizing polymers from monomers, different types of lubricants to reduce friction in machines working under various temperature conditions by using **principles of science** for solving **engineering** problems	2
CO 5	PO 1	**Explain** the importance of green synthesis to minimize the generation of hazardous substances, different types of solid, liquid and gaseous fuels with their characteristics and calorific value by applying **mathematical** expressions for finding calorific value using **principles of science** and mathematics for solving engineering problems.	3
	PO 2	**Identify the given problem** and **formulate** for finding the calorific value of fuel with the given **information and data** by applying principles of science.	2
	PO 7	Make use of gaseous fuels like LPG, CNG to reduce the pollutants in atmosphere and know the impact in **socio economic and environmental** contexts for sustainable development.	2
CO 6	PO 1	**Explain** the concept of **living** and non living resources and the utility of these resources, effect of pollutants on air, water and soil that causes the environmental pollution for solving engineering problems by applying the **principles of science**	2
	PO 7	**Make use** of renewable and non renewable resources, control measures for air pollution, water pollution, soil pollution and noise pollution in **socio economic** an **environmental** contexts for sustainable development.	2

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

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

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

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

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.
0 - $0 \leq C \leq 5\%$ – No correlation
2 - 40 % $<C <$ 60% –Moderate
1-5 $<C\leq$ 40% – Low/ Slight
3 - $60\% \leq C < 100\%$ – Substantial /High

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

XVI ASSESSMENT METHODOLOGY DIRECT:

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

XVII ASSESSMENT METHODOLOGY INDIRECT:

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

XVIII SYLLABUS:

MODULE I	**ELECTROCHEMISTRY AND BATTERIES**
	Electro chemical cells: Electrode potential, standard electrode potential, Calomel electrode and Nernstequation; Electrochemical series and its applications; Numerical problems; Batteries: Primary (Dry cell) and secondary batteries (Lead-acid storage battery, Li-ion battery). Corrosion: Causes and effects of corrosion: Theories of chemical and electrochemical corrosion, mechanism of electrochemical corrosion; Corrosion control methods: Cathodic protection, sacrificial anode and impressed current Cathodic protection; Surface coatings: Metallic coatings- Methods of coating- Hot dipping- galvanization and tinning, electroplating
MODULE II	**WATER TECHNOLOGY**
	Introduction: Hardness of water, causes of hardness; types of hardness: temporary and permanent hardness, expression and units of hardness; estimation of hardness of water by complexometric method; potable water and its specifications, Steps involved in the treatment of water, disinfection of water by chlorination and ozonization; External treatment of water; Ion-exchange process; Desalination of water: Reverse osmosis, numerical problems
MODULE III	**ENGINEERING MATERIALS**
	Polymers-classification with examples, polymerization-addition, condensation and co-polymerization; Plastics: Thermoplastics and thermosetting plastics; Compounding of plastics; Preparation, properties and applications of polyvinyl chloride, Teflon, Bakelite and Nylon-6, 6; Biodegradable polymers. Elastomers: Natural rubber, processing of natural rubber, vulcanization; Buna-s and Thiokol rubber; Lubricants: characteristics of lubricants, mechanism of lubrication – thick film, thin film, extreme pressure lubrication, properties – flash and fire point, cloud and pour point, viscosity and oiliness of lubricants.

MODULE IV	**GREEN CHEMISTRY AND FUELS**
	Introduction: Definition of green chemistry, methods of green synthesis: aqueous phase, microwave method, phase transfer catalyst and ultra sound method. Fuels: definition, classification of fuels ; Solid fuels: coal; analysis of coal: proximate and ultimate analysis; Liquid fuels: Petroleum and its refining; Gaseous fuels: Composition, characteristics and applications of LPG and CNG; Calorific value: Gross Calorific value(GCV) and Net Calorific value(NCV), numerical problems.
MODULE V	**NATURAL RESOURCES AND ENVIRONMENTAL POLLUTION**
	Natural resources: Classification of resources, living and nonliving resources; Water resources: Use and over utilization of surface and ground water, floods and droughts, dams, benefits and problems; Land resources; Energy resources: renewable and non-renewable energy sources, use of alternate energy source. Environmental pollution: Causes, effects and control measures of air pollution, water pollution, soil pollution and noise pollution.

TEXTBOOKS

1. P. C. Jain and Monica Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company, 16th Edition, 2017.
2. Shashi Chawla, "Engineering Chemistry", Dhanat Rai and Company, 2011, 1st Edition.
3. Prashanth rath, B.Rama Devi, Ch.Venkata Ramana Reddy, Subhendu Chakroborty, Cengage Learning Publishers, 1st Edition, 2018
4. Anubha Kaushik, C.P.Kaushik, "Environmental Studies" New Age International publishers, 4th Edition, 2015.
5. Dr B.N.Srinivas, P.Kishore, K.Subba Rao "Engineering Chemistry" University Science Press,2015,1st Edition.

REFERENCE BOOKS:

1. 1. Dr.Bharathi Kumari, "A text book of Engineering Chemistry", VGS Book Links, 8th Edition,2016.
2. 2. B. Siva Shankar, "Engineering Chemistry", Tata McGraw Hill Publishing Limited, 3rd Edition, 2015.
3. 3. S. S. Dara, Mukkanti, "Text of Engineering Chemistry", S. Chand Co, New Delhi, 12thEdition, 2006.

XIX COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	W1
CONTENT DELIVERY (THEORY)			
1	Outcome Based Education.		

2	Recall the concept of electro chemical cells.	CO 1	T1:6.1,R1: 2.6
3	Explain the electrode potential, standard electrode potential, electrochemical series and its applications.	CO 2	T1:6.2,R1: 2.9
4	Derive Nernst equation , numerical problems on cell potential.	CO 2	T1:6.5,R1: 2.6.3
5	Demonstate about calomel electrode. Batteries: primary (dry cell).	CO 1	T1: 6.7, R1:2.12
6	Explain the secondary batteries (Lead-acid storage battery), Li-ion battery.	CO 1	T1:6.12,R1: 2.12
7	Recognize the causes and effects of corrosion, chemical corrosion.	CO 1	T1:7.1, R1:2.14
8	Explain the electrochemical corrosion, mechanism of electrochemical corrosion.	CO 1	T1:7.2, R1:2.17
9	Explain about cathodic protection, sacrificial anode and impressed current.	CO 1	T1:7.14, R1:2.20
10	Apply metallic coatings, methods of coatings, hot dipping, galvanizing , tinning and electroplating.	CO 1	T1:7.14,R1: 2.22
11	Recall the hardness of water, causes of hardness.	CO 3	T1:1.3,R1: 1.4
12	Explain the types of hardness, temporary and permanent, units of hardness.	CO 3	T1:1.3,1.5,
13	Estimation of hardness of water by complexometric method,	CO 3	T1:1.5,R1: 1.6.2
14	Estimation of hardness of water by complexometric method.	CO 3	T1:1.14,R1: 1.6.4
15	Define potable water and its specifications, steps involved in treatment of water, disinfection of water by chlorination and ozonization.	CO 3	T1:1.12,R1: 1.6.5
16	Explain about external treatment of water; ion-exchange process.	CO 3	T1:1.11, R1:1.8.1
17	Explain about desalination of water: reverse osmosis.	CO 3	T1:1.13, R1:1.10
18	Recall polymers-classification with examples and Explain about the polymerization-addition, condensation and co- polymerization	CO 4	T1: 3.5,R1: 3.1
19	Explain the concept of compounding of plastics.	CO 4	T1:1.4, R1: 3.1.4
20	Expalin the preparation, properties and applications of polyvinyl chloride, teflon.	CO 4	T1:3.5,R1: 3.2
21	Explain the bakelite and nylon-6, 6.	CO 4	T1: 3.12,R1: 3.2.2
22	Define biodegradable polymers, synthetic biodegradable polymers.	CO 4	T1:3.14,R1: 3.2.3
23	Explain rubbers, natural rubber its process and vulcanization, Buna-s and thiokol rubber.	CO 4	T1: 3.15, R1:3.2.3
24	Elastomers: Synthetic rubbers,Buna-s and thiokol rubber.	CO 4	T1: 3.22, R1:3,3.4

25	Lubricants: characteristics of lubricants, mechanism of lubrication – thick film, thin film, extreme pressure lubrication.	CO 4	T1: 3.24,R1: 3.5
26	Properties–flash and fire point, cloud and pour point, viscosity and oiliness of lubricants.	CO 4	T1: 3.25,R1: 3.7
27	Definition and importance of green chemistry, methods of green synthesis: aqueous phase method.	CO 5	T5:6.8, T2:1.1
28	Explain the microwave method and phase transfer catalyst.	CO 5	T5: 6.8.3,T2: 8.1
29	Explain the ultra sound method.	CO 5	T5: 6.8.3, T2:9.2
30	Define fuels, classification of fuels and characteristics of a good fuels.	CO 5	T1:4.2, R1:6.2.1
31	Explain solid fuels, coal, Analysis of coal, proximate and ultimate analysis.	CO 5	T1:4.4.1, R1:7.1
32	Explain liquid fuels, petroleum and its refining.	CO 5	T1:4.5.2, R1:15.2
33	Explain the gaseous fuels, Composition, characteristics and applications of LPG and CNG.	CO 5	T1:4.6, R1:9.2
34	Apply the concept of calorific value, gross calorific value (GCV) and Net calorific value(NCV) to find calorific value of fuel, numerical problems.	CO 5	T1:4.8, R1:5.2
35	Recall natural resources: classification of resources, living and nonliving resources.	CO 6	T4:2.1
36	Explain the water resources: use and over utilization of surface and ground water, floods and droughts, Dams, benefits and problems.	CO 6	T4:2.2
37	Define energy resources, renewable and non-renewable energy sources.	CO 6	T4:2.3
38	Explain the alternate energy sources, land resources	CO 6	T4:2.5,5.2
39	Define environmental pollution, causes, effects and control of air pollution.	CO 6	T4: 4.2
40	Explain the causes, effects and control of water pollution.	CO 6	T4: 4.6
41	Explain the causes, effects and control of soil pollution and noise pollution.	CO 6	T4:4.12
PROBLEM SOLVING/ CASE STUDIES			
42	Problems on EMF of voltaic cell	CO 2	T1:6.2,R1: 2.9
43	Problems on EMF of a cell	CO 2	T1:6.5,R1: 2.6.3
44	Problems on electrode potential of the half cell by using Nernst equation	CO 2	T1:6.2,R1: 2.9
45	Problems on electrode potential of EMF of the cell by using Nernst equation.	CO 2	T1:6.5,R1: 2.6.3
46	Problems on temporary and permanent hardness in Degree French.	CO 3	T1:1.5, R1: 1.6.2
47	Problems on temporary, permanent and total hardness in ppm	CO 3	T1:1.14,R1: 1.6.4
48	Problems on the temporary, permanent and total hardness of water in Degree Clark.	CO 3	T1:1.5,R1: 1.6.2

49	Problems on the temporary, permanent and total hardness of water in Mg/L.	CO 3	T1:1.14,R1: 1.6.4
50	Problems on the total hardness in terms of calcium carbonate equivalents by using EDTA method.	CO 3	T1:1.5,R1: 1.6.2
51	Problems on the permanent hardness in terms of calcium carbonate equivalents by using EDTA method.	CO 3	T1:1.14,R1: 1.6.4
52	Problems on the temporary hardness in terms of calcium carbonate equivalents by using EDTA method.	CO 3	T1:1.5,R1: 1.6.2
53	Problems on the higher and lower calorific values of the fuel.	CO 5	T1:4.8, R1:5.2
54	Problems on the gross and net calorific values of the fuel.	CO 5	T1:4.8, R1:5.2
55	Problems on HCV and LCV	CO 5	T1:4.8, R1:5.2
56	Problems on GCV and NCV	CO 5	T1:4.8, R1:5.2
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Definitions & terminology discussion on electrochemistry and corrosion	CO 1	T1:1.3,R1: 1.4
58	Definitions & terminology discussion on water technology	CO 3	T1: 3.5,R1: 3.1
59	Definitions & terminology discussion on engineering	CO 4	T1: 3.5,R1: 3.1
60	Definitions & terminology discussion on green chemistry and fuels	CO 5	T1:4.2, R1:6.2.1
61	Definitions & terminology discussion on natural resources and environmental pollution	CO 1, CO 6	T4:2.1,2.8
DISCUSSION OF QUESTION BANK			
62	Question bank discussion on electrochemistry and Corrosion	CO 1	T1: 6.1, R1:2.12
63	Question bank discussion on water technology	CO 3	T1:1.3, R1: 1.4
64	Question bank discussion on engineering materials	CO 4	T1: 3.5,R1: 3.1
65	Question bank discussion on green chemistry and fuels	CO5	T1:4.2, R1:6.2.1
66	Question bank discussion on natural resources and environmental Pollution	CO 6	T4:2.1,2.8

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

INSTITUTE OF AERONAUTICAL ENGINEERING
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COURSE DESCRIPTION

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

I COURSE PRE-REQUISITES:

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

II COURSE OVERVIEW:

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

III MARKS DISTRIBUTION:

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

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

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

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

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

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

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

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

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

VI COURSE OBJECTIVES:

The students will try to learn:

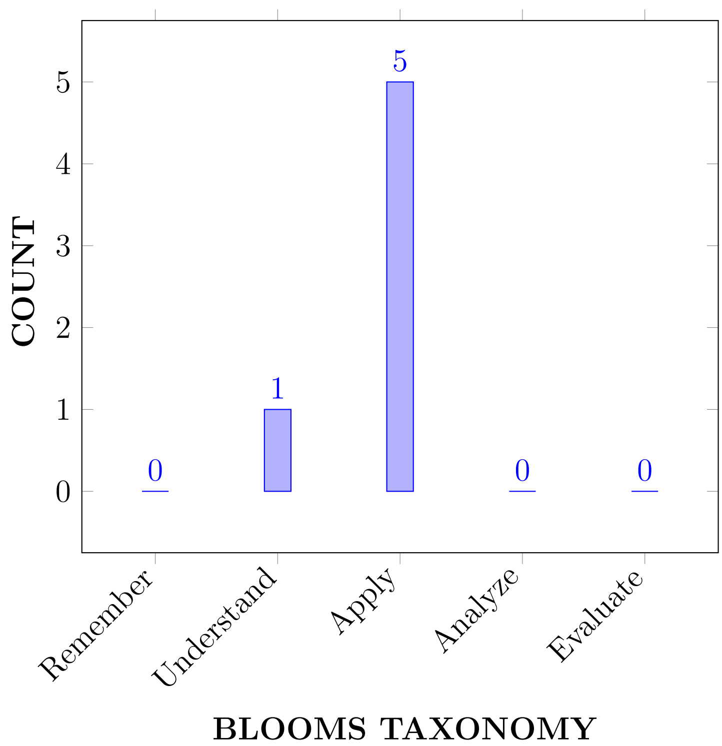
I	The transformation of ordinary differential equations in Laplace field and its applications
II	The operation of non-periodic functions by Fourier transforms.
III	The concepts of multiple integration for finding areas and volumes of physical quantities.
IV	The Integration of several functions by transforming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

VII COURSE OUTCOMES:

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

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

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

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

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

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

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

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

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	2	Seminar/ Conferences/ Research Papers
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	-	-
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.	-	-

3 = High; 2 = Medium; 1 = Low

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

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

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

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

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO5	PO2	**Develop** the **statement** and **formulation** differential calculus of **complex engineering problems** which transforms vector functions, gradients. Divergence, curl, and integral theorems using **principle of mathematics** to different bounded regions in calculating areas. by **interpretation of results**	6
CO6	PO1	**Solve** Lagrange's linear equation related to **complex engineering problems** such as dependent and independent variables the nonlinear partial differential equation by the method of Charpit concern to the engineering field **Principle of Mathematics**.	2
	PO2	**Describe** the **statement** and **formulation** of Lagrange's linear equation (understand) related to **complex engineering problems**, solutions are attained based on **principles of mathematics** to the **physical problems of engineering** by the **interpretation of results**.	6

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

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

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

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

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

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

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

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

XVI ASSESSMENT METHODOLOGY-DIRECT:

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

XVII ASSESSMENT METHODOLOGY-INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**LAPLACE TRANSFORMS**
	Definition of Laplace transform, linearity property, piecewise continuous function, existence of Laplace transform, function of exponential order, first and second shifting theorems, change of scale property, Laplace transforms of derivatives and integrals, multiplied by t, divided by t, Laplace transform of periodic functions. Inverse Laplace transform: Definition of Inverse Laplace transform, linearity property, first and second shifting theorems, change of scale property, multiplied by s, divided by s; Convolution theorem and applications to ordinary differential equations.
MODULE II	**FOURIER TRANSFORMS**
	Fourier integral theorem, Fourier sine and cosine integrals; Fourier transforms; Fourier sine and cosine transform, properties, inverse transforms, finite Fourier transforms.
MODULE III	**MULTIPLE INTEGRALS**

	Double Integrals: Evaluation of double integrals in Cartesian coordinates and Polar coordinates; Change of order of integration; Area as a double integral; Transformation of coordinate system. Triple Integrals: Evaluation of triple integrals in Cartesian coordinates; volume of a region using triple integration.

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

TEXTBOOKS

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

REFERENCE BOOKS:

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

WEB REFERENCES:

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

COURSE WEB PAGE:

XIX COURSE PLAN:

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

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

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

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

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

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

Signature of Course Coordinator **HOD,EEE**

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

COURSE DESCRIPTION

Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**
Course Title	PROGRAMMING FOR PROBLEM SOLVING USING C
Course Code	ACSC04
Program	B.Tech
Semester	II
Course Type	FOUNDATION
Regulation	UG-20

<table>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>3</td><td>-</td><td>3</td><td>-</td><td>-</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Dr. J Sirisha Devi, Associate Professor</td></tr>
</table>

I COURSE PRE-REQUISITES:

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

II COURSE OVERVIEW:

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

III MARKS DISTRIBUTION:

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

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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0 %	Analyze

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

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

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

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

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

VI COURSE OBJECTIVES:

The students will try to learn:

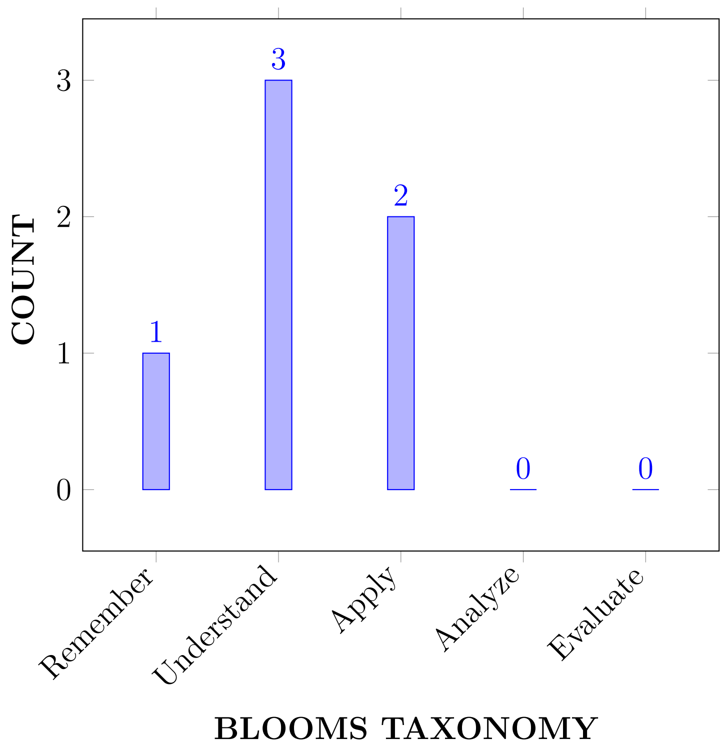
I	Problem-solving through programming.
II	Programming language, programming, reading a set of Data, stepwise refinement, concepts of Loops, Functions, Control structure, Arrays, Structure, Pointer and File concept.
III	To build efficient programs in C language essential for future programming and software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

VII COURSE OUTCOMES:

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

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

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

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

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

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

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	2	Tech talk/Open ended experiments

3 = High; 2 = Medium; 1 = Low

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

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	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	Developing algorithms and draw flowcharts for solving **mathematical** and **engineering problems** related to **areas of computer science.**	3
	PO 2	Understand the various symbols to **draw** a flowchart, **identify** the appropriate symbols to solve a problem, then **formulate** the solution, and **interpret** the result for the **improvement** of the **solution.**	6
	PSO 1	Understand the features of procedural programming for **designing** and **analyzing** computer programs for **problem-solving.**	3
CO 2	PO 1	Understand branching statements, loop statements, and apply the fundamentals of **mathematics**, **science** and **engineering**.	3
	PO 2	Understand the **problem statement**, **control** the flow of data, **design** the solution and **analyze** the same to **validate** the results in a program to solve **complex** engineering problems.	6
	PO 3	**Recognize** an appropriate control structure to **design** and **develop** a solution for a **real-time** scenario, and **communicating** effectively with engineering community.	5
CO 3	PO 1	Recognize the importance of recursionfor developing programs in real-time scenarios using principles of **mathematics**, and **engineering fundamentals**.	3
	PO 2	Understand the various kinds of **functions**, **identify** the suitable type of function to **solve** a problem, **formulate** the solution, and **interpret** the result for the **improvement** of the solution.	6
	PO 5	Apply techniques of **structured decomposition** to dividea problem into smaller pieces with an understanding of its limitations.	1
CO 4	PO 1	Extend the focus on the usage of heterogeneous data types as a **basic building block** in problem solving using principles of **science**, and **engineering** fundamentals.	3
	PO 2	**Recognize** the representation of the structure, **assess** in solving a problem, **express the solution**, and **analyze** the result for **solution enhancement**.	5
	PO 5	Understand pointers conceptually and apply them in modeling a **complex engineering** activity.	1

CO 5	PO 1	Make a use of an appropriate type of file to store a large volume of **persistent data** and give solution to **engineering problems**.	2
	PO 5	To identify appropriate mode to access a file and run the same **program** multiple times.	1
CO 6	PO 12	**Realize** the need and the desire to **train** and **invest** in autonomous and **lifelong learning** in the widest sense of **technical transition** to achieve **employability expertise** and excel advanced **engineering concepts**.	7

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

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

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

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

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	-	-

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

XVI ASSESSMENT METHODOLOGY-DIRECT:

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

XVII ASSESSMENT METHODOLOGY-INDIRECT:

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

XVIII SYLLABUS:

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

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

TEXTBOOKS

1. Byron Gottfried, “Programming with C”, Schaum’s Outlines Series, McGraw Hill Education, 3rd Edition, 2017

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

REFERENCE BOOKS:

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

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

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

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

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

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

WEB REFERENCES:

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

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

XIX COURSE PLAN:

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

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

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

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

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

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

COURSE DESCRIPTION

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

I COURSE OVERVIEW:

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

II COURSE PRE-REQUISITES:

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

III MARKS DISTRIBUTION:

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

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

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

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

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

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

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

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

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

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

VI COURSE OBJECTIVES:

The students will try to learn:

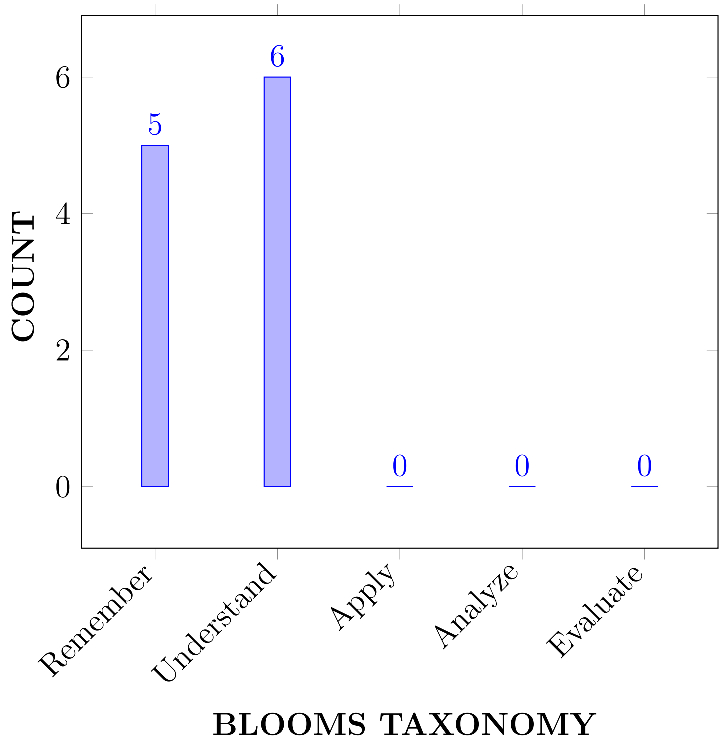
I	The network reduction techniques such as source transformation, mesh analysis, nodal analysis and network theorems to solve different networks.
II	The basic concept of AC circuits for optimization of household and industrial circuitry.
III	The various configurations of electromagnetic induction used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

VII COURSE OUTCOMES:

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

CO 1	**Define** the various terminology used to study the characteristics of DC and AC electrical networks.	Remember
CO 2	**Discuss** the different lawsand indirect quantities associated with electrical circuit for branch currents and nodal voltages.	Understand
CO 3	**Summarize** the procedure for several theorems to reduce complex network into simple equivalent network with DC and AC excitation.	Understand
CO 4	**Describe** the electromagnetic induction, magnetic flux, self and mutual inductance in the single coil and coupled coils magnetic circuits to know total magnetomotive force and total ampere turns values.	Understand
CO 5	**Recognize** the two port parameters and network topology for graphical and digital representation of complex circuits to be measure easily, without solving for all the internal voltages and currents in the different networks.	Remember
CO 6	**Define** the importance of dual network for compare both mesh and nodal networks.	Remember

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

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

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

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

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

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 2	Focus on the components of power system, its analysis, operation, control and protection; electrical drives with its converter topologies for energy conversion, management and auditing in specific applications of industry and academia	2	CIE / 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**	Recall the basics of mathematics, engineering sciences and other sciences to understand the concept of DC and AC Circuits.	3
	PO 2	Validate the principles of different laws associated with electrical circuits from obtained principles using basics fundamentals of mathematics and engineering sciences.	5
CO 2	**PO 1**	Recall the basics of mathematics, engineering sciences and other sciences to understand the concept of Kirchhoff's laws	3
	PO 2	Analyze mesh analysis and nodal analysis technique using principles of mathematics, science and engineering fundamentals	5
CO 3	**PO 1**	Recollect the concept of Electrical circuits basics analysis.	3
	PO 2	Describes the diifferent Theorems with AC and DC excitation from obtained principles using basics fundamentals of mathematics and engineering sciences.	5
	PO 4	Conduct Investigations of Complex Problems with AC and DC excitation Use research methods including design of experiments.	5
CO 4	**PO 1**	Apply the knowledge of mathematics, science, engineering fundamentals to the solution of magnetic circuits	3
	PO 2	Describes the fundamental characteristics of electromagnetic induction, self and mutual inductance in the single coil and coupled coils magnetic circuits using basics fundamentals of mathematics and engineering sciences.	5
CO 5	**PO 1**	Recall the basics of mathematics, engineering sciences and other sciences to understand the concept of two port network and graph theory.	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	Validate the principles of different parameters and network topology from obtained principles using basics fundamentals of mathematics and engineering sciences.	5
	PSO 2	Identify complex engineering problems on two port network and graph theory using first principles of mathematics, natural sciences, and engineering sciences.	2
CO 6	**PO 3**	Recall the basics of mathematics, engineering sciences and other sciences to understand the concept of duality.	3

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

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

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

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

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

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

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO(s)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	2	-	1	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO 6	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	33	10	-	1	-	-	-	-	-	-	-	-	-	2	-
AVERAGE	3	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 & Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION TO ELECTRICAL CIRCUITS**
	Circuit concept: Basic definitions, Ohm's law at constant temperature, classifications of elements, independent and dependent sources, voltage and current relationships for passive elements, Single phase AC circuits: Representation of alternating quantities, properties of different periodic wave forms, phase and phase difference, concept of impedance and admittance, power in AC circuits.
MODULE II	**ANALYSIS OF ELECTRICAL CIRCUITS**
	Circuit analysis: Source transformation, Kirchhoff's laws, total resistance, inductance and capacitance of circuits, Star - delta transformation technique, mesh analysis and nodal analysis, inspection method, super mesh, super node analysis.
MODULE III	**NETWORK THEOREMS (DC AND AC)**
	Network Theorems: Tellegen's, superposition, reciprocity, Thevenin's, Norton's, maximum power transfer, Milliman's and compensation theorems for DC excitations, numerical problems. Network Theorems: Tellegen's, superposition, reciprocity, Thevenin's, Norton's, maximum power transfer, Milliman's and compensation theorems for AC excitations, numerical problems.

MODULE IV	**MAGNETIC CIRCUITS**
	Magnetic circuits: Faraday's laws of electromagnetic induction, concept of self and mutual inductance, dot convention, coefficient of coupling, composite magnetic circuit, analysis of series and parallel magnetic circuits.
MODULE V	**TWO PORT NETWORK AND GRAPH THEORY**
	Two Port Network: Two port parameters, interrelations, Two port Interconnections. Network topology: Definitions, incidence matrix, basic tie set and basic cut set matrices for planar networks, duality and dual networks.

TEXTBOOKS

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

REFERENCE BOOKS:

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

WEB REFERENCES:

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

COURSE WEB PAGE:

XIX COURSE PLAN:

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

S.No	Topics to be covered	CO(s)	Reference
	OBE DISCUSSION		
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	-
	CONTENT DELIVERY (THEORY)		
2	Introduction to Electrical Circuits	CO 1	T1: 2.1
3	Basic Definitions and Ohm's Law at Constant Temperature	CO 1	T1:2.4
4	Classifications of Elements	CO 1	T1:2.4
5	Voltage and current relationships for passive elements	CO 1	T1:2.5
6	Introduction to Single phase AC circuits, Representation of alternating quantities	CO 1	T1: 2.1
7	Properties of different periodic wave forms, Phase and phase difference	CO 1	T1:2.4
8	Concept of Impedance, Admittance and Power in AC Circuits	CO 1	T1:2.4
9	Source transformation	CO 2	T1:1.5-1.6
10	Kirchhoff's laws	CO 2	T1:1.8-1.12

11	Equivalent Values of Series, Parallel R, L & C Networks	CO 2	T1:1.13-1.18
12	Star to Delta or Delta to Star Transformation Technique	CO 2	T1:1.1-1.18
13	Mesh Analysis Solved Technique with simple example and Animation	CO 2	T1:5.1-5.2
14	Nodal analysis Solved Technique with simple example and Animation	CO 2	T1:5.3
15	Inspection Method Solved Technique with simple example and Animation	CO 2	T1:5.7
16	Super mesh analysis Solved Technique with simple example and Animation	CO 2	T1:5.4-5.6
17	Super node analysis Solved Technique with simple example and Animation	CO 2	T1:6.5-6.11
18	Tellegen's theorem for DC excitations Solved Technique with simple example and Animation	CO 3	T1:7.1 -7.4
19	Superposition theorem for DC excitations Solved Technique with simple example and Animation	CO 3	T1:5.3
20	Reciprocity theorem for DC excitations Solved Technique with simple example and Animation	CO 3	T1:5.7
21	Thevenin's theorem for DC excitations Solved Technique with simple example and Animation	CO 3	T1:5.1-5.2
22	Norton's theorem for DC excitations Solved Technique with simple example and Animation	CO 3	T1:5.3
23	Maximum power transfer theorem for DC excitations Solved Technique with simple example and Animation	CO 3	T1:5.7
24	Milliman's theorem for DC excitations Solved Technique with simple example and Animation	CO 3	T1:5.4-5.6
25	Compensation theorem for DC excitations Solved Technique with simple example and Animation	CO 3	T1:6.5-6.11
26	Tellegen's theorem for AC excitations	CO 3	T1:7.1 -7.4
27	Superposition theorem for AC excitations	CO 3	T1:8.4-8.6
28	Reciprocity theorem for AC excitations	CO 3	T1: 8.12-8.15
29	Thevenin's theorem for AC excitations	CO 3	T1:8.4-8.6
30	Norton's theorem for AC excitations	CO 3	T1: 8.12-8.15
31	Maximum power transfer theorem for AC excitations	CO 3	T1:8.4-8.6
32	Milliman's and compensation theorems theorem for AC excitations	CO 3	T1: 8.12-8.15
33	Faraday's laws of electromagnetic induction	CO 4	T1:8.4-8.6
34	Concept of self and mutual inductance	CO 4	T1: 8.12-8.15

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

62	Module I	CO 1,2	R4:2.1
63	Module II	CO 3	T4:7.3
64	Module III	CO 4	R4:5.1
65	Module IV	CO 5	T1:7.5
66	Module V	CO 6	T1: 4.1

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

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

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

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

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

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

ANNEXURE - II

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

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

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

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

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTION

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

I COURSE OVERVIEW:

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

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSB02	I	-

III MARKS DISTRIBUTION:

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

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

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

Continuous Internal Assessment (CIA):

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

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

Continuous Internal Examination (CIE):

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

1. **Experiment Based**

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

2. **Programming Based**

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

VI COURSE OBJECTIVES:

The students will try to learn:

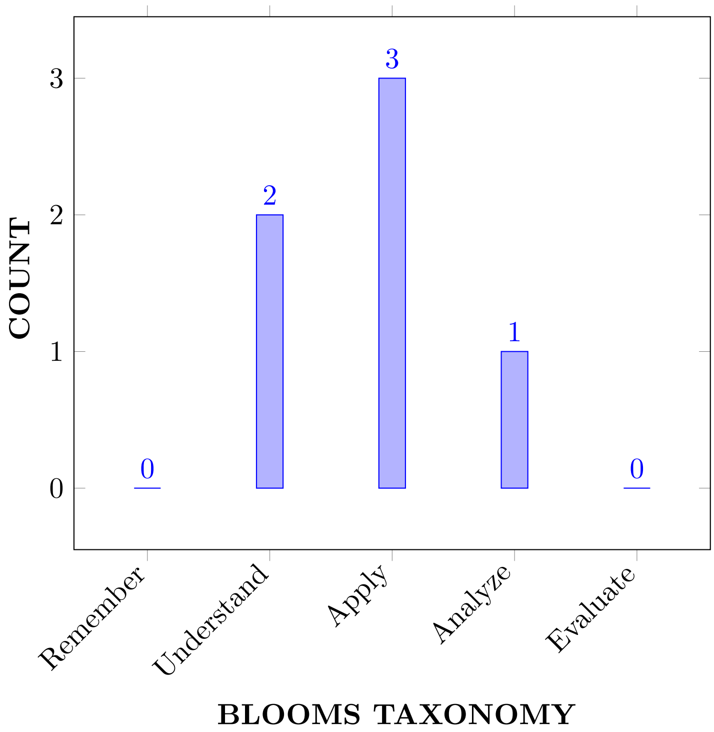
I	The hands on experience in design, develop, implementation and evaluation by using Asymptotic notation.
II	The demonstration knowledge of basic abstract data types (ADT) and associated algorithms for organizing programs into modules using criteria that are based on the data structures of the program.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

VII COURSE OUTCOMES:

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

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

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

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

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

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		**Strength**	**Proficiency Assessed by**
PSO 1	**Professional Skills:** The ability to research, understand and implement computer programs in the areas related to algorithms, system software, multimedia, web design, big data analytics, and networking for efficient analysis and design of computer-based systems of varying complexity. .	2	Viva-voce Laboratory Practices
PSO 2	**Software Engineering Practices:** The ability to apply standard practices and strategies in software service management using open-ended programming environments with agility to deliver a quality service for business success .	2	Viva-voce Laboratory Practices
PSO 3	**Successful Career and Entrepreneurship:** The ability to employ modern computer languages, environments, and platforms in creating innovative career paths, to be an entrepreneur, and a zest for higher studies. .	2	Viva-voce Laboratory Practices

3 = High; 2 = Medium; 1 = Low

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

COURSE OUTCOMES	PO'S PSO'S	**Justification for mapping (Students will be able to)**	No. of Key Competencies
CO 1	PO 1	Understand (knowledge) the basic concept of algorithm analysis which provides theoretical estimates for the resources needed by any algorithm for a given computational problem. These estimates provide an insight into reasonable directions of search for efficient algorithms by applying the principles of **mathematics and science**	3

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

CO 6	PO 1	Outline the importance of searching algorithms to retrieve an element from any data structure where it is stored by **understanding and applying the fundamentals of mathematics, science and engineering**	2
	PO 10	Understand the use of searching techniques that retrieve information stored within some data structure by **communicating effectively with engineering communit.**	3

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

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

XII ASSESSMENT METHODOLOGY DIRECT:

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

XIII ASSESSMENT METHODOLOGY INDIRECT:

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

XIV SYLLABUS:

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

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

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

TEXTBOOKS

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

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

REFERENCE BOOKS:

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

2. Cornelisse, J.W., Rocket Propulsion and Space Dynamics, J.W., Freeman & Co. Ltd., London, 1982.

3. Parker, E.R., Materials for Missiles and Spacecraft, McGraw-Hill Book Co. Inc., 1982.

XV COURSE PLAN:

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

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

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

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

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

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

<table>
<tr><td>Course Title</td><td colspan="5">ENGINEERING WORKSHOP PRACTICE LABORATORY</td></tr>
<tr><td>Course Code</td><td colspan="5">AMEC02</td></tr>
<tr><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>Semester</td><td colspan="5">II</td></tr>
<tr><td>Course Type</td><td colspan="5">Foundation</td></tr>
<tr><td>Regulation</td><td colspan="5">IARE-UG20</td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>2</td><td>1</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Mr.B.Vijaya Krishna, Assistant Professor.</td></tr>
</table>

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AMEC04	II	-

II COURSE OVERVIEW:

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

III MARKS DISTRIBUTION:

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

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

	Experiment Based	Programming based
20 %	To test the preparedness for the experiment.	-
20 %	To test the performance in the laboratory.	-
20 %	To test the calculations and graphs related to the concern experiment.	-
20 %	To test the results and the error analysis of the experiment.	-
20 %	To test the subject knowledge through viva – voce.	-

Continuous Internal Assessment (CIA):

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

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

Continuous Internal Examination (CIE):

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

1. **Experiment Based**

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

2. **Programming Based**

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

VI COURSE OBJECTIVES:

The students will try to learn:

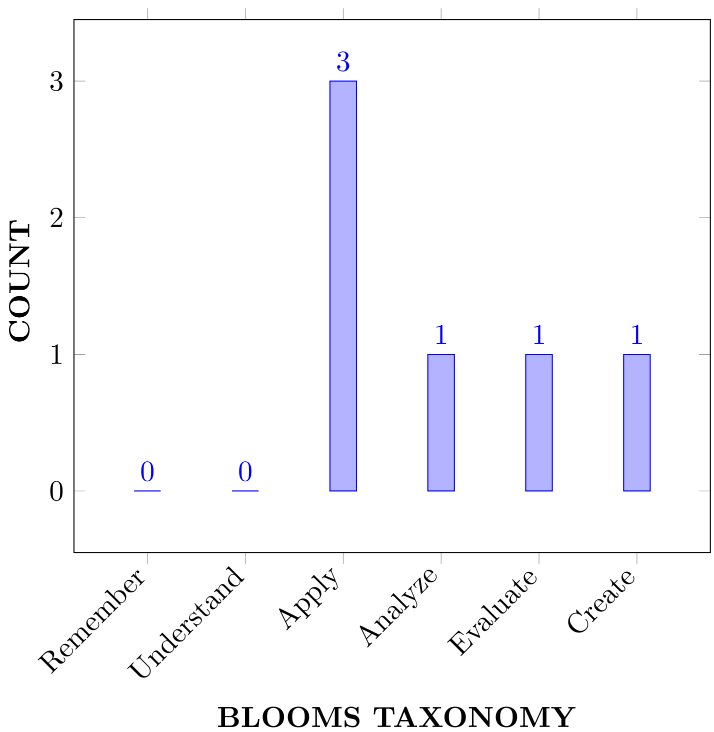
I	Use of common instruments including measuring, marking and cutting tools in various types of manufacturing processes.
II	Basic manufacturing concepts used in carpentry, fitting, black-smithy and tin-smithy.
III	Demonstrating skills by converting electrical circuit's diagrams into electrical wiring.
IV	Compare experimental results with diagrammatic measurements and to determine the source of any apparent differences.

VII COURSE OUTCOMES:

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

CO 1	**Identify** the ability to work from drawings and blueprints and demonstrate proficiency with hand tools common to carpentry.	Apply
CO 2	**Determine** the ability to Produce Fitting jobs as per specified dimensions in addition to demonstrating proficiency with hand tools common to fitting.	Evulate
CO 3	**Create** works of metal art using fire and furnace to convert given shape into useable elements using basic blacksmith techniques .	Create
CO 4	**Organisze** the moulding techniques for producing casting of different and complex shapes using various patterns.	Apply
CO 5	**Develop** various engineering and household articles such as tin boxes, cans, funnels, ducts etc., from a flat sheet of metal.	Apply
CO 6	**Compare** various wiring diagrams using conduit system of wiring and Prepare different types of wiring joints on the given circuit boards using appropriate electrical tools.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

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

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Lab Experiments / CIE / SEE
PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	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.	2	Lab Experiments / CIE / SEE
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	3	Lab Experiments / CIE / SEE

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer	2	Lab Experiments / CIE / SEE

3 = High; 2 = Medium; 1 = Low

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

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

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

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies matched.
CO 1	PO 1	Apply the knowledge of **engineering fundamentals** to join given wooden pieces according to given sketch to develop required joint..	1
	PO 3	Conversion of given design into a practical output using design solution for **complex engineering problems** and **design system components**.	2
	PO 5	Develop the given **resources and engineering tools** into proper fitment as given in the diagrammatical representation .	2
	PO 11	**Demonstrate** knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in **multidisciplinary environments.** .	2
	PS03	Make use of **Experimental tools** for Building Career Paths towards **Innovation Startups**, Employability in different mechanical trades.	2
CO 2	PO 1	the knowledge of **engineering fundamentals**to join given metal pieces according to given sketch to develop required joint.	1
	PO 5	Develop the given **resources and engineering tools** into proper fitment as given in the diagrammatical representation..	2
	PO 11	**Demonstrate** knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	2
	PSO 3	Make use of **Experimental tools** for Building Career Paths towards **Innovation Startups**, Employability in different mechanical trades.	2
CO 3	PO 1	Apply the knowledge of **engineering fundamentals** to make metal rod into given required shape according to given sketch to develop required joint.	1
	PO5	Develop the given **resources and engineering toolsinto** required shape as given in the diagrammatical representation..	2
	PSO3	Make use of **Experimental tools** for Building Career Paths towards **Innovation Startups**, Employability in different mechanical trades..	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 knowledge of **engineering fundamentals** to make the casting product from given materials according to given sketch to develop required shape..	1
	PO 3	Conversion of given design into a practical output using design solution for **complex engineering problems and design system components**.	2
	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.**.	2
CO 5	PO 5	Develop the given **resources and engineering tools** into required shape as given in the diagrammatical representation	2
	PO 11	**Demonstrate**knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in **multidisciplinary environments** .	2
CO 6	PO 1	Apply the knowledge of **engineering fundamentals** to make the required electrical connection according to given circuit diagram to develop connection..	1
	PO 5	Develop the given **resources and engineering tools** into proper fitment as given in the diagrammatical representation.	2
	PO 11	**Demonstrate** knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in **multidisciplinary environments.**	2
	PSO 3	Make use of **Experimental tools** for Building Career Paths towards Innovation Startups, Employability in different mechanical trades. .	2

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

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

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

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	**10**	**10**	**11**	**1**	**5**	**3**	**3**	**12**	**5**	**12**	**8**	**5**	**11**	**7**
CO 1	33.3	-	20	-	100	-	-	-	-	-	16.6	-	-	-	66.6
CO 2	33.3	-	-	-	100	-	-	-	-	-	-	-	-	-	66.6
CO 3	33.3	-	20	-	100	-	-	-	-	-	-	-	-	-	66.6
CO 4	33.3	-	20	-	100	-	-	-	-	-	16.6	-	-	-	-
CO 5	-	-	-	-	100	-	-	-	-	-	16.6	-	-	-	-
CO 6	33.3	-	-	-	100	-	-	-	-	-	16.6	-	-	-	66.6

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

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

0 - $0 \leq C < 5\%$ – No correlation

1 - $5 < C < 40\%$ – Low/ Slight

2 - $40\ \% < C < 60\%$ –Moderate

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

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

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

XVI ASSESSMENT METHODOLOGY DIRECT:

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

XVII ASSESSMENT METHODOLOGY INDIRECT:

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

XVIII SYLLABUS:

WEEK-I	**CARPENTRY-I**
	Batch I: Preparation of Tenon joint as per given dimensions. Batch II: Preparation of Mortise joint as per given taper angle.
WEEK-II	**CARPENTRY-II**
	Batch I: Preparation of dove tail joint as per given taper angle. Batch II: Preparation of lap joint as per given dimensions.
WEEK-III	**FITTING - I**
	Batch I: Make a straight fit for given dimensions. Batch II: Make a square fit for given dimensions.
WEEK-IV	**FITTING - II**
	Batch I: Make a V fit for given dimensions. Batch II: Make a semicircular fit for given dimensions.
WEEK-V	**BLACKSMITHY- I**
	(Batch I: Prepare S-bend for given MS rod using open hearth furnace. Batch II: Prepare J-bend for given MS rod using open hearth furnace.
WEEK-VI	**BLACKSMITHY- II**
	Batch I: Prepare Fan hook for given dimensions. Batch II: Prepare Round to Square for given dimensions.
WEEK-VII	**MOULD PREPARATION-I.**
	Batch I: Prepare a wheel flange mould using a given wooden pattern. Batch II: Prepare a bearing housing using an aluminum pattern.
WEEK-VIII	**MOULD PREPARATION-II**

	Batch I: Prepare a bearing housing using an aluminum pattern. Batch II: Prepare a wheel flange mould using a given wooden pattern.
WEEK-IX	**TINSMITHY- I**
	Batch I: Prepare the development of a surface and make a rectangular tray for given dimensions. Batch II: Prepare the development of a surface and make a round tin for given dimensions.
WEEK-X	**TINSMITHY- II**
	Batch I: Prepare the development of a surface and make a Square Tin, for given dimensions. Batch II: Prepare the development of a surface and make a Conical Funnel for given dimensions.
WEEK-XI	**ELECTRICAL WIRING-I**
	Batch I: Make an electrical connection of two bulbs connected in series. Batch II: Make an electrical connection of two bulbs connected in parallel.
WEEK-XII	**ELECTRICAL WIRING-II**
	Batch I: Make an electrical connection of one bulb controlled by two switches connected. Batch II: Make an electrical connection of tube light.

REFERENCE BOOKS:

1. Gowri P. Hariharan, A. Suresh Babu," Manufacturing Technology – I", Pearson Education, 2018.
2. Roy A. Lindberg, "Processes and Materials of Manufacture", Prentice Hall India, 4th Edition, 2018.
3. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw-Hill House, 2019.
4. Workshop technology by K.L.Narayana, 2020.

WEB REFERENCE BOOKS:

http://www.iare.ac.in

XIX COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
1	Tenon joint and Mortise joint.	CO 1	R1:11.1-11.5
2	Dove tail joint and Lap joint.	CO 2	R1:11.1-11.5
3	Straight fit and Square fit.	CO 3	R1:4.8 , R1:7.2
4	V fit and Semicircular fit.	CO 4	R1:4.8 , R1:7.2

5	S-bend and J-bend.	CO 3	R2:10.4 , R2:7.2
6	(a)Fan and Round to Square shape.	CO 4	R2:10.4 , R1:7.2
7	Wheel flange and bearing housing.	CO 4	R2:10.4 , R1:7.2
8	Bearing housing and Wheel flange .	CO 5	R1:8.2-8.5
9	(Rectangular tray and Round tin.	CO 5	R1:11.1-11.5
10	Make a Square Tin and Conical Funnel.	CO 5	R1:10.1 , R1:10.2
11	Series connection and parallel Connection.	CO 6	R1:11.1-11.5
12	One bulb controlled by two switches and tube light connection..	CO 6	R3:3.12 , R1:12.7

XX EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Connecting & Verifying Bell Circuit through House wiring trade.
2	Making of semitriangular fit using fitting trade.
3	Making of star shape using blacksmithy trade.
4	Preparation of hexognal tin using tinsmithy trade.
5	Preparation of dumbell shape using .

Course Coordinator **HOD,EEE**
Mr. B.VijayaKrishna, Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

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

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

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

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

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

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PO Number	**NBA Statement / Key Competencies Features (KCF)**	**No. of KCF's**
PSO1	Formulate and evaluate engineering concepts of design, thermal and production to provide solutions for technology aspects in digital manufacturing.	**3**
PSO2	Formulate and Evulate the concept of thermo fluid.	**3**
PSO3	Make use of computational and experimental tools for creating innovative career paths, to be an entrepreneur and desire for higher studies.	**3**

INSTITUTE OF AERONAUTICAL ENGINEERING
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Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTION

Course Title	**ELECTRICAL CIRCUITS LABORATORY**				
Course Code	AEEC03				
Program	B.Tech				
Semester	II	EEE			
Course Type	Foundation				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Mr. A Srikanth, Assistant Professor				

I COURSE OVERVIEW:

Electrical circuits laboratory experiments are designed to expose students into the practical executions of the fundamental analysis and techniques of Electrical and Electronics Engineering. This laboratory covers all the basic devices, examines the basic laws, network reduction techniques, network theorems, characteristics of AC Circuits, two port network, design of transformer, measurement of electrical parameters and includes the basic concepts of MATLAB. The purpose of laboratory is to continue to build circuit construction skills using different circuit elements.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEC01	I	Fundamentals of Electrical Engineering

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Rocket and Missiles	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

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

Continuous Internal Assessment (CIA):

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

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

Continuous Internal Examination (CIE):

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

1. **Experiment Based**

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

2. **Programming Based**

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

VI COURSE OBJECTIVES:

The students will try to learn:

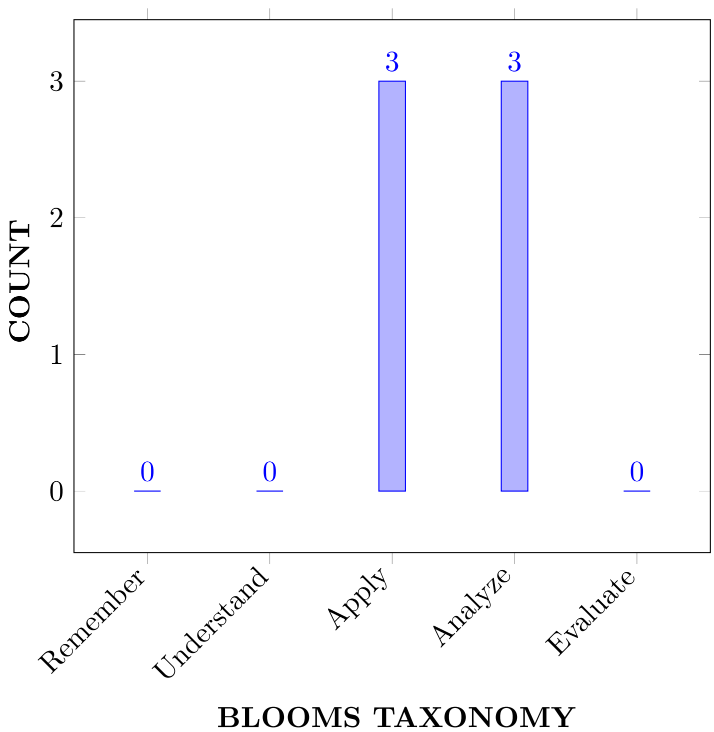
I	The basic laws, network reduction techniques and theorems for different circuits.
II	The characteristics of AC and two port networks for measurement of electrical quantities.
III	The properties and construct of electromagnetic induction used in magnetic circuits.

VII COURSE OUTCOMES:

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

CO 1	**Solve** the source resistance, currents, voltage and power using various laws associated with electrical circuits. .	Apply
CO 2	**Analyze** the alternating quantities for different periodic wave forms.	Understand
CO 3	**Perform** the superposition principle, reciprocity and maximum power transfer condition for the electrical network with DC excitation.	Apply
CO 4	**Demonstrate** the Thevenin's and Norton's theorems to reduce complex network into simple equivalent network with DC excitation.	Apply
CO 5	**Calculate** the faraday's laws of electromagnetic induction used in construction of magnetic circuit.	Analyze
CO 6	**Use of** the two port parameters to be measure easily, without solving for all the internal voltages and currents in the different networks.	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
PO 2	**Problem analysis:** AIdentify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	Lab Exercises
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	CIA
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

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involving Power generation, Transmission, Distribution and Utilization.	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 basic concept of various laws associated with electrical circuits. These concepts provide a vision for solving **mathematical and engineering problems** related to multi-disciplinary areas.	3
	PO 2	Recognize the importance of laws to analyze the solutions for **complex engineering problems and design system using principles of mathematics, science, and engineering fundamentals.**	5
CO 2	PO 1	Understand the concept of alternating quantities with peak, average and root mean square values for different periodic wave forms by **understanding and applying the fundamentals of mathematics, science and engineering.**	3
	PO 3	Identify the unknow values for different periodic wave forms **and design solutions for complex engineering problems.**	4
CO 3	PO 2	Prove the different theorems for the electrical network with DC excitation by applying the **basic knowledge of mathematics, science, engineering fundamentals.**	3
	PO 2	Focus on network theorems **to analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics.**	4
	PO 3	**Design solutions for complex engineering problems** in electrical network and design system components that meet the specified needs with theorems **for the public safety and environmental considerations.**	5
CO 4	PO 1	Simplify the electrical network with the help of different theorems with DC excitation by applying the **basic knowledge of mathematics, science, engineering fundamentals.**	3
	PO 2	Focus on network theorems **to analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics.**	4
	PO 3	**Design solutions for complex engineering problems** in electrical network and design system components that meet the specified needs with theorems **for the public safety and environmental considerations.**	5
CO 5	PO 1	Describe the use of electromagnetic induction in construction of magnetic circuit for problem solving **using principles of mathematics, science, and engineering fundamentals.**	3

	PO 5	Make use of transformers, chock coils, fluorescent lamp **design and develop efficient real-time computational problems.**	1
	PSO 1	**Contrast** the electromagnetic induction using for different application in winding of electrical machines and various equipment.	2
CO 6	PO 1	Make use of two port parameter to be measure easily in the different networks by **applying the knowledge of mathematics, science, Engineering fundamentals.**	3
	PO 2	Identify the two-port network **and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.**	5
	PSO 1	**Design the** two-port network parameter and measure the unknow values of current and voltage in **transmission line.**	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	PSO 1
CO 1	3	5			
CO 2	3		4		
CO 3	3	4	5		
CO 4	3	4	5		
CO 5	3			1	2
CO 6	3	5			2

XII ASSESSMENT METHODOLOGY DIRECT:

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

XIII ASSESSMENT METHODOLOGY INDIRECT:

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

XIV SYLLABUS:

WEEK I	**VERIFICATION OF OHMS LAW AND KIRCHOFF LAWS**
	Draw the V-I characteristics of resistor element, examine voltage and current division in an electrical circuit using hardware and digital simulation.
WEEK II	**MESH ANALYSIS**
	Determination of mesh currents in complex electrical circuit using hardware and digital simulation.
WEEK III	**NODAL ANALYSIS**
	Determination of nodal voltages in complex electrical circuit using hardware and digital simulation.
WEEK IV	**CHARACTERISTICS OF PERIODIC WAVEFORMS**
	Calculate Instantaneous, Peak, Peak to peak, Average and RMS values of periodic wave form using hardware and digital simulation.
WEEK V	**DETERMINATION OF CIRCUIT IMPEDANCE**
	Find the impedance of series RL, RC and RLC circuits using hardware and digital simulation.
WEEK VI	**THEVENINS THEOREM**
	Determine load or unknown current using Thevenins equivalent circuit using hardware and digital simulation.
WEEK VII	**NORTONS THEOREM**
	Determine load or unknown current using Nortons equivalent circuit using hardware and digital simulation.
WEEK VIII	**SUPERPOSITION THEOREM**
	Verify of Superposition theorem using hardware and digital simulation.
WEEK IX	**RECIPROCITY THEOREM**
	Verify of Reciprocity theorem using hardware and digital simulation.
WEEK X	**MAXIMUM POWER TRANSFER THEOREM**

	Verification of Maximum Power Transfer theorem using hardware and digital simulation.
WEEK XI	**MEASUREMENT OF POWER CONSUMED BY A FLUORESCENT LAMP**
	Examine the power consumed by Fluorescent lamp using electrical devices using hardware and digital simulation.
WEEK XII	**DESIGN OF CHOKE AND SMALL TRANSFORMER**
	Measure resistance and inductance of coil and construct the winding of transformer using winding machine using hardware and digital simulation.
WEEK XIII	**Z And Y PARAMETERS**
	Determine the open circuit and short circuit parameters for two port network using hardware and digital simulation.
WEEK XII	**H AND ABCD PARAMETERS**
	Determine the hybrid and transmission line parameters for two port network using hardware and digital simulation.

TEXTBOOKS

1. 1. A Sudhakar, Shyammohan S Palli, "Circuits and Networks", Tata McGraw-Hill, 4th Edition, 2010

2. 2. M E Van Valkenberg, "Network Analysis", PHI, 3rd Edition, 2014.

REFERENCE BOOKS:

1. 1. John Bird, "Electrical Circuit Theory and Technology", Newnes, 2nd Edition, 2003.

2. 2. C L Wadhwa, "Electrical Circuit Analysis including Passive Network Synthesis", New Age International, 2nd Edition, 2009.

3. 3. David A Bell, "Electric circuits", Oxford University Press, 7th Edition, 2009.

XV COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
1	Verification of ohms law and kirchoff laws	CO 1	T1:1.1 – 1.7
2	Mesh analysis.	CO 2	T1:2.1 – 2.3
3	Nodal analysis	CO 2	T1:2.4 – 2.6
4	Characteristics of periodic waveforms	CO 3	T1:5.1 – 5.2
5	Determination of circuit impedance	CO 3	T1:6.1 – 6.8
6	Thevenins theorem	CO 5	T1:4.6 – 4.6
7	Nortons theorem	CO 5	T1:4.7 – 4.7
8	Superposition theorem	CO 4	T1:4.1 – 4.1
9	Reciprocity theorem	CO 4	T1:4.2 – 4.2
10	Maximum power transfer theorem	CO 4	T1:4.8 – 4.8
11	Measurement of power consumed by a fluorescent lamp	CO 5	T2:2.1 – 2.3
12	Design of choke and small transformer	CO 6	T2:2.6 – 2.6
13	Z and Y parameters	CO 6	T2:7.1 – 7.5
14	H and ABCD parameters	CO 6	T2:7.6 – 7.9

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	**Filters:** Designing of various prototype Filters and analyze its frequency response.
2	**Simulation:** MATLAB Simulation of Network Theorems for DC and AC Circuits.
3	**Locus Diagrams:** Locus Diagram of RL and RC Series Circuits.

Signature of Course Coordinator **HOD,EEE**
Mr. A. Srikanth, Assistant Professor

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

COURSE DESCRIPTION

Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**				
Course Title	**NETWORK ANALYSIS**				
Course Code	AEEC05				
Program	B.Tech				
Semester	III				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	
Course Coordinator	Dr. D Shobha Rani, Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEC02	II	Electrical Circuits
B.Tech	AHSC07	II	Mathematical Transform Techniques

II COURSE OVERVIEW:

This course introduces the basic concepts of network theory which is the foundation for all subjects of the electrical engineering discipline. The emphasis of this course is laid on the basic analysis of circuits with three phase supply. The course also includes transient analysis of DC and AC circuits, network functions, and locus diagrams, design and analysis of filters.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Network 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). 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
66.6 %	Understand
33.3 %	Apply
0 %	Analyze

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

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

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

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

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

VI COURSE OBJECTIVES:

The students will try to learn:

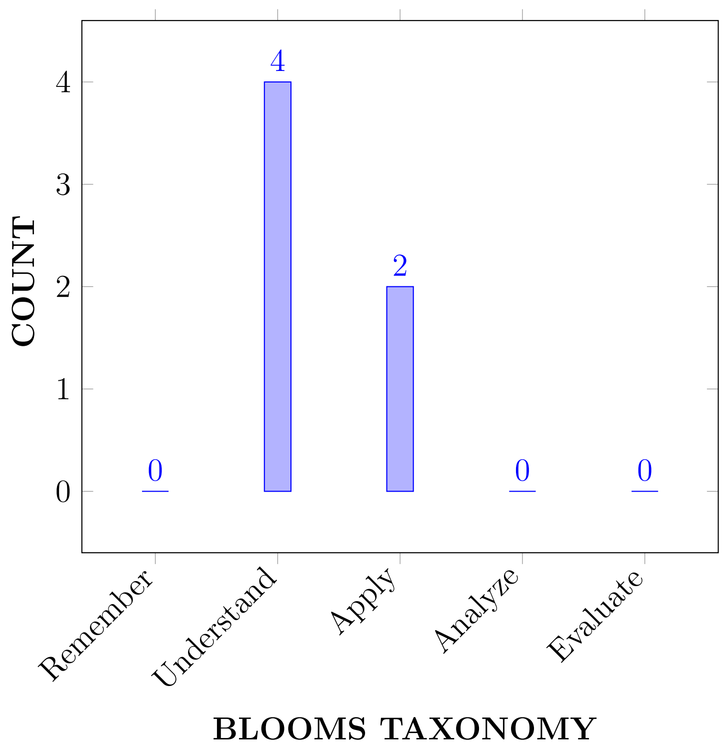
I	Understand the three phase systems for star and delta connected systems and perform three phase power calculations for balanced and unbalanced loads.
II	Present the necessary mathematical background for the transient analysis of DC and AC circuits and study the transients using differential equation and Laplace transform approach for series and parallel circuits
III	The concept of locus diagram for series and parallel circuits and discuss network functions and the stability criteria
IV	The steady state response of complex electrical circuits with AC supply and application of concept of electrical resonance
V	Classify and design different types of filters and study their characteristics.

VII COURSE OUTCOMES:

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

CO 1	**Discuss** the steady state response and resonance of electrical circuits to AC supply	Understand
CO 2	**Understand** the concept of initial conditions of RLC elements to determine the transient response of first and second order electric circuits using differential equation approach and Laplacetransform technique.	Understand
CO 3	**Illustrate** the locus diagram for series and parallel circuits and describe the network functions in time domain and frequency domain approach.	Understand
CO 4	**Solve** the relation between line and phase quantities of three phase star and delta connected systems to analyze balanced and unbalancedcircuits.	Apply
CO 5	**Demonstrate** the operation of wattmeter to measure the three-phase active and reactive power in three phase systems.	Understand
CO 6	**Develop** the various types of active filters and understand their characteristics, execute digital simulation using MATLAB.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

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

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

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

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

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 Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	1	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	**Recall the engineering sciences** to understand steady state responce of AC electrical circuits	3
CO 2	PO 1	**Recall the engineering sciences** to understand the concept of initial conditions of RLC elements to determine the transient response	3
	PO 2	Develop the solutions for initial conditions of RLC elements to determine the transient response of first and second order electric circuits with help of basic mathematics and engineering sciences.	2
CO 3	PO 1	**Recall the engineering sciences** to understand locus diagram for series and parallel circuits	3
	PO 2	Develop the the network functions in time domain and frequency domain approach using which complex engineering problems can be solved with help of basic mathematics and engineering sciences.	2
CO 4	PO 1	**Recall the engineering sciences** to understand phase quantities of three phase star and delta connected systems	3
	PO 2	Understand three-phase active and reactive power in three phase systems	2
	PSO 2	Understand the locus diagram for series and parallel circuits	1

CO 5	PO 1	**Recall the engineering sciences** to understand two wattmeter method for three phase star and delta connected systems	3
	PSO 2	Understand two wattmeter method in three phase systems	1
CO 6	PO 1	**Recall the engineering sciences** to understand the filter characteristics	3
	PO 2	Develop the various types of active filters using which complex engineering problems can be solved with help of basic mathematics and engineering sciences.	2
	PSO 2	Understand the active filters characteristics, execute digital simulation using MATLAB	1

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

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

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

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

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

1 -5 <C$\leq$ 40% – Low/ Slight

2 - 40 % <C < 60% –Moderate

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

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

XVI ASSESSMENT METHODOLOGY-DIRECT:

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

XVII ASSESSMENT METHODOLOGY-INDIRECT:

	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**ANALYSIS OF AC CIRCUITS**
	Steady state analysis: Steady state analysis of RL, RC and RLC circuits (in series, parallel and series parallel combinations) with sinusoidal excitation; Resonance: Series and parallel resonance, concept of band width and Q factor.
MODULE II	**SOLUTION OF FIRST AND SECOND ORDER NETWORKS**
	Transient response: Initial conditions, transient response of RL, RC and RLC series and parallel circuits with DC and AC excitations, differential equation and Laplace transform approach.
MODULE III	**LOCUS DIAGRAMS AND NETWORKS FUNCTIONS**
	Locus diagrams: Locus diagrams of RL, RC, RLC circuits. Network Functions: The concept of complex frequency, physical interpretation, transform impedance, series and parallel combination of elements, terminal ports, network functions for one port and two port networks, poles and zeros of network functions, significance of poles and zeros, properties of drivingpoint functions and transfer functions, necessary conditions for driving point functions and transfer functions, time domain response from polezero plot.

MODULE IV	**THREE PHASE CIRCUITS**
	Three phase circuits: Star and delta connections, phase sequence, relation between line and phase voltages and currents in balanced systems(both Y and Delta), three phase three wire and three phase four wire systems, analysis of balanced and unbalanced three phase circuits, measurement of active and reactive power.
MODULE V	**FILTERS**
	Classification of filters, filter networks, classification of pass band and stop band, characteristic impedance in the pass and stop bands, constant k low pass filter, high pass filter, m derived T section,band pass filter and band elimination filter.

TEXTBOOKS

1. A Chakrabarthy, "Electric Circuits", Dhanpat Rai Sons, 6th Edition, 2010.
2. A Sudhakar, Shyammohan S Palli, "Circuits and Networks", Tata McGraw Hill, 4th Edition, 2010

REFERENCE BOOKS:

1. John Bird, "Electrical Circuit Theory and technology", Newnes, 2nd Edition, 2003.
2. C L Wadhwa, "Electrical Circuit Analysis including Passive Network Synthesis", New Age International, 2nd Edition, 2009
3. David A Bell, "Electric Circuits", Oxford University press, 7th Edition, 2009.
4. M E Van Valkenberg, "Network Analysis", Prentice Hall India, 3rd Edition, 2014.
5. Rudrapratap, "Getting started with MATLAB: A Quick Introduction for Scientists and Engineers", Oxford University Press, 1st Edition, 1994

WEB REFERENCES:

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

XIX COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference T1: 4.1
OBE DISCUSSION			
1	OBE DISCUSSION		
CONTENT DELIVERY (THEORY)			
2-4	Steady state analysis of RL, RC and RLC circuits (in series, parallel and series parallel combinations) with sinusoidal excitation	CO 1	T2: 1.1-1.5, T1: 4.1

5-8	Resonance: Series and parallel resonance	CO 1	T2: 2.1-2.2, R1: 3.1
9-10	concept of band width and Q factor.	CO 1	T2: 2.3-2.4
11	Observe the Transient behavior of R, L and C elements in a circuit.	CO 2	T2: 2.5-2.6,
12-13	Compute initial conditions and time response for current and voltage in first order R-L and R-C circuits to DC excitation	CO 2	T2: 3.3
14	Analyze and solve problems on complicated RLC circuits to DC excitation	CO 2	T2: 3.4
15	Describe the AC Transient analysis of a series RL, RC circuits to AC excitation	CO 2	T2: 3.3
16	Analyze Transient behavior of a series RLC circuits to AC excitation	CO 2	T2: 4.2
17-18	Analyze the Transients using Laplace transform method	CO 2	T2: 5.1
19	Discuss the concepts of locus diagram	CO 3	T2: 5.2
20	RL locus diagrams	CO 3	T2: 4.5
21	Learn about complex frequency	CO 3	T1: 4.1
22	Design Transform Impedance and Transform Circuits	CO 3	T2: 5.1
23-25	Learn terminal pairs or ports	CO 3	T2: 5.2
26-27	Study the significance of poles and zeros	CO 3	T2: 4.5
28-29	Understand the properties of Transfer functions, Necessary conditions for driving point functions	CO 3	T1: 4.1
30-31	Study the Necessary conditions for transfer functions, time domain response from pole zero plot	CO 3	T1: 4.1
32-38	Three phase three wire and three phase four wire systems, analysis of balanced and unbalanced three phase measurement of active and reactive power.	CO 4	T1: 4.2
39-41	Tutorial Problems	CO 5	T1: 4.3
PROBLEM SOLVING/ CASE STUDIES			
42-44	Understand the Constant-k Low Pass filter characteristics	CO 6	T2: 5.2
45-46	Design the Constant-k High Pass filter and study its characteristics	CO 6	T2: 5.2
47-49	Understand the m-derived T-section Low Pass filter characteristics and design	CO 6	T2: 5.2
50-51	Design the m-derived T-section High Pass filter and study	CO 6	T1: 7.2
52-58	Analyze and Design Band Pass filter	CO 6	T1: 7.5
DISCUSSION OF DEFINITION AND TERMINOLOGY			
59-62	Understand the characteristics of Band Elimination filter	CO 6	T1: 7.5
63-65	Tutorial Problems	CO 6	R2:7.5

DISCUSSION OF QUESTION BANK			
1	Module I	CO 1	R4:2.1
2	Module II	CO 2	T4:7.3
3	Module III	CO 3	R4:5.1
4	Module IV	CO 4,5	T1:7.5
5	Module V	CO 6	T1: 4.1

Signature of Course Coordinator **HOD, EEE**
Dr. D Shobha Rani, Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**
Course Title	**Electromagnetic Fields**
Course Code	AEEC06
Program	B.Tech
Semester	III
Course Type	CORE
Regulation	UG-20

<table>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>3</td><td>1</td><td>4</td><td>-</td><td>-</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Dr.Sayanti Chatterjee, Associate Professor</td></tr>
</table>

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSC02	I	Linear Algebra Calculus
B.Tech	AHSC03	I	Engineering Physics

II COURSE OVERVIEW:

This course will equip the students with good understanding of underlying principles and laws in electromagnetic fields and waves. The concepts of vector algebra, principles and basic laws of electrostatics, characteristics and properties of conductors and dielectrics, behavior of static magnetic field and application of Ampere's law, determination of force in magnetic field and magnetic potential, concept of time varying fields and propagation of electro-magnetic waves.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Electromagnetic Fields	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).

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

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

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

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

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

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

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

VI COURSE OBJECTIVES:

The students will try to learn:

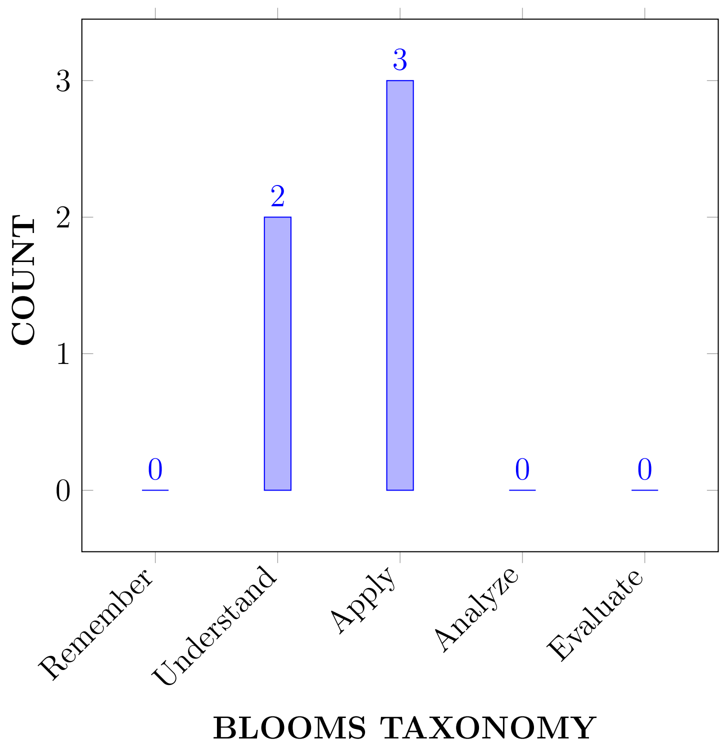
I	The behavior of charge under rest with static electric field in terms of electric field intensity, electric displacement and electric potential.
II	The charge distribution in conductors, dielectrics and condensers.
III	The sources to study the effect of static and dynamic fields in terms of magnetic field intensity, displacement and potential.
IV	The nature of electromagnetic wave propagation in free space, conductors and dielectric materials.

VII COURSE OUTCOMES:

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

CO 1	**Make use of** Vector Calculus, Coulomb's Law and Gauss Law for obtaining electric field intensity, Potential and behavior of electrostatic field	Apply
CO 2	**Calculate** the capacitance of different physical configuration based on the behavior of the conductors and dielectric materials.	Apply
CO 3	**Demonstrate** Biot-Savart law and Ampere circuital law for derivation of magnetic field intensity due to different current carrying conductors.	Understand
CO 4	**Predict** the force due to moving charge/current in the static magnetic field, thereby obtaining the inductance for different configurations of wires and energy stored in the coil	Understand
CO 5	**Apply** the Faraday's law of Electromagnetic induction and Maxwell Equations to produce a wave equation for the free- space, insulators and conductors for propagation of electromagnetic waves.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

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

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/Quiz/AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	CIE/Quiz/AAT
PO 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 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	Design, develop, fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization.	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	✓	✓	✓	✓	-	-	-	-	-	✓	-	✓	✓	-	-

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	Recollect the basics of matter , types of charge distribution and vector analysis for solving the force and electric field intensity using **the knowledge of mathematics, science, and engineering fundamentals.**	3
	PO 2	Determine the standard expressions for electric filed intensity , torque, Potential due to line, surface and volume charge distributions **to analyze complex engineering problems using principles of mathematics and engineering sciences.**	10
	PO 3	Design the basic electrical components using **principles and laws of electromagnetic to meet the required specifications**	5
	PO 4	Understand the knowledge of electric field and potential **to analyze complex engineering problems using principles of mathematics and engineering sciences for future research.**	2
	PO 10	Students are given teck-talk and concept video **to improve their communication skills towards scientific discussion.**	1
	PO 12	Vector algebra, electromagnetic field and poential helps **in lifelong learning in significant skills.**	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PSO 1	Make use of Coloumb's law in structuring the principles of electrostatic instruments using in system for **generation, transmission and distribution of power.**	1
CO 2	PO 1	Understand the behavior of conductors and dielectrics with the **knowledge of mathematics, science and engineering fundamentals** for capacitance calculation.	3
	PO 2	Derive the standard expression for different configured capacitors to **analyse complex engineering problems be framed using basics of mathematics and engineering sciences**	10
	PO 3	Determine capacitance of power system equipments to design electrical components at specifications of **different stages to meet the required**	5
	PO 4	Understand the knowledge of current ,conductor and dielectric **to analyze complex engineering problems using principles of mathematics and engineering sciences for future research.**	8
	PO 10	Students are given teck-talk and concept video **to improve their communication skills towards scientific discussion.**	1
	PO 12	Capacitor, dielectric etc. helps **in lifelong learning in significant skills.**	4
	PSO 1	Recognize the importance of conductors and dielectrics in **generation, transmission and distribution of power.**	1
CO 3	PO 1	**Use the basics of mathematics, science and engineering fundamentals** for obtaining magnetic field intensity and magnetic flux density	3
	PO 2	Standard expressions of magnetic field intensity and density with helps in **solving complex engineering problems.**	7
	PO 3	Design the characteristics of magnetic field using bio savart and ampere laws which helps in **obtaining the desired specifications of electrical components.**	5
	PO 4	Understand the knowledge of magnetic field intensity and magnetic flux density **to analyze complex engineering problems using principles of mathematics and engineering sciences for future research.**	2
	PO 10	Students are given teck-talk and concept video **to improve their communication skills towards scientific discussion.**	1
	PO 12	characteristics of magnetic field using bio savart and ampere laws which helps in **tin lifelong learning in significant skills.**	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PSO 1	Understand the characteristics of magnetic field the structure using **principles of electrical equipment in power systems.**	1
CO 4	PO 1	Type of force due to different configured conductors and their inductances with the help of **basic fundamentals of mathematics science and engineering fundamentals.**	3
	PO 2	Develop the standard expressions of self and mutual inductance for different shaped coils by **identifying different coil configuration**	7
	PO 3	Solve the self and mutual inductance of complex engineering problems **to obtain the desired specifications of electrical component in power system.**	5
	PO 4	Understand the knowledge of magnetic field intensity and magnetic flux density **to analyze complex engineering problems using principles of mathematics and engineering sciences for future research.**	2
	PO 10	Students are given teck-talk and concept video **to improve their communication skills towards scientific discussion.**	1
	PO 12	characteristics of magnetic field using bio savart and ampere laws which helps in **tin lifelong learning in significant skills.**	2
	PSO 1	Summarize the features of coils their by constructing the various **types of windings for required output from electrical machines in power system.**	1
CO 5	PO 1	Make use of expressions obtained during analysis of electrostatics and magneto statics fields their deducing the same for time varying fields using **knowledge of mathematics , science and engineering fundamentals.**	3
	PO 2	Interpret the solution of complex problems on time varying fields and obtain some standard conclusion on properties of time varying fields using **to analyse the behaviour of time varying field**	7
	PO 3	Obtain the standard expressions for electromagnetic wave propagation in free space, insulators and conductors to conclude solution of complex engineering problems to **develop the solutions of different medium**	7
	PO 4	Understand the knowledge of electromagnetic field intensity and magnetic flux density **to analyze complex engineering problems using principles of mathematics and engineering sciences for future research.**	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 10	Students are given teck-talk and concept video **to improve their communication skills towards scientific discussion.**	1
	PO 12	characteristics of electromagnetic field using Faraday and Maxwell's laws which helps in **tin lifelong learning in significant skills.**	2
	PSO 1	Build the electrical machinery and components based on **Faraday's law of electromagnetic induction, Maxwell's Law and wave propagation, at different modes of power system.**	1

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	10	5	2	-	-	-	-	-	1	-	2	2	-	-
CO 2	3	10	5	8	-	-	-	-	-	1	-	4	2	-	-
CO 3	3	7	7	6	-	-	-	-	-	1	-	4	2	-	-
CO 4	3	7	5	6	-	-	-	-	-	1	-	4	2	-	-
CO 5	3	7	7	8	-	-	-	-	-	1	-	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	50	18	-	-	-	-	-	20	-	25	50	-	-
CO 2	100	100	50	72	-	-	-	-	-	20	-	25	50	-	-
CO 3	100	70	70	54	-	-	-	-	-	20	-	50	50	-	-
CO 4	100	70	50	54	-	-	-	-	-	20	-	50	50	-	-
CO 5	100	70	70	80	-	-	-	-	-	20	-	25	50	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

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

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

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 3	3	3	3	2	-	-	-	-	-	1	-	2	2	-	-
CO 4	3	3	2	2	-	-	-	-	-	1	-	2	2	-	-
CO 5	3	3	3	3	-	-	-	-	-	1	-	1	2	-	-
TOTAL	15	15	12	11	-	-	-	-	-	5	-	8	10	-	-
AVERAGE	3	3	2.4	1.2	-	-	-	-	-	1	-	1.6	2	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	PO 1, PO2, PO3 ,PO 4	SEE Exams	PO 1, PO2, PO3 ,PO 4	Seminars	PO 1, PO 2, PO 3 ,PSO 2
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	PO 1, PO2, PO3 ,PO 4	Open Ended Experiments	PSO 1, PSO 2, PSO 3
Assignments					

XVII ASSESSMENT METHODOLOGY-INDIRECT:

	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**ELECTROSTATICS**
	Introduction to Cartesian, cylindrical and spherical co-ordinates. Conversion of one type of coordinates to another; Electrostatic fields: Coulomb's law, electric field intensity due to line and surface charges, work done in moving a point charge in an electrostatic field, electric potential, properties of potential function, potential gradient, Gauss's law, application of Gauss's law, Maxwell's first law, Laplace's and Poisson's equations, solution of Laplace's equation in one variable
MODULE II	**CONDUCTORS AND DIELECTRICS**
	Dipole moment, potential and electric field intensity due to an electric dipole, torque on an electric dipole in an electric field, behavior of conductors in an electric field, electric field inside a dielectric material, polarization, conductor and dielectric, dielectric boundary conditions, capacitance of parallel plate and spherical and coaxial capacitors with composite dielectrics, energy stored and energy density in a static electric field, current density, conduction and convection current densities, Ohm's law in point form, equation of continuity.

MODULE III	**MAGNETOSTATICS**
	Biot-Savart's law, magnetic field intensity, magnetic field intensity due to a straight current carrying filament, magnetic field intensity due to circular, square and solenoid current carrying wire, relation between magnetic flux, magnetic flux density and magnetic field intensity, Maxwell's second equation, div(B)=0. Magnetic field intensity due to an infinite sheet of current and a long current carrying filament, point form of Ampere's circuital law, Maxwell's third equation, Curl (H)=Jc, field due to a circular loop, rectangular and square loops.
MODULE IV	**FORCE IN MAGNETIC FIELD AND MAGNETIC POTENTIAL**
	Moving charges in a magnetic field, Lorentz force equation, force on a current element in a magnetic field, force on a straight and a long current carrying conductor in a magnetic field, force between two straight long and parallel current carrying conductors, magnetic dipole and dipole moment, a differential current loop as a magnetic dipole, torque on a current loop placed in a magnetic field; Vector magnetic potential and its properties, vector magnetic potential due to simple configurations, Poisson's equations, self and mutual inductance, Neumann's formula, determination of selfinductance of a solenoid, toroid and determination of mutual inductance between a straight long wire and a square loop of wire in the same plane, energy stored and density in a magnetic field, characteristics and applications of permanent magnets.
MODULE V	**TIME VARYING FIELDS AND WAVE PROPAGATION**
	Faraday's laws of electromagnetic induction, integral and point forms, Maxwell's fourth equation, statically and dynamically induced EMFs, modification of Maxwell's equations for time varying fields, displacement current. Derivation of Wave Equation, Uniform Plane Waves, Maxwell's equation in phasor form, Wave equation in Phasor form, Plane waves in free space and in a homogenous material. Wave equation for a conducting medium, Plane waves in loss dielectrics, Propagation in good conductors, Skin effect. Poynting theorem.

TEXTBOOKS

1. K.B. MadhuSahu, “ Eelectromagnetic Fields”, Scitech Ltd., 2nd Edition.

2. David J Griffiths, “Introduction to Electrodynamics” Pearson Education Ltd., 4th Edition, 2014.

3. Sunil Bhooshan, “Fundamentals of Engineering Electromagnetics”, Oxford University Press, st Edition, 2012.

4. E Kuffel, W S Zaengl, J Kuffel, “High Voltage Engineering Fundamentals”, Newnes, 2nd Edition, 2000.

REFERENCE BOOKS:

1. Matthew N O Sadiku, S V Kulkarni, “Principles of Electromagnetics”, Oxford University Press,6th Edition, 2015.

2. AS Mahajan , AA Rangwala “Electricity And Magnetism”, McGraw Hill Publications, 1st Edition, 2000.

3. MS Naidu, V Kamaraju “High Voltage Engineering”, McGraw Hill Publications, 3rd Edition, 2013.

4. William H Hayt, John A Buck, “Problems and Solutions in Electromagnetics”, McGraw Hill Publications, 1st Edition, 2010.

XIX COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference T1: 4.1
OBE DISCUSSION			
0	Discussion of OBE: Course Objective, Course Outcomes (CO), Program Outcomes(PO), CO-PO mapping	-	-
CONTENT DELIVERY (THEORY)			
1	Introduction to vector algebra	CO1	T1: 1.12, RR4:1.1-1.8
2	Analysis and conversion of different types of co-ordinates	CO1	T1: 2.4-2.5, R2:2.9-3.3
3	Introduction to electro static fields and coulomb's Law	CO1, CO3	T1:2.16-2.17, R2:2.9-2.10
4	Derive the work done in moving a point charge in an electrostatic field	CO2, CO3	T1:2.13-2.14, R2:2.11
5	State Gauss's law and application of Gauss's law.	CO1	T1:2.20-2.21, R2:3.5
6	Deduce Maxwell's first law.	CO1	T1: 3.1-3.4,R2: 3.7
7	Determine the solution of Laplace's equation in one variable	CO1	T1:4.1-4.5, R2:4.1,5.1
8	Derive the Laplace's and Poisson's equations.	CO2	T1:4.3.2,4, 3.3, R2:5.2
9	Study behavior of conductors in an electric field.	CO2	T2: T1:4.6, R2:5.4
10	Understand electric field inside a dielectric material.	CO2	T1:3.5.2-3.5.5 R2:4.3-4.5
11	Discuss on polarization, conductor and dielectric.	CO2	T1:4.7-4.8 R2:6.1

12	Derive dielectric boundary conditions.	CO2,	T1:4.9-4.10, R2:6.2
13	Calculate capacitance of parallel plate and spherical and coaxial capacitors with composite dielectrics	CO2	T1: 5.4-5.7,R2:7.4
14	Define current density, conduction and convection current densities.	CO2	T1:5.8 R2:7.3
15	Define current density, conduction and convection current densities.	CO2	T1:5.8 R2:7.3
16	Calculation of Electric field intensity due to line and surface charges.	CO3	TT1:6.1-6.5. R2:7.7-7.8
17	Derive the work done in moving a point charge in an electrostatic field.	CO3	T1:6.2 R2:6.3 R2:7.3
18	Introduction to static magnetic fields.	CO3	T1:6.3-6.4 R2:7.8
19	State Biot-Savart's law and magnetic field intensity	CO3	T1:7.5-7.7, R2:8.6
20	Find magnetic field for square and solenoid current carrying wire.	CO4	T1:7.8-7.9, R2:8.6-8.7
21	Relation between magnetic flux, magnetic flux density and magnetic field intensity.	CO3	T1:8.2, R2:7.12-7.13
22	Deduce Maxwell's second equation, div (B)=0.	CO3	T1:8.3-8.4, R2:9.4-9.5
23	State point form of Ampere's circuital law	CO3	T1:8.3-8.8 R2:9.4-9.5
24	Deduce Maxwell's third equation, Curl (H)=Jc	CO3	T1:9.2,9.4 R2:9.1
25	Estimate field due to a circular loop, rectangular and square loops.	CO3	T1:4.1-4.5, R2:4.1,5.1
26	Expression for force due to Moving charges in a magnetic field, Lorentz force equation, magnetic dipole.	CO3	T1:4.3.2,4, 3.3, R2:5.2
27	Define vector magnetic potential and its properties.	CO4	T2: T1:4.6, R2:5.4

28	Explain Poisson's equations, self and mutual inductance.	CO4	T1:3.5.2-3.5.5 R2:4.3-4.5
29	Derive Neumann's formula, determination of self inductance of a solenoid, toroid.	CO4	T1:4.7-4.8 R2:6.1
30	State Faraday's laws of electromagnetic induction.	CO5	T1:4.9-4.10, R2:6.2
31	Deduce integral and point forms.	CO5	T1: 5.4-5.7,R2:7.4
32	Derive Maxwell's fourth equation..	CO5	T1:5.8 R2:7.3
33	Derive , statically and dynamically induced emf.	CO5	T1:5.8 R2:7.3
34	Modification of Maxwell's equations for time varying fields.	CO5	TT1:6.1-6.5. R2:7.7-7.8
35	Define displacement current.	CO 5	T1:6.2 R2:6.3 R2:7.3
36	Analysis of wave equation in phasor form	CO5	T1:6.3-6.4 R2:7.8
37	Behavior of plane waves in homogeneous material.	CO5	T1:7.5-7.7, R2:8.6
38	Explain wave equation in conductors and dielectrics.	CO5	T1:7.8-7.9, R2:8.6-8.7
39	Deducing wave equation in conductors and dielectrics.	CO5	T1:8.2, R2:7.12-7.13
40	State skin effect and derive pointing theorem	CO5	T1:8.3-8.4, R2:9.4-9.5
PROBLEM SOLVING/ CASE STUDIES			
1	Vector Algebra	CO1	T1:3.5.2-3.5.5 R2:4.3-4.5
2	Problem on co ordinate conversion	CO1	T1:3.5.2-3.5.5 R2:4.3-4.5

3	Problem on application of coulomb's law	CO1	T1:3.5.2-3.5.5 R2:4.3-4.5
4	Problems on Field intensity calculation	CO1	T1:3.5.2-3.5.5 R2:4.3-4.5
5	Problems on Electrical potential calculation	CO1	T1:4.1-4.5, R2:4.1,5.1
6	Deduce on Laplace and Poisson's Equation	CO1	T1:4.3.2,4, 3.3, R2:5.2
7	Deduce the dipole moment and torque	CO2	T2: T1:4.6, R2:5.4
8	Calculation of capacitance	CO2	T1:3.5.2-3.5.5 R2:4.3-4.5
9	Using Bio-Savart's law find the expression for magnetic field intensity inside a long solenoid carrying current I.	CO2	T1:4.7-4.8 R2:6.1
10	Calculation of energy stored in capacitance	CO2	T1:4.9-4.10, R2:6.2
11	Ampere circuital law for infinitely long current carrying conductor and infinite sheet	CO3	T1: 5.4-5.7,R2:7.4
12	Problems on force calculation of current carrying conductor	CO3	T1:5.8 R2:7.3
13	Problem on self and mutual inductance calculation	CO4	T1:4.204.21, R2:4.5
14	Problems on magnetic dipole moment calculation	CO4	TT1:6.1-6.5. R2:7.7-7.8
15	Problems on emf calculation of time varying field	CO5	T1:6.2 R2:6.3 R2:7.3
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Co ordinate Point charge, unit vector, field intensity, permittivity of Medium, charge distribution	CO1	T1:1.5-1.7, R2:1.1-1.6
2	Electric Dipole, electric dipole moment, potential and toque due to electric dipole.	CO2	T1:2.1-2.8 R2:3.6-8.7

3	Magnetostatics. Magnetic field, magnetic field intensity permeability of core intensity of magnetization.	CO3	T1:4.5-4.10, R2:3.12-3.13
4	magnetic dipole. magnetic dipole moment. torque due to magnetic dipole.	CO4	T1:6.1-6.5. R2:7.7-7.8
5	Dynamically and statistically induced induced emf., time varying field, total current density, displacement and conduction current density. types of emf induced in coil.	CO5	T1:8.3-8.4, R2:9.4-9.5
DISCUSSION OF QUESTION BANK			
1	Module I	CO 1	R4:2.1
2	Module II	CO 2	T4:7.3
3	Module III	CO 3	R4:5.1
4	Module IV	CO 4	T1:7.5
5	Module V	CO 5	T1: 4.1

Signature of Course Coordinator **HOD,EEE**

Dr. Sayanti Chatterjee, Associate Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

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

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

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

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

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

ANNEXURE - II

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	PSO Statement / Key Competencies Features (KCF)	No. of KCF(s)
PSO 1	Design, develop, fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization. 1. Operate, control and protect electrical power system. 2. Validate the interconnected power system. 3. Ensure reliable, efficient and compliant operation of electrical systems. 4. Familiarize the safety, legal and health norms in electrical system. 5. Adopt the engineering professional code and conduct.	**5**
PSO 2	Focus on the components of electrical drives with its converter topologies for energy conversion, management and auditing in specific applications of industry and sustainable rural development. 1. Control the electric drives for renewable and non-renewable energy sources. 2. Fabricate converters with various components and control topologies. 3. Synthesis, systematic procedure to examine electrical components/machines using software tools. 4. Inspect, survey and analyze energy flow. 5. Control and manage the power generation and utilization. 6. Familiarize the safety, legal and health norms in electrical system. 7. Adopt the engineering professional code and conduct. 8. Explore autonomous power 9. Evolve into green energy and assess results 10. Realize energy policies and education 11. Potential contribution of clean energy for rural development.	**11**

PSO 3	Gain the hands-on competency skills in PLC automation, process controllers, HMI and other computing tools necessary for entry level position to meet the requirements of the employer. 1. Explicit software and programming tools for electrical systems. 2. Adopt technical library resources and literature search. 3. Model, program for operation and control of electrical systems. 4. Constitute the systems employed for motion control. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

COURSE DESCRIPTION

<table>
<tr><td>Department</td><td colspan="5">ELECTRICAL AND ELECTRONICS ENGINEERING</td></tr>
<tr><td>Course Title</td><td colspan="5">ANALOG ELECTRONICS</td></tr>
<tr><td>Course Code</td><td colspan="5">AECC07</td></tr>
<tr><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>Semester</td><td colspan="5">III</td></tr>
<tr><td>Course Type</td><td colspan="5">CORE</td></tr>
<tr><td>Regulation</td><td colspan="5">UG-20</td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>3</td><td>1</td><td>4</td><td>-</td><td>-</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Ms.V.Bindusree,Assistant Professor</td></tr>
</table>

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEB03	II	Electrical Circuits
B.Tech	AHSB04	II	Waves and Optics

II COURSE OVERVIEW:

This course provides the knowledge over the principles and construction of analog electronics. It covers the characteristics of electronic devices such as diodes,transistors,operational amplifiers and analysing amplifier circuits using small signal model and hybrid pi model,linear and nonlinear waveshaping. It focuses on applications in the area of power electronics,digital electronics and VLSI design.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Analog Electronics	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

<table>
<tr><td>✓</td><td>PPT</td><td>✓</td><td>Chalk & Talk</td><td>x</td><td>Assignments</td><td>x</td><td>MOOC</td></tr>
<tr><td>x</td><td>Open Ended Experiments</td><td>x</td><td>Seminars</td><td>x</td><td>Mini Project</td><td>x</td><td>Concept Videos</td></tr>
<tr><td>x</td><td colspan="7">Others</td></tr>
</table>

V EVALUATION METHODOLOGY:

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

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

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

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

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

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

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

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

VI COURSE OBJECTIVES:

The students will try to learn:

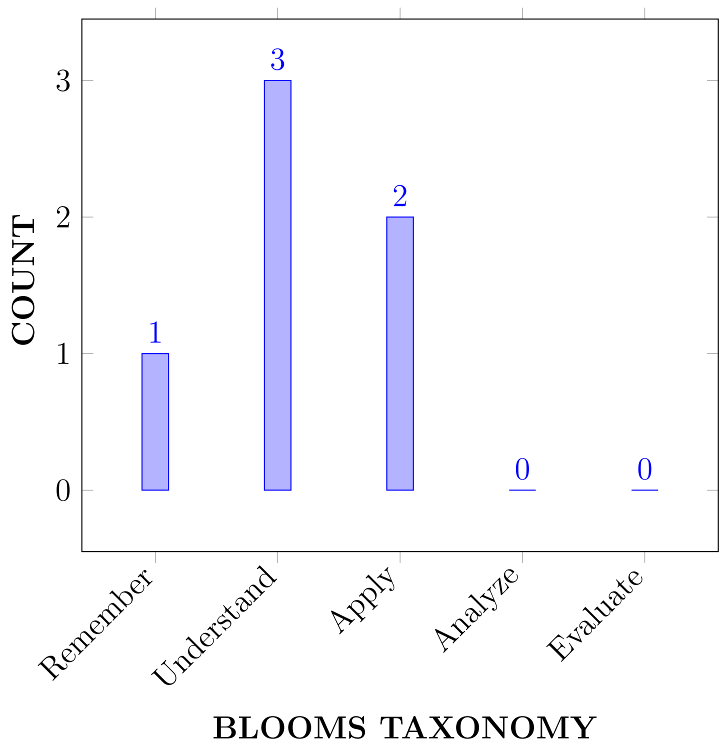
I	The operational principles of analog electronic circuits such as feedback amplifiers and operational amplifiers.
II	The analog circuits fundamental theory to build signal conversion circuits, filter circuits,data converters and automatic gain control.
III	The analog circuits applications in the advanced fields power electronics such as power factor monitoring circuits, power quality measurement, SMPS and battery controls..

VII COURSE OUTCOMES:

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

CO 1	**Recall** the principles and operation of pn diode for the applications such as rectifiers, clippers, and clampers.	Remember
CO 2	**Illustrate** the characteristics of bipolar and uni polar transistor for operating in different regions of operation.	Understand
CO 3	**Demonstrate** differential amplifiers and power amplifiers using transistor high frequency model.	Understand
CO 4	**Estimate** feedback amplifiers parameters based on sampling and mixer circuits.	Apply
CO 5	**Determine** frequency of oscillations for the RC, LC, Hartley and Colpitts oscillators.	Apply
CO 6	**Utilize** inverting and non inverting amplifiers as waveform generators and in IC related real time 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		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	CIE/Quiz/AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIE/Quiz/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	Assignments/ 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	4	Assignments/ SEE /CIE, AAT, QUIZ

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		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		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	✓	✓	-	-	✓	-	-	-	-	✓	-	-	✓	-	-
CO 2	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 3	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 4	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 5	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 6	✓	✓	✓	-	✓	-	-	-	-	✓	-	-	✓	-	-

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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Illustrate**(understand)** the volt ampere characteristics**(knowledge)** of P N diode and identify, formulate**(apply)** to derive mathematical model for diode current, static and dynamic resistance and state a (complex) **problem** to **develop**(apply) solutions to the diode applications such as rectifier ,clipper and clamper for **complex engineering problems** by applying the principles of **mathematics, science to interpret** the result.	3
	PO 2	Understand the given the application **problem statement** and finding the **solution implementation** of clipper, clamper and rectifier circuits by **analyzing complex engineering problems.**	4
	PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling the basic electronic circuits using P-N junction diode by **complex Engineering activities** with an understanding of the limitations.	1
	PO 10	**Describe** the principle of operation of pn diode for the diode applications such as rectifiers, clippers, and clampers **to make effective presentations** and **give clear instructions .**	2
	PSO 1	**Demonstrate** and Develop the capability to **analyze and design** simple circuits like electrical systems containing nonlinear elements such as transistors using the concepts of load lines, operating points and incremental anlysis.	1

CO 2	PO 1	**Recall** the concept of transistor operation and **understand** the input and output characteristics of a transistor and **apply** the small signal equivalent model to common emitter, common base and common collector to transistor circuit with the use of the principles of **science to engineering problems.**	3
	PO 10	**Describe** the principle of operation of of bipolar and uni polar transistor for operating in different regions of operation. **to make effective presentations** and **give clear instructions .**	2
CO 3	PO 1	Estimate (Knowledge) the characteristic parameters of BJT amplifier circuits for negative feedback amplifiers for **solving complex engineering problems** by applying **mathematics, science engineering fundamentals.**	3
	PO 10	**Describe** differential amplifiers and power amplifiers using transistor high frequency model **to make effective presentations, and give clear instructions .**	2
CO 4	PO 1	Determine **(understand)** the Common Emitter configuration Hybrid - model to **find** the unity gain bandwidth and gain bandwidth product by principles of **mathematics, science to the solutions of complex engineering problems.**	3
	PO 2	Analyze high frequency signal analysis **problem statements** of BJT, FET amplifier circuits using **mathematics principles.**	3
	PO 10	**Describe** feedback amplifiers parameters based on sampling and mixer circuits **to make effective presentations, and give clear instructions .**	2
CO 5	PO 1	**Recall** and **understand** the amplifier characteristics to **design** (knowledge) the various oscillator circuits for stable operation by applying **mathematics, science and engineering fundamentals for complex engineering problems.**	3
	PO 2	**Design** (knowledge) and **demonstrate**(understand) the various oscillator circuits amplifier circuits and **identify, formulate**(apply) for stable operation to develop solution using appropriate general characteristics in certain areas of communication(problems) by applying **mathematics, science** and **engineering fundamentals** for **complex engineering problems.**	6
	PO 10	**Describe** inverting and non inverting amplifiers as waveform generators and in IC related real time applications **to make effective presentations** and **give clear instructions .**	2

CO 6	PO 1	**Recall** and **understand** the op-amp characteristics to **analyze** the applications like inverting amplifier, non-inverting amplifier, integrator, differentiator and waveform generators using Op-Amp in **complex problem** analysis **using mathematics.**	3
	PO 2	**Design** (knowledge) and **demonstrate**(understand) the various operational amplifier circuits and **identify, formulate**(apply) for stable operation to develop solution using appropriate general characteristics in certain areas of communication**(problems)** by applying **mathematics, science and engineering fundamentals for complex engineering problems.**	6
	PO 3	Design solutions for **complex Engineering problems** and **design system components** ofop-amp **applications** that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations.	3
	PO 5	Create, select, and **apply** appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling the basic electronic circuits using P-N junction diode complex Engineering activities with an understanding of the limitations.	1
	PO 10	**Describe** inverting and non inverting amplifiers as waveform generators and in IC related real time applications **to make effective presentations**, and **give clear instructions .**	2
	PSO 1	**Demonstrate** and Develop the capability to **analyze and design** simple circuits like electrical systems containing nonlinear elements such as op-amp using the concepts of load lines, operating points and incremental analysis.	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	3	4	-	-	1	-	-	-	-	2	-		1	-	-
CO 2	3	-	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 3	3	-	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 4	3	3	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 5	3	6	-	-	-	-	-	-	-	2	-		-	-	-
CO 6	3	6	3	-	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	100	40	-	-	100	-	-	-	-	40	-	-	50	-	-
CO 2	100	-	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 3	100	-	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 4	100	30	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 5	100	60	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 6	100	60	30	-	100	-	-	-	-	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
2 - 40 % <C < 60% –Moderate
1-5 <C$\leq$ 40% – Low/ Slight
3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	2	-	-	3	-	-	-	-	2	-		2	-	-
CO 2	3	-	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 3	3	-	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 4	3	1	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 5	3	3	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 6	3	3	1	-	3	-	-	-	-	2	-	-	2	-	-
TOTAL	18	9	1	-	6	-	-	-	-	12	-	-	4	-	-
AVERAGE	3	2.25	1	-	3	-	-	-	-	2	-	-	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:

X	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities/Modelling and experimental tools in engineering by experts		

XVIII SYLLABUS:

MODULE I	**DIODE CIRCUITS**
	P-N junction diode, I-V characteristics of a diode; review of half-wave and full-wave rectifiers, clamping and clipping circuits. Input output characteristics of BJT in CB, CE, CC configurations, biasing circuits, Load line analysis, common emitter, common base and common collector amplifiers; Small signal equivalent circuits.
MODULE II	**MOSFET CIRCUITS**
	MOSFET structure and I-V characteristics. MOSFET as a switch. small signal equivalent circuits - gain, input and output impedances, small-signal model and common-source, common-gate and common-drain amplifiers, trans conductance, high frequency equivalent circuit.
MODULE III	**MULTI-STAGE AND POWER AMPLIFIERS**
	Classification of Amplifiers, Distortion in amplifiers, Different coupling schemes used in amplifiers, Frequency response and Analysis of multistage amplifiers, Cascade amplifier, Darlington pair. Transistor at High Frequency: Hybrid - model of Common Emitter transistor model, fα, β and unity gain bandwidth, Gain band width product. Differential Amplifiers, Power amplifiers - Class A, Class B, Class C, Class AB.
MODULE IV	**FEEDBACK AMPLIFIERS**
	Concepts of feedback: Classification of feedback amplifiers, general characteristics of Negative feedback amplifiers, effect of feedback on amplifier characteristics, voltage series, voltage shunt, current series and current shunt feedback configurations, simple problems; Oscillators: Condition for Oscillations, RC type Oscillators RC phase shift and Wien-bridge Oscillators, LC type Oscillators, generalized analysis of LC Oscillators, Hartley and Colpitts oscillators.
MODULE V	**OPERATIONAL AMPLIFIERS**
	Ideal op-amp, Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product, Inverting and non-inverting amplifier, Differentiator, integrator, Square-wave and triangular-wave generators.

TEXTBOOKS

1. Jacob Millman, Christos C Halkias, "Integrated Electronics", McGraw Hill Education, 2nd Edition 2010.

2. Ramakanth A Gayakwad, "Op-Amps & Linear ICS", PHI, 1st Edition, 2003.

REFERENCE BOOKS:

1. Electronic Devices – Conventional current version – Thomas L Floyd, 2015, Pearson
2. J Millman and A Grabel, "Microelectronics", McGraw Hill Education, 1988.
3. P Horowitz and W Hill, "The Art of Electronics", Cambridge University Press, 1989.
4. P. R Gray, R.G. Meyer and S. Lewis,"Analysis and Design of Analog Integrated Circuits", John Wiley & Sons, 2001.

WEB REFERENCES:

1. https://www.mdp.eng.cam.ac.uk/web/library/enginfo/electrical/hong1.pdf
2. https://www.archive.org/details/ElectronicDevicesCircuits
3. https://www.nptel.ac.in/courses/webcourse-contents/IIT-ROORKEE/BASICELECTRONICS/home_page.htm
4. http://notes.specworld.in/pdc-pulse-and-digital-circuits/.

E-TEXT BOOKS:

1. https://www.mdp.eng.cam.ac.uk/web/library/enginfo/electrical/hong1.pdf
2. https://nptel.ac.in/courses/122106025
3. http://www.freebookcentre.net/electronics-ebooks-download/Electronic-Devices-and-Circuits-(PDF-313p).html
4. http://www.introni.it/pdf/Millmam-Taub-Pulse and Digital Switching Waveforms 1965.pdf
5. https://www.jntubook.com/pulse-digital-circuits-textbook-free-download/

XIX COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
0	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	-
CONTENT DELIVERY (THEORY)			
1-5	Understand the P-N junction diode-FB & RB using V-I characteristics	CO 1	T2:1.1-1.8, 2.2
6-7	Analysis of half-wave rectifiers-Vac, Irms, PIV, Efficiency, Ripple factor..	CO 1	T2:1.10,
8	Analysis of full-wave rectifiers.	CO 1	T2:2.7
9-10	Analysis of Clipping circuits. Analysis of Clamping circuits.	CO 1	T2:2.8
11-12	Analysis of Input output characteristics of BJT in CB,CE,CC configurations. Design the different biasing circuits- Fixed bias, Emitter follower bias Self bias.	CO 1	T2:2.8
15-16	Understand the Load line analysis. Analysis of CE,CB,CC amplifiers.	CO 2	T2:3.1-3.2

17-18	Design the Small signal equivalent circuits. Understand the MOSFET structure, I-V characteristics, MOSFET as a switch.	CO 2	T2:3.3-3.7
19-21	Determine the gain, input and output impedances. Apply small-signal model to MOSFET.	CO 2	T2:4.2,7.1-7.4
22-25	Apply small-signal model to MOSFET. Analyze the CS,CG and CD amplifiers. Determine the Trans conductance.	CO 2	T2: 7.6 7.7, 8.9-8.10
26-27	Understand the classification of Amplifiers. Understand the distortion in amplifiers.	CO 3	T3:1.1 R3:1.1-1.4
28-30	Analyze the different coupling schemes-Direct coupled Analyze the different coupling schemes- Transformer coupled.	CO 3	T3:1.1-1.2 R3:1.5-1.7
31-32	Analyze the frequency response and Analysis of multistage amplifiers. Analyze the Cascade amplifier.	CO 4	T3:1.3 R3:1.7,7.4
33-35	Analyze the Darlington pair circuit. Analyze the Hybrid - pi model of Common Emitter transistor model, fα, β.	CO 4	T3:3.1-3.4 R3:2.1-2.4
36-37	Analyze the Hybrid - pi model of Common Emitter transistor model, fα, β. Understand the unity gain bandwidth, Gain band width product.	CO 5	T3:3.3-3.5 R3:2.6
38-39	Analyze the Differential Amplifiers-DIBO, DIUO, SIBO andSIUO. Analyze the Class A, Class B, Class C , Class AB Power amplifiers.	CO 5	T3:5.1-5.3 R3:2.8,3.7-3.8
40-43	Understand the Concepts of feedback, Classification of feedback amplifiers. Understand the general characteristics of Negative feedback amplifiers. Analyze the effect of feedback on amplifier characteristics Analyze the voltage series, Voltage shunt feedback configuration.	CO 5	T4:5.1.-5.10 R3:3.6
44-45	Analyze the current series and current shunt feedback configurations. Distinguish the constructional features and operation of feedback amplifiers and oscillators.	CO 6	T3:4.4-4.6 T4: 5.11 R3:3.10
46-47	Understand the Condition for Oscillations, RC phase shift Oscillator, Wien-bridge Oscillator. Analyze the Generalized analysis of LC Oscillators, Hartley and Colpitts oscillators	CO 6	T4:6.1,6.4 R3:4.1-4.5
48-49	Understand the concept of Ideal op-amp. Determine the Output offset voltage, input bias current, input offset current, slew rate and gain bandwidth product.	CO 6	T4:6.2-6.3,6.7 R3:4.8,4.11

50-51	Analyze the Inverting and non-inverting amplifier. Analyze the Differentiator and integrator.	CO 6	T4:6.3,6.10 R3:4.9-4.10
52-54	Discuss the classifications of data converters	CO 4	R2:7.5
55	Discuss and Analyze DAC techniques and characteristics.	CO 6	T4:7.1 R3:5.2-5.3
56-58	Discuss and Analyze ADC techniques and characteristics	CO 6	T4:7.2-7.6 R3:5.4-5.5
59-60	classification amplifiers	CO 5	T4:7.7-7.10 R3:5.5
61	feedback amplifiers	CO 4	T4:8.1-8.3 R3:6.1-6.2 R3:5.5
62	design of op amp applications	CO 6	T4:8.4-8.7 R3:6.3-6.5
PROBLEM SOLVING/ CASE STUDIES			
9	Static, dynamic resistances Clampers	CO 1	T1: 1.1
10	Rectifiers	CO 1	R3: 1.7
18	Clippers.	CO 1	T1: 2.1-2.6
19	Clampers	CO 2	T1: 6.1-6.6
30	CE,CC amplifiers.	CO 2	T1: 2.7-2.12
31	CB amplifier.	CO 2	T1: 2.7-2.12
32	CS,CG amplifier	CO 3	T1: 3.7-3.12
42	CD amplifier	CO 4	T1: 7.7-7.12
43	and Transition, diffusion capacitances	CO 5	T3: 1.7
44	Derive the specifications of analog to digital.	CO 5	T3: 1.7
51	Design the programmable logic devices using memories	CO 6	R4: 4.2
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Diode circuits	CO 1	T1:4.1
57	Transistors	CO 2	T2:4.1
58	Multi stage amplifiers	CO 3	T3:2.1
59	Feedback amplifiers.	CO 4	R4: 4.2

60	Operational amplifiers	CO 5	T2:6.1
DISCUSSION OF QUESTION BANK			
61	Analysis of Transistor.	CO 1	T1:4.1
62	Analysis of Transistor Analysis of amplifiers	CO 2	T2:4.1
63	Analysis of multistage amplifiers.	CO 3	T3:2.1
64	Feedback amplifiers.	CO 5	R4: 4.2
65	Op-amp applications.	CO 6	T2:6.1

Signature of Course Coordinator **HOD,ECE**
Ms.V.Bindusree, 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	**Electrical and Electronics Engineering**				
Course Title	**DC MACHINES AND TRANSFORMERS**				
Course Code	AEEC07				
Program	B.Tech				
Semester	III	EEE			
Course Type	Core				
Regulation	UG 20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mr. A Sathish Kumar, Assistant Professor				

I COURSE OVERVIEW:

This course deals with the basic theory, construction, operation, performance characteristics and application of electromechanical energy conversion devices such as DC generators and motors. It also gives an in-depth knowledge on the operation of single phase and three phase transformers and it's testing. It also focus on the auto transformers, on-load, off-load tap changers which are widely used in real time applications.

II COURSE PRE-REQUISITES:

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

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
DC Machines and Transformers	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

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

Percentage of Cognitive Level	Blooms Taxonomy Level
33%	Remember
67 %	Understand
0 %	Apply
0 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):

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

<table>
<tr><th colspan="2">Component</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td rowspan="4">CIA</td><td>Continuous Internal Examination – 1 (Mid-term)</td><td>10</td><td rowspan="4">30</td></tr>
<tr><td>Continuous Internal Examination – 2 (Mid-term)</td><td>10</td></tr>
<tr><td>AAT-1</td><td>5</td></tr>
<tr><td>AAT-2</td><td>5</td></tr>
<tr><td>SEE</td><td>Semester End Examination (SEE)</td><td>70</td><td>70</td></tr>
<tr><td colspan="3">Total Marks</td><td>100</td></tr>
</table>

Continuous Internal Examination (CIE):

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

Alternative Assessment Tool (AAT)

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

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

VI COURSE OBJECTIVES:

The students will try to learn:

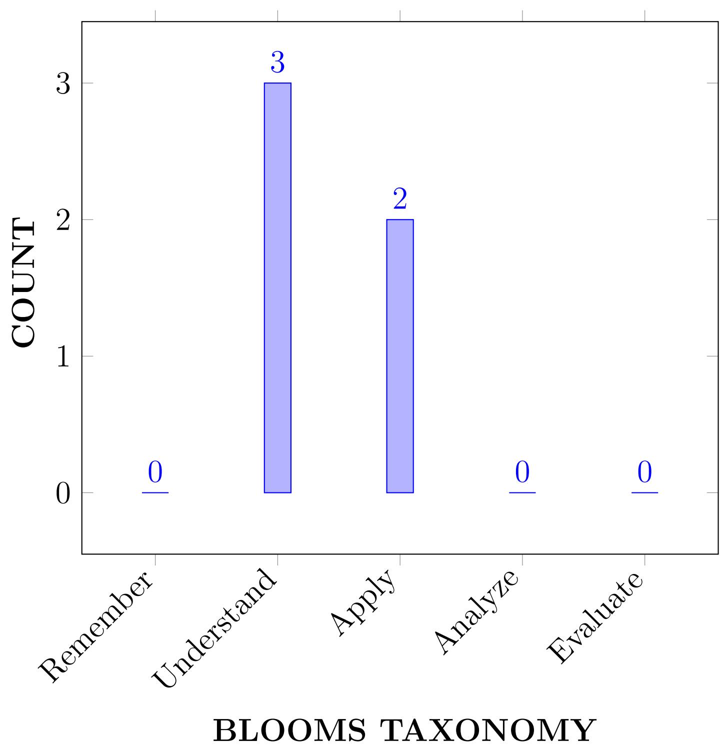
I	The principles of single excited and multiple excited systems leading to the energy balance equations.
II	The construction, working and operation of self and separately excited DC machines
III	The performance characteristics of different DC machines when they are under no load and load conditions.
IV	The energy transformation using single and poly phase transformers under no load and load conditions.

VII COURSE OUTCOMES:

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

CO 1	**Use** the concepts of complex algebra, phasor operations, principles of electromagnetism and circuit theory . for analysing the performance related issues in electrical machines.	Apply
CO 2	**Demonstrate** the working of linear machine as generator, motor and transformer by applying electromagnetic laws and its mathematical models under different loading conditions.	Understand
CO 3	**Identify** various control strategies for calculating the performance parameters and voltage regulation of electrical machines .	Apply
CO 4	**Illustrate** the equivalent circuits and connections of three phase transformers and auto transformers for power system analysis.	Understand
CO 5	**Describe** the load sharing capabilities and reliability of electrical machines using parallel operation under various loading conditions.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

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

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	SEE / CIE / AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	SEE / CIE / AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	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	Design, Develop, Fabricate and Commission the Electrical Systems involving Power generation, Transmission, Distribution and Utilization.	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	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-

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 engineering sciences** to principles of electromagnetisim and circuit theory for analysing the performance related issues in electrical machines	2
	PO 2	Validate the principles of electrical devices and design the electric machines from obtained principles using **fundamentals of mathematics and engineering sciences**	7
	PO 3	**Understand** the constructional features of DC machines using components or processes that meet the specified needs with appropriate consideration, safety considerations.	5
CO 2	PO 1	Demonstrate electromagnetic laws for the operation of DC machines with **engineering sciences**	2
	PO 2	**Understand** the operation of DC motor and DC generator using engineering sciences	4
CO 3	PO 1	Determine voltage regulation, speed control, torque and efficiency of DC machines with the knowledge of mathematics and engineering sciences	3
	PO 2	Solve the complex problems related to voltage regulation, speed control, torque and efficiency of DC machines and validate specifications of DC machines with **basics of engineering sciences and mathematics.**	5
CO 4	PO 1	Understand the connection of three phase transformer and autotransformers with the **knowledge of mathematics and engineering sciences.**	3
	PO 2	Solve the equivallent circuit parameers and voltage, current realtions of three phase transformer with the **first principles of mathematics, natural sciences, and engineering sciences.**	5
	PSO 1	Understand the connections of three phase transformer and autotransformers for smooth operation of power system	2
CO 5	PO 1	Demonstrate how load sharing of DC machine happens with their parallel operation to increase rating of power system with **knowledge of mathematics of engineering sciences.**	3
	PO 2	Calculate the electrical parameters involved in load sharing of DC machines for solving the complex problems related to parallel operation of DC machines **first principles of mathematics, natural sciences, and engineering sciences**	5

Note: For Key Attributes refer **Anexure-1**

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

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

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

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

XV COURSE ARTICULATION MATRIX (PO - PSO MAPPING):

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

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	-	-	-	-	-	-	-	-		-	-	-
CO 2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	2	-	-		-	-	-	-	-	-		3	-	-
CO 5	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	**15**	**11**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**
AVERAGE	**3**	**2.2**	**0.4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.6**	**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	-
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	**DC GENERATORS**
	DC generators: Principle of operation, construction, lap and wave windings, simplex and multiplex windings, commutator, EMF equation, types of DC generators, Armature reaction: Cross magnetization and demagnetization, ampere turns per pole, compensating winding; Commutation: Methods of improving commutation; Open circuit characteristics, voltage buildup, critical field resistance and critical speed, causes for failure to self-excite and remedial measures, load characteristics of shunt, series and compound generators; Conditions and necessity for parallel operation, load sharing, equalizer bars, cross connection of field windings, numerical problems
MODULE II	**DC MOTORS**
	DC motors: Principle of operation, back EMF, torque equation, types of DC motors, condition for maximum power developed, armature reaction and commutation, characteristics, types of starters, numerical problems
MODULE III	**PERFORMANCE OF DC MACHINES**
	Losses and efficiency: Types of losses, efficiency, condition for maximum efficiency Speed Control Methods: Speed control of DC machines; Testing methods: Swinburnes test, brake test, retardation test, separation of stray losses, Hopkinsons test, and fields test, numerical problems.
MODULE IV	**SINGLE PHASE TRANSFORMERS**
	Single phase transformers: Principle of operation, construction, types of transformers, EMF equation, concept of leakage flux and leakage reactance, operation of transformer under no load and on load, phasor diagrams, equivalent circuit, efficiency, regulation and all day efficiency; Testing of transformers: objective of testing, polarity test, measurement of resistance, OC and SC tests, back to back test, heat run test, parallel operation, problems
MODULE V	**POLY PHASE TRANSFORMERS**
	Three phase transformer: Principle of operation, star to star, delta to delta, star to delta, delta to star, three phase to six phase, open delta connection, Scott connection; Auto transformers: Principles of operation, equivalent circuit, merits and demerits, no load and on load tap changers, harmonic reduction in phase voltages, cooling methods of transformers problems.

TEXTBOOKS

1. A E Fitzgerald and C Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. P S Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
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1. M G Say, "Alternating Current Machines", Pitman Publishing Ltd, 4th Edition, 1976.

2. P C Sen, "Principles of Electric Machines and Power Electronics", John Wiley & Sons, 2007.
3. S K Bhattacharya, "Electrical Machines", TMH publication, 2nd Edition, 2006.

WEB REFFERENCES

1. https://www.electricaltechnology.org
2. https://www.cet.edu.in
3. https://gndec.ac.in

COURSE WEB PAGE:

1. https://www.iare.ac.in/sites/default/files/Courses-description/EEE - Electrical machines -I

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	Presentation on Outcome based education		
CONTENT DELIVERY (THEORY)			
1	Understand principle of operation of DC generator.	CO 2	T1:4.1-4.2
2	Know the different parts in a DC machine and understand the functioning of each component..	CO 2	T1:4.3
3	Know the different types of windings used in DC generators.	CO 4	T1:4.4-4.9
4	Understand why the core of a DC machine is laminated and functioning of commutator	CO 14	T1:4.3
5	Derive the equation of EMF induced in a DC generator and solve the simple problems	CO 4	T1:4.10
6	Distinguish the different types of DC generators and know how the voltage is buildup in DC generators	CO 6	T1:6.1-6.2
7	Distinguish the different types of DC generators and know how the voltage is buildup in DC generators.	CO 6	T1:6.1-6.2
8	Problems on the different types of DC generators.	CO 6	T1:6.1-6.2
9	Problems on the different types of DC generators.	CO 6	T1:6.1-6.2
10	Understand the concept of critical field resistance and critical speed.	CO 6	T1:6.7-6.12
11	Understand the different causes for the failure of excitation in DC generators and know the remedies to solve the problem	CO 6	T1:6.13-6.14

12	Understand the concept of armature reaction in DC generator	CO 6	T1:5.1-5.2
13	Understand the concept of cross magnetization and demagnetization in DC generator	CO 9	T1:5.3
14	Solve the problems on armature reaction	CO 9	T1:5.7
15	Understand the concept of commutation, and know different methods used for improving the commutation	CO 9	T1:5.4-5.6
16	Draw the different types of characteristics for DC generators	CO 6	T1:6.5-6.11
17	Understand the basic principle of operating the generators in parallel	CO 11	T1:7.1 -7.4
18	Understand the function of equalizer bar and its usage	CO 11	T1:7.2
19	Solve the different types of numerical problems related to DC generators.	CO 9	T1:4.1-7.4
20	Understand the basic principle of dc motor and its function	CO 4	T1:8.2
21	Understand how the back EMF is induced in DC motor and derive the torque equation.	CO 4	T1:8.4-8.6
22	Know different types of motors and solve simple problems.	CO 6	T1:8.7.1-8.7.5
23	Understand the occurrence of armature reaction and study the commutation techniques	CO 7	T1:8.16
24	Draw the performance characteristics of DC motors	CO 7	T1:8.18-8.23
25	Understand the methods of speed control	CO 7	T1:9.1-9.3
26	Know why starters are used and different types of starters	CO 5	T1:9.4-97
27	Understand the differ types of losses that are occurred in a DC motor.	CO 10	T1:10.1-10.4
28	Solve different numerical problems related to efficiency of DC motor	CO 10	T1:10.1-10.4
29	Conduct the Swinburne's test and Brake test on DC motor and compare the two methods	CO 10	T1:10.7
30	Conduct the regenerative test, Hopkinson's test and determine the efficiency of DC motor	CO 10	T1:10.8
31	Conduct the field's test on DC series motor, and retardation test on DC shunt motor	CO 10	T1:10.9-10.10
32	Summarize the different types of losses and separate the each loss from total losses	CO 10	T4:10.10
33	Solve the different types of numerical problems related to DC motors testing	CO 10	T1:8.2-10.10
34	Explain the operation, construction and types of single phase transformer	CO 4	T1:1.1-1.4, T1:1.24
35	Derive the equation of EMF induced in transformer and understand the concept of leakage flux and reactance	CO 4	T1:1.5-1.6
36	Discuss the operation of transformer under no load and on load with the phasor diagrams	CO 4	T1:1.8-1.12

37	Draw the equivalent circuit of single phase transformer and study the concept of regulation and all day efficiency	CO 11	T1:1.13-1.18
38	Solve the Numerical problems on EMF equation and draw the phasor diagrams	CO 4	T1:1.1-1.18
39	Understand the objectives of testing, and kwon how to conduct polarity test and how to measure resistance	CO 10	T1:1.19.1-1.19.2
40	Conduct OC and SC tests on transformer and determine the efficiency and regulation at different loads	CO 11	T1:1.193-1.195
41	Conduct back to back test / heat run test and determine the efficiency and regulation	CO 11	T1:1.19.6
42	Solve the problems on transformer testing	CO 11	T1:1.19.1-1.19.6
43	Understand the necessity and importance of parallel connection of transformers	CO 9	T1:10.3.1
44	STATCOM design summary	CO 11	T1:2.11.1-2.11.
45	Solve the different types of numerical problems related to single phase transformers	CO 11	T1:1.1-2.11
46	Understand the principle of operation of three phase transformers	CO 13	T1:2.1-2.2
47	Analyze the different connections of three phase transformers	CO 13	T1:2.3.1-2.3.2
48	Solve the problems on three phase transformer connections	CO 13	T1:2.1-2.3.2
49	Analyze how a transformer can work on open delta connection	CO 13	T1:2.4.1-2.4.2
50	Describe how scott connection is performed to convert three phase supply to two phase and vice versa	CO 13	T1:2.5
51	Understand the principle of operation auto transformers	CO 12	T1:2.12
52	Draw the equivalent circuit and explain the merits and demerits of auto transformers	CO 12	T1: 2.12.2
53	Solve the problems on Autotransformers	CO 12	T1: 2.12.2
54	Understand the operation of no load and on load tap changers	CO 13	T1:1.17.1-2.17.2
55	Know how to reduce the harmonics in phase voltages	CO 13	T1:2.62
56	Discussion on Question bank and definition terminology of DC Generators	CO 13	T1:4.4-4.9
57	Discussion on Question bank and definition terminology of DC motors	CO 1, CO2, CO 5, CO 6	T1:8.2-10.10
58	Discussion on Question bank and definition terminology of performance of dc machines	CO 1, CO2, CO 5, CO 6	T1:1.1-1.18
59	Discussion on Question bank and definition terminology of single phase transformers	CO 1, CO10, CO 13 CO 6	T1:2.4.1-2.4.2

60	Discussion on Question bank and definition terminology of poly phase transformers	CO 1, CO10, CO 12, CO 6	T1:1.17.1-2.17.2
DISCUSSION OF QUESTION BANK			
63	Module I	CO 2	T2: 3.2-3.3
64	Module -II	CO 1, 2, 3, 5	T3: 6.9-6.14
65	Module - III	CO 1, 2 ,3 , 5	T2: 5.1-5.20
66	Module - IV	CO 1, 2 ,3 ,5	T2: 7.1-7.20
67	Module - V	CO 4	T3:36.8

Course Coordinator **HOD,EEE**
Mr A Sathish Kumar, Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

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

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

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

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

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

ANNEXURE - II

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	PSO Statement / Key Competencies Features (KCF)	No. of KCF(s)
PSO 1	Design, develop, fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization. 1. Operate, control and protect electrical power system. 2. Validate the interconnected power system. 3. Ensure reliable, efficient and compliant operation of electrical systems. 4. Familiarize the safety, legal and health norms in electrical system. 5. Adopt the engineering professional code and conduct.	**5**
PSO 2	Focus on the components of electrical drives with its converter topologies for energy conversion, management and auditing in specific applications of industry and sustainable rural development. 1. Control the electric drives for renewable and non-renewable energy sources. 2. Fabricate converters with various components and control topologies. 3. Synthesis, systematic procedure to examine electrical components/machines using software tools. 4. Inspect, survey and analyze energy flow. 5. Control and manage the power generation and utilization. 6. Familiarize the safety, legal and health norms in electrical system. 7. Adopt the engineering professional code and conduct. 8. Explore autonomous power 9. Evolve into green energy and assess results 10. Realize energy policies and education 11. Potential contribution of clean energy for rural development.	**11**

PSO 3	Gain the hands-on competency skills in PLC automation, process controllers, HMI and other computing tools necessary for entry level position to meet the requirements of the employer. 1. Explicit software and programming tools for electrical systems. 2. Adopt technical library resources and literature search. 3. Model, program for operation and control of electrical systems. 4. Constitute the systems employed for motion control. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

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

I COURSE PRE-REQUISITES:

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

II COURSE OVERVIEW:

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

III MARKS DISTRIBUTION:

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

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

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

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

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

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

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

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

is given in table.

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

VI COURSE OBJECTIVES:

The students will try to learn:

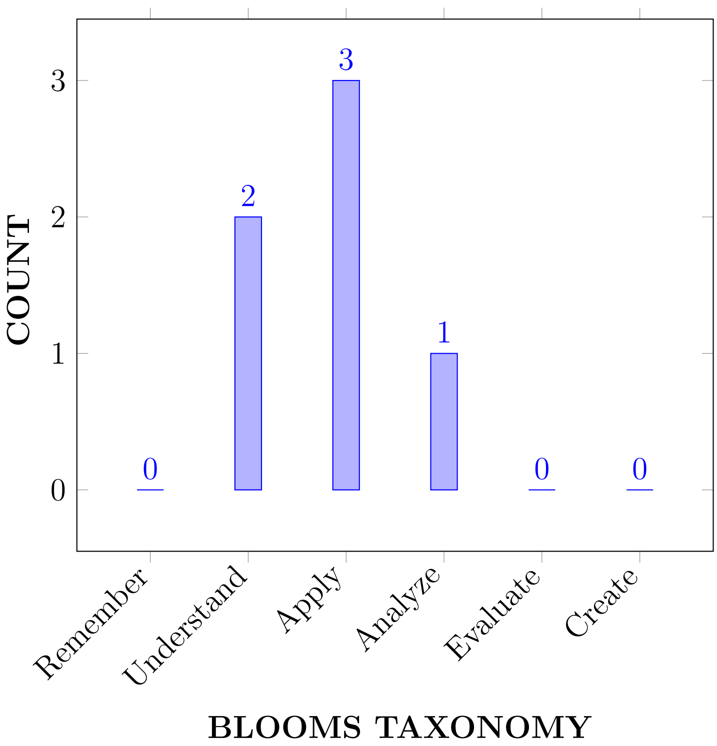
I	To provide students with skills needed to understand and analyze performance trade-offs of different algorithms / implementations and asymptotic analysis of their running time and memory usage.
II	To provide knowledge of basic abstract data types (ADT) and associated algorithms: stacks, queues, lists,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

VII COURSE OUTCOMES:

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

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

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

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

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

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

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

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

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	3	CIA/ SEE/ Tech Talk/ Concept Videos
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	2	CIA/ SEE/ Tech Talk/ Concept Videos
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.	2	CIA/ SEE/ Tech Talk/ Concept Videos

3 = High; 2 = Medium; 1 = Low

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

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

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

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

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

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

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

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

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

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

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

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

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

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

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

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

XVI ASSESSMENT METHODOLOGY DIRECT:

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

XVII ASSESSMENT METHODOLOGY INDIRECT:

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

XVIII SYLLABUS:

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

TEXTBOOKS

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

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

REFERENCE BOOKS:

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

WEB REFERENCES:

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

COURSE WEB PAGE:

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

XIX COURSE PLAN:

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

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

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

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

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

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

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

ELECTRICAL AND ELECTRONICS ENGINEERING
COURSE DESCRIPTION

Course Title	N/W ANALYSIS AND SCIENTIFIC COMPUTING LAB				
Course Code	AEEC08				
Program	B.Tech				
Semester	III	EEE			
Course Type	Core				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	2	2
Course Coordinator	Ms.T Saritha Kuamri, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSB04	II	Waves and Optics
B.Tech	AHSB11	II	Mathematical Transform Techniques
B.Tech	AEE002	II	Electrical Circuits

II COURSE OVERVIEW:

The Network Analysis and Scientific Computing Laboratory is designed to give hands-on experience on virtual instrumentation through digital simulation techniques. These techniques enable the students in examining characteristics of DC and AC circuits, filters, solution of differential equation, generation of three phase and complex wave forms using MATLAB.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Network Analysis and Scientific Computing Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

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

Continuous Internal Assessment (CIA):

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

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

Continuous Internal Examination (CIE):

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

Programming Based

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

VI COURSE OBJECTIVES:

The students will try to learn:

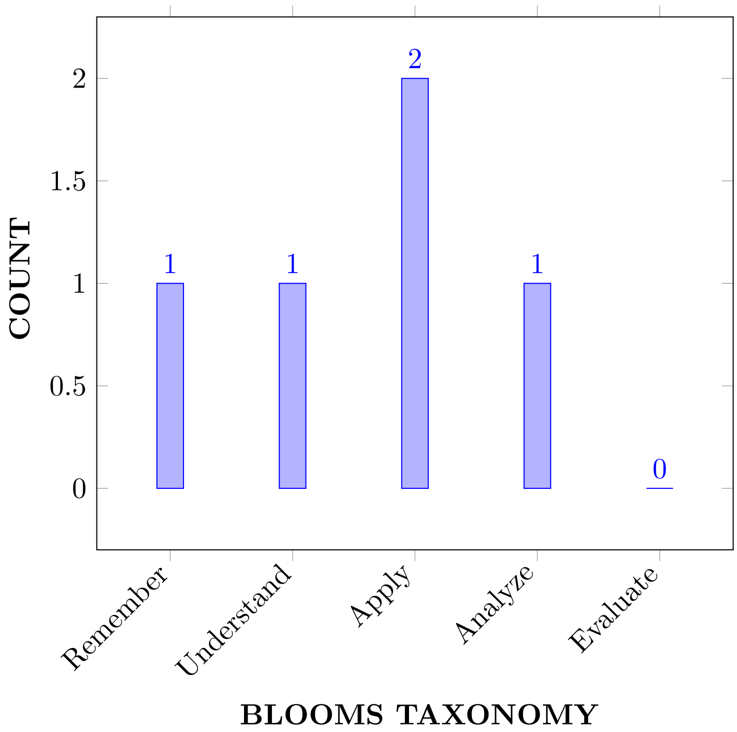
I	Time varying characteristics of series and parallel circuits using MATLAB.
II	Transfer function of electrical circuits using MATLAB.
III	Relations between electrical quantities in complex electrical networks using MATLAB.
IV	The performance of single phase and three phase circuits using Lab View.

VII COURSE OUTCOMES:

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

CO 1	**Identify** the symbols, tool kits and connections in Simulink environment for computing the quantities associated with electrical circuits.	Remember
CO 2	**Examine** the transfer function for studying transient response of RL, RC and RLC circuits.	Understand
CO 3	**Analyze** the virtual instrumentation (VI) using control loops, arrays, charts and graphs.	Analyze
CO 4	**Determine** various alternating quantities of single phase and three phase signals generated in MATLAB/ LabVIEW.	Apply
CO 5	**Design** the various sensors for measuring electrical and non-electrical quantities through digital simulation.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

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

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

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Laboratory experiments, internal and external lab exam
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	Laboratory experiments, internal and external lab exam

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 limitation.	1	Laboratory experiments, internal and external lab exam
PO 8	**Ethics:** Apply ethical principles and commit to professikonal ethics and responsibilties and norms of the engineering practice.	3	Laboratory experiments, internal and external lab exam
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	Laboratory experiments, internal and external lab exam
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	Laboratory experiments,internal and external lab exam
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	2	Laboratory experiments, internal and external lab exam

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		**Strength**	**Proficiency Assessed by**
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involving Power generation, Transmission, Distribution and Utilization.	2	Lab Exercises
PSO 3	Gain the hands-on competency skills in PLC automation, process controllers, HMI and other computing tools necessary for entry level position to meet the requirements of the employer.	1	Lab Exercises

3 = High; 2 = Medium; 1 = Low

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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	State the symbols, tool kits and connections related to electrical circuits to obtain the electrical quantities of given circuit with **knowledge of mathematics, science and engineering fundamentals.**	3
	PO 2	Calculate the quantities associated with electrical circuit for **the validation** of network analysis techniques	1
	PO 5	Create,select and apply appropriate techniques,resources and modern engineering and IT tools **in calculating the quantities of circuits**	1
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice **in calculating the quantities of circuits**	1
	PO 9	Work effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings **in calculating the quantities of circuits**.	3
	PO 10	Communicate effectively on complex engineering activities with the engineering community and with society **in calculating the quantities of circuits**.	5
	PO 12	The preparation and ability to engage in independent and life-long learning in the broadest context of technological change **in calculating the quantities of circuits**.	3
	PSO 1	Apply network analysis techniques to obtain the quantities of electrical networks **in the field of electrical system.**	1
	PSO 3	**Simulate the electrical system** for measure of electrical quantities using Simulink.	3
CO 2	PO 1	Define the transient response of electrical circuit with the **knowledge of mathematics, science and engineering fundamentals.**	3
	PO 5	Create,select and apply appropriate techniques,resources and modern engineering and IT tools **in obtaing the transient response of series and parallel electrical networks**	1
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice **in obtaing the transient response of series and parallel electrical networks**	1
	PO 9	Work effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings **in obtaing the transient response of series and parallel electrical networks**.	3

	PO 10	Communicate effectively on complex engineering activities with the engineering community and with society **in obtaing the transient response ofseries and parallel electrical networks**.	5
	PO 12	The preparation and ability to engage in independent and life-long learning in the broadest context of technological change **in obtaing the transient response of series and parallel electrical networks**.	3
	PSO 1	Obtain the time varying characteristics to know the behavior of series and parallel electrical networks **in the field of electrical system.**	3
	PSO 3	**Simulate the electrical system** to examine the transient response of series and parallel electrical networks.	3
CO 3	PO 1	Obtain the virtual instrumentation using control loops, arrays and graphs with the **knowledge of mathematics, science and engineering fundamentals.**	3
	PO 5	Editing and Building a VI, creating a sub VI in virtual instrumentation using control loops, arrays and graphs **helps in simulation for all requited specifications.**	2
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice **in analyzing VI using control loops, arrays and graphs**	1
	PO 9	Work effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings **in analyzing VI using control loops, arrays and graphs**.	3
	PO 10	Communicate effectively on complex engineering activities with the engineering community and with society **in analyzing VI using control loops, arrays and graphs**.	5
	PO 12	The preparation and ability to engage in independent and life-long learning in the broadest context of technological change **in analyzing VI using control loops, arrays and graphs**.	3
	PSO 1	Analyze the VI using control loops, arrays and graphs **in the field of electrical system.**	3
	PSO 3	**Simulate the electrical system** by building a VI, creating a sub VI in virtual instrumentation using control loops, arrays and graphs.	3
CO 4	PO 1	Determine the various alternating quantities of an AC system using MATLAB/LabVIEW with the **knowledge of mathematics and engineering fundamentals.**	3
	PO 2	Explain the three phase AC waveform with different phase differences and phase sequences **using basics of mathematics and engineering sciences.**	3
	PO 5	Determine the various alternating quantities of an AC system using MATLAB/LabVIEW **helps in simulation for all requited specifications.**	2

	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice **in determining the various alternating quantities of an AC system**	1
	PO 9	Work effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings **in determining the various alternating quantities of an AC system**.	3
	PO 10	Communicate effectively on complex engineering activities with the engineering community and with society **in determining the various alternating quantities of an AC system**.	5
	PO 12	The preparation and ability to engage in independent and life-long learning in the broadest context of technological change **in determining the various alternating quantities of an AC system**.	3
	PSO 1	Interpret the three phase AC waveform for different phase differences and phase sequences **in the field of electrical system.**	1
	PSO 3	**Simulate the electrical system** by determining the various alternating quantities of an AC system using MATLAB/LabVIEW.	1
CO 5	PO 1	Design the electric and electronic circuit of sensor with the **knowledge of mathematics and engineering fundamentals.**	2
	PO 5	Sensor electric and electronic circuit design **helps in simulation for all requited specifications.**	2
	PO 5	Design the electric and electronic circuit of sensor with the **helps in simulation for all requited specifications.**	2
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice **in designing the electric and electronic circuit of sensor**	1
	PO 9	Work effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings **in designing the electric and electronic circuit of sensor** .	3
	PO 10	Communicate effectively on complex engineering activities with the engineering community and with society **in designing the electric and electronic circuit of sensor** .	5
	PO 12	The preparation and ability to engage in independent and life-long learning in the broadest context of technological change **in designing the electric and electronic circuit of sensor** .	3
	PSO 1	Design the electric and electronic circuit of sensor **in the field of electrical system.**	1

	PSO 3	**Simulate the electrical system to** by designing the electric and electronic circuit of sensor.	1

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

COURSE OUTCOMES	PROGRAM OUTCOMES							PSO	
	PO 1	PO 2	PO 5	PO 8	PO 9	PO10	PO12	PSO1	PSO 3
CO 1	3	1	1	1	3	3	3	1	1
CO 2	3		1	1	3	3	3	1	1
CO 3	3		1	1	3	3	3	1	1
CO 4	3	1	1	1	3	3	3	1	1
CO 5	3		1	1	3	3	3	1	1

XIII ASSESSMENT METHODOLOGY DIRECT:

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

XIV ASSESSMENT METHODOLOGY INDIRECT:

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

XV SYLLABUS:

WEEK I	**INTRODUCTION TO MATLAB**
	Problem Statement: Identify the symbols, tool kits and connections in Simulink environment for computing the quantities associated with electrical circuits. **Solutions Expected:** 1. Observation of change in voltage w.r.t change in current. 2. Verification of resistance value theoretically. 3. Verification of Ohm's law.

WEEK II	**TRANSIENT RESPONSE OF SERIES RL, RC AND RLC CIRCUITS.**
	Problem Statement: Examine the time varying characteristics of series RL, RC and RLC circuits for given values of R, L and C using MATLAB software. **Solutions Expected:** 1. Obtain the inductor current response in RL circuit with the given parameters 2. Obtain the capacitor charging in RC circuit with the given parameters 3. Obtain the current response in RLC circuit with the given parameters
WEEK III	**SOLVING DIFFEENTIAL EQUATIONS**
	Problem Statement: Perform the solution of differential equation which is representing mathematical model of electric circuit using MATLAB software. **Solutions Expected:** 1. Obtain the capacitor charging in parallel RC circuit with the given parameters 2. Obtain the capacitor discharging in parallel RC circuit with the given parameters
WEEK IV	**TRANSFER FUNCTION OF ELECTRICAL CIRCUIT**
	Problem Statement: Determine the voltage transfer function of series RLC electrical circuit for frequencies from 10Hz to 100KHz using MATLAB software. **Solutions Expected:** 1. Generation of voltage transfer function of series RLC circuit with the given parameters. 2. Get the magnitude plot of the voltage transfer function of RLC circuit with the given frequency range 3. Get the phase response of the voltage transfer function of RLC circuit with the given frequency range.
WEEK V	**TRANSIENT RESPONSE OF PARALLEL RL, RC AND RLC CIRCUITS**
	Problem Statement: Examine the time varying characteristics of parallel RL, RC and RLC circuits for given values of R, L and C using MATLAB software. **Solutions Expected:** 1. Get the inductor current response in RL circuit with the given parameters 2. Get the capacitors charging in RC circuit with the given parameters 3. Get the current response in RLC circuit with the given parameters.

WEEK VI	**GENERATION OF THREE PAHSE WAVEFORM**
	Problem Statement: Generate the three phase AC wave form for different phase differences and phase sequences using MATLAB software. **Solutions Expected:** 1. Three phase AC wave form generation for different phase differences 2. Three phase AC wave form generation for different phase sequences.
WEEK VII	**THREE PAHSE MEASUREMNETS**
	Problem Statement: Determine the electrical quantities of three phase wave form using MATLAB software. **Solutions Expected:** 1. Get the line currents and neutral current of 3 phase Y-Y connected system 2. Get the voltage drops across the line impedances and load impedances of the system 3. Get the complex power of the system.
WEEK VIII	**VIRTUAL INSTRUMENTS (VI) USING LABVIEW**
	Problem Statement: Infer the Editing and Building a Virtual Instrumentation (VI), Creating a VI using LabVIEW software. **Solutions Expected:** 1. Creating a VI for finding average of four numbers. 2. Creating a sub VI for finding average of four numbers. 3. Editing and Running VI for finding average of four numbers.
WEEK IX	**GENERATION OF COMMON WAVE FORMS AND FREQUENCY MEASUREMENT USING LABVIEW**
	Problem Statement: Illustrate the AC Signal generation and display of waveform, minimum and maximum values of wave form and modulation in LabVIEW software **Solutions Expected:** 1. Display of maximum and minimum values of a sinusoidal signal. 2. Display of modulation of two sinusoidal signals
WEEK X	**FREQUENCY MEASUREMENT USING LISSAJIOUS PATTERN IN LABVIEW**
	Problem Statement: Measure the frequency of unknown signal using Lissajious pattern in LabVIEW software. **Solutions Expected:** 1. Display of Lissajious pattern for sinusoidal voltages of same frequencies. 2. Display of Lissajious pattern for sinusoidal voltages of same different frequencies

WEEK XI	**STRUCTURES USING LABVIEW**
	Problem Statement: Analyze the virtual instrumentation (VI) using control loops, arrays, charts and graphs in LabVIEW software. **Solutions Expected:** 1. Obtain VI using For loop and While loop. 2. Obtain VI using charts and arrays. 3. Obtain VI using graphs.
WEEK XII	**SIMULATION OF LOW PASS AND HIGH PASS FILTERS USING DIGITAL SIMULATION**
	Problem Statement: Plot the frequency characteristics of low pass and high pass filters for frequencies from 0Hz to 1000KHz using MATLAB software. **Solutions Expected:** 1. Get the frequency responses from 0Hz to 1000 KHz of active low pass filter using frequency gain equation 2. Get the frequency responses from 0Hz to 1000 KHz of active high pass filter using frequency gain equation

TEXTBOOKS

1. Rudrapratap, "Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers",Oxford University Press, 1st Edition, 1999.
2. Nesimiertugrul, "Labview for electric circuits, machines, drives, and laboratories", prentice hall, 1st Edition, 2002

REFERENCE BOOKS:

1. A Chakrabarti, "Circuit Theory", Dhanpat Rai Publications, 6th Edition, 2006.
2. William Hayt, Jack E Kemmerly S.M. Durbin, "Engineering Circuit Analysis", Tata McGraw Hill, 7th Edition, 2010.
3. K S Suresh Kumar, "Electric Circuit Analysis", Pearson Education, 1st Edition, 2013.

XVI COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
1	Check the symbols, tool kits and connections related to electrical circuits in MATLAB.	CO 1	R1: 1.2
2	Plot the time varying characteristics of series circuits using MATLAB.	CO 2	R2: 3.5
3	Obtain the solution of differential equation representing electric network using MATLAB.	CO 2	R1: 3.4
4	Determine the transfer function of electrical circuit using MATLAB.	CO 2	R1: 2.2

5	Plot the time varying characteristics of parallel circuits using MATLAB.	CO 2	R1: 2.4
6	Generate the three phase AC wave form for different phase differences and phase sequences using MATLAB.	CO 4	R3: 4.5
7	Determine the electrical quantities of three phase wave form using MATLAB.	CO 4	R3: 4.6
8	Editing and building a Virtual Instrumentation (VI), creating a sub VI.	CO 3	R2: 5.1
9	AC Signal generation and display of wave form, minimum and maximum values of waveform and modulation.	CO 4	R2: 5.2
10	Measure the frequency of unknown signal using Lissajious pattern in LAB View.	CO 4	R1: 7.1
11	Using FOR loop, WHILE loop, charts and arrays, graph and analysis to analyze VIs.	CO 3	R1:7.2
12	Plot the characteristics of low pass and high pass filters using MATLAB	CO 2	R1:7.3
13	Design the electric and electronic circuit of sensor using LAB View	CO 5	R1:7.2
14	Measure the speed of the machine with proximity sensor in LAB View	CO 5	R1:7.3

XVII EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	**Locus Diagrams:** Locus Diagrams: Locus Diagram of RL and RC Series Circuits.
2	**Resonance:** Verification of resonance phenomena for series and parallel circuits.

Signature of Course Coordinator **HOD,EEE**
Ms. T Saritha Kumari, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043
ELECTRICAL AND ELECTRON ICS ENGINEERING
COURSE DESCRIPTION

Course Title	**DC Machines Laboratory**				
Course Code	AEEC09				
Program	B.Tech				
Semester	III	EEE			
Course Type	Core				
Regulation	UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Mr. A Sathish kumar, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEC03	II	Electrical Circuits Lab

II COURSE OVERVIEW:

This laboratory course is to meet the requirements of practical work meant for basic operation, analysis and design of electrical machines. It provides hands-on experience by examining the electrical and mechanical characteristics of various DC machines. Analyze the characteristics of DC machines and separate the various losses in electrical machines by conducting different tests..

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
DC Machines Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

	Experiment Based	Programming based
20 %	Objective	-
20 %	Analysis	-
20 %	Design	-
20 %	Conclusion	-
20 %	Viva	-

Continuous Internal Assessment (CIA):

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

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

Continuous Internal Examination (CIE):

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

1. **Experiment Based**

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

2. **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 elementary experimental and modelling skills for handling problems with electrical machines in the industries and domestic applications to excel in professional career.
II	The operation of DC Machines and its role in power transmission and distribution.

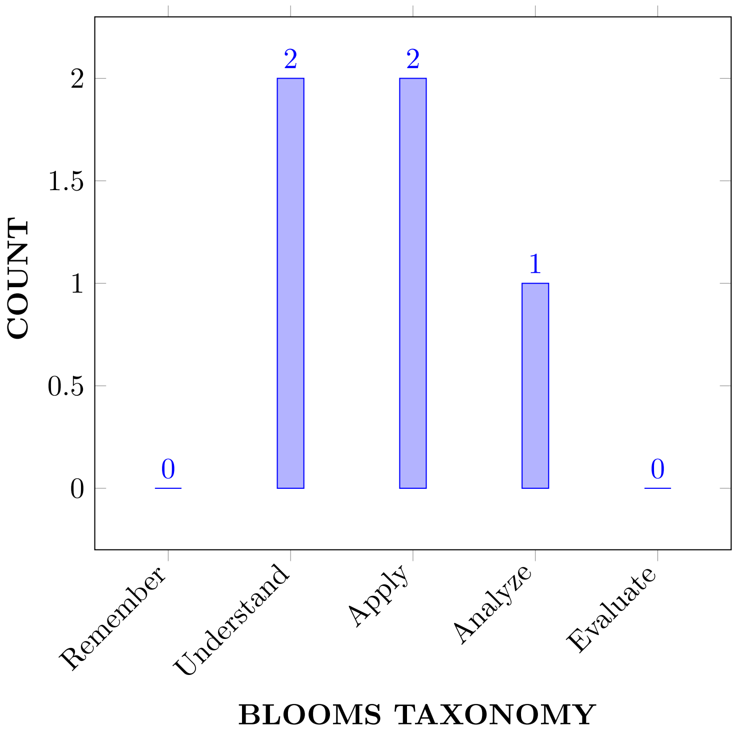
III	The intuitive knowledge needed to test and analyze the performance leading to design of electric machines by conducting various tests and calculate the performance parameters.

VII COURSE OUTCOMES:

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

CO 1	**Analyze** the performance characteristics of dc machine under various loading conditions. .	Analyze
CO 2	**Determine** the critical field resistance and speed of dc shunt generator using open circuit characteristics.	Understand
CO 3	**Examine** the performance of DC shunt machine with different speed control techniques and predetermine the efficiency.	Apply
CO 4	**Estimate** and separate the core losses in dc machine by conducting a suitable test.	Understand
CO 5	**Examine** the performance and speed control of dc machines using simulation tools.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

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

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

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

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

PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	Lab Exercises
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	3	Lab Exercises
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	2	Lab Exercises
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	2	Lab Exercises
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	3	Lab Exercises
PO 9	**Individual and 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 having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	3	Lab Exercises

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		**Strength**	**Proficiency Assessed by**
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involving Power generation, Transmission, Distribution and Utilization.	2	Lab Exercises
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	2	Lab Exercises

PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.	3	Lab Exercises

3 = High; 2 = Medium; 1 = Low

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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Observe the working of electrical machines using mathematical model under loaded and unloaded conditions using **principles of mathematics and engineering science**	2
	PO 2	Understand the working of electrical machines using mathematical model under loaded and unloaded conditons **with problem statement by analyzing complex engineering problems.**	6
	PO 3	Demonstrate the given power electronic components voltage current characteristics **for design solutions of complex engineering problems**	6
	PO 4	Understand the working of electrical machines using mathematical model under loaded and unloaded conditions **with analysis and interpretation of data**	6
	PO 6	Illustrate the working of electrical machines using mathematical model under loaded and unloaded conditions **for safety issues in professional engineering practice**	4
	PO 8	Understand the working of electrical machines using mathematical model under loaded and unloaded conditions **with ethical principles, professional ethics and responsibilities**	2
	PO 9	Demonstarte working of electrical machines using mathematical model under loaded and unloaded conditions **to function effectively as an individual and as a member in team**	8
	PO 10	Interpret working of electrical machines using mathematical model under loaded and unloaded conditions **with communication of complex engineering practices**	3
	PO 12	Understand the working of electrical machines using mathematical model under loaded and unloaded conditions **in life long learning in technological change**	6
	PSO 1	Demonstrate the working of electrical machines using mathematical model under loaded and unloaded conditions **in the electrical systems involved in power genration, transmikssion and distribution**	3

	PSO 2	Understand the working of electrical machines using mathematical model under loaded and unloaded conditions **in electrical drives with converter topologies for energy conversion and management**	7
	PSO 3	Illustrate the given working of electrical machines using mathematical model under loaded and unloaded conditions **in automation process using PLC and process controllers**	4
CO 2	PO 1	Observe the the load sharing capabilities and reliability of DC generators using parallel operation under various loading conditions using **principles of mathematics and engineering sciences**	2
	PO 2	Understand the load sharing capabilities and reliability of DC generators using parallel operation under various loading conditions with**problem statement by analyzing complex engineering problems.**	6
	PO 3	Develop the load sharing capabilities and reliability of DC generators using parallel operation under various loading conditions **for design solutions of complex engineering problems**	6
	PO 4	Understand thethe load sharing capabilities and reliability of DC generators using parallel operation under various loading conditions **with analysis and interpretation of data**	6
	PO 6	Illustrate the load sharing capabilities and reliability of DC generators using parallel operation under various loading conditions **for safety issues in professional engineering practice**	4
	PO 8	Understand the load sharing capabilities and reliability of DC generators using parallel operation under various loading conditions **with ethical principles, professional ethics and responsibilities**	2
	PO 9	Demonstarte the the load sharing capabilities and reliability of DC generators using parallel operation under various loading conditions **to function effectively as an individual and as a member in team**	8
	PO 10	Interpret the load sharing capabilities and reliability of DC generators using parallel operation under various loading conditions **with communication of complex engineering practices**	3
	PO 12	Understand the load sharing capabilities and reliability of DC generators using parallel operation under various loading conditions **in life long learning in technological change**	6
	PSO 1	Demonstrate the the load sharing capabilities and reliability of DC generators using parallel operation under various loading conditions **in the electrical systems involved in power genration, transmikssion and distribution**	3

	PSO 2	Understand the load sharing capabilities and reliability of DC generators using parallel operation under various loading conditions **in electrical drives with converter topologies for energy conversion and management**	7
	PSO 3	Illustrate the load sharing capabilities and reliability of DC generators using parallel operation under various loading conditions **in automation process using PLC and process controllers**	4
CO 3	PO 1	Observe magnetization characteristics of dc shunt generator for calculating the critical resistance and critical speed using **principles of mathematics and engineering science**	2
	PO 2	Understand magnetization characteristics of dc shunt generator for calculating the critical resistance and critical speed **with problem statement by analyzing complex engineering problems.**	6
	PO 3	Demonstrate magnetization characteristics of dc shunt generator for calculating the critical resistance and critical speed **for design solutions of complex engineering problems**	6
	PO 4	Understand magnetization characteristics of dc shunt generator for calculating the critical resistance and critical speed **with analysis and interpretation of data**	6
	PO 5	Understand magnetization characteristics of dc shunt generator for calculating the critical resistance and critical speed **modelling using IT tools such as MATLAB**	6
	PO 6	Illustrate magnetization characteristics of dc shunt generator for calculating the critical resistance and critical speed **for safety issues in professional engineering practice**	4
	PO 8	Understand magnetization characteristics of dc shunt generator for calculating the critical resistance and critical speed **with ethical principles, professional ethics and responsibilities**	2
	PO 9	Demonstarte magnetization characteristics of dc shunt generator for calculating the critical resistance and critical speed **to function effectively as an individual and as a member in team**	8
	PO 10	Interpret magnetization characteristics of dc shunt generator for calculating the critical resistance and critical speed **with communication of complex engineering practices**	3
	PO 12	Understand magnetization characteristics of dc shunt generator for calculating the critical resistance and critical speed **in life long learning in technological change**	6
	PSO 1	Demonstrate magnetization characteristics of dc shunt generator for calculating the critical resistance and critical speed **in the electrical systems involved in power genration, transmikssion and distribution**	3

	PSO 2	Understand magnetization characteristics of dc shunt generator for calculating the critical resistance and critical speed**in electrical drives with converter topologies for energy conversion and management**	7
	PSO 3	Illustrate magnetization characteristics of dc shunt generator for calculating the critical resistance and critical speed **in automation process using PLC and process controllers**	4
CO 4	PO 1	Observe the starting and speed control of various DC motors for necessary to do mechanical work in a proper way using **principles of mathematics and engineering science**	2
	PO 2	Understand the starting and speed control of various DC motors for necessary to do mechanical work in a proper way **with problem statement by analyzing complex engineering problems.**	6
	PO 3	Demonstrate the starting and speed control of various DC motors for necessary to do mechanical work in a proper ways **for design solutions of complex engineering problems**	6
	PO 4	Understand the starting and speed control of various DC motors for necessary to do mechanical work in a proper ways **with analysis and interpretation of data**	6
	PO 5	Understand the starting and speed control of various DC motors for necessary to do mechanical work in a proper ways **modelling using IT tools such as MATLAB**	6
	PO 6	Illustrate the starting and speed control of various DC motors for necessary to do mechanical work in a proper ways **for safety issues in professional engineering practice**	4
	PO 8	Understand the starting and speed control of various DC motors for necessary to do mechanical work in a proper ways **with ethical principles, professional ethics and responsibilities**	2
	PO 9	Demonstarte the starting and speed control of various DC motors for necessary to do mechanical work in a proper ways **to function effectively as an individual and as a member in team**	8
	PO 10	Interpret the starting and speed control of various DC motors for necessary to do mechanical work in a proper ways **with communication of complex engineering practices**	3
	PO 12	Understand the starting and speed control of various DC motors for necessary to do mechanical work in a proper waysn **in life long learning in technological change**	6
	PSO 1	Demonstrate the starting and speed control of various DC motors for necessary to do mechanical work in a proper ways **in the electrical systems involved in power genration, transmikssion and distribution**	3

	PSO 2	Understand the starting and speed control of various DC motors for necessary to do mechanical work in a proper ways **in electrical drives with converter topologies for energy conversion and management**	7
	PSO 3	Illustrate the starting and speed control of various DC motors for necessary to do mechanical work in a proper ways **in automation process using PLC and process controllers**	4
CO 5	PO 1	Observe the core losses of DC shunt machines for dividing the set losses using **principles of mathematics and engineering science**	2
	PO 2	Understand the core losses of DC shunt machines for dividing the set losses **with problem statement by analyzing complex engineering problems.**	6
	PO 3	Demonstrate the core losses of DC shunt machines for dividing the set losses **for design solutions of complex engineering problems**	6
	PO 4	Understand the core losses of DC shunt machines for dividing the set losses **with analysis and interpretation of data**	6
	PO 6	Illustrate the core losses of DC shunt machines for dividing the set losses**for safety issues in professional engineering practice**	4
	PO 8	Understand the core losses of DC shunt machines for dividing the set losses **with ethical principles, professional ethics and responsibilities**	2
	PO 9	Demonstarte the core losses of DC shunt machines for dividing the set losses **to function effectively as an individual and as a member in team**	8
	PO 10	Interpret the core losses of DC shunt machines for dividing the set losses **with communication of complex engineering practices**	3
	PO 12	Understand the core losses of DC shunt machines for dividing the set losses **in life long learning in technological change**	6
	PSO 1	Demonstrate the core losses of DC shunt machines for dividing the set losses **in the electrical systems involved in power genration, transmikssion and distribution**	3
	PSO 2	Understand the core losses of DC shunt machines for dividing the set losses **in electrical drives with converter topologies for energy conversion and management**	7
	PSO 3	Illustrate the core losses of DC shunt machines for dividing the set losses **in automation process using PLC and process controllers**	4

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	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	-	2	-	3	2	2	-	2	2	3	3
CO 2	3	3	3	3	-	2	-	3	2	2	-	2	2	3	3
CO 3	3	3	3	3	3	2	-	3	2	2	-	2	2	3	3
CO 4	3	3	3	3	3	2	-	3	2	2	-	2	2	3	3
CO 5	3	3	3	3	-	2	-	3	2	2	-	2	2	3	3

XIII ASSESSMENT METHODOLOGY DIRECT:

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

XIV ASSESSMENT METHODOLOGY INDIRECT:

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

XV SYLLABUS:

WEEK I	**OPEN CIRCUIT CHARACTERISTICS OF DC SHUNT GENERATOR**
	Problem statement Develop the circuit for analyzing the characteristics of DC shunt generator **Solutions expected** 1. From the Open circuit characteristics calculate the critical resistance of field winding. 2. Using magnetization characteristics calculate the critical speed of DC shunt generator at 100 ohms. 3. Determine the performance of DC generator using the magnetization curve. 4. Calculate the critical value of shunt field resistance at 1500 rpm. .

WEEK II	**LOAD TEST ON DC SHUNT GENERATOR**
	Problem statement Design the DC shunt generator circuit under full, 3/4th, half and 1/4th load conditions for analyzing the performance of the machine **Solutions expected** 1. Calculate the different armature currents (i.e ia equal il plus if) for shunt generator under various loads. 2. Draw the External characteristics using armature currents (0 to 13 A) with respect to the load currents. 3. Draw the Internal characteristics using generated induced emf(0 to 220V) with respect to the field currents(0 to 2A).
WEEK III	**LOAD TEST ON DC SERIES GENERATOR**
	Problem statement Design the DC series generator circuit under full, 3/4th, half and 1/4th load conditions for analyzing the performance of the machine **Solutions expected** 1. Calculate the different armature currents (i.e ia equal il plus if) for series generator under various loads. 2. Draw the External characteristics using armature currents (0 to 13 A) with respect to the load currents. 3. Draw the Internal characteristics using generated induced emf(0 to 220V) with respect to the field currents(0 to 2A).
WEEK IV	**LOAD TEST ON DC COMPOUND GENERATOR**
	Problem statement Design the DC compound generator circuit under full, 3/4th, half and 1/4th load conditions for analyzing the performance of the machine **Solutions expected** 1. Calculate the different armature currents (i.e ia equal il plus if) for compound generator under various loads. 2. Draw the External characteristics using armature currents (0 to 13 A) with respect to the load currents. 3. Draw the Internal characteristics using generated induced emf(0 to 220V) with respect to the field currents(0 to 2A).
WEEK V	**HOPKINSON'S TEST**
	Problem statement Develop a method of testing for two identical dc shunt machines which are mechanically coupled and also electrically connected in parallel **Solutions expected** 1.Calculate the efficiency of two identical dc shunt machines if the armature resistance of each machine is 0.025 ohms, line voltage of 230V and line current excluding both the field currents 2A, motor armature current 10A, field current 1A and 2A. 2. Draw the performance characteristics of two identical dc shunt machines . 3. Find the iron losses depend on the emf generated in the armature

WEEK VI	**FIELD'S TEST**
	Problem statement Develop a method of testing for two similar dc series machines depend on the accuracy with which the motor input and generator output are measured l **Solutions expected** 1. Calculate the efficiency of both dc series machines if the armature resistance of each machine is 2 ohms 2. Draw the performance characteristics of two dc series machines . 3. Find the no load rotational losses of both the machines and total losses in the whole set
WEEK VII	**SWINBURNE'S TEST AND SPEED CONTROL OF DC SHUNT MOTOR**
	Problem statement Design the suitable test under no load conditions to measure no load losses in Dc shunt machines and speed control of DC shunt motor. l **Solutions expected** 1. Calculate the output power and efficiency when motor takes 10A on full load and 5A on half load 2. Measure the no load machine losses by using indirect method of testing 3. Perform the speed control by varying the armature circuit resistance and field circuit resistance of DC shunt motort
WEEK VIII	**BRAKE TEST ON DC COMPOUND MOTOR**
	Problem statement Develop the circuit for conducting brake test on DC compound motor. l **Solutions expected** 1. Calculate the efficiency of DC compound motor under different load conditions 2. Calculate the shaft torque and shaft power at rated load. 3. Determine the mechanical output power under different weights
WEEK IX	**BRAKE TEST ON DC SHUNT MOTOR**
	Problem statement Develop the circuit for conducting brake test on DC shunt motor. l **Solutions expected** 1. Calculate the efficiency of DC shunt motor under different load conditions 2. Calculate the shaft torque and shaft power at rated load. 3. Determine the mechanical output power under different weights
WEEK X	**RETARDATION TEST**
	Problem statement Develop the test for separating the mechanical losses of the DC shunt machine **Solutions expected** 1. Find the rotational losses i.e. friction, wind age and iron losses 2. Measure the moment of inertia of the armature under normal speed of a DC machine 1000rpm.

	3. Calculate the efficiency of DC shunt machine when time taken for the speed to fall from 1030 rpm to 970 rpm is 15 seconds with field normally excited
WEEK XI	**SEPARATION OF LOSSES IN DC SHUNT MOTOR**
	Problem statement Design the circuit for separating the iron losses in DC shunt motor **Solutions expected** 1. Calculate the hysteresis and eddy current losses in Dc shunt motor 2. Draw the curve for total iron losses for various field currents.
WEEK XII	**MAGNETIZATION CHARACTERISTICS OF DC SHUNT GENERATOR USING MATLAB**
	Problem statement Develop the circuit for analyzing the magnetization characteristics of DC shunt generator using MATLAB. **Solutions expected** 1. From the Open circuit characteristics calculate the critical resistance of field windingr 2. Using magnetization characteristics calculate the critical speed of DC shunt generator at 100 ohms. 3. Determine the performance of DC generator using the magnetization curve. 4. Calculate the critical value of shunt field resistance at 1500 rpm
WEEK XIII	**LOAD TEST ON DC SHUNT GENERATOR USING DIGITAL SIMULATION**
	Problem statement Design the DC shunt generator circuit under full, 3/4th, half and 1/4th load conditions for analyzing the performance of the machine using MATLAB **Solutions expected** 1. Calculate the different armature currents (i.e ia equal il plus if) for shunt generator under various loads 2. Draw the External characteristics using armature currents (0 to 13 A) with respect to the load currents. 3. Draw the Internal characteristics using generated induced emf(0 to 220V) with respect to the field currents(0 to 2A).
WEEK XIV	**SPEED CONTROL OF DC SHUNT MOTOR USING DIGITAL SIMULATION**
	Problem statement Design the suitable test for speed control of DC shunt motor using MATAB **Solutions expected** 1. Perform the speed control by varying the armature circuit resistance of DC shunt motor 2. Perform the speed control by varying the field circuit resistance of DC shunt motor.

TEXTBOOKS

1. J B Guptha “Theory and performance of Electrical machiines”, S.K.Kataria and Sons Publishers 14th Edition, 2009

2. M G Say, E O Taylor, "Direct Current Machines", Longman Higher Education, 1st Edition,1985

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1. P S Bimbhra, R.P., —Electrical Machinery, Khanna Publishers, New Delhi 2011

2. I J Nagrath and D P Kothari., Electric Machines, McGraw Hill Education Co. Ltd., 2010.

3. A E Fitzgerald and C Kingsley, "Electric Machinery", New York, McGraw Hill Education, 1st Edition, 2013.

XVI COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
1	Magnetization characteristics of DC shunt generator.	CO 2	R1: 1.2
2	Determination of efficiency by load test in DC shunt generator.	CO 1	R2: 3.5
3	Determination of efficiency by load test on DC series generator	CO 1	R1: 3.4
4	Determination of efficiency by load test on DC compound generator	CO 1	R1: 2.2
5	Study the performance characteristics of two identical DC shunts machines.	CO 1	R1: 2.4
6	Study the performance characteristics of two identical DC series machines.	CO 1	R3: 4.5
7	Predetermine the efficiency and study the characteristics of DC shunt machine with different speed control techniques.	CO 3	R3: 4.6
8	Study the performance characteristics of DC compound motor	CO 1	R2: 5.1
9	Study the performance characteristics of DC shunt motor by brake test.	CO 1	R2: 5.2
10	Study the performance characteristics by using retardation test on DC shunt motor.	CO 1	R1: 7.1
11	Study the method used for separation of losses in DC shunt motor.	CO 4	R1:7.2
12	Study the magnetization characteristics of DC shunt generator using digital simulation	CO 5	R1:7.3
13	Perform the load test on DC shunt generator using digital simulation	CO 5	R2: 7.1
14	Verify the speed control techniques of DC motor using digital simulation.	CO 5	R3: 8.1

XVII EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	**Twin vortex formation:** Design of brushless DC motor for Hybrid Electrical Vehicles.
2	**Open channel:** Design of parallel operation of DC generators for load sharing capabilities .

3	**Capillary action:** Modelling of direct drive motors for performance improvement by design and control.
4	**Buoyancy** Design of three point starter using digital simulation.
5	**Flow through pipes:** Design of permanent magnet DC Motor for Hybrid Electrical Vehicles

Signature of Course Coordinator **HOD,EEE**
Mr.A Sathish Kumar, Assistant Professor

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

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTION

Course Title	**DATA STRUCTURES LABORATORY**				
Course Code	ACSC10				
Program	B.Tech				
Semester	III	EEE			
Course Type	Core				
Regulation	IARE - UG 20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Ms. K Laxminarayanamma, Assistant Professor				

I COURSE OVERVIEW:

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

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSC02	I	Python Programming Laboratory
B.Tech	ACSC08	III	Data Structures

III MARKS DISTRIBUTION:

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

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

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

Continuous Internal Assessment (CIA):

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

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

Continuous Internal Examination (CIE):

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

1. **Experiment Based**

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

2. **Programming Based**

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

VI COURSE OBJECTIVES:

The students will try to learn:

I	To provide students with skills needed to understand and analyze performance trade-offs of different algorithms / implementations and asymptotic analysis of their running time and memory usage.

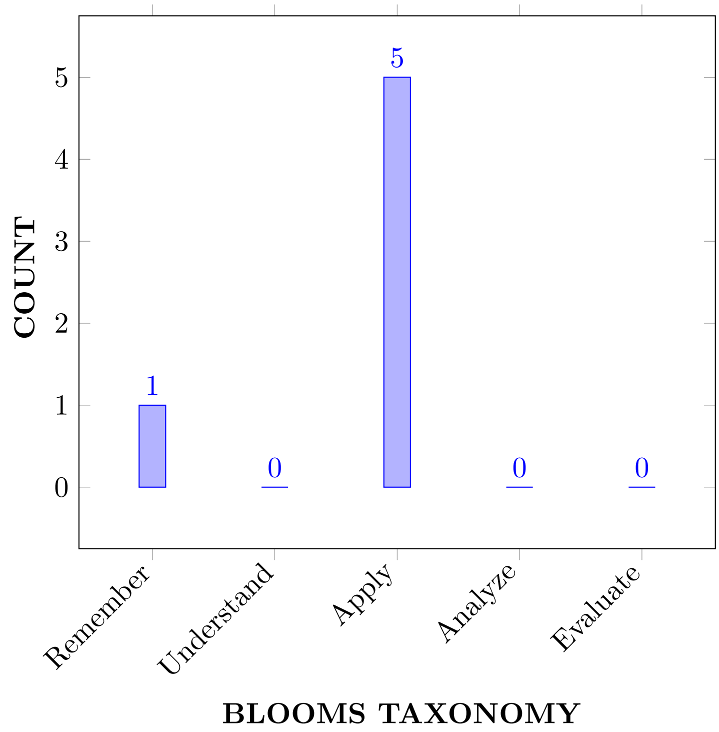
II	To provide knowledge of basic abstract data types (ADT) and associated algorithms: stacks, queues, lists, tree, graphs, hashing and sorting, selection and searching. .
III	The fundamentals of how to store, retrieve, and process data efficiently.
IV	To provide practice by specifying and implementing these data structures and algorithms in Python.
V	Understand essential for future programming and software engineering courses.

VII COURSE OUTCOMES:

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

CO 1	**Identify** appropriate searching technique for efficient retrieval of data stored location. .	Apply
CO 2	**choose** sorting technique to represent data in specified format to to optimize data searching.	Apply
CO 3	**Make use of** stacks and queues representation, operations and their applications to organize specified data	Understand
CO 4	**utilize** linked lists to implement and perform operations for for organizing specified data	Apply
CO 5	**Construct** tree to perform different traversal techniques	Apply
CO 6	**Select** Appropriate graph traversal techniques to visit the vertices of a graph	Remember

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Lab Exercises
PO 2	**Problem Analysis:** Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences	3	Lab Exercises
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	Lab Exercises
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions	2	Lab Exercises
PO 5	**Modern Tool Usage:**Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	1	Lab Exercises
PO 6	**The Engineer and Society** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice	2	Lab Exercises
PO 8	**Ethics** Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice	3	Lab Exercises
PO 9	**Individual and Teamwork** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings	3	Lab Exercises
PO 10	**Communication:** Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions	4	Lab Exercises

PO 12	**Life - Long Learning:**Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	3	Lab Exercises

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		**Strength**	**Proficiency Assessed by**
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	2	Lab Exercises
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	2	Lab Exercises
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.	2	Lab Exercises

3 = High; 2 = Medium; 1 = Low

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

COURSE OUTCOMES	PO'S PSO'S	**Justification for mapping (Students will be able to)**	No. of Key Competencies
CO 1	PO 1	Identify appropriate searching technique for efficient retrieval of data stored location by applying the **principles of Mathematics and Engineering** , **Scientific principles and methodology**,**engineering disciplines to integrate / support study**	3
	PO 2	Identify appropriate searching technique for efficient retrieval of data stored location by applying Problem Analysis **Problem statement and system definition**,**Information and data collection**,**Solution development or experimentation / Implementation**	3
	PO 3	**Identify** appropriate searching technique for efficient retrieval of data stored location by applying **Design/Development of Solutions**	3
	PO 4	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by applying **Conduct Investigations of Complex Problems**	2
	PO 5	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by applying Computer software / simulation packages / diagnostic equipment / technical library resources / literature search toolsl	1

	PO 6	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by applying **reasoning informed by the contextual knowledge**	2
	PO 8	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by applying **ethical principles** and commit to professional **ethics and responsibilities** and norms of the Engineering practice	3
	PO 9	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by applying Function **effectively** as an individual, and as a member or leader to get Ability to work with all levels of people in an organization	3
	PO 10	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by **Communicate effectively** on **complex Engineering activities**	3
	PO 12	Identify**apply**appropriate searching technique for efficient retrieval of data stored location by **Keeping current in CSE and advanced engineering concepts**	3
	PSO 1	Identify appropriate searching technique for efficient retrieval of data stored location in **search engines**	2
	PSO 2	Identify appropriate searching technique for efficient retrieval of data stored location in **mobile and web applications development**	2
	PSO 3	Identify appropriate searching technique for efficient retrieval of data stored location **in shipping real world software, using industry standard tools**	3
CO 2	PO 1	choose sorting technique to represent data in specified format to optimize data searching by applying the **principles of Mathematics and Engineering** , **Scientific principles and methodology**,**engineering disciplines to integrate / support study**	3
	PO 2	choose sorting technique to represent data in specified format to optimize data searching by applying Problem Analysis **Problem statement and system definition**,**Information and data collection**,**Solution development or experimentation / Implementation**	3
	PO 3	**Identify** choose sorting technique to represent data in specified format to optimize data searching by applying **Design/Development of Solutions**	3
	PO 4	**choose** sorting technique to represent data in specified format to optimize data searching by applying **Conduct Investigations of Complex Problems**	2
	PO 5	choose sorting technique to represent data in specified format to optimize data searching by applying Computer software / simulation packages / diagnostic equipment / technical library resources / **literature search toolsl**	1
	PO 6	choose sorting technique to **represent** data in specified format to optimize data searching by applying **reasoning informed by the contextual knowledge**	2

	PO 8	**choose** sorting technique to represent data in specified format to optimize data searching by applying **ethical principles** and commit to professional **ethics and responsibilities** and norms of the Engineering practice	3
	PO 9	choose sorting technique to **represent** data in specified format to optimize data searching by applying Function **effectively** as an individual, and as a member or leader to get Ability to work with all levels of people in an organization	3
	PO 10	choose**Apply** sorting technique to represent data in specified format to optimize data searching by **Communicate effectively** on **complex Engineering activities**	3
	PO 12	**choose** sorting technique to **represent** data in specified format to optimize data searching by **Keeping current in CSE and advanced engineering concepts**	3
	PSO 1	choose**Apply** sorting technique to represent data in specified format to optimize data searching in **search engines**	2
	PSO 2	choose**Apply** sorting technique to represent data in specified format to optimize data searching in **mobile and web applications development**	2
	PSO 3	choose**Apply** sorting technique to represent data in specified format to optimize data searching **in shipping real world software, using industry standard tools**	3
CO 3	PO 1	Make use of stacks and queues representation, operations and their applications to organize specified data by applying the **principles of Mathematics and Engineering** , **Scientific principles and methodology**,**engineering disciplines to integrate / support study**	3
	PO 2	Make use of stacks and queues representation, operations and their applications to organize specified data by applying Problem Analysis **Problem statement and system definition**,**Information and data collection**,**Solution development or experimentation / Implementation**	3
	PO 3	**Identify**, **Make use of** stacks and queues representation, operations and their applications to organize specified data by applying **Design/Development of Solutions**	3
	PO 4	Make use of **Apply**stacks and queues representation, operations and their applications to organize specified data by applying **Conduct Investigations of Complex Problems**	2
	PO 5	Make use of stacks and queues representation, operations and their applications to organize specified data by applying Computer software / simulation packages / diagnostic equipment / technical library resources / **literature search tools**	1

	PO 6	**Make use of** stacks and queues representation, operations and their applications to organize specified data by applying **reasoning informed by the contextual knowledge**	2
	PO 8	Make use of stacks and queues **representation**, operations and their applications to organize specified data by applying **ethical principles** and commit to professional **ethics and responsibilities** and norms of the Engineering practice	3
	PO 9	**Make use of** stacks and queues representation, operations and their applications to organize specified data by applying Function **effectively** as an individual, and as a member or leader to get Ability to work with all levels of people in an organization	3
	PO 10	Make use of stacks and queues representation, **operations and their applications** to organize specified data by **Communicate effectively** on **complex Engineering activities**	3
	PO 12	Make use of stacks and queues **representation**, operations and their applications to organize specified data by **Keeping current in CSE and advanced engineering concepts**	3
	PSO 1	Make use of stacks and queues **representation**, operations and their applications to organize specified data in **search engines**	2
	PSO 2	Make use of stacks and queues **representation**, operations and their applications to organize specified data **mobile and web applications development**	2
	PSO 3	Make use of stacks and queues **representation**, operations and their applications to organize specified data **in shipping real world software, using industry standard tools**	2
CO 4	PO 1	utilize linked lists to implement and perform operations for organizing specified data by applying the **principles of Mathematics and Engineering , Scientific principles and methodology**,**engineering disciplines to integrate / support study**	3
	PO 2	utilize linked lists to implement and perform operations for organizing specified data by applying Problem Analysis **Problem statement and system definition**,**Information and data collection**,**Solution development or experimentation / Implementation**	3
	PO 3	utilize**Apply** linked lists to **implement** and perform operations for organizing specified data by applying **Design/Development of Solutions**	3
	PO 4	utilize linked lists to **implement** and perform operations for organizing specified data by applying **Conduct Investigations of Complex Problems**	2

	PO 5	utilize linked lists to implement and perform operations for organizing specified data by applying Computer software / simulation packages / diagnostic equipment / technical library resources / **literature search toolsl**	1
	PO 6	utilize linked lists to implement and perform operations for organizing specified data by applying **reasoning informed by the contextual knowledge**	2
	PO 8	utilize linked lists to **implement** and perform operations for organizing specified data by applying **ethical principles** and commit to professional **ethics and responsibilities** and norms of the Engineering practice	3
	PO 9	utilize **Apply**linked lists to implement and perform operations for organizing specified data by applying Function **effectively** as an individual, and as a member or leader to get Ability to work with all levels of people in an organization	3
	PO 10	utilize linked lists to implement and **perform** operations for organizing specified data by **Communicate effectively** on **complex Engineering activities**	3
	PO 12	utilize**Apply** linked lists to implement and perform operations for organizing specified data by **Keeping current in CSE and advanced engineering concepts**	3
	PSO 1	utilize**Apply** linked lists to implement and perform operations for organizing specified in **search engines**	2
	PSO 2	utilize**Apply** linked lists to implement and perform operations for organizing specified in **mobile and web applications development**	2
	PSO 3	utilize**Apply** linked lists to implement and perform operations for organizing specified **in shipping real world software, using industry standard tools**	2
CO 5	PO 1	Construct tree to perform different traversal techniques by applying the **principles of Mathematics and Engineering** , **Scientific principles and methodology**,**engineering disciplines to integrate / support study**	3
	PO 2	Construct tree to perform different traversal techniques by applying Problem Analysis **Problem statement and system definition**,**Information and data collection**,**Solution development or experimentation / Implementation**	3
	PO 3	Construct**Apply** tree to **perform** different traversal techniques by applying **Design/Development of Solutions**	3
	PO 4	**Construct** tree to perform different traversal techniques by applying **Conduct Investigations of Complex Problems**	2

	PO 5	Construct tree to perform different traversal techniques by applying Computer software / simulation packages / diagnostic equipment / technical library resources / **literature search tools**	1
	PO 6	Construct tree to **perform** different traversal techniquesby applying **reasoning informed by the contextual knowledge**	2
	PO 8	ConstructApply tree to perform different traversal techniques by applying **ethical principles** and commit to professional **ethics and responsibilities** and norms of the Engineering practice	3
	PO 9	Construct tree to perform different traversal techniquesby applying Function **effectively** as an individual, and as a member or leader to get Ability to work with all levels of **people in an organization**	3
	PO 10	Construct tree to **perform** different traversal techniques by **Communicate effectively** on **complex Engineering activities**	3
	PO 12	**Construct** tree to perform different traversal techniques by **Keeping current in CSE and advanced engineering concepts**	3
	PSO 1	Construct tree to **perform** different traversal techniques in **search engines**	2
	PSO 2	Construct tree to **perform** different traversal techniques in **mobile and web applications development**	2
	PSO 3	Construct tree to **perform** different traversal techniques **in shipping real world software, using industry standard tools**	2
CO 6	PO 1	Select Appropriate graph traversal techniques to visit the vertices of a graph by applying the **principles of Mathematics and Engineering** , **Scientific principles and methodology**,**engineering disciplines to integrate / support study**	3
	PO 2	Select Appropriate graph traversal techniques to visit the vertices of a graph by applying Problem Analysis **Problem statement and system definition**,**Information and data collection**,**Solution development or experimentation / Implementation**	3
	PO 3	Select Appropriate graph traversal techniques to visit the vertices of a graph by applying **Design/Development of Solutions**	3
	PO 4	**Select** Appropriate graph traversal techniques to visit the vertices of a graph by applying **Conduct Investigations of Complex Problems**	2
	PO 5	Select Appropriate graph traversal techniques to visit the vertices of a graph by applying Computer software / simulation packages / diagnostic equipment / technical library resources / **literature search tools**	1

	PO 6	**Select** Appropriate graph traversal techniques to visit the vertices of a graph by applying **reasoning informed by the contextual knowledge**	2
	PO 8	**Select** Appropriate graph traversal techniques to visit the vertices of a graph by applying **ethical principles** and commit to professional **ethics and responsibilities** and norms of the Engineering practice	3
	PO 9	**Select** Appropriate graph traversal techniques to visit the vertices of a graph by applying Function **effectively** as an individual, and as a member or leader to get Ability to work with all levels of people in an organization	3
	PO 10	**Select** Appropriate graph traversal techniques to visit the vertices of a graph by **Communicate effectively** on **complex Engineering activities**	3
	PO 12	**Select** Appropriate graph traversal techniques to visit the vertices of a graph by **Keeping current in CSE and advanced engineering concepts**	3
	PSO 1	**Select** Appropriate graph traversal techniques to visit the vertices of a graph in **search engines**	2
	PSO 2	**Select** Appropriate graph traversal techniques to visit the vertices of a graph in **mobile and web applications development**	2
	PSO 3	**Select** Appropriate graph traversal techniques to visit the vertices of a graph **in shipping real world software, using industry standard tools**	2

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

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

XII ASSESSMENT METHODOLOGY DIRECT:

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

XIII ASSESSMENT METHODOLOGY INDIRECT:

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

XIV SYLLABUS:

WEEK I	**SEARCHING TECHNIQUES**
	Write Python programs for implementing the following searching techniques. a. Linear search. b. Binary search. c. Fibonacci search.
WEEK II	**SORTING TECHNIQUES**
	Write Python programs for implementing the following sorting techniques to arrange a list of integers in ascending order. a. Bubble sort. b. Insertion sort. c. Selection sort
WEEK III	**SORTING TECHNIQUES**
	Write Python programs for implementing the following sorting techniques to arrange a list of integers in ascending order. a. Quick sort. b. Merge sort.
WEEK IV	**IMPLEMENTATION OF STACK AND QUEUE**
	Write Python programs to a. Design and implementation Stack and its operations using Arrays. b. Design and implementation Queue and its operations using Arrays
WEEK V	**APPLICATIONS OF STACK**
	Write Python programs for the following: a. Uses Stack operations to convert infix expression into postfix expression. b. Uses Stack operations for evaluating the postfix expression.
WEEK VI	**IMPLEMENTATION OF SINGLE LINKED LIST**
	Write Python programs for the following: a. Uses functions to perform the following operations on single linked list. (i) Creation (ii) insertion (iii) deletion (iv) traversal b. To store a polynomial expression in memory using linked list.
WEEK VII	**IMPLEMENTATION OF CIRCULAR SINGLE LINKED LIST**
	Write Python programs for the following: Uses functions to perform the following operations on Circular linked list. (i) Creation (ii) insertion (iii) deletion (iv) traversal
WEEK VIII	**IMPLEMENTATION OF DOUBLE LINKED LIST**
	Write Python programs for the following: Uses functions to perform the following operations on double linked list. (i) Creation (ii) insertion (iii) deletion (iv) traversal in both ways.
WEEK IX	**IMPLEMENTATION OF STACK USING LINKED LIST**
	Write Python programs to implement stack using linked list.
WEEK X	**IMPLEMENTATION OF QUEUE USING LINKED LIST**
	Write Python programs to implement queue using linked list.
WEEK XI	**GRAPH TRAVERSAL TECHNIQUES**
	Write Python programs to implement the following graph traversal algorithms: a. Depth first search. b.Breadth first search.

WEEK XII	**IMPLEMENTATION OF BINARY SEARCH TREE**
	Write a Python program that uses functions to perform the following: a. Create a binary search tree. b.Traverse the above binary search tree recursively in pre-order, post-order and in-order. c. Count the number of nodes in the binary search tree.

TEXTBOOKS

1. Rance D. Necaise, “Data Structures and Algorithms using Python”, Wiley Student Edition.
2. Benjamin Baka, David Julian, “Python Data Structures and Algorithms”, Packt Publishers, 2017.

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1. Michael H Goldwasser, David Letscher, —Object Oriented Programming in Python‖, Prentice Hall, 1 st Edition, 2007.
2. Yashavant Kanetkar, Aditya Kanetkar, —Let us Python‖, BPB publication, 1st Edition, 2019.
3. Ashok Kamthane, Amit Kamthane, —Programming and Problem Solving with Python‖, McGraw Hill Education (India) Private Limited, 2018.
4. Taneja Sheetal, Kumar Naveen, —Python Programming – A modular approach‖, Pearson, 2017.
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2. https://python.swaroopch.com/oop.html
3. https://python-textbok.readthedocs.io/en/1.0/Object-Oriented-Programming.html
4. https://www.programiz.com/python-programming/
5. . https://www.geeksforgeeks.org/python-programming-language

XV COURSE PLAN:

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

S.No	Topics to be covered	CO’s	Reference
1	Searching Techniques	CO 1	T1
2	Sorting Techniques.	CO 2	T1
3	Sorting Techniques	CO 2	T1,T2
4	Implementation of Stack and Queue	CO 3	T1,T2
5	Applications of Stack.	CO 3	T1, W1
6	Implementation of Single Linked List	CO 4	T1,W2
7	Implementation of Circular Single Linked List.	CO 4	T1,W3

8	Implementation of Double Linked List	CO 4	T2,W3
9	Implementation of Stack Using Linked List.	CO 3,CO 4	T2,W2
10	Implementation of Queue Using Linked List	CO 3,CO 4	T2,W5
11	Graph Traversal Techniques.	CO 6	T2,W2
12	Implementation of Binary Search Tree	CO 5	T1,W5

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	**Twin vortex formation:** Design a Data Structure SpecialStack that supports all the stack operations like push(), pop(), isEmpty(), isFull() and an additional operation getMin() which should return minimum element from the SpecialStack. All these operations of SpecialStack must be O(1). To implement SpecialStack, you should only use standard Stack data structure and no other data structure like arrays, list, . etc.
2	**Open channel:** In class, we studied binary search trees that do not allow us to insert duplicate elements. However, sometimes we do need to store duplicates. For example, a database of student marks might contain one record for every mark by every student; so if you've taken two courses, there will be two records with the same key (your student number) and different data (your two marks). To accomplish this, we might use a data structure called a "BST with duplicates", or BSTD
3	**Capillary action:** The variable tos in the Stack class is the index of the array element that would be filled the next time push() is called. Modify the code so that tos is the index of the top element actually in use. In other words, tos is to be the index of the top array element occupied by a value that has been "pushed" onto the stack. Write your changes on the code above. Don't forget to fix the comments. You do not need to add preconditions as in part-a.
4	**Buoyancy** Given an adjacency matrix representation of a graph, describe with pseudo code an algorithm that finds a single path, if one exists, between any two different vertices.
5	**Flow through pipes:** There is a garage where the access road can accommodate any number of trucks at one time. The garage is building such a way that only the last truck entered can be moved out. Each of the trucks is identified by a positive integer (a truck-id). Write a program to handle truck moves, allowing for the following commands: a) On-road (truck-id); b) Enter-garage (truck- id); c) Exit-garage (truck-id); d) Show-trucks (garage or road); If an attempt is made to get out a truck which is not the closest to the garage entry, the error message Truck x not near garage door

Signature of Course Coordinator **HOD,EEE**
Mrs. K LAXMINARAYANAMMA, Assistant Professor

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

COURSE DESCRIPTION

Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**				
Course Title	**COMPLEX ANALYSIS AND PROBABILITY DISTRIBUTIONS**				
Course Code	AHSC11				
Program	B. Tech				
Semester	IV				
Course Type	Foundation				
Regulation	IARE-UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Ms B Praveena, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
10+2	-	-	-

II COURSE OVERVIEW:

The course focuses on more Advanced Engineering Mathematics which provide with the relevant mathematical tools required in the analysis of engineering problems and scientific professions. The course includes complex functions and differentiation, complex integration, power series expansion of complex function and Probability of single random variables with its distributions. The mathematical skills derived from this course form a necessary base to analytical and design concepts encountered in the program.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Complex Analysis and probability distributions	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
36 %	Understand
64 %	Apply
0 %	Analyze

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

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

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

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

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

VI COURSE OBJECTIVES:

The students will try to learn:

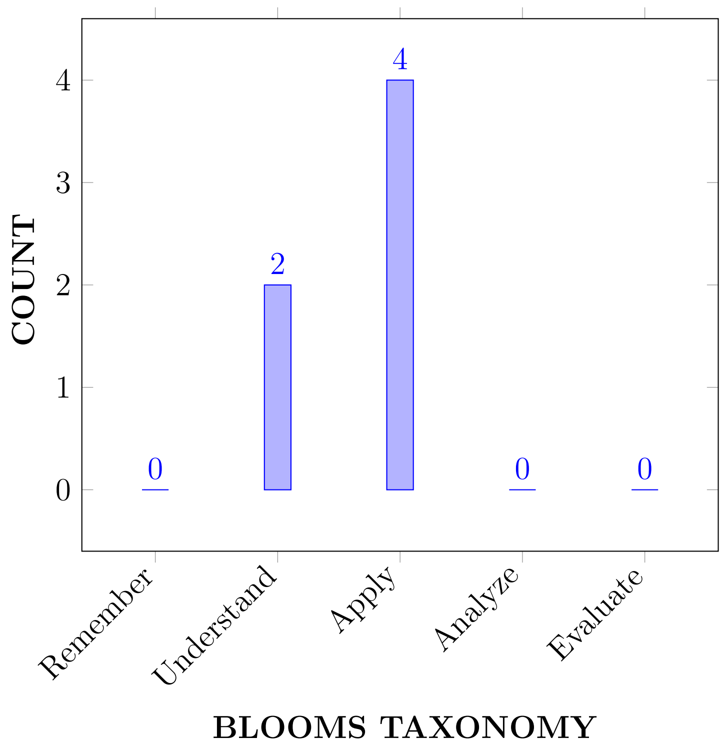
I	The applications of complex variable and conformal mapping in two dimensional complex potential theories.
II	The fundamental calculus theorems and criteria for the independent path on contour integral used in problems of engineering
III	Enrich the knowledge of probability on single random variables and probability distributions

VII COURSE OUTCOMES:

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

CO 1	**Identify** the fundamental concepts of analyticity and differentiability for finding complex conjugates , conformal mapping of complex transformations.	Apply
CO 2	**Apply** integral theorems of complex analysis and its consequences for the analytic function with derivatives of all orders in simple connected region.	Apply
CO 3	**Extend** the Taylor and Laurent series for expressing the function in terms of complex power series.	Apply
CO 4	**Apply** Residue theorem for computing definite integrals by using the singularities and polesof real and complex analytic functions over closed curves.	Apply
CO 5	**Explain** the concept of random variables and types of random variables by using suitable real time examples.	Understand
CO 6	**Interpret** the parameters of random variate Probability distributions by using their probability functions, expectation and variance.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

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

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

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

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involving Power generation, Transmission, Distribution and Utilization.	-	-
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development	-	-
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.	-	-

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 OUT COMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	**PO 1**	Identify the basic properties of analytic functions which are closed with respect to the fundamental operations of arithmetic (knowledge), algebra and applicability in solving majority of functions in various engineering problems by applying Mathematical principles.	2
CO 2	**PO 1**	Apply the integral theorem of complex analysis (knowledge) and its consequences to the analytic function for solving complex problems by applying the principal problems of mathematics.	2
	PO 2	Identify the problem statement to build extensions of Cauchy's theorem and application of necessary condition to vanish a contour integral around the simple connected regions from the provided information and data in reaching substantiated conclusions by using principles of mathematics.	4
	PO 4	Apply quantitative methods to simplify the calculation of certain contour integrals (knowledge) on simply connected regions in order to solve engineering problems.	2
CO 3	**PO 1**	Apply the knowledge of geometric series that enable us to use Cauchy's integral formula for understanding power series representations of analytic functions by applying the principles of mathematics.	2
	PO 2	IdeIdentify the problem formulation and abstraction of rational complex functions for expressing in negative or positive terms of power series (knowledge) using Laurent's series and Taylor's series by applying the principles of mathematics.	4
CO 4	**PO 1**	Apply the method of finding residues of given real or complex integrand (knowledge) the singular points and poles of complex functions and applicability of Residue theorem to solve definite and indefinite complex integrals by applying the principles of mathematics.	2

	PO 4	Make use of the quantitative methods of finding residues for evaluating line integrals (length of curve) of analytic functions over closed curves and applicability of Residue theorem by applying the principles of mathematics.	2
CO 5	**PO 1**	Explain(understanding) the concept of random variables and Calculate the expected values, variances (Application) of the discrete and continuous random variables (knowledge) for making decisions in complex engineering problems under randomized probabilistic conditions by using principles of mathematics.	3
	PO 2	Apply the concepts of discrete and continuous probability distributions which involves the role of Arithmetic mean, median, mode and variance, mathematical functions (principles of mathematics)for solving complex engineering problems under probabilistic conditions	1
CO 6	**PO 1**	Interpret the Probability distributions such as Binomial, Poisson and Normal distribution (Understanding) with the support of evaluation of integrals (principles of mathematics) and appreciate their importance and applicability (Apply) in solving complex engineering problems involving uncertainty.	3

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

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

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

XV ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓PO4	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	Tech-talk	✓	Concept video	✓
Assignments	-				

XVI ASSESSMENT METHODOLOGY-INDIRECT:

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

XVII SYLLABUS:

MODULE I	**COMPLEX FUNCTIONS AND DIFFERENTIATIONS**
	Complex functions and its representation on argand plane, concepts of limit, continuity, differentiability, analyticity, Cauchy-Riemann conditions and harmonic functions; Milne-Thomson method, Bilinear Transformation
MODULE II	**COMPLEX INTEGRATION**
	Line integral: Evaluation along a path and by indefinite integration; Cauchy's integral theorem; Cauchy's integral formula; Generalized integral formula; Power series expansions of complex functions And contour Integration: Radius of convergence.
MODULE III	**POWER SERIES EXPANSION OF COMPLEX FUNCTION**
	Expansion in Taylor's series, Maclaurin's series and Laurent series. Singular point; Isolated singular point; Pole of order m; Essential singularity; Residue: Cauchy Residue Theorem. Evaluation of Residue by Laurent Series and Residue Theorem. Evaluation of integrals of the type $\int_0^{2\pi} f(\cos\theta, \sin\theta)d\theta$ and $\int_0^{\infty} f(x)dx$
MODULE IV	**SINGLE RANDOM VARIABLES**
	Random variables: Discrete and continuous, probability distributions, mass function-density function of a probability distribution. Mathematical expectation. Moment about origin, central moments, moment generating function of probability distribution.

MODULE V	**PROBABILITY DISTRIBUTIONS**
	Binomial, Poisson and normal distributions and their properties.

TEXTBOOKS

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons Publishers, 10th Edition,2010
2. B. S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2015.

REFERENCE BOOKS:

1. T.K.V Iyengar, B. Krishna Gandhi, "Engineering Mathematics - III", S. Chand and Co., 12th Edition, 2015.
2. Churchill, R.V. and Brown, J.W, "Complex Variables and Applications", Tata Mc Graw-Hill, 8th Edition, 2012.

WEB REFERENCES:

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

COURSE WEB PAGE:

1. lms.iare.ac.in

XVIII COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference T1: 4.1
OBE DISCUSSION			
1	In Out Come Based Education student should Identify curves and regions in the complex planedefined by simple expressions. Describe basic properties of complex integration and having the ability to compute such integrals. Decide when and where a given function is analytic and be able to find it series developement. Describe conformal mappings between various plane regions.Present the central ideas in the solution of Dirichlets problem. Able to Classify Singularities and Poles of Complex functions. Relate improper integrals with beta and gamma functions. Idenatify the role of Bessel functions for solving differential equations.	-	
CONTENT DELIVERY (THEORY)			
2	Understanding the complex function in Argand plane	CO 1	T1:12.4, R1:4.13
3	Apply the limit of a complex function	CO 1	T1:12.4, R1:4.13
4	Apply the continuity of a complex function	CO 1	T1:12.4, R1:4.13
5	Apply the differentiability and analyticity of a complex function	CO 1	T1:12.4, R1:4.13
6	Identify and Apply the of Cauchy-Riemann conditions in Cartesian and Polar forms	CO 1	T1:12.4, R1:4.13

7	Evaluate the Harmonic Conjugates	CO 1	T1:12.4, R1:4.13
8	Apply the Milne-Thomson method to find the Analytic function	CO 1	T1:12.4, R1:4.13
9	Apply the properties of Bilinear transformation for complex functions.	CO 1	T1:12.5, R1:8.8
10	Evaluate the Line Integral for a given path	CO 2	T1:13.1, R1:5.3
11	Apply the Cauchy's integral theorem in a given plane	CO 3	T1:13.1, R1:5.3
12	Apply the Cauchy's integral formula for evaluating contour integration	CO 3	T1:13.1, R1:5.3
. 13	Apply the Cauchy's general integral formula for evaluating contour integration.	CO 3	T1:13.1, R1:5.3
14	Define the Power series expansions of complex functions and contour Integration	CO 4	T1:14.1, R1:6.1
15	Evaluate the Radius of convergence of power series complex function	CO 4	T1:14.1, R1:6.1
16	Identify the types of power series expansions	CO 4	T1:14.1, R1:6.1
17	Define the types of Singularities and its nature	CO 4	T1:15.2 , R1:6.6
18	Define the concept of Residues	CO 4	T1:15.2 , R1:6.6
19	Evaluate the Residues of complex functions.	CO4	T1:15.2 , R1:6.6
20	Evaluate of contour integrals by Residue theorem.	CO4	T1:15.2 , R1:6.6
21	Establish the basic concepts of Random variables	CO 5	T2: 7.14, R1:1.6
22	Analyze the types of Probability distributions	CO5	T2: 7.14, R1:1.6
23	Discuss the Mass function, Density function	CO5	T2: 7.14, R1:1.6
24	Asses the Expectations of Probability Distribution	CO5	T2: 7.14, R1:1.6
25	Discuss and Estimate the Moment and Central moments	CO 5	T2: 16.6, R1:7.36
26	Discuss and Estimate the Moment Generating functions	CO 5	T2: 16.8, R1:7.41

27	Analyze and Apply the parameters	CO 5	T2: 16.9, R1:7.42
28	Analyze and Apply the Poisson Distribution parameters	CO 6	T2: 16.9, R1:7.42
29	Analyze and Apply the Normal Distribution parameters	CO 6	T2: 16.9, R1:7.42
30	Complex functions differentiation and integration: Complex functions and its representation on argand plane	CO 2	T2: 16.9, R1:7.42
31	Concepts of limit, continuity	CO 1	T1:12.4, R1:4.13
32	Establish the basic concepts of Random variables	CO5	T2: 7.14 R1:1.6
33	Analyze the types of Probability distributions	CO5	T2: 7.15 R1:16.5
34	Discuss the Mass function, Density function	CO8, CO9	T2:11.3 R1:16.5
35	Asses the Expectations of Probability Distribution	CO5	T2: 16.5 R1:7.32
36	Discuss and Estimate the Moment and Central moments	CO 5	T2: 16.6 R1:16.9
37	Discuss and Estimate the Moment Generating functions	CO 5	T2: 11.4 R1:16.18
38	Analyze and Apply the Binomial Distribution parameters	CO6	T2: 16.8 R1:7.41
39	Analyze and Apply the Poisson Distribution parameters	CO 6	T1:17.5-17.6, R1:16.3.1
40	Analyze and Apply the Normal Distribution parameters	CO 6	T2: 16.9, R1:7.422 ,
41	Problems on integral formula	CO 4	T1:13.4, R1:5.10
PROBLEM SOLVING/ CASE STUDIES			
42	Problems on generalized integral formula	CO 2	T1:14.1, R1:6.1
43	Problems on generalized integral formula	CO 2	T1:14.1, R1:6.1
44	Problems on power series expansions of complex functions Expansion in Taylor's series	CO 3	T1:14.1, R1:6.1
45	Problems on Maclaurin's series	CO 3	T1:15.2 , R1:6.6
46	Problems on Laurent series	CO 3	T1:15.3, R1:7.9

47	Problems on types of singularities , pole of order m	CO 4	T1:15.3, R1:7.9
48	Problems on evaluation of residue by Laurent Series	CO 3	T1:15.3, R1:7.9
49	Problems on Residue Theorem.	CO 4	T1:14.1, R1:6.1
50	Problems on definite integrals of the type -I	CO 3	T1:15.3, R1:7.9
51	Problems on indefinite integrals of type-II	CO 4	T1:15.3, R1:7.9
52	Problems on Binomial Distribution	CO 6	T2: 16.9, R1:7.42
53	Problems on Poisson Distribution	CO 6	T2: 16.9, R1:7.42
54	Problems on Normal Distribution	CO 6	T2: 16.9, R1:7.42
55	Problems on Moment Generating functions	CO 5	T2: 16.7, R1:7.36
56	Definitions and terminology Cauchy-Riemann conditions in Cartesian and Polar forms	CO 1,CO2	T1:12.4, R1:4.13
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Definitions and terminology the differentiability and analyticity of a complex function	CO 1,CO2	T1:12.4, R1:4.13
58	Definitions and terminology Milne-Thomson method to find the Analytic function	CO 1,CO2	T1:12.4, R1:4.13
59	Definitions and terminology on Cauchy's general integral formula for evaluating contour integration, on types of singularities , pole of order m	CO 4	T1:13.4, R1:5.10
60	Definitions and terminology on probabilities.	CO 5	T1:15.2 , R1:6.6
61	Definitions and terminology on distributions	CO 6	T1:12.4, R1:4.13
DISCUSSION OF QUESTION BANK			
62	Discussion of Question Bank of Module II Complex functions and differentiation	CO 1	T1:12.3, R1:4.4
63	Discussion of Question Bank of Module II complex integration	CO 2	T1:12.5, R1:8.8
64	Discussion of Question Bank of Module III power series expansion of complex function	CO3,CO 4	T1:15.1, R1:7.4

65	Discussion of Question Bank of Module IV Random variables	CO 5	T2: 7.15, R1:1.65
66	Discussion of Question Bank of Module V Probability distributions	CO 6	T2: 16.9, R1:7.42

Course Coordinator: **HOD, EEE**
Ms. B Praveena , Assistant Professor

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

COURSE DESCRIPTION

<table>
<tr><td>Department</td><td colspan="5">ELECTRICAL POWER GENERATION SYSTEMS</td></tr>
<tr><td>Course Title</td><td colspan="5">AEEC10</td></tr>
<tr><td>Course Code</td><td colspan="5">B.Tech</td></tr>
<tr><td>Program</td><td colspan="5">IV</td></tr>
<tr><td>Semester</td><td colspan="5">EEE</td></tr>
<tr><td>Course Type</td><td colspan="5">Core</td></tr>
<tr><td>Regulation</td><td colspan="5">UG-20</td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>3</td><td>-</td><td>3</td><td>-</td><td>-</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Dr V. Chandra Jagan Mohan, Associate Professor</td></tr>
</table>

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSC03	I	Engineering Physics

II COURSE OVERVIEW:

This course provides ability to recognize, analyze and troubleshoot different elements in electricpower generation systems. It deals with conventional energy systems like thermal and nuclear power stations. This course also introduces non-conventional energy systems like solar energy (radiation, collection, storage, and application), Hydro and Wind energy. This course will also discuss some environmental impacts of power generation and also look at alternative and sustainable energy resources.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Electrical power Generation systems	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

<table>
<tr><td>✓</td><td>Power Point Presentations</td><td>✓</td><td>Chalk & Talk</td><td>✓</td><td>Assignments</td><td>x</td><td>MOOC</td></tr>
<tr><td>x</td><td>Open Ended Experiments</td><td>x</td><td>Seminars</td><td>x</td><td>Mini Project</td><td>x</td><td>Videos</td></tr>
<tr><td>x</td><td colspan="7">Others</td></tr>
</table>

V EVALUATION METHODOLOGY:

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%	Remember
%	Understand
%	Apply
0 %	Analyze

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

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

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

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

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

VI COURSE OBJECTIVES:

The students will try to learn:

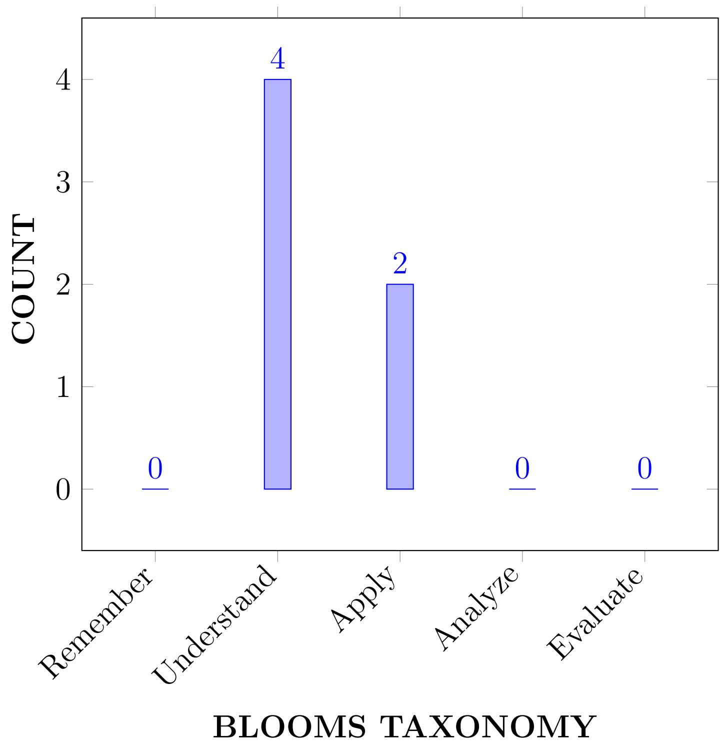
I	The fundamental concepts of power generation and gain knowledge about the different renewable and non-renewable energy sources.
II	Thorough theory on the construction and working principle of thermal, hydro-electric, nuclear and gas power plants.
III	The key aspects in solar and wind power energy systems and analyze their environmental aspects in the present-day scenario to obtain clean energy.
IV	The various factors affecting cost of generations and the different Tariff methods for electrical energy consumption to attain optimum utilization of generated electrical energy.
V	The ability to incorporate the knowledge of electrical power generation in working with minor and major projects and to take up research work in future.

VII COURSE OUTCOMES:

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

CO 1	**Explain** the operating principle of thermal and nuclear power stations to evaluate the significance.	Understand
CO 2	**Elucidate** the working principle and layout of hydroelectric power station (HPS) along with its multi-purpose utility.	Understand
CO 3	**Paraphrase** the solar power generation using photovoltaic effect and its applications.	Understand
CO 4	**Explain** the working principle of wind energy system (WES), types of turbines and the importance of WES.	Understand
CO 5	**Maintain** the optimised working of wind power plants.	Apply
CO 6	**Interpret** the effect of role of tariff on the cost of power generation.	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	
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	
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	Synthesize and analyze aircraft structures, propulsion, production technologies and computer aided engineering in aeronautical systems including air traffic controls standards	3	Quiz
PSO 2	Focus on broad knowledge of aeronautical engineering in innovative, dynamic challenging environment for design and development of new products.	1	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	Understand the working principle of thermal power station with the knowledge of mathematics and science.	2
	PO 2	Identify the merits and demerits for the validation of thermal power station.	6
	PSO 1	Understand the operating principle of thermal power station in the field of electrical power generation.	5
CO 2	PO 1	Understand the layout and working principle of hydroelectric power station with basic fundamentals of mathematics and science.	2
	PO 2	Identify the multi-use of hydroelectric power stationusing basics of mathematics and engineering sciences.	6
	PSO 1	Understand the operation of hydroelectric power station in the field of electrical power generation.	5
CO 3	PO 1	Understand the concept of power generation using solar energy by photovoltaic effect with the help ofmathematics and sciences.	2
	PO 2	Recognize the various applications of solar energy using basics of mathematics and engineering sciences.	6
	PSO 1	Analyze the solar power generation system using photovoltaic effect in the field of power generation.	5
CO 4	PO 1	Understand the operation of wind energy systems and different water turbines with the principles of mathematics and sciences.	2
	PO 2	Analyze the merits and demerits of wind energy systems for validation.	6
	PSO 1	Understand the basic concepts of wind energy systems in the field of power generation.	5
CO 5	PO 1	Understand the operation of wind poer plants mathematics and sciences	.2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	Analyze the merits and demerits of wind power plants for validation.	6
	PSO 1	Understand the basic concepts of wind power plants.	5
CO6	PO 1	Understand various tariff methods used in electrical power economics with the use of mathematics and sciences.	2
	PO 2	Identify the role of tariff on the cost of power generation for validation.	6
	PSO 1	Analyze the tariff methods under economics of power generation in the field of power generation.	5

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

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

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	66.7	40	-	-	-	-	-	-	-	-	-		80	-	-
CO 2	66.7	40	-	-	-	-	-	-	-	-	-	-	80	-	-
CO 3	66.7	40	-	-	-	-	-	-	-	-	-	-	80	-	-
CO 4	66.7	40	-	-		-	-	-	-	-	-		80	-	-
CO 5	66.7	50	-	-	-	-	-	-	-	-	-	-	60	-	-
CO 6	66.7	50	-	-		-	-	-	-	-	-		60	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

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

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

1 -5 $<C \leq 40\%$ – Low/ Slight

2 - 40 % $<C < 60\%$ –Moderate

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	1	-	-	-	-	-	-	-	-	-	-	3	-	-
CO 2	2	1	-	-	-	-	-	-	-	-	-	-	3	-	-
CO 3	3	1	-	-	-	-	-	-	-	-	-	-	3	-	-
CO 4	3	1	-	-	3	-	-	-	-	-	-	-	3	-	-
CO 5	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
CO 6	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
TOTAL	28	16	2	4	3	-	-	-	-	-	-	-	18	-	-
AVERAGE	3	1.3	-	-	.5	-	-	-	-	-	-	-	3	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	PO1.PO2, PO3,PO4	SEE Exams	PO1.PO2, PO3,PO4	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	PO 4	Open Ended Experiments	-
Assignments	PO1.PO2, PO3,PO4				

XVII ASSESSMENT METHODOLOGY-INDIRECT:

	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**CONVENTIONAL POWER GENERATION SYSTEMS**
	Thermal Power Stations: Evaluation of power systems, present day scenario, Line diagram of thermal power station (TPS) showing paths of coal, steam, water, air, ash and flue gasses; Brief description of TPS components: Economizers, boilers, super heaters, turbines, condensers, chimney and cooling towers. Nuclear power stations: Nuclear fission and chain reaction, nuclear fuels, principle of operation of nuclear reactor, reactor components, moderators, control rods, reflectors and coolants, radiation hazards, shielding and safety precautions, types of nuclear reactors and brief description of PWR, BWR and FBR; Gas power stations: Principle of operation and components (Block diagram approach only).
MODULE II	**HYDROELECTRIC POWER STAIONS**
	Hydroelectric Power Stations: Elements of hydro electric power station, types, concept of pumped storage plants, storage requirements, mass curve (explanation only), estimation of power developed from a given catchment area, heads and efficiencies; Hydraulic turbines: Classification of turbines, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine, working proportions, work done, efficiencies, hydraulic design, draft tube theory, functions and efficiency.

MODULE III	SOLAR ENERGY
	Solar radiation: Environmental impact of solar power, physics of the sun, solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on tilted surface, instruments for measuring solar radiation, solar radiation data, solar concentrators, collectors, thermal applications, design of standalone solar systems, simple problems. Photovoltaic systems: Photovoltaic effect, semiconducting materials, band gap theory, photo emission of electrons, cell configuration, types of solar cells, cell properties, device physics, electrostatic field across the depletion layer, voltage developed, I-V characteristics, module structure and fabrication, output power and efficiency, fill factor, maximum power point tracking (MPPT), solar grid connected inverters, simple problems.
MODULE IV	WIND ENERGY
	Wind energy: Sources and potential, power from wind, Betz criterion, components of wind energy conversion system, types of turbines, horizontal and vertical axis wind turbines, aerodynamics, operational characteristics, blade element theory, types of generating systems for wind energy, permanent magnet generators, DC generators, induction generators, doubly fed induction generators, applications of wind energy, safety and environmental aspects, simple problems.
MODULE V	ECONOMIC ASPECTS OF POWER STATIONS
	Terms commonly used in system operation, various factors affecting cost of generations; load curves, connected load, maximum demand, peak load, base load and peak load power plants, load factors, plant capacity factor, plant use factor, demand factors, diversity factor, cost of power plant, tariffs.

TEXTBOOKS

1. C L Wadhawa, "Generation, Distribution and Utilization of Electrical Energy", New Age International Limited, New Delhi, 3rd Edition,2005
2. G D Rai, "Non-Conventional Energy Sources", Khanna Publishers, 1st Edition, 2011
3. G N Tiwari, M K Ghosal, "Fundamentals of Renewable Energy Sources", Narosa Publications, New Delhi, 1st Edition, 2007
4. Chetan Singh Solanki, "Solar Photovoltaics", PHI Publications, 2nd Edition, 2011
5. M L Soni, P V Gupta, U S Bhatnagar and A Chakraborti, "A text book on Power system engineering", Dhanpat Rai and Co. Pvt. Ltd, 1999

REFERENCE BOOKS:

1. C L Wadhawa, "Generation, Distribution and Utilization of Electrical Energy", New Age International Limited, New Delhi, 3rd Edition,2005
2. J B Gupta, "A Course in Electrical Power", S K Kataria and Sons, New Delhi, 15th Edition,2013.
3. M V Deshpande, "Elements of Power Station Design", Prentice Hall Learning Private Limited New Delhi, 1st Edition, 1992.
4. Mukund R Patel, "Wind and Solar Power Systems", CRC Press, 1st Edition, 1999.
5. V K Mehta and Rohit Mehta, "Principle of Power Systems", S Chand and Company, Ltd, New Delhi, 3rd Edition,2005.
6.

WEB REFERENCES:

1. https://www.electrical4u.com
2. https://www.freevideolectures.com
3. 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 T1: 4.1
OBE DISCUSSION			
1	Introduction		
CONTENT DELIVERY (THEORY)			
2	Evaluation of power systems, present day scenario	CO 2	T2: 1.2-1.8 R2:1.1
2-3	Line diagram of thermal power station (TPS) showing paths of coal, steam, water, air, ash and flue gasses	CO 1	T2:1.9 R2:1.5 R1: 3.1
4-5	Brief description of TPS components: Economizers, boilers, super heaters, turbines, condensers, chimney and cooling towers	CO 1	T2:1.10 R2:1.2,1.4
6	Thermal efficiency and efficiency of TPS	CO 1	T2: 2.3-2.5 R2:1.6
7	Nuclear fission and chain reaction, nuclear fuels, principle of operation of nuclear reactor	CO 1	T2:1.12 R2:1.14
8	Reactor components, moderators, control rods, reflectors and coolants, radiation hazards, shielding and safety precautions	CO 1	T2: 2.6 R2:1.7,1.8
9-10	Types of nuclear reactors and brief description of PWR, BWR and FBR	CO 1	T2: 2.7 R2:1.12
11	Gas power stations: Principle of operation and components (Block diagram approach only)	CO 1	T2: 2.6 R2:1.7,1.8
12	Elements of hydro electric power stationl CO 2 T2: 1.11 R2:6.2 13 Types, concept of pumped storage plants)	CO 2	T2: 10.4 R2:4.0
14	Storage requirements, mass curve (explanation only)	CO 2	T2: 10.5.1.3 R2:4.0
15-16	Estimation of power developed from a given catchment area, heads and efficiencies	CO 2	T2: 10.5.1.3 R2:4.0
17	Hydraulic turbines: Classification of turbines, impulse and reaction turbinesl	CO 2	T2:7.1 R2:5.2
18	Pelton wheel, Francis turbine and Kaplan turbine	CO 2	T2:7.6 R2:5.3

19-20	Working proportions, work done, efficiencies	CO 2	T2:7.2 R2:5.4
21	Hydraulic design, draft tube theory, functions and efficiency	CO 2	T2: 7.6.1 R2:5.7
22	Environmental impact of solar power, physics of the sun, solar constant, extraterrestrial and terrestrial solar radiation	CO 3	T2: 7.6.3 R2:5.10,5.11
23-24	Solar radiation on tilted surface, instruments for measuring solar radiationv.	CO 3	T2: 7.7 R2:5.16
25-26	Solar concentrators, collectors, thermal applications	CO 3	T2: 7.7.6 R2:5.21,5.22
27	Design of standalone solar systems	CO 3	T2:7.7.5 R2:5.20
28-29	Simple problems	CO 3	T2:4.1 R2:2.1
30	Photovoltaic effect, semiconducting materials, band gap theory	CO 3	T:4.5-4.6 R2:2.2
31-32	Photo emission of electrons, cell configuration, types of solar cells	CO 3	T2: 5.2.4.1 R2:3.2
33	Cell properties, device physics, electrostatic field across the depletion layer	CO 3	T2:6.5 R2:602
34	Voltage developed, I-V characteristics, module structure and fabrication	CO 3	T2: 6.6.1 R2:6.6
35	Output power and efficiency	CO 3	T2: 6.9-6.10 R2:6.13,6.15
36	Fill factor, maximum power point tracking (MPPT), solar grid connected inverters	CO 3	T2:9.3 R2:7.2
37	Simple problems	CO 3	T2: 9.3.1 R2:7.8
38	Sources and potential, power from wind, Betz criterion	CO 4	T2: 8.4 R2:7.11
39	Components of wind energy conversion system, types of turbines	CO 4	T2: 8.4 R2:7.13
40	Horizontal and vertical axis wind turbines, aerodynamics, operational characteristics	CO 4	T2: 8.8 R2:7.16
PROBLEM SOLVING/ CASE STUDIES			
1-2	Blade element theory, types of generating systems for wind energy	CO 4	T2: 8.8 R2
3-4	Permanent magnet generators, DC generator	CO 4	T4: 4.11 R2:8.1
5-6	Induction generators, doubly fed induction generators	CO 5	T4: 4.23 R2:8.8,8.17
7-8	Applications of wind energy, safety and environmental aspects	CO 5	T4: 4.19,5.2 R2:8.22.5
9-10	Simple Problems	CO 5	T4:4.23 R2:8.23

11-12	Terms commonly used in system operation, various factors affecting cost of generations	CO 6	T4: 6.4-6.5 R2:9.1
13-14	Load curves, connected load, maximum demand, peak load	CO 6	T4: 6.6 R2:9.21,9.22
15-16	Base load and peak load power plants, load factors	CO 6	T4:6.3 R2:9.3
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57-58	Plant capacity factor, plant use factor, demand factors, diversity factor, cost of power plant	CO 6	T4:6.7 R2:9.5
59-60	Tariffs	CO 6	T4:6.6 R2:9.7
DISCUSSION OF QUESTION BANK			
1	CONVENTIONAL POWER GENERATION	CO 1,2, 3	R4:2.1
2	HYDRO ELECTRIC POWER STATIONS	CO 4,11	T4:7.3
3	WIND ENERGY	CO 6,7	R4:5.1
4	SOLAR ENERGY	CO 8,11	T1:7.5
5	ECONOMIC ASPECTS OF POWER STATIONS	CO 9,10, 11	T1: 4.1

Signature of Course Coordinator

HOD,EEE

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

COURSE DESCRIPTION

<table>
<tr><td>Department</td><td colspan="5">Electrical and Electronics Engineering</td></tr>
<tr><td>Course Title</td><td colspan="5">AC Machines</td></tr>
<tr><td>Course Code</td><td colspan="5">AEEC11</td></tr>
<tr><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>Semester</td><td colspan="5">IV</td></tr>
<tr><td>Course Type</td><td colspan="5">Core</td></tr>
<tr><td>Regulation</td><td colspan="5">UG-20</td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>3</td><td>-</td><td>3</td><td>-</td><td>-</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Mr. K Devender Reddy, Assistant Professor</td></tr>
</table>

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEC07	III	DC Machines and Transformers

II COURSE OVERVIEW:

This course deals with the basic theory, construction, operation, performance characteristics and application of electromechanical energy conversion devices such as synchronous and asynchronous machines. It also facilitates the study of the alternating machines which are the major part of industrial drives and agricultural pump sets.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
AC Machines	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

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

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

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

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

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

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

VI COURSE OBJECTIVES:

The students will try to learn:

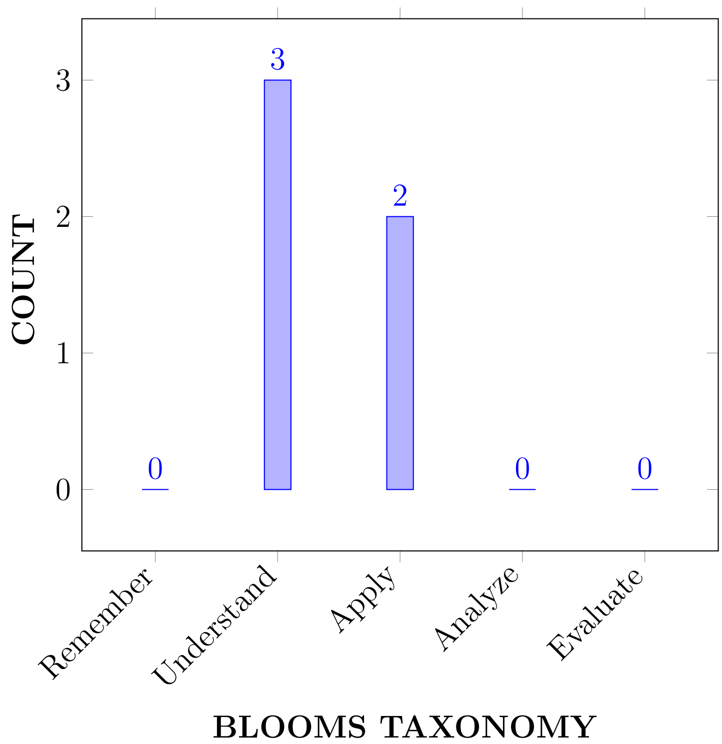
I	The principle of operation and the effect of pulsating, rotating magnetic fields on the working of AC machines
II	The armature winding layouts and concept of armature reaction with phasor diagrams.
III	The staring, speed control methods and equivalent circuit diagram of poly phase and single phase machines.

VII COURSE OUTCOMES:

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

CO 1	**Demonstrate** various winding factors, spatially displaced armature windings to generate electro motive force in AC machines.	Understand
CO 2	**Illustrate** electromagnetic laws used for the construction and operation of synchronous and asynchronous machines.	Understand
CO 3	**Identify** various control strategies for calculating the performance parameters and voltage regulation of AC machines.	Apply
CO 4	**Demonstrate** the parallel operation of alternators for load sharing under various loading conditions.	Understand
CO 5	**Examine** the behavior of synchronous motor with variable excitation and loadings for calculating armature current, power and power factor	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	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 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	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
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	2	SEE/CIE/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Design, develop, fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization.	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	✓	✓	✓	-	-	-	-	-	✓	✓	-	✓	-	-	-

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	Generation of various magnetic fields and different armature windings using the **knowledge of mathematics and engineering sciences**	2
	PO 2	Calculate the induced EMF using winding factors with **first principles of mathematics and engineering sciences**	4
	PO 3	**Demonstrate** spatial displaced windings and winding factors for production of EMF with **design solutions for complex engineering problems**	5
	PO 9	Function effectively as an individual, and as a member or leader in diverse teams for analyzing the importance winding factors.	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 presentation and give and receive clear instructions.	2
	PO 12	Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the context of employability and higher education	4
	PSO 1	**Understand** various windings and winding factors for **generation** of induced EMF	4

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 2	PO 1	Demonstrate electromagnetic laws for the operation of AC machines with **engineering sciences**	2
	PO 2	**Understand** the operation and constructional features of synchronous and asynchronous machines using engineering sciences	4
	PO 9	Function effectively as an individual, and as a member or leader in diverse teams to understand constructional features and operation of various types of AC machines.	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 presentation and give and receive clear instructions.	2
	PO 12	Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the context of employability and higher education	4
	PSO 1	**Understand** electromagnetic laws for the operation of electrical machines for power generation and utilization	4
CO 3	PO 1	Calculate performance parameters of AC machines using **mathematics, science and engineering fundamentals**	3
	PO 2	Draw the circle diagram for calculating equivalent circuit parameters using **first principles of mathematics and engineering sciences**	5
	PO 3	calculate equivalent circuit parameters of AC machines using **design solutions for complex engineering problems**	5
	PO 4	Calculate the voltage regulation of alternator using research-based knowledge and research methods including design of experiments	6
	PO 9	Function effectively as an individual, and as a member or leader in diverse teams to calculate the performance parameters of electrical machines.	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 presentation and give and receive clear instructions.	2
	PO 12	Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the context of employability and higher education	4
CO 4	PO 1	**Understand** necessity and conditions for synchronization of alternators with **knowledge of mathematics and engineering sciences.**	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	**Demonstrate** the load sharing of alternators under various loading conditions using **complex engineering problems with first principles of mathematics and engineering sciences**	5
	PO 4	Calculate the load sharing of synchronized alternator using research-based knowledge and research methods including design of experiments	6
	PO 9	Function effectively as an individual, and as a member or leader in diverse teams to analyse the impartane of parallel operation.	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 presentation and give and receive clear instructions.	2
	PO 12	Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the context of employability and higher education	4
	PSO 1	**Understand** parallel operation of alternators using electrical systems involving in **power generation**	4
CO 5	PO 1	**Understand** the effects of excitation on synchronous motor performance with the **knowledge of engineering sciences**	2
	PO 2	**Demonstrate** the effect of excitation and variable load on performance of synchronous motor using **first principles of mathematics and engineering sciences**	5
	PO 3	Calculate power factor and excitation of synchronous motorusing using **design solutions for complex engineering problems**	5
	PO 9	Function effectively as an individual, and as a member or leader in diverse teams to understand excitation and power circles.	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 presentation and give and receive clear instructions.	2
	PO 12	Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the context of employability and higher education	4
	PSO 1	**Explain** the effect of variable excitation and load on synchronous motor used in transmission, distribution	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	4	5	-	-	-	-	-	5	2	-	4	4	-	-
CO 2	2	4	-	-	-	-	-	-	5	2	-	4	4	-	-
CO 3	3	5	5	6	-	-	-	-	5	2	-	4	-	-	-
CO 4	2	5	-	4	-	-	-	-	5	2	-	4	4	-	-
CO 5	2	5	4	-	-	-	-	-	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	40	50	-	-	-	-	-	33	40	-	50	60	-	-
CO 2	66.6	40	-	-	-	-	-	-	33	40	-	50	60	-	-
CO 3	100	50	50	-	-	-	-	-	33	40	-	50	-	-	-
CO 4	66.6	50	-	-	-	-	-	-	33	40	-	50	60	-	-
CO 5	66.6	50	40	-	-	-	-	-	33	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	1	2	-	-	-	-	-	1	1	-	2	2	-	-
CO 2	3	1	-	-	-	-	-	-	1	1	-	2	2	-	-
CO 3	3	2	2	1	-	-	-	-	1	1	-	2	-	-	-
CO 4	1	2	-	1	-	-	-	-	1	1	-	2	2	-	-
CO 5	2	2	1	-	-	-	-	-	1	1-	-	2	-	-	-
TOTAL	**12**	**8**	**5**	**1**	**0**	**0**	**0**	**0**	**5**	**5**	**0**	**10**	**6**	**0**	**0**
AVERAGE	**2.4**	**1.6**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**2**	**2**	**0**	**0**

XVI ASSESSMENT METHODOLOGY-DIRECT:

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

XVII ASSESSMENT METHODOLOGY-INDIRECT:

	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**THREE PHASE INDUCTION MACHINES**
	Magnetic fields: Constant magnetic field, pulsating magnetic field, rotating magnetic field; Three phase induction motors: Construction, types of induction motors, slip and frequency of rotor currents, rotor MMF and production of torque, equivalent circuit, power across air gap, torque and power output, torque slip characteristics, generating and braking modes, maximum (breakdown) torque, starting torque, maximum power output, problems. Equivalent circuit model; Induction generator
MODULE II	**TESTING AND SPEED CONTROL OF INDUCTION MOTORS**
	Testing: Brake test, no load and blocked rotor test, circuit model, circle diagram, determination of induction motor parameters from circle diagram, problem. Starting methods: Slip ring induction motor and squirrel cage induction motor starting methods; Speed control of induction motors, problems
MODULE III	**ALTERNATORS**
	Synchronous generators: Introduction, principle of operation, constructional features, armature windings, integral slot and fractional slot windings, distributed and concentrated windings, winding factors, basic synchronous machine model, circuit model of a synchronous machine, armature reaction, phasor diagrams,. Voltage regulation: Determination of synchronous impedance, short circuit ratio, and leakage reactance, Calculation of regulation by synchronous impedance method, MMF, ZPF and ASA methods; Parallel operation of alternators, synchronization of alternators; Slip test, problems.
MODULE IV	**SYNCHRONOUS MOTORS**
	Single phase induction motor: Principle of operation, two reaction theory, equivalent circuit analysis, split phase motor, construction, principle of operation, capacitor start, capacitor run, capacitor start - capacitor run motor, shaded pole motor, torque speed characteristics.

MODULE V	SINGLE-PHASE INDUCTION MOTORS
	Single phase induction motor: Principle of operation, two reaction theory, equivalent circuit analysis, split phase motor, construction, principle of operation, capacitor start, capacitor run, capacitor start - capacitor run motor, shaded pole motor, torque speed characteristics of single phase induction motors.

TEXTBOOKS

1. A E Fitzgerald and C Kingsley, ”Electric Machinery”, McGraw Hill Education, 2013.
2. P S Bimbhra, “Electrical Machinery”, Khanna Publishers, 2011.
3. I J Nagrath and D P Kothari, “Electric Machines”, McGraw Hill Education, 2010.

REFERENCE BOOKS:

1. M G Say, “Alternating Current Machines”, Pitman Publishing Ltd, 4th Edition, 1976.
2. P C Sen, “Principles of Electric Machines and Power Electronics”, John Wiley & Sons, 2007.
3. S K Bhattacharya, “Electrical Machines”, TMH publication, 2nd Edition, 2006.

WEB REFFERENCES

1. https://www.electricaltechnology.org
2. https://www.cet.edu.in
3. https://gndec.ac.in

COURSE WEB PAGE:

1. https://www.iare.ac.in/sites/default/files/Courses-description/EEE-AC Machines

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	Lecture on Outcome based education		
CONTENT DELIVERY (THEORY)			
2	Constant magnetic field, pulsating magnetic field, alternating current in windings with spatial displacement	CO 2	T2: 3.2-3.3
3	Revolving magnetic field	CO 2	T2: 3.2-3.3
5	Construction and working principle of three phase induction motor	CO 2	T2: 6.2
6	Torque production and various torque relations in induction motor	CO 2	T2: 6.9
7	Equivalent circuit of poly phase induction motor	CO 2	T2: 6.8
8	Power flow diagram and losses, efficiency of induction motor	CO 2	T2: 6.6
9	Torque – slip and torque – speed characteristics of three phase induction motor	CO 2	T2: 6.9

10	Brake test, no load and blocked rotor test on three phase induction motor	CO 3	T2: 6.11
11	Circle diagram procedure	CO 3	T2: 6.12
12-13	Speed control methods of three phase induction motor	CO 3	T2: 6.14
14-15	Starting methods of three phase induction motor	CO 3	T2: 6.14
16	Induction generator principle of operation	C0 2	T2: 6.16
17	Principle operation and constructional features of synchronous generator	CO 2	T2: 5.1
18	Armature reaction of alternator	CO 2	T2: 5.1
19	Types of armature windings	CO 1	T2: 7.1
20	EMF equation and winding factors	CO 1	T2: 7.1
21	Determination of voltage regulation of alternator by synchronous impedance method (EMF)	CO 3	T2: 5.4.1
22	Determination of voltage regulation of alternator by zero power factor method (ZPF)	CO 3	T2: 5.4.2
23	Determination of voltage regulation of alternator by zero power factor method (ZPF)	CO 3	T2: 5.4.3
24	Determination of voltage regulation of alternator by ASA method	CO 3	T2: 5.4.4
25	Synchronization and Parallel operation of alternators	CO 4	T2: 5.13
26	Blondel's two reaction concept for salient pole alternator	CO 4	T2: 5.16
27	Power developed by salient pole synchronous machine and power angle curve	CO 5	T2: 5.12
28	Principle of operation and constructional features of synchronous motor	CO 2	T2: 5.1
29	Starting methods of synchronous motor	CO 3	T2: 5.20
30	Power developed and power flow within synchronous motor	CO 5	T2: 5.12
31	Equivalent circuit of synchronous motor and synchronous motor with different Excitations	CO 3	T2: 5.6
32	Synchronous motor on load with constant excitation and different torques associated with a synchronous motor	CO 5	T2: 5.7
33	Synchronous motor phasor diagrams for different excitations at constant load	CO 5	T2: 5.7
34	Torque and power relations in synchronous motor	CO 2	T2: 5.13
35	Power and excitation circles of synchronous motor	CO 5	T2: 5.9
36	Two reaction concepts for salient pole synchronous motor	CO 3	T2: 5.16
37	Double revolving and cross field theory	CO 2	T3:3.6.8
38	Split phase motor, construction, principle of operation, torque speed characteristics	CO 2	T3:3.6.8
39	Principle of operation, torque speed characteristics of capacitor start, capacitor run induction motors	CO 2	T3:3.6.8
40	Principle of operation and torque speed characteristics of shaded pole motor	CO 2	T3:3.6.8
41	Equivalent circuit analysis of single-phase induction motor	CO 2	T3:3.6.2

PROBLEM SOLVING/ CASE STUDIES			
42	Calculate slip, speed and equivalent circuit parameters of three phase induction motor	CO 2, 3	T3: 6.9-6.14
43	Calculate torque and find condition for maximum torque of three phase induction motor	CO 2, 3	T3: 6.9-6.14
44	Calculate power developed, efficiency and losses of three phase induction motor	CO 2, 3	T3: 6.9-6.14
45	Calculate various parameters of three phase induction motor from circle diagram	CO 3	T3: 6.9-6.14
46	Numerical problems related to starting methods of three phase induction motor	CO 3	T3: 6.9-6.14
47	Numerical problems on speed control methods of three phase induction motor	CO 3	T3: 6.9-6.14
48	Calculate induced EMF, pitch factor, distribution factor	CO 1	T2: 7.1
49	Calculate power developed and efficiency of alternator	CO 2	T2: 7.1
50	Calculate power developed and efficiency of alternator	CO 2	T2: 7.1
51	Numerical problems related to synchronization and load sharing of alternators	CO 4	T2: 5.13
52-55	Estimate voltage regulation of alternator using various methods like EMF, MMF, ZPF and ASA methods	CO 3	T2: 5.4
56	Calculate equivalent circuit parameters of single-phase induction motor	CO 3	T3:3.6.2
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Constant, pulsating and revolving magnetic fields and properties of ferro magnetic materials	CO 1	T2: 3.2-3.3
58	Faradays laws, slip, slip speed, RMF, Torque, losses starting and speed control of three phase induction motor	CO 2, 3,	T3: 6.9-6.14
59	Synchronous speed, voltage regulation, armature windings, winding factors, synchronization of alternators	CO 1, 3, 4	T2: 5.1-5.20
60	Back EMF, load angle, internal angle, power factor, excitation, starting methods, synchronous condenser of synchronous motor	CO 3, 5	T3:36.8
61	Double revolving and cross fields, centrifugal switch, auxiliary and starting winding of single phase induction motor	CO 2	T3:36.8
DISCUSSION OF QUESTION BANK			
62	Three Phase Induction Machines	CO 1	T2: 3.2-3.3
63	Testing and Speed Control of Induction Motors	CO 2, 3	T3: 6.9-6.14

64	Alternators	CO 1, 2, 3, 4	T2: 5.1-5.20
65	Synchronous Motors	CO 2, 3, 5	T2: 7.1-7.20
66	Single Phase Induction Motors	CO 2, 3	T3:36.8

Course Coordinator **HOD,EEE**
Mr K.Devender Reddy, Assistant Professor

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

COURSE DESCRIPTION

Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**				
Course Title	**CONTROL SYSTEMS**				
Course Code	AEEC12				
Program	B.Tech				
Semester	IV				
Course Type	CORE				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	3	1.5
Course Coordinator	Ms.K Harshini, 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 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

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

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

VI COURSE OBJECTIVES:

The students will try to learn:

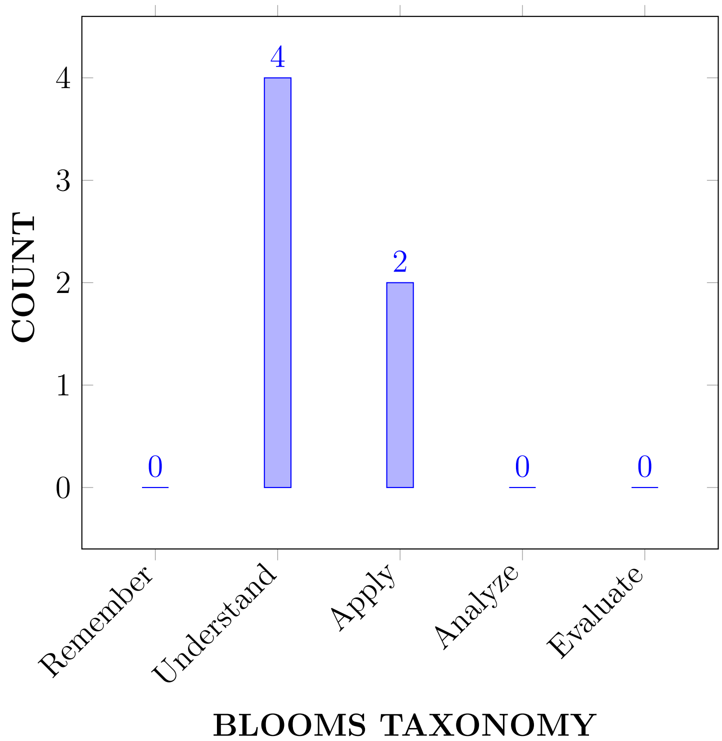
I	The mathematical models of dynamic systems using the concepts of basic sciences.
II	The system performance using time domain and frequency domain analysis for standard inputs.
III	Classification of controllers and compensators as per the desired dynamic response of the system.
IV	The different ways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



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.
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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.
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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 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	Design, develop fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization.	1	Research Paper / Quiz / AAT
PSO 2	Focus on the components of electrical drives with its converter topologies, for energy conversion, management and auditing in specific applications of industry and sustainable rural development.	1	Research Paper / Quiz / AAT
PSO 3	Gain the hands-on competency skills in PLC automation, process controllers, HMI and other computing tools necessary for entry level position to meet the requirements of the employer.	1	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
	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

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

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

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	-	-	-	-	-	2	-	2	-	-	1
CO 2	3	3	7	5	-	-	-	-	-	2	-	3	2	-	-
CO 3	3	5	5	5	-	-	-	-	-	-	-	-	2	-	-
CO 4	3	4	7	7	-	-	-	-	-	-	-	-	-	1	-
CO 5	3	5	7	8	-	-	-	-	-	2	-	2	2	2	-
CO 6	3	4	7	-	-	-	-	-	-	-	-	-	-	-	-

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	100.0	66.7	9.09	-	-	-	-	-	20.0	-	8.3	-	-	14.2
CO 2	100	100.0	66.7	9.09	-	-	-	-	-	20.0	-	8.3	40.0	-	-
CO 3	100.0	100.0	50.0	9.09	-	-	-	-	-	-	-	-	20.0	-	-
CO 4	100.0	66.7	66.7	100.0	-	-	-	-	-	-	-	-	-	9.09	-
CO 5	100.0	66.7	66.7	100.0	-	-	-	-	-	20.0	-	8.3	40.0	18.2	-
CO 6	100	66.7	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	3	2	1	-	-	-	-	-	1	-	1	-	-	1
CO 2	3	3	2	1	-	-	-	-	-	1	-	1	2	-	-
CO 3	3	3	3	1	-	-	-	-	-	-	-	-	1	-	-
CO 4	3	2	2	3	-	-	-	-	-	-	-	-	-	1	-
CO 5	3	2	2	3	-	-	-	-	-	1	-	1	2	2	-
CO 6	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	18	15	13	9	-	-	-	-	-	3	-	3	5	3	1
AVERAGE	3	2.5	2.0	1.8	-	-	-	-	-	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 criterions 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:

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,EEE**

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INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**				
Course Title	**DIGITAL ELECTRONICS**				
Course Code	AEC019				
Program	B.Tech				
Semester	FOUR				
Course Type	CORE				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Ms.V.Bindusree,Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	-	-	-

II COURSE OVERVIEW:

This course intended to logic gates, various logic families. Design of digital circuits using logic gates, combinational circuits and sequential circuits. Apply op-amp characteristics to design analog to digital converters and digital to analog converters. Classification and characteristics of memories such as Read-only memory, Random access memory and programmable logic devices such as programmable logic array and programmable array logic.

III MARKS DISTRIBUTION:

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

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Remember
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) and 10 marks for Alternative Assessment Tool (AAT).

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

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

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

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

VI COURSE OBJECTIVES:

The students will try to learn:

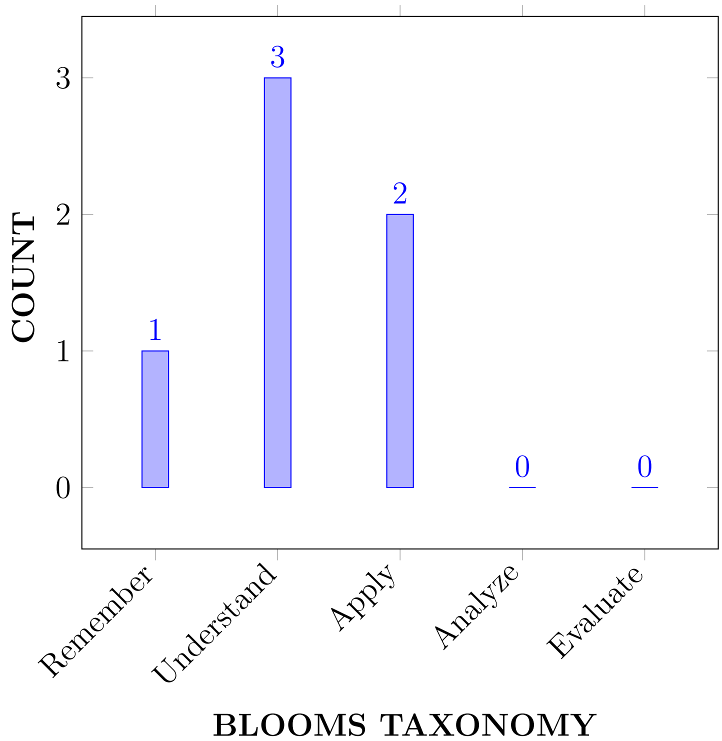
I	The Fundamentals of number systems, Boolean algebra and representation of switching functions using Boolean expressions and their minimization techniques.
II	The combinational and sequential logic circuits to design various complex switching devices, and their realizations.
III	The programmable logic devices, Semiconductor memories and their use in realization of switching functions.
IV	Analog to Digital and Digital to Analog converters applicable in the field of microprocessors, microcontrollers and VLSI

VII COURSE OUTCOMES:

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

CO 1	**Understand** the different forms of number representations and binary codes in digital logic circuits.	Remember
CO 2	**Make use of** Boolean postulates, theorems and k-map for obtaining minimized Boolean expressions.	Apply
CO 3	**Utilize** the functionality and characteristics of flip-flops and latches for designing sequential circuits.	Understand
CO 4	**Construct** the synchronous and asynchronous modules using flip-flops used for memory storing applications.	Apply
CO 5	**Choose** an appropriate A/D and D/A converters for signal processing applications.	Undersatnd
CO 6	**Extend** the knowledge of memories and programmable logic devices for understanding the architectural blocks of FPGA.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

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

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/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	CIE/Quiz/AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	CIE/Quiz/AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society 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		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	Understand the number systems, binary addition and subtraction, 2's complement representation and operations, complements of numbers, codes- binary codes, BCD code by applying its **mathematical principles** and **engineering problems.**	2
	PO 2	Illustrate the minimization techniques for **validation** of Boolean expressions apply for basic theorems and properties.	1
	PO 10	Demonstrate the ability to convert the analog signal to digital signal to **communicate** effectively	1
CO 2	PO 1	Demonstrate the design procedures of half and full Adders, subtractors, serial and parallel adders, BCD Adder for fundamental block realization in any processor **complex engineering problems** by applying **mathematical principles**	2
	PO 2	Identify the importance of SOP and POS canonical forms in the **optimization** of conventional Boolean formulas in general and digital circuits	1
	PSO1	Analyze the basic theorems and its properties, switching functions, canonical and standard form by applying its **mathematical models**	1
CO 3	PO 1	Understand the sequential circuits **methodology** and the **principles** of flipflops, latches	2
	PO 2	Identify the bi-stable elements like latches, flip-flop and excitation tables of different flip flops for **implementing** the **memory storage elements.**	2
	PO 3	Design **solutions** for different type of counters using excitation table of flip flops by **applying engineering problems** and design system components.	3
CO 4	PO 1	Implement the bidirectional and universal shift registers using the **principles** of shift registers for organization of data applications **methodology**	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	Compare the Asynchronous counters using **design** procedure of sequential circuit and excitation tables of flip– flops for **memory harvesting applications**.	2
	PO 3	Design **solutions** for different type of counters using excitation table of flip flops by **applying engineering problems** and design system components.	3
CO 5	PO 1	Understand the **fundamentals** of analog to digital converter and **develop** the **different techniques** of analog to digital converter	3
	PO 2	Design the different techniques of digital to analog converters and **implement** the different specifications of converters.	2
CO 6	PO 1	Design the **solution** of PLA and PLDs and **implement** combinational and sequential logic circuits using PLA and PLDs	2
	PO 3	Design the different memory **techniques** of memories. **memories**	2
	PSO 1	Understand the memory organization and implement the **Fundamental blocks** of CAM, FPGA.	1

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

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

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	66.6	10	-	-	-	-	-	-	-	10	-		-	-	-
CO 2	66.6	10	-	-	-	-	-	-	-	10	-	-	100	-	-
CO 3	66.6	20	100	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	66.6	20	100	-		-	-	-	-	-	-		-	-	-
CO 5	100	20	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	66.6	20	33.3	-		-	-	-	-	-	-		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	1	-	-	-	-	-	-	-	1	-	-	1	-	-
CO 3	3	1	3	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	1	3	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	1	1	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	18	6	7	-	-	-	-	-	-	-	-	-	1	-	-
AVERAGE	3	1	2	-	-	-	-	-	-	-	-	-	2	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

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

XVII ASSESSMENT METHODOLOGY-INDIRECT:

	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	FUNDAMENTALS OF DIGITAL SYSTEMS AND LOGICFAMILIES
	Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, number systems-binary, signed binary, octal hexadecimal number, binary arithmetic, ones and two's complements arithmetic, codes, error detecting and correcting codes, characteristics of digital lCs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-state logic

MODULE II	**COMBINATIONAL DIGITAL CIRCUITS**
	Standard representation for logic functions, K-map representation, and simplification of logic functions using Kmap, minimization of logical functions. Dont care conditions, Multiplexer, DeMultiplexer, Decoders, Adders, Sub tractors, BCD arithmetic, carry look ahead adder, serial ladder, ALU, elementary ALU design, popular MSI chips, digital comparator, parity checker/generator, code converters, priority encoders, decoders, drivers for display devices, Q-M method of function realization.
MODULE III	**SEQUENTIAL CIRCUITS AND SYSTEMS**
	1-bit memory, the circuit properties of Bi-stable latch, the clocked SR flip flop, J- K-T and D types flip flops, applications of flip flops, shift registers, applications of shift registers. Serial to parallel converter: Parallel to serial converter, ring counter, sequence generator, ripple (Asynchronous) counters, synchronous counters, counters design using flip flops, special counter IC's, asynchronous sequential counters, applications of counters.
MODULE IV	**A/D AND D/A CONVERTERS**
	Digital to analog converters: weighted resistor, converter, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter lCs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converter ICs.
MODULE V	**SEMICONDUCTOR MEMORIES AND PROGRAMMABLE LOGIC DEVICES**
	Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory(RAM), content addressable memory (CAM), charge de coupled device memory (CCD), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).

TEXTBOOKS

1. P Jain, "Modern Digital Electronics", McGraw Hill Education, 2009.

2. M M Mano, "Digital logic and Computer design", Pearson Education India, 2016.

REFERENCE BOOKS:

1. A Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.

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			
0	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	CO 1	T1:4.1
CONTENT DELIVERY (THEORY)			
1-5	Understand the need for digital systems, review of number systems, number base conversion	CO 1	T2:1.1-1.8, 2.2
6-7	Complements of numbers, codes-binary codes, BCD code and its Properties.	CO 1	T2:1.10,
8	Unit distance code, alphanumeric codes, and error detecting and correcting codes	CO 1	T2:2.7
9-10	Design and analyze the combinational circuits using TTL/CMOS logic	CO 1	T2:2.8
11-12	Design and analyze the sequential circuits using TTL/CMOS logic.	CO 1	T2:2.8
15-16	SIdentify basic building blocks of digital systems and Minimization using three variables; four variables; five variable K-Maps; Don't Care Conditions.	CO 2	T2:3.1-3.2
17-18	Design functions using universal gates. NAND and NOR Implementation; Other Two-Level Implementation; Exclusive –OR function. .	CO 2	T2:3.3-3.7
19-21	Combinational design, arithmetic circuits- adders, subtractors.	CO 2	T2:4.2,7.1-7.4
22-25	Design different combinational logic circuits comparators Multiplexers,	CO 2	T2: 7.6 7.7, 8.9-8.10
26-27	Demultiplexer, Decoder	CO 3	T3:1.1 R3:1.1-1.4
28-30	Understand the elementary ALU design	CO 3	T3:1.1-1.2 R3:1.5-1.7
31-32	popular MSI chips	CO 4	T3:1.3 R3:1.7,7.4
33-35	Combinational and sequential circuits, the binary cell, the Fundamentals of sequential machine operation.	CO 4	T3:3.1-3.4 R3:2.1-2.4
36-37	Flip-flop	CO 5	T3:3.3-3.5 R3:2.6

38-39	D-Latch Flip-flop.	CO 5	T3:5.1-5.3 R3:2.8,3.7-3.8
40-43	Clocked T Flip-flop.	CO 5	T4:5.1.-5.10 R3:3.6
44-45	Clocked JK Flip-flop.	CO 6	T3:4.4-4.6 T4: 5.11 R3:3.10
46-47	Shift Registers	CO 6	T4:6.1,6.4 R3:4.1-4.5
48-49	Synchronous, Asynchronous Counters	CO 7	T4:6.2-6.3,6.7 R3:4.8,4.11
50-51	Excitation tables of Flip-flops	CO 7	T4:6.3,6.10 R3:4.9-4.10
52-54	Discuss the classifications of data converters	CO 8	R2:7.5
55	Discuss and Analyze DAC techniques and characteristics.	CO 9	T4:7.1 R3:5.2-5.3
56-58	Discuss and Analyze ADC techniques and characteristics	CO 9	T4:7.2-7.6 R3:5.4-5.5
59-60	classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory (RAM),	CO 10	T4:7.7-7.10 R3:5.5
61	Discuss and analyze PLA, PAL, PLD	CO 11	T4:8.1-8.3 R3:6.1-6.2 R3:5.5
62	FPGA	CO 12	T4:8.4-8.7 R3:6.3-6.5
PROBLEM SOLVING/ CASE STUDIES			
9	Problems on number conversions	CO 1	T1: 1.1
10	Problems on Hamming code	CO 1	R3: 1.7
18	Derive the Boolean theorems and properties.	CO 1	T1: 2.1-2.6
19	Problems on 3 and 4 variable k-maps.	CO 2	T1: 6.1-6.6
30	Design the Decoder,Encoder.	CO 2	T1: 2.7-2.12

31	Design the multplexer and demultiplexer.	CO 2	T1: 2.7-2.12
32	Construct the registers using flipflops	CO 3	T1: 3.7-3.12
42	Design and construct the counters using flipflops.	CO 4	T1: 7.7-7.12
43	Design the analog to digital and digital analog converter	CO 5	T3: 1.7
44	Derive the specifications of analog to digital.	CO 5	T3: 1.7
51	Design the programmable logic devices using memories	CO 6	R4: 4.2
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Hamming code	CO 1	T1:4.1
57	Multiplexer and demultiplexer	CO 2	T2:4.1
58	Twisted ring counter	CO 3	T3:2.1
59	Analog to digital converter specifications.	CO 4	R4: 4.2
60	Programmable logic devices.	CO 5	T2:6.1
DISCUSSION OF QUESTION BANK			
61	Solve the given 8bit data word 01011011, generate the 12-bit composite word for the hamming code that corrects and detects single errors.	CO 1	T1:4.1
62	implify the following 3 variable expression using Boolean algebra Y = M(3, 5, 7)	CO 2	T2:4.1
63	Explain the working of 2 to 4 decoder and also implement a 2 to 4 decoder using 1 to 2 decoders.	CO 3	T3:2.1
64	Design a synchronous counter using JKFF to count the following sequence 0, 2, 5, 6 undesired states 1,3,4,7must go to 0 on the next clock pulse.	CO 5	R4: 4.2
65	Compare logic families of CMOS,TTL and ECL with their specifications.	CO 6	T2:6.1

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

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

COURSE DESCRIPTION

Department	**Electrical and Electronics Engineering**				
Course Title	**AC MACHINES LABORATORY**				
Course Code	AEEC13				
Program	B.Tech				
Semester	IV				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Mr. K Devender Reddy, Assistant Professor				

I COURSE PRE-REQUISITES AND CO-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEC07	III	DC Machines and Transformers
B.Tech	AEEC11	IV	AC Machines

II COURSE OVERVIEW:

This course is intended to train the students on alternating current machines. It provides hands-on experience by conducting various direct and indirect tests on transformers, synchronous and asynchronous machines to analyse the characteristics of AC machines and separate various losses. This course also enables to develop skills to select, install, operate, and maintain various types of AC machines and transformers

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
AC Machines Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner,

both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

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

Continuous Internal Assessment (CIA):

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

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

Continuous Internal Examination (CIE):

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

1. **Experiment Based**

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

2. **Programming Based**

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

VI COURSE OBJECTIVES:

The students will try to learn:

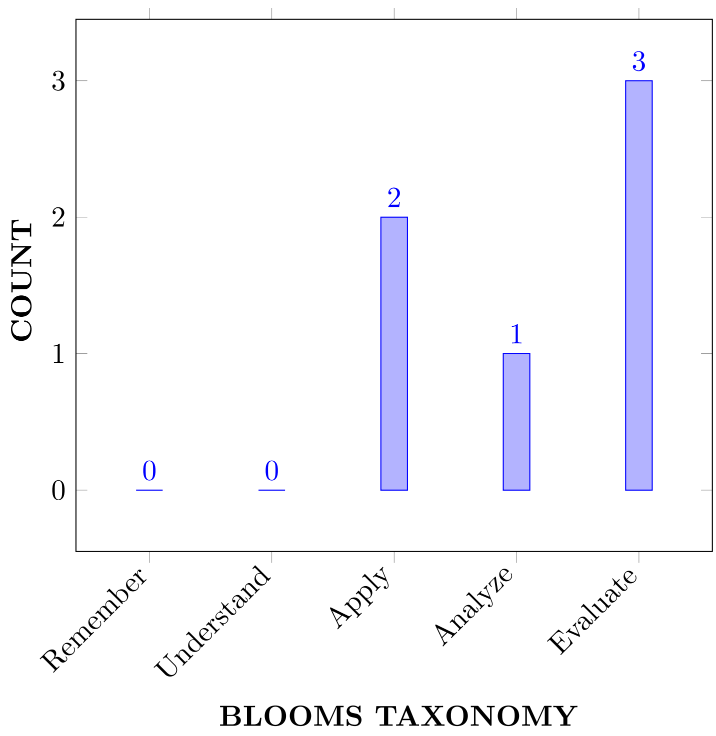
I	The elementary experimental and modelling skills for handling problems with electrical machines in industries and domestic applications.
II	The operation of AC machines and its role in power transmission and generating stations.
III	The automation concepts through programmable logic controllers to control the speed and starting current.

VII COURSE OUTCOMES:

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

CO 1	**Select** suitable testing strategies for evaluating the performance characteristics of transformers.	Apply
CO 2	**Determine** the performance parameters of induction motor by conducting direct and indirect tests.	Evaluate
CO 3	**Explain** the parallel operation of alternators for load sharing under various loading conditions.	Evaluate
CO 4	**Distinguish** the synchronous impedance and ampere turns methods for the computation of voltage regulation of an alternator.	Analyze
CO 5	**Estimate** the voltage and current swings in salient pole alternator for determination of direct and quadrature axis reactance.	Evaluate
CO 6	**Apply** programmable logic controllers for limiting the starting current of poly phase induction motors.	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.	3	Lab Exercises
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 Exercise
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 Exercise
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.	3	Lab Exercise
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
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	2	Lab Exercises
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	2	Lab Exercises
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 Exercise
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 Exercise

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Design, develop, fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization.	3	Lab Exercises
PSO 3	Gain the hands-on competency skills in PLC automation, process controllers, HMI and other computing tools necessary for entry level position to meet the requirements of the employer.	2	Lab Exercises

3 = High; 2 = Medium; 1 = Low

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

Course Outcomes	PO'S, PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies
CO 1	PO 1	Understand the performance characteristics of transformer using **principles of Mathematics and Engineering**	2
	PO 2	Solve the complex problems related to efficiency and characteristics of transformers and validate their specifications with **basics principles of mathematics and engineering sciences**.	7
	PO 3	Demonstrate the single phase transformer characteristics **for design solutions of complex engineering problems**	7
	PO 4	Understand the working of transformers using mathematical model under loaded and unloaded conditions **with analysis and interpretation of data**	9
	PO 6	Illustrate the working of transformers using mathematical model under loaded and unloaded conditions **for safety issues in professional engineering practice**	3
	PO 8	Understand the working of transformers using mathematical model under loaded and unloaded conditions **with ethical principles, professional ethics and responsibilities**	2
	PO 9	Demonstarte working of transformers using mathematical model under loaded and unloaded conditions **to function effectively as an individual and as a member in team**	6

	PO 10	**Communicate** effectively on **complex Engineering activities** with the Engineering community and with society at large, such as, being able to comprehend and**write effective reports** and **design documentation**, make effective presentation and give and receive clear instructions.	3
	PO 12	Understand the working of transformer using mathematical model under loaded and unloaded conditions **in life long learning in technological change**	4
	PSO 1	Understand different transformer connections in **Power transmission**	2
	PSO 3	Illustrate the working of transformers using mathematical model under loaded and unloaded conditions **in automation process using PLC and process controllers**	5
CO 2	PO 1	Understand the performance characteristics of poly phase induction motors and determine equivalent circuit parameters by applying the principles of **mathematics, science to the solutions of complex engineering problems**.	2
	PO 2	Solve the **complex engineering problems** related to efficiency and characteristics of induction motors and **validate** their specifications with **basics principles of mathematics and engineering sciences**.	4
	PO 3	Demonstrate the poly phase induction motor characteristics **for design solutions of complex engineering problems**	7
	PO 4	Understand the working of three phase induction motor using mathematical model under loaded and unloaded conditions **with analysis and interpretation of data**	9
	PO 6	Illustrate the working of three phase induction motor using mathematical model under loaded and unloaded conditions **for safety issues in professional engineering practice**	3
	PO 8	Understand the working of three phase induction motor using mathematical model under loaded and unloaded conditions **with ethical principles, professional ethics and responsibilities**	2
	PO 9	Function effectively as an individual, and as a member or leader in diverse teams for analyzing the importance winding factors.	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 presentation and give and receive clear instructions .	3
	PO 12	Understand the working of induction machines using mathematical model under loaded and unloaded conditions **in life long learning in technological change**	4

	PSO 1	Understand different function of different types of induction motors in **Power utilization**	2
	PSO 3	Illustrate the working of induction machines using mathematical model under loaded and unloaded conditions **in automation process using PLC and process controllers**	7
CO 3	PO 1	Apply the **(knowledge)** of load characteristics for the parallel operation of alternator by analyzing **complex engineering problems** using the principles of **mathematics, engineering science.**	2
	PO 2	Understand the load sharing capabilities and reliability of alternators using parallel operation under various loading conditions with**problem statement by analyzing complex engineering problems.**	7
	PO 3	Develop the load sharing capabilities and reliability of synchronous generators using parallel operation under various loading conditions **for design solutions of complex engineering problems**	7
	PO 4	Understand thethe load sharing capabilities and reliability of alternators using parallel operation under various loading conditions **with analysis and interpretation of data**	9
	PO 6	Illustrate the load sharing capabilities and reliability of AC generators using parallel operation under various loading conditions **for safety issues in professional engineering practice**	3
	PO 8	Understand the load sharing capabilities and reliability of AC generators using parallel operation under various loading conditions **with ethical principles, professional ethics and responsibilities**	2
	PO 9	Demonstarte the the load sharing capabilities and reliability of synchronous generators using parallel operation under various loading conditions **to function effectively as an individual and as a member in team**	6
	PO 10	**Communicate** effectively on **complex Engineering activities** with the Engineering community and with society at large, such as, being able to comprehend and**write effective reports** and **design documentation**, make effective presentation and give and receive clear instructions .	3
	PO 12	Understand the load sharing capabilities and reliability of AC generators using parallel operation under various loading conditions **in life long learning in technological change**	4
	PSO 1	Demonstrate the the load sharing capabilities and reliability of AC generators using parallel operation under various loading conditions **in power genration**	4

	PSO 3	Illustrate the load sharing capabilities and reliability of AC generators using parallel operation under various loading conditions **in automation process using PLC and process controllers**	7
CO 4	PO 1	Apply the **(knowledge)** of no load and load characteristics for computing voltage regulation by analyzing **complex engineering problems** using the principles of **mathematics, engineering science.**	2
	PO 2	Demonstrate synchronous impedance and ampere turns methods and apply these methods for **problem formulation** to determine the voltage regulation using **basic principles of mathematics.**	7
	PO 3	Demonstrate the synchronous impedance and ampere turns methods **for design solutions of complex engineering problems**	7
	PO 4	Understand the voltage regulation calculations by graphical methods **with analysis and interpretation of data**	9
	PO 6	Illustrate the synchronous impedance and ampere turns methods **for safety issues in professional engineering practice**	3
	PO 8	Understand the voltage regulation calculation methods **with ethical principles, professional ethics and responsibilities**	2
	PO 9	Demonstarte the voltage regulation calculation methods **to function effectively as an individual and as a member in team**	6
	PO 10	**Communicate** effectively on **complex Engineering activities** with the Engineering community and with society at large, such as, being able to comprehend and**write effective reports** and **design documentation**, make effective presentation and give and receive clear instructions .	3
	PO 12	Understand the synchronous impedence and ampere turns methods for **in life long learning in technological change**	4
	PSO 1	Demonstrate the voltage regulation calculations **in power genration**	4
	PSO 3	Illustrate the synchronous impedence and ampere turns methods of AC generators **in automation process using PLC and process controllers**	5
CO 5	PO 1	Understand the voltage and current swings in salient pole alternator using **principles of Mathematics and Engineering**	2
	PO 2	Analyze the phasor diagram of salient pole synchronous machine to understand mathematical equations of direct and quadrature axis components and validate their specifications with basic principles of mathematics and engineering science	7

	PO 3	Demonstrate the slip test **for design solutions of complex engineering problems**	7
	PO 4	Understand the direct axis and quadrature axis reactance calculations **with analysis and interpretation of data**	9
	PO 6	Illustrate the voltage and current swings in salient pole alternators **for safety issues in professional engineering practice**	3
	PO 8	Understand the direct and quadrature axis reactance calculations **with ethical principles, professional ethics and responsibilities**	2
	PO 9	Function effectively as an individual, and as a member or leader in diverse teams for analyzing the importance of voltage and current swings in synchronous motor	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 presentation and give and receive clear instructions.	3
	PSO 1	Illustrate the effect of voltage and current swings on power generation and its effect on inter connected devices in **power system.**	2
	PSO 3	Illustrate the voltage and current swings of synchronous motors **in automation process using PLC and process controllers**	5
CO 6	PO 1	Understand the starting methods of poly phase induction motor using **principles of Mathematics and Engineering**	2
	PO 2	Analyze the starting methods of poly phase induction motor using programmable logic controllers and validate their specifications with basic principles of mathematics and engineering science	7
	PO 3	Demonstrate programmable logic controllers for limiting the starting current **for design solutions of complex engineering problems**	7
	PO 4	Understand the programmable logic controllers application for limiting starting current **with analysis and interpretation of data**	9
	PO 5	Create, select, and apply appropriate techniques, resources, and **modern Engineering tools** for starting and speed control of poly phase induction motors using programmable logic controllers to complex Engineering activities with an understanding of the limitations.	1
	PO 6	Illustrate the function of PLCs for limiting starting current of three phase induction motors**for safety issues in professional engineering practice**	3

	PO 8	Understand the function of PLCs for limiting starting current of three phase induction motors **with ethical principles, professional ethics and responsibilities**	2
	PO 9	Function effectively as an individual, and as a member or leader in diverse teams for analyzing the importance PLCs in limiting the starting current in three phase induction motor	6
	PO 10	**Communicate** effectively on **complex Engineering activities** with the Engineering community and with society at large, such as, being able to comprehend and**write effective reports** and **design documentation**, make effective presentation and give and receive clear instructions .	3
	PSO 1	Illustrate the function of PLCs for limiting the starting current in three phase induction motor **power system.**	4
	PSO 3	Design the different control circuits using programmable logic controller and different tools necessary for entry level position to meet the Requirements of the Employer	7

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	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	-	2	-	3	3	3	-	2	3	0	2
CO 2	3	3	3	3	-	2	-	3	3	3	-	2	3	0	3
CO 3	3	3	3	3	-	2	-	3	3	3	-	2	3	0	3
CO 4	3	3	3	3	-	2	-	3	3	3	-	2	3	0	2
CO 5	3	3	3	3	-	2	-	3	3	3	-	2	3	0	2
CO 6	3	3	3	3	3	2	-	3	3	3	-	2	3	0	3

XIII ASSESSMENT METHODOLOGY DIRECT:

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

XIV ASSESSMENT METHODOLOGY INDIRECT:

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

XV SYLLABUS:

WEEK I	**OC AND SC TEST ON SINGLE PHASE TRANSFORMER**
	Determine the equivalent circuit parameters; predetermine the efficiency and regulation by open circuit and short circuit test on a single phase transformer.
WEEK II	**SUMPNER'S TEST**
	Predetermine the efficiency and regulation of two identical single phase transformers
WEEK III	**PARALLEL OF OPERATION OF SINGLE PHASE TRANSFORMERS**
	Determine load sharing by parallel operation of single phase transformer.
WEEK IV	**SCOTT CONNECTION OF TRANSFORMERS**
	Conversion of three phase to two phase using single phase transformers
WEEK V	**SEPARATION OF CORE LOSSES IN SINGLE PHASE TRANSFORMER**
	Find out the eddy current and hysteresis losses in single phase transformer
WEEK VI	**BRAKE TEST ON THREE PHASE SQUIRREL CAGE INDUCTION MOTOR**
	Plot the performance characteristics of three phase induction motor.
WEEK VII	**CIRCLE DIAGRAM OF THREE PHASE SQUIRREL CAGE INDUCTION MOTOR**
	Plot the circle diagram and predetermine the efficiency and losses of three phase squirrel cage induction motor.
WEEK VIII	**REGULATION OF ALTERNATOR BY EMF METHOD**
	Determine the regulation of alternator using synchronous impedance method.
WEEK IX	**REGULATION OF ALTERNATOR BY MMF METHOD**
	Determine the regulation of alternator using ampere turns method.
WEEK X	**SLIP TEST ON THREE PHASE SALIENT POLE SYNCHRONOUS MOTOR**
	Determination of Xd and Xq in a three phase salient pole synchronous motor
WEEK XI	**V AND INVERTED V CURVES OF SYNCHRONOUS MOTOR**
	Plot V and inverted V curves to study the effect of power factor in synchronous motor.
WEEK XII	**EQUIVALENT CIRCUIT PARAMETERS OF SINGLE PHASE INDUCTION MOTOR**
	Determine the equivalent circuit parameters of a single phase induction motor.
WEEK XIII	**HEAT RUN TEST ON SINGLE PHASE TRANSFORMERS**
	Determine the temperature rise in three single phase transformers set.
WEEK XIV	**STAR – DELTA STARTER OF INDUCTION MOTOR USING PLC**
	Implementation of star-delta starter using PLC.

TEXTBOOKS

1. P S Bimbhra, "Electrical Machinery", Khanna Publishers, 1^{st} Edition, 2011.

2. J B Guptha "Theory and performance of Electrical machines", S.K.Kataria and Sons Publishers 14^{th} Edition, 2009.

3. I J Nagrath and D P Kothari, "Electric Machines", McGraw Hill Education, 1^{st} Edition, 2010.

REFERENCE BOOKS:

1. M G Say, E O Taylor, "Direct Current Machines", Longman Higher Education, 1^{st} Edition, 2002.
2. A E Fitzgerald and C Kingsley, "Electric Machinery", New York, McGraw Hill Education, 1^{st} Edition, 2013

XVI COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
1	OC and SC test on single phase transformer.	CO 1	T2:1.21
2	Sumpner's test.	CO 1	T2:2.10
3	Load test on single phase transformers	CO 1	T2:1.19
4	Scott connection of transformers	CO 1	T2:2.5
5	Separation of core losses in single phase transformer.	CO 1	T2.1.19
6	Brake test on three phase squirrel cage induction motor.	CO 2	T2:7.29
7	Circle diagram of three phase squirrel cage induction motor	CO 2	T2:7.31
8	Regulation of alternator by EMF method.	CO 4	T2:3.17
9	Regulation of alternator by MMF method.	CO 4	T2:3.17
10	Slip test on three phase salient pole synchronous motor.	CO 5	T2:5.11
11	V and inverted v curves of synchronous motor.	CO 3	T2:5.13
12	Equivalent circuit parameters of single phase induction motor.	CO2	T2:10.7
13	Heat run test on single phase transformers.	CO 1	T2:2.3
14	Implementation of star-delta starter using PLC.	CO 6	T2:8.2

XVII EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Design two phase to three phase conversion system using single phase transformers.
2	Design parallel operation of alternators with synchro scope.
3	Design speed control of induction motor using digital simulation.
4	Design back-to-back connection of identical single phase transformers using digital simulation.
5	Design zero power factor method for calculating voltage regulation.

Signature of Course Coordinator **HOD, EEE**
Mr. K Devender Reddy, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTION

Course Title	**ANALOG AND DIGITAL ELECTRONICS LABORATORY**				
Course Code	AECC17				
Program	B.Tech				
Semester	IV	ECE			
Course Type	core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1
Course Coordinator	MS.V.Bindusree, Assistant Professor				

I COURSE OVERVIEW:

The objective of this laboratory course is to meet the requirements of practical work meant for components basics, analysis and design and provides hands-on experience by examining the characteristics of various semiconductor devices and measuring instruments. This lab covers the analysis of the characteristics of semiconductor devices and functionality of the digital circuits to use as elementary blocks in analog and digital circuit applications. Students will proficiency with the capability to use simulation tools for performing various analysis of semiconductor devices, combinational and sequential circuit applications.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
B.Tech	AECB02	III	Analog Electronics	4

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Analog and Digital Electronics 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 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	Lab Experiments / CIE / SEE

3 = High; 2 = Medium; 1 = Low

VII HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		**Strength**	**Proficiency Assessed by**
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	2	Lab Experiments / CIE / SEE

3 = High; 2 = Medium; 1 = Low

VIII COURSE OBJECTIVES:

The students will try to learn:

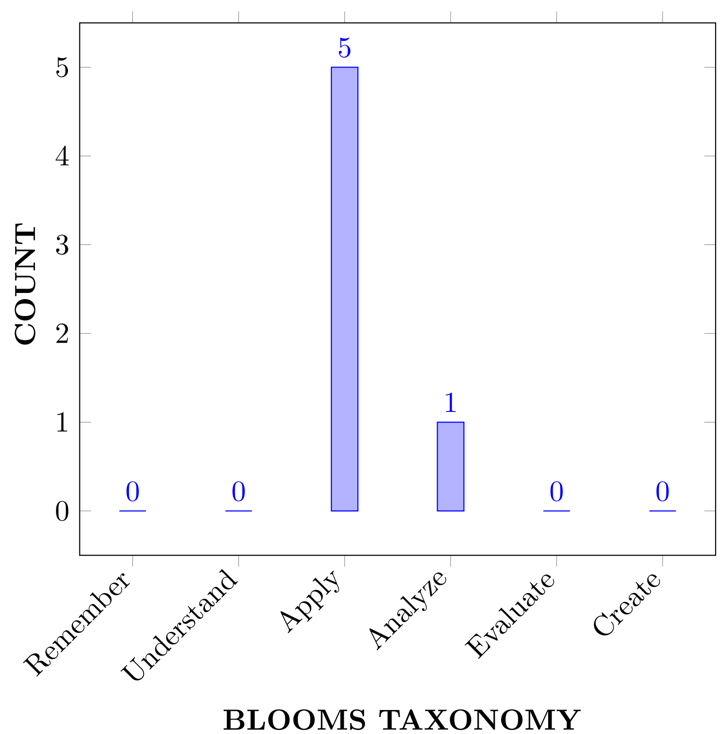
I	The characteristics and applications of diodes.
II	The characteristics of transistor in different configurations.
III	The function and applications of gates.
IV	The different combinational circuits.

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 PN junction characteristics for the diode applications such as half wave and full wave rectifier	Apply
CO 2	**Apply** the volt-ampere characteristics of PN junction diode,Zener diode for finding cut-in voltage,static and dynamic resistance	Apply
CO 3	**Analyze** the input and output characteristicsof transistor configurations for determining the input-output resistances.	Analyze
CO 4	**Identify** the functionality of Boolean expressions using gates such as and,or,not,nand,nor,xor and xnor	Apply
CO 5	**Build** combinational circuits such as adder, subtractor, multiplexers and comparators realization using low level elementary blocks.	Apply
CO 6	**Construct** shift registers using the functionality of the flip flops.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



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

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

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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 2	**Understand** the given diode application **problem statement** and finding the **solution implementation** of rectifier circuits by **analyzing complex engineering problems**	3
	PO 10	communicate effectively on **complex Engineering activities** with the engineering community with society at large such as being able to comprahend and **write effective reports** and **design documentation,**make **effective presentations** and give and recieve clear instructions	4
	PS01	**Design**and **Develop** the rectifier circuit aplications in the field of intelligent technologies	2
CO 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,science and engineering**	5
	PO 10	**Able to communicate effectively** on engineering activities	1

CO 3	PO 2	**Understand** the input and output transistor configuration for **problem formulation** to determine the transistor characteristic parameters such as input-output resistance,current gain and voltage gain **using mathematical principles**	3
	PO 10	Communicate effectively on **complex engineering activities**with the engineering community and with society at large,and being able to comprehend and **write effective reports** and **design documentation,**make **effective presentations** and give and recieve clear instructions	4
CO 4	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 5	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
	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	Communicate effectively on **complex engineering activities**with the engineering community and with society at large,and being able to comprehend and **write effective reports** and **design documentation,**make **effective presentations** and give and recieve clear instructions	4
CO 6	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

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

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	-	30	-	-	-	-	-	-	-	80	-	-	100	-	-
CO 2	-	50	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 3	-	30	-	-	-	-	-	-	-	80	-	-	-	-	-
CO 4	-	30	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 5	-	50	30	-	100	-	-	-	-	80	-	-	-	-	-
CO 6	-	30	-	-	100	-	-	-	-	20	-	-	-	-	-

XIV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

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

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

COURSE OUTCOMES	**PROGRAM OUTCOMES**												**PSO'S**		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	1	-	-	-	-	-	-	-	3	-	-	2	-	-
CO 2	-	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	-	1	-	-	-	-	-	-	-	3	-	-	-	-	-
CO 4	-	1	-	-	3	-	-	-	-	1	-	-	-	-	-
CO 5	-	2	1	-	3	-	-	-	-	3	-	-	-	-	-
CO 6	-	1	-	-	3	-	-	-	-	1	-	-	-	-	-
TOTAL	**0**	**8**	**1**	**0**	**9**	**0**	**0**	**0**	**0**	**12**	**0**	**0**	**2**	**0**	**0**
AVERAGE	**0**	**1.3**	**1**	**0**	**3**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**2**	**0**	**0**

XV ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-	Assignments	-
Laboratory Prac-tices	✓	Student Viva	✓	Mini Project	-	Certification	
Term Paper	-	5 Minutes Video	-	Open Ended Experi-ments	✓	-	-

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	**UNDERSTAND THE PN JUNCTION DIODE CHARACTERISTICS**
	Verify the V-I characteristics of pn junction diode
Week-2	**UNDERSTAND THE ZENER DIODE CHARACTERISTICS AND VOLTAGE REGULATOR.**
	Verify the V-I characteristics of zener diode and how it works as regulator.
Week-3	**UNDERSTAND HALF WAVE AND FULL WAVE RECTIFIER WITH AND WITHOUT FILTER**
	Verify the operation of half wave and full wave rectifier with and without filter.
Week-4	**TRANSISTOR CE CHARACTERISTICS**
	Verification of Input and Output characteristics of CE configuration using hardware
Week-5	**TRANSISTOR CB CHARACTERISTICS**
	Verification of Input and Output characteristics of CB configuration using hardware
Week-6	**FREQUENCY RESPONSE OF CE AMPLIFIER**
	Determine the Gain and Bandwidth of CE amplifier using hardware
Week-7	**BOOLEAN EXPRESSIONS USING GATES**
	Realization of Boolean Expressions using Gates
Week-8	**UNIVERSAL GATES**
	Design and realization of logic gates using universal gates
Week-9	**NAND / NOR GATES**
	Generation of clock using NAND / NOR gates
Week-10	**ADDER/ SUBTRACTOR**
	Design a 4 – bit Adder / Subtractor
Week-11	**BINARY TO GRAY CONVERTER**
	Design and realization of a 4 – bit gray to Binary and Binary to Gray Converter
Week-12	**TRUTH TABLES AND EXCITATION TABLES**
	Verification of truth tables and excitation tables
Week-13	**SHIFT REGISTER**
	Design and realization of an 8 bit parallel load and serial out shift register using flip-flops
Week-14	**MULTIPLEXER**
	Design and realization of 8x1 using 2x1 MUX

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. Jacob Millman, Herbert Taub, Mothiki S PrakashRao, ―Pulse Digital and Switching Waveforms‖, Tata McGraw-Hill, 3rd Edition, 2008.
2. David A. Bell, ―Solid State Pulse Circuits‖, PHI, 4th Edition, 2002.
3. D Roy Chowdhury, ―Linear Integrated Circuits‖, New Age International (p) Ltd, 2nd Edition, 2003.
4. Ramakanth A. Gayakwad, ―Op-Amps linear ICs‖, PHI, 3rd Edition, 2003.

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	Understand the pn junction diode characteristics.	CO1	T1 13.2
2	Understand the Zener diode characteristics and voltage regulator.	CO2	T1 14.5
3	Understand half wave and full wave rectifier with and without filter	CO3	T1 14.8
4	Analyze input and output CE characteristics	CO3	T1 15.5 -15.9
5	Analyze input and output CB characteristics	CO3	T1 15.17
6	Understand the frequency response of CE amplifier.	CO3	T1 15.16
7	Understand Boolean expressions using gates	CO4	T1 16.1,
8	Understand universal gates	CO4	R4 4.1
9	Understand Nand / nor gates	CO4	R4 4.2
10	Understand adder/ subtractor	CO5	R4 4.3
11	Understand binary to gray conversion	CO5	R4 4.6
12	Verify truth tables and excitation tables	CO5	R4 4.10
13	Realize shift register	CO6	R4 5.6
14	Realize 8x1 multiplexer	CO6	R4 5.9
15	Realize 2 bit comparator	CO6	R4 5.10

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

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

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

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTION

Course Title	**CONTROL SYSTEMS LABORATORY**				
Course Code	AEEC14				
Program	B.Tech				
Semester	IV	EEE			
Course Type	Core				
Regulation	IARE - UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	K Harshini, Assistant Professor				

I COURSE OVERVIEW:

The Control Systems laboratory course is indeed to train the students practically on the modelling, analysis and design of linear feedback control systems. This course deals with modelling of dynamical systems, and the control components and designing the compensator. The hands on training in the laboratory enable students to apply and modelling control principles in various areas of industrial applications.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSC07	II	Mathematical Transform Techniques
B.Tech	AEEC05	III	Network Analysis
B.Tech	AEEC07	III	DC Machines and Transformers
B.Tech	AEEC12	IV	Control Systems

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Control Systems 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 estimation of stability of dynamical systems using Digital simulation.
II	The various techniques of modeling and analysing system's performance.
III	Design the time and frequency response of system by both classical and modern techniques.

VII COURSE OUTCOMES:

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

CO 1	**Make use of** the knowledge of digital simulation tool for system analysis with different standard inputs .	Apply
CO 2	**Model** the dynamic systems in transfer function using digital simulation tool and validate the performance characteristics of motors.	Apply
CO 3	**Analyse** and select various electronics devices for improving system performance along with tuning mechanism in virtual environment.	Analyse
CO 4	**Experiment** the types of compensation techniques for improving the system's accuracy	Apply
CO 5	**Analyse** the system's stability in time and frequency domain by computing gain and phase margin.	Analyse

COURSE KNOWLEDGE COMPETENCY LEVEL

VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Lab Exercises

PO 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
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
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
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	2	Lab Exercises
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	2	Lab Exercises
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	textbfCommunication: Communicate effectively on complex engineering activities with the engineering community and with society 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	Lab Exercises
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	2	Lab Exercises

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Design, develop, fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization.	2	Lab Exercises
PSO 2	Focus on the components of electrical drives with its converter topologies for energy conversion, management and auditing in specific applications of industry and sustainable rural development.	1	Lab Exercises
PSO 3	Gain the hands-on competency skills in PLC automation, process controllers, HMI and other computing tools necessary for entry level position to meet the requirements of the employer.	3	Lab Exercises

3 = High; 2 = Medium; 1 = Low

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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Understands the standard test signals using the**fundamentals of mathematics, science, and engineering fundamentals**	3
	PO 2	Formulate the standard test signals using the**using first principles of mathematics and engineering sciences**	3
	PO 3	Understand the (**Problem Solving**) for step input at various gain levels and, analysis the data, and using the (complex Engineering problems)	3
	PO 4	Understand the (**research-based knowledge**) step response for second order at various gain levels and, analysis and interpretation of data (provided **synthesis of the information to provide valid conclusions**)	3
	PO 5	Analyse (**computational and experimental tools**) of various dynamic systems into transfer function **for analysing systems performance using digital simulation**	1
	PO 6	Apply the (**knowledge**) to assess societal issues and the consequent responsibilities relevant to the professional engineering practice. **the professional engineering practice.**	2
	PO 8	Apply the (**ethical principles**) to assess second order responses for step input as per the **norms of the engineering practice**	2

	PO 9	Understands the (**Individual and team work**) to assess second order responses for step input as per the **multidisciplinary**and as a member or leader in diverse teams	2
	PO 10	Understands the (**Communication**) effectively on complex engineering activities with the engineering community and with society and design documentation **multidisciplinary**and as a member or leader in diverse teams	2
	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 Apply (**Life-Long Learning**) recognize the need of it and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	2
	PSO 1	Understands (**knowledge**) the basics of various test signals and apply to the RLC network which involves in **transmission and distribution of Electrical Energy**	2
	PSO 2	Understands (**knowledge**) the basics of various test signals and apply to the RLC network which involves in **transmission and distribution of Electrical Energy**	2
CO 2	PO 1	Explain (understand) the characteristics of electrical and mechanical physical systems **using principles of mathematics, science, and engineering fundamentals.**	2
	PO 2	Formulate the (given **problem statement**) the mathematical equations for a governing system (from the provided **framed using basics of mathematics and engineering sciences**) in solving analysis problems.	4
	PO 5	Analyse (**computational and experimental tools**) of various plots in time and frequency domain **for improving the system performance using virtual tools**	1
	PSO 2	Understands (**knowledge**) the working of components in servomotors which **specify the applications of industry and sustainable rural development.**	2
CO 3	PO 1	Summarize (**knowledge**) the characteristics of types of controllers **using principles of mathematics, science, and engineering fundamentals.**	1
	PO 2	Formulate the (given **problem statement**) the mathematical equations for a electronic devices (from the provided **framed using basics of mathematics and engineering sciences**) in solving analysis problems.	4
	PO 5	Analyse (**computational and experimental tools**) of the electronic devices **for improving the system performance using virtual tools**	1

	PSO 2	Understands (knowledge) the characteristics of P, I, D, PID controllers which in solving aircraft analysis problems by applying the **specify the applications of industry and sustainable rural development.**	3
CO 4	PO 1	Understand (knowledge) the characteristics of(apply) types of compensators **using principles of mathematics, science, and engineering fundamentals.**	3
	PO 3	Understand the (**Problem Solving**) for types of compensator s and, analysis the data, and (provided **synthesis of the information to provide valid conclusions**)	3
	PO 5	Analyse (**computational and experimental tools**) of various compensators schemes **for improving the system performance using virtual tools**	1
	PSO 2	Understands (knowledge) the characteristics of compensators which**specify the applications of industry and sustainable rural development.**	3
CO 5	PO 1	Understand the concept of Root Locus, Bode Plots and Nyquist Plot to determine stability using **mathematical principles** basic fundamentals of mathematics science and engineering fundamentals. **engineering fundamentals** of control systems.	2
	PO 2	Determine the **problem statement** stability performance in time and frequency domain transfer function of control system for **interpretation** using basics of mathematics and engineering sciences.	2
	PO 5	Analyse (**computational and experimental tools**) of various plots in time and frequency domain **for improving the system performance using virtual tools**	1

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

COURSE OUTCOMES	PROGRAM OUTCOMES											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	2	1	3	2	-	1	2	3	-	1
CO 2	3	2	2	2	2	2	-	1	3	3	-	1
CO 3	3	1	2	2	2	2	-	2	3	3	-	2
CO 4	3	1	2	2	3	2	-	1	2	3	-	1
CO 5	3	1	2	2	3	2	-	2	2	3	-	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	**TIME RESPONSE OF SECOND ORDER SYSTEM**
	To obtain the time response of a given second order system with time domain specifications.
WEEK II	**TRANSFER FUNCTION OF DC MOTOR**
	Determine the transfer function, time response of DC motor and verification with digital simulation.
WEEK III	**AC SERVO MOTOR**
	Study of AC servomotor and plot its torque speed characteristics.
WEEK IV	**EFFECT OF VARIOUS CONTROLLERS ON SECOND ORDER SYSTEM**
	Study the effect of P, PD, PI and PID controller on closed loop second order systems.
WEEK V	**COMPENSATOR**
	Study lead-lag compensator and obtain its magnitude, phase plots.
WEEK VI	**TEMPERATURE CONTROLLER**
	Study the performance of PID controller used to control the temperature of an oven.
WEEK VII	**DESIGN AND VERIFICATION OF OP-AMP BASED PID CONTROLLER**
	Implementation of op-amp based PID Controller and verification using MATLAB.
WEEK VIII	**STABILITY ANALYSIS USING DIGITAL SIMULATION**
	Stability analysis using root locus, Bode plot, Polar, Nyquist criterions of linear time invariant system by digital simulation.
WEEK IX	**STATE SPACE MODEL USING DIGITAL SIMULATION**
	Verification of state space model from transfer function and transfer function from state space model using digital simulation.
WEEK X	**LINEAR SYSTEM ANALYSIS (TIME DOMAIN ANALYSIS USING MATLAB)**
	To write a program and simulate dynamical system of I/O model

WEEK XI	**CONTROL SYSTEM DESIGN TOOLS USING LABVIEW**
	Study the various control system design tools in LABVIEW
WEEK XII	**DC MOTOR SPEED CONTROL**
	Study the speed control of DC Motor using LABVIEW on the Quanser Controls Board
WEEK XIII	**DC MOTOR POSITION CONTROL**
	Study the position control of DC Motor using LABVIEW on the Quanser Controls Board
WEEK XIV	**STABILITY ANALYSIS USING LABVIEW**
	Study the stability of a system using LABVIEW on the Quanser Controls Board

TEXTBOOKS

1. Norman S. Nise, "Control Systems Engineering", John Wiley Sons, Inc., 6th Edition, 2004.
2. J Nagrath, M Gopal, "Control Systems Engineering", New Age International, 3rd Edition,2007.
3. John W. webb, Ronald A.Reis, "Programmable Logic Controllers, Principles and Applications",5th Edition, 2002.
4. A Nagoor Kani, "Control Systems", RBA Publications,1st Edition, 2009.

REFERENCE BOOKS:

1. 1. Benjamin Kuo, "Automatic Control Systems", PHI, 7th Edition, 1987.
2. 2. K Ogata, "Modern Control Engineering", Prentice Hall, 4th Edition, 2003.

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	Time response of Second Order system.	CO 1	T1:2.1
2	Transfer function of DC motor.	CO 2	T1:3.1
3	Characteristics of Ac Servo Motor	CO 3	T1:3.11
4	Effect of various Controllers on second order systems	CO 4	T1:4.8
5	Compensator.	CO 4	T1:4.8
6	Temperature Controller.	CO 4	T1.5.5
7	Design and verification of Op-Amp Based PID Controller.	CO 4	T1:5.6
8	Stability Analysis Using Digital Simulation.	CO 5	T1:8.3
9	State Space Model Using Digital Simulation.	CO 6	T1:8.3
10	Linear System Analysis (Time Domain Analysis using Matlab).	CO 1	T1:2.1
11	Control System Design Tools Using Labview.	CO 6	T1:8.3
12	DC Motor Speed Control.	CO 2	T1:3.1
13	DC Motor Position Control	CO 2	T1:3.1
14	Stability Analysis Using Labview.	CO 5	T1:8.3

XVI EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	**Design the lead compensator using MATLAB:** Modelling of lead compensator using Matlab to study its characteristics .
2	**Controllers using LABVIEW:** Develop the circuits of Controllers for analysing the performance using LABVIEW .
3	**Step Response of system using LABVIEW:** Design various control system circuits using LABVIEW .
4	**Stability Analysis:** Study the stability of a given system by root locus, Bode plot, Nyquist plot using LABVIEW .
5	**Inverted Pendulum:** Study the Inverted Pendulum of DC Motor using LABVIEW on the Quanser Controls Board

Signature of Course Coordinator **HOD,EEE**
K Harshini, Assistant Professor

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

COURSE DESCRIPTION

Department	**Electrical and Electronics Engineering**				
Course Title	**Electrical Energy Conservation and Auditing**				
Course Code	AEEC20				
Program	B.Tech				
Semester	V				
Course Type	Elective				
Regulation	UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr. M Laxmidevi Ramanaiah, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEC07	III	DC Machines and Transformers
B.Tech	AEEC10	IV	Electrical Power Generation Systems
B.Tech	AEEC11	IV	AC Machines

II COURSE OVERVIEW:

This course is aimed to introduce the fundemental topics of Energy conservation and Energy Audit and Management including general philosophy , procedures and techniques, evaluation of saving opportunities, energy audit report, energy policy planning and implementation, energy balance and MIS and energy audit instruments . This course also covers the concepts of energy efficiency technologies in industrial and in electrical systems

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Electrical Measurements and Instrumentation	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 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
60%	Understand
40%	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):

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

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

Continuous Internal Examination (CIE):

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

Quiz - Online Examination

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

Alternative Assessment Tool (AAT)

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

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

VI COURSE OBJECTIVES:

The students will try to learn:

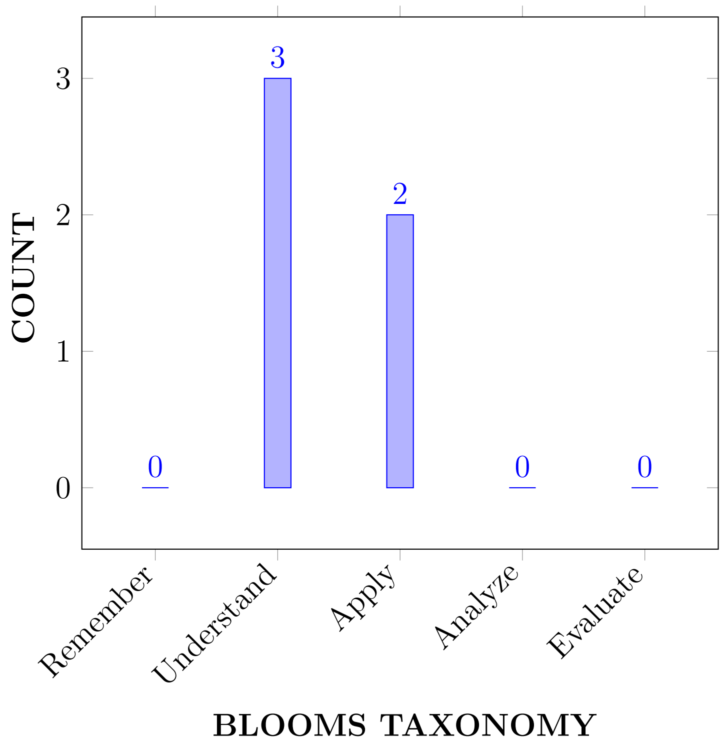
I	Explain the current energy scenario and importance of energy conservation.
II	Understand the concepts of energy management.
III	Discuss the methods of improving energy efficiency in different electrical systems.
IV	Understand the concepts of different energy efficient devices.

VII COURSE OUTCOMES:

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

CO 1	**Summarize** the current energy scenario, environmental impact,energy sector reforms for policy programmes and implementation of energy conservation activities by the government	Understand
CO 2	**Illustrate the types, methods and instruments** the types, methods and instruments for conducting energy audit .	Understand
CO 3	**Interpret** the impact of power factor improvement, load management, maximum demand control for improving energy efficiency in electrical systems.	Understand
CO 4	**Identify** the energy efficiency of systems used in industries such as compressed air systems, fans, blowers, pumps and pumping systems	Apply
CO 5	**Make use of** energy efficient technologies in view of energy saving potential in electrical systems	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 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 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	3	SEE/CIE/AAT
PO 10	**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.	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 Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	1	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	✓	✓	✓	✓	-	-	-	-	-	✓	-	-	-	-	-

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	**Knowledge** of the different energy resources available to meet the current energy needs of the country and government policies.	3
	PO 2	**Identify t** the existing energy resources to analyze the complex engineering problems.	4
	PO 7	**Understand the impact** of energy conservation on the environment	2
	PO 10	Demonstrate the ability to communicate effectively in writing /orally to obtain the solutions for problems to minimize errors in PMMC, MI and electrostatic instruments.	2
CO 2	PO 1	Apply the knowledge of different sectors **scientific principles and mathematical principles** for energy efficiency and conservation	3
	PO 2	textbfIdentify energy conservation issue using engineering sciences and Collect the data using the instruments to perform energy audit	5
	PO 10	Demonstrate the ability to communicate effectively in writing /orally for minimizing phase angle error and ratio error to operate at desired specifications of electrical components in power systems.	2

Course Outcomes	**PO'S PSO'S**	**Justification for mapping (Students will be able to)**	**No. of Key competencies matched.**
CO 3	PO 1	Knowledge of energy conservation to understand engineering problems,	2
	PO 2	Identify and analyze complex engineering problems such as power factor improvement, electrical load management, energy efficiency in electrical systems from the information and data collected and validate the results.	3
	PO 10	Demonstrate the ability to communicate effectively in writing /orally to find solutions to power system problems.	2
CO 4	PO 1	ARecall the concepts of thermal energy which form the basis of engineering fundamentals	3
	PO 2	Review the different types of cooling towers and their working and provide solutions to improve their efficiency by applying the principles of engineering sciences and Analyze the efficiency aspect of fans, blowers, pumps and pumping systems using the principles of engineering	4
	PSO 1	Energy conservation is an important aspect of electrical engineer's function to solve current and future energy problems.	1
	PO 10	Demonstrate the ability to communicate effectively in writing /orally to understand the problems based on passive parameters.	2
CO 5	PO 1	Recall the importance of energy saving using different technologies and Knowledge of engineering fundamentals in electrical systems	3
	PO 2	Understand the working of motors and analyze the efficiency aspect of electrical motors using the principles of engineering.	3
	PO 3	Design energy efficient motors, transformers	5
	PO 4	Instruments provide the limitations of the processes in electrical and industrial systems and thus can be used for industrial applications	5
	PO 10	Demonstrate the ability to communicate effectively in writing /orally to understand non-electrical parameter measurement.	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	4	-	-	-	-	2	-	-	2	-	-	-	-	-
CO 2	3	5	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 3	3	3	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 4	3	4	-	-	-	-	-	-	-	2	-	-	-	1	-
CO 5	3	3	5	5	-	-	-	-	-	2	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	40	-	-	-	-	66.7	-	-	40	-	-	-	-	-
CO 2	100	40	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 3	100	30	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 4	100	40	-	-	-	-	-	-	-	40	-	-	-	9.1	-
CO 5	100	30	50	45.5	-	-	-	-	-	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	-	-	-	-	3	-	-	1	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	3	1	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	2		-	-	-	-	-	-	1	-	-	-	1	-
CO 5	3	1	2	2	-	-	-	-	-	1	-	-	-	-	-
TOTAL	15	8	2	2	-	-	3	-	-	5	-	-	-	1	-
AVERAGE	3	1.6	2	2	-	-	3	-	-	1	-	-	-	1	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

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

XVII ASSESSMENT METHODOLOGY-INDIRECT:

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

XVIII SYLLABUS:

MODULE I	**ENERGY SCENARIO**
	Commercial and Non-commercial energy: Primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long, medium and short term energy scenarios, energy pricing, energy sector reforms, energy and environment, energy security, conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution ,climate change. Energy Conservation Act-2001 and its features.
MODULE II	**ENERGY MANAGEMENT AND AUDIT**
	Energy audit: Need, types, approach understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.
MODULE III	**ENERGY EFFICIENCY IN ELECTRICAL SYSTEMS**
	Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity and heat transfer, units and conversion; Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, efficiency, factors of performance, losses in induction motors, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

MODULE IV	**ENERGY EFFICIENCY IN INDUSTRIAL SYSTEMS**
	Compressed air system: Types of air compressors, efficiency, efficient compressor operation, compressed air system components, capacity assessment, leakage test, factors of performance and savings opportunities in HVAC; Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities; Pumps and pumping system: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities; Cooling tower: Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities, assessment of cooling towers
MODULE V	**ENERGY EFFICIENT TECHNOLOGIES IN ELECTRICAL SYSTEMS**
	Maximum demand controllers: Automatic power factor controllers, energy efficient motors, Automatic power factor controllers, energy efficient motors, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.

TEXTBOOKS

1. A K Sawhney, —Electrical and Electronic measurement and instruments, Dhanpat Rai and Sons Publications, 2002

2. E W Golding and F C Widdis , Electrical measurements and measuring instruments,Wheeler publishing, 2006

REFERENCE BOOKS:

1. Buckingham and Price, —Electrical measurements, Prentice Hall

2. D V S Murthy, Transducers and Instrumentation, Prentice Hall of India, London, 2009.

3. A S Morris, Principles of measurement of instrumentation, Pearson/Prentice Hall of India, 1994.

4. H S Kalsi,Electronic Instrumentation, Tata McGraw-Hill Publications, 1995.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/105/108105153/

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	Presentation on Outcome based education		
CONTENT DELIVERY (THEORY)			
2	Commercial and Non-commercial energy: Primary energy resources, commercial energy production, final energy consumption	CO 1, CO 2	T2: 1.1-1.5, T1: 4.1

3	Energy needs of growing economy, long, medium and short term energy scenarios, energy pricing	CO 1	T2: 2.1-2.2, R1: 3.1
4	Energy needs of growing economy, long, medium and short term energy scenarios, energy pricing	CO 1	T2: 2.1-2.2, R1: 3.1
5	Energy sector reforms, energy and environment	CO 1	T2: 2.3-2.4
6	Energy sector reforms, energy and environment	CO 1	T2: 2.3-2.4
7	Energy security, conservation and its importance, restructuring of the energy supply sector	CO 1	T2: 2.5-2.6,
8	Energy security, conservation and its importance, restructuring of the energy supply sector	CO 1	T2: 2.5-2.6,
9	Energy strategy for the future, air pollution ,climate change. Energy Conservation Act-2001 and its features.	CO 2	T2: 3.3
10	Energy strategy for the future, air pollution ,climate change. Energy Conservation Act-2001 and its features.	CO 2	T2: 3.3
11	Energy audit: Need, types, approach understanding energy costs	CO 2	T2: 3.4
12	Energy audit: Need, types, approach understanding energy costs	CO 2	T2: 3.4
13	Bench marking, energy performance, matching energy use to requirement	CO 2	T2: 3.3
14	Bench marking, energy performance, matching energy use to requirement	CO 2	T2: 3.3
15	Maximizing system efficiencies, optimizing the input energy requirements, fuel &energy substitution	CO 2	T2: 4.2
16	Maximizing system efficiencies, optimizing the input energy requirements, fuel &energy substitution	CO 2	T2: 4.2
17	Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation	CO 3	T2: 5.1
18	Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation	CO 3	T2: 5.1
19	Electrical load management and maximum demand control	CO 3	T2: 5.2
20	Electrical load management and maximum demand control	CO 3	T2: 5.2
21	Power factor improvement and its benefit, selection and location of capacitors	CO 4	T2: 4.5
22	Power factor improvement and its benefit, selection and location of capacitors	CO 4	T2: 4.5
23	Performance assessment of PF capacitors, distribution and transformer losses	CO 4	T1: 4.1
24	Performance assessment of PF capacitors, distribution and transformer losses	CO 4	T1: 4.1
25	Electric motors: Types, efficiency	CO 5	T1: 4.2
26	Electric motors: Types, efficiency	CO 5	T1: 4.2

27	Climate change	CO 5	T1: 4.3
28	Climate change	CO 5	T1: 4.3
29	Factors of performance	CO 5	T2: 5.2
30	Factors of performance	CO 5	T2: 5.2
31	Losses in induction motors	CO 5	T2: 5.2
32	Losses in induction motors	CO 5	T2: 5.2
33	Rewinding and motor replacement issues	CO 5	T2: 5.2
34	Rewinding and motor replacement issues	CO 5	T2: 5.2
35	Election of materials for spacecraft for specific requirement	CO 5	T1: 7.2
36	Election of materials for spacecraft for specific requirement	CO 5	T1: 7.2
37	Automatic power factor controllers	CO 5	T1: 7.5
38	Energy saving opportunities with energy efficient motors.s	CO 5	T1: 7.5
39	Energy saving potential of each technology	CO 5	R2:7.5
40	Energy saving potential of each technology	CO 5	R2:7.5
41	Energy saving potential of each technology	CO 5	R2:7.5
PROBLEM SOLVING/ CASE STUDIES			
43	Energy needs of growing economy, long, medium and short term energy scenarios, energy pricing	CO 1	T2: 2.1-2.2, R1: 3.1
44	Energy security, conservation and its importance	CO 1	T2: 2.5-2.6,
45	Restructuring of the energy supply sector	CO 1	T2: 2.5-2.6,
46	Energy strategy for the future	CO 2	T2: 3.3
47	air pollution ,climate change. Energy Conservation Act-2001 and its features.	CO 2	T2: 3.3
48	Energy audit: Need, types,	CO 2	T2: 3.4
49	Energy audit: approach understanding energy costs	CO 2	T2: 3.4
50	Bench marking, energy performance	CO 2	T2: 3.3
51	matching energy use to requirement	CO 2	T2: 3.3
52	Maximum demand meter	CO 3	T2: 4.2
53	Optimizing the input energy requirements, fuel &energy substitution	CO 2	T2: 4.2
54	Power factor improvement and its benefit	CO 4	T2: 4.5
55	Electric motors: Types, efficiency	CO 5	T1: 4.2
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Energy reforms	CO 1	T1:1.1,6.1 8.1
57	Energy audit and managemen	CO 2	T1:14.1, 19.1
58	Energy efficiecy of electrical systems	CO 3	T1:10.1, 11.1

59	Energy efficiecy of mechanical systems	CO 4	T1:13.1, 16.1
60	Energy efficient devices	CO 5	T1:25.1, 21.1
DISCUSSION OF QUESTION BANK			
61	Energy scenario	CO 1	T1:1.1,6.1, 8.1
62	Energy audit and management	CO 2	T1:14.1, 19.1
63	Electrical systems	CO 3	T1:10.1, 11.1
64	Industrial systems like fans, blowers	CO 4	T1:13.1, 16.1
65	Energy efficient motors, transformers	CO 5	T1:25.1, 21.1

Signature of Course Coordinator **HOD,EEE**
Dr M Laxmidevi Ramanaiah

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

ANNEXURE - II

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	PSO Statement / Key Competencies Features (KCF)	No. of KCF(s)
PSO 1	Design, develop, fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization. 1. Operate, control and protect electrical power system. 2. Validate the interconnected power system. 3. Ensure reliable, efficient and compliant operation of electrical systems. 4. Familiarize the safety, legal and health norms in electrical system. 5. Adopt the engineering professional code and conduct.	**5**
PSO 2	Focus on the components of electrical drives with its converter topologies for energy conversion, management and auditing in specific applications of industry and sustainable rural development. 1. Control the electric drives for renewable and non-renewable energy sources. 2. Fabricate converters with various components and control topologies. 3. Synthesis, systematic procedure to examine electrical components/machines using software tools. 4. Inspect, survey and analyze energy flow. 5. Control and manage the power generation and utilization. 6. Familiarize the safety, legal and health norms in electrical system. 7. Adopt the engineering professional code and conduct. 8. Explore autonomous power 9. Evolve into green energy and assess results 10. Realize energy policies and education 11. Potential contribution of clean energy for rural development.	**11**
PSO 3	Gain the hands-on competency skills in PLC automation, process controllers, HMI and other computing tools necessary for entry level position to meet the requirements of the employer. 1. Explicit software and programming tools for electrical systems. 2. Adopt technical library resources and literature search. 3. Model, program for operation and control of electrical systems. 4. Constitute the systems employed for motion control. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

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

COURSE DESCRIPTION

Department	**Electrical and Electronics Engineering**				
Course Title	**Electrical Power Transmission systems**				
Course Code	AEEC15				
Program	B. Tech				
Semester	V				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Mrs. T Saritha Kumari, Assistant Professor, EEE				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEC05	III	Network Analysis
B.Tech	AEEC10	IV	Electrical Power Generating Systems

II COURSE OVERVIEW:

Electrical Power Transmission Systems deals with the modeling, analysis and design of electrical power transmission lines. It gives an emphasis on overhead line insulators, underground cables, transient behavior of the lines, corona phenomena, Extra High Voltage Alternating Current (EHVAC) and High Voltage Direct Current (HVDC) transmission system.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Electrical Power Transmission systems	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	✓	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
5%	Remember
50 %	Understand
40%	Apply
5 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

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

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

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

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

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

VI COURSE OBJECTIVES:

The students will try to learn:

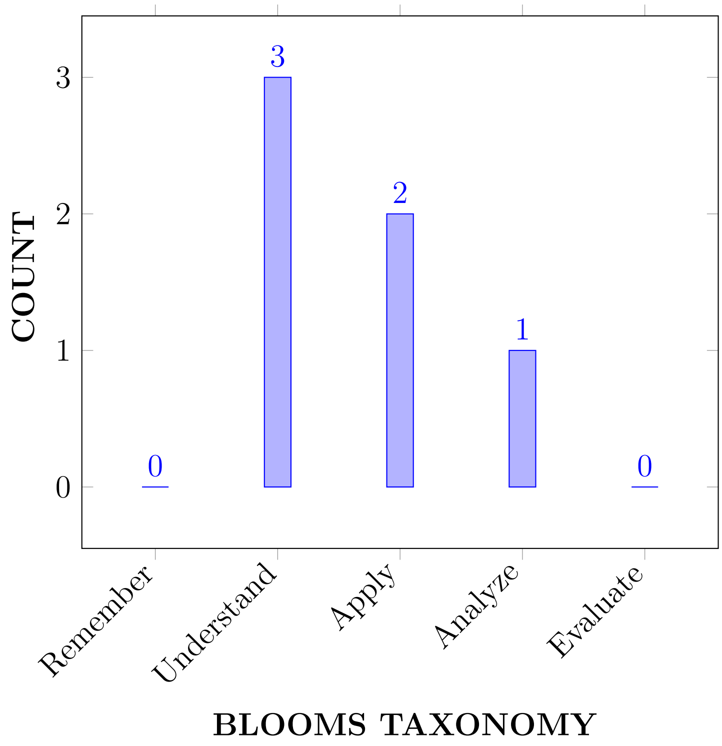
I	The mathematical solutions for transmission line parameters of a single phase and three phase system.
II	The mechanical design of overhead transmission lines, the use of insulators and underground cables in electrical power transmission system.
III	The mathematical modeling of short, medium and long transmission linesalong with the transient behavior.
IV	The Extra High Voltage Alternating Current (EHVAC) and High Voltage Direct Current (HVDC) transmission systems used for transmitting electrical power to consumers.

VII COURSE OUTCOMES:

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

CO 1	**Compute** the line parameters of a single phase and three phase transmission lines using the concepts of Geometric Mean Radius (GMR) and Geometric Mean Distance (GMD).	Apply
CO 2	**Discuss** about ovehead line insulators, string efficiency, sag and tesion parameters which are used in the mechanical design of transmission lines.	Understand
CO 3	**Classify** the transmission lines and model them using ABCD constants to evalutate the performance of tranmission system.	Apply
CO 2	**Discuss** the concepts of skin effect, proximity effect, Ferranti effect, surge impedance and corona effect in electrical power transmission inorder to improve the performance of lines.	Understand
CO 3	**Analyze** the power system transients under different loding conditions of tranmission line using circuit concepts and Bewley's lattice diagram method.	Analyze
CO 6	**Describe** the EHV, HVDC and Underground transmission systems along with its parameters which affects the efficiency and quality operation of power system.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

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

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	CIE/AAT/SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	CIE/AAT/SEE
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	CIE/AAT/SEE
PO 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	CIE/AAT/SEE

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involving Power generation, Transmission, Distribution and Utilization.	2	CIE/AAT/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 2	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 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 knowledge of **mathematics,science and electrical engineering fundamentals** and apply them to calculate the resistance, inductance and capacitance of transmission lines.	3
	PO 2	**Identify** the type of tranmsiision line, Formulate the equations to calculate the transmission line parameters using the **first principles of mathematics, science and engineering.**	6
	PO 3	**Develop** the solutions for complex netwroks involving double ciruit lines, neighbouring communicaton system by effectively **designing** the tranmission system.	5
	PO 10	**Demonstrate** the process of developing the equations of calculation of inductance and capacitance using the conscept of GMR and GMD using the PPT presentation and wtriting the technical paper.	3
	PSO 1	**Analyze** the types of overhead transmission line systems and **develop** the equations for transmission line inductance and capacitance using the concepts of GMR and GMD.	3
CO 2	PO 1	**Classify** the types of overhead insulators and calcualte the string efficiency, sag and tension by applying the e **knowledge of science, engineering fundamentals.**	3

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 2	**Develop** the equations for determining the string efficiency and sag of ovehead lines using the **principles of mathematics, science and engineering fundamentals.**	5
	PO 10	**Explain** the importance of string efficiency and methods of improving it by using the PPT presentation and wtriting the technical paper.	3
	PSO 1	**Investigate** the methods available to increase the string efficiency or voltage distribution across a string of insulators and to increse the flexibility of tranmission system.	23
CO 3	PO 1	**Classify** the types of transmission lines based on the distance and define the performance parameters of lines using the **knowledge of science, engineering fundamentals.**	3
	PO 2	**Analyze** the performance parameters (efficiency and regulation) of lines using the ABCD constants using the first **principles of mathematics, and engineering sciences.**	6
	PO 3	**Develop** the mathematical **solutions** by mathematical **modeling** of transmission lines and solve **the complex engineering problems** related to these lines.	5
	PO 10	**Demonstrate** the classification of tranmission lines and the performance calculations using the PPT presentation and wtriting the technical paper.	3
	PSO 1	**Analyze** the performance of short, medium and long transmission lines using the ABCD constants and observe the Ferranti effect in transmission line system.	3
CO 2	PO 1	**Define** the skin effect, proximity effect, Ferranti effect and corona effect from the **knowledge of science, engineering fundamentals.**	3
	PO 2	**Analyze** the surge impedance and surge impedance loading of lines and also **identify the solutions** to minimize the skin effect, proximity effect, Ferranti effect and corona effect using the **principles of mathematics, natural sciences, and engineering sciences.**	4
	PO 10	**Describe** the different types of effects like proximity effet, skin effect, corona effect in transmission system using the PPT presentation and wtriting the technical paper.	3
CO 3	PO 1	**Understand** the incident, reflected and refracted waves and specifications of travelling waves from the **basic knowledge of science and engineering fundamentals.**	3
	PO 2	**Analyze** the travelling wave under different loading conditions using the **principles of mathematics, natural sciences, and engin eering sciences.**	5

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 3	**Solve** the **complex engineering problems** related to travelling waves using Bewley's lattice diagram.	4
	PO 10	**Explain** the transients in power systems and effects of trasnsients under different loading conditions using the PPT presentation and wtriting the technical paper.	3
	PSO 1	**Investigate** the causes for surges in electrical power system and **analyze** the surges which are propagating in the form of a travelling wave and suggest the methods to minimize the effect of surges.	2
CO 6	PO 1	Know the insulation resistance, capacitance and dielectric stress of cables and **Compare** the EHVAC and HVDC transmission systems from the basic **knowledge of science and engineering fundamentals.**	3
	PO 2	**Analyze** the dielectric stress in cables and HVDC links using the **principles of mathematics and engineering sciences.**	5
	PO 10	**Discuss** the importance of HVDC and EHV transmission in power trasmission system using the PPT presentation and wtriting the technical paper.	3
	PSO 1	**Analyze** the underground cable operating parameters such as insulation resistance, capacitance and dielectric stress and know the Indian electricity rules and HVDC tranmission systems in India **suggest** the methods to get uniform dielectric stress in cable and to improve the power tranmission system.	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	6	5	-	-	-	-	-	-	3	-	-	3	-	-
CO 2	3	5	-	-	-	-	-	-	-	3	-	-	3	-	-
CO 3	3	6	5	-	-	-	-	-	-	3	-	-	3	-	-
CO 2	3	4	-	-	-	-	-	-	-	3	-		-	-	-
CO 3	3	5	4	-	-	-	-	-	-	3	-	-	2	-	-
CO 6	3	5	-	-	-	-	-	-	-	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
CO 1	100	60	50	-	-	-	-	-	-	60	-	-	60	-	-
CO 2	100	50	-	-	-	-	-	-	-	60	-	-	60	-	-

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

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

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

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

1 -5 <C$\leq$ 40% – Low/ Slight

2 - 40 % <C < 60% –Moderate

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	-	-	-	-	-	-	3	-		3	-	-
CO 2	3	2	-	-	-	-	-	-	-	3	-	-	3	-	-
CO 3	3	3	2	-	-	-	-	-	-	3	-	-	3	-	-
CO 2	3	1	-	-	-	-	-	-	-	3	-		-	-	-
CO 3	3	2	1	-	-	-	-	-	-	3	-	-	1	-	-
CO 6	3	2	-	-	-	-	-	-	-	3	-		1	-	-
TOTAL	18	13	5	-	-	-	-	-	-	18	-	-	- 11	-	-
AVERAGE	3.0	2.16	1.67	-	-	-	-	-	-	3.0	-	-	2.2	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

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

XVII ASSESSMENT METHODOLOGY-INDIRECT:

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

XVIII SYLLABUS:

MODULE I	**TRANSMISSION LINE PARAMETERS**
	Transmission line parameters: Types of conductors, calculation of resistance for solid conductors, description and effect of resistance on solid conductors, calculation of inductance for single phase and three phase, single and double circuit lines, concept of GMR, GMD, symmetrical and asymmetrical conductor configuration with and without transposition, Skin and Proximity effect ; Numerical Problems: Calculation of capacitance for 2 wire and 3 wire systems, effect of ground on capacitance, capacitance calculations for symmetrical and asymmetrical single and three phase, single and double circuit lines, numerical problems.
MODULE II	**MECHANICAL DESIGN OF TRANSMISSION LINES**
	Overhead line insulators: Types of insulators, string efficiency and methods for improvement, numerical problems, voltage distribution, calculation of string efficiency, capacitance grading and static shielding, testing of insulators; Sag and tension calculations: Sag and tension calculations with equal and unequal heights of towers, effect of wind and ICE on weight of conductor, numerical problems, stringing chart and sag template and its applications; mechanical design of typical towers and conductors for 400KV, 220KV and 132KV operations
MODULE III	**PERFORMANCE OF TRANSMISSION LINES**
	Performance of short and medium length transmission lines: Classification of transmission lines, short, medium and long line and their model representations, nominal-T, nominal-Pie and A, B, C, D constants for symmetrical and asymmetrical networks, numerical problems, mathematical solutions to estimate regulation and efficiency of all types of lines, numerical problems.
	Performance of long transmission lines: Long transmission line, rigorous solution, evaluation of A, B, C, D constants, representation of long lines, equivalent-T and equivalent Pie network models (numerical problems); Ferranti effect, charging current, effect on regulation of the transmission line, surge impedance and SIL of long lines, wave length and velocity of propagation of waves.
MODULE IV	**POWER SYSTEM TRANSIENTS AND FACTORS GOVERNING PERFORMANCE OF TRANSMISSION LINES**
	Power systems transients: Incident reflected and refracted waves, Types of system transients, travelling or propagation of surges, attenuation, distortion, reflection and refraction coefficients, termination of lines with different types of conditions, open circuited line, short circuited line, T-junction, lumped reactive junctions (numerical problems), Bewley's lattice diagrams (for all the cases mentioned with numerical examples); Corona, description of the phenomenon, factors affecting corona, critical voltages and power loss, radio interference, Electrostatic and electromagnetic interference with communication lines.

MODULE V	UNDERGROUND CABLES, EHV TRANSMISSION AND HVDC TRANSMISSION
	Underground cables: Types of cables, construction, types of insulating materials, calculation of insulation resistance and stress in insulation, numerical problems, capacitance of single and 3core belted cables, numerical problems, grading of cables, capacitance grading, numerical problems, description of inter-sheath grading, HV cables. Need of EHV transmission systems, types of DC links, comparison of AC and DC transmission, advantage of DC transmission, HVDC systems in India.

TEXTBOOKS

1. D P Kothari and I J Nagrath, "Power System Engineering", McGraw-Hill Education, 2nd Edition, 2007.
2. V K Mehta and Rohit Mehta, "Principles of Power System", S Chand, 3rd revised Edition, 2015.
3. D Das, "Electrical Power systems", New age international publishers, 2nd edition, 2006.
4. K R Padiyar, "HVDC transmission Systems", New age international publishers, 2nd edition, 2005.
5. B R Guptha, "Power system analysis and Design" S. Chand Publishing, 2nd edition, 1998.

REFERENCE BOOKS:

1. C L Wadhwa, "Electric Power Systems", New age publications, New Delhi, 9th Edition, 2007.
2. Turan Gonen, "Electrical Power Distribution System Engineering", CRC Press, 3rd Edition, 2014.
3. V Kamaraju, "Electrical Power Distribution Systems", TMH, Publication, Edition 2009.
4. Singh S N, "Electric Power Generation, Transmission and Distribution", Prentice Hall of India Pvt. Ltd., New Delhi, 2nd Edition, 2002.

XIX COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	-
CONTENT DELIVERY (THEORY)			
2	Introduction, Types of conductors	CO 1	T1: 2.1-2.5, R1:2.2- 2.8
3	Calculation of resistance for solid conductors, description and effect of resistance on solid conductors, skin effect and proximity effect	CO 1	T1: 2.11, R1:2.13

4	Calculation of inductance for single phase line	CO 1	T1: 2.3, R1:2.1-2.3
5	Calculation of inductance for three phase line	CO 1	T1: 2.4, R1:2.4
6	Single and double circuit lines, concept of GMR, GMD	CO 1	T1: 2.6, R1:2.5
7	Inductance of bundled conductors and double circuit transmission line	CO 1	T1: 2.7, R1: 2.11
8	Capacitance for 3 wire line symmetrical and asymmetrical line	CO 1	T1: 2.8, R1: 2.6-2.7
9	Capacitance for bundled conductor line and double circuit line.	CO 1	T1: 2.8, R1: 2.6-2.7
10	Effect of ground on capacitance	CO 1	T1: 2.9, R1: 2.10
11	Overhead line insulators: properties, materials used and types of insulators	CO 2	T2: 8.4-8.5, R1: 81
12	String efficiency and methods for improvement	CO 2	T2: 8.6, R1: 8.2
13	Testing of insulators	CO 2	T2: 8.4-8.5, R1: 81
14	Sag and tension calculations with equal and unequal heights of towers, Effect of wind and ICE on weight of conductor	CO 2	T2: 8.15& 8.16
15	Stringing chart, sag template and its applications, Mechanical design of typical towers and conductors for 400KV, 220KV and 132KV operations	CO 2	T2: 8.16, R1: 7.4&7.5
16	Classification of transmission lines, modeling, equivalent representation and performance of short lines	CO 3	T1: 5.1-5.2, R1: 4.1-4.2
17	Modeling of nominal –T and Nominal –Pie representation of medium lines.	CO 3	T1:5.3, R1: 4.3
18	Modeling and performance of long transmission line using rigorous solution	CO 3	T1:5.4, R1:4.4
19	Evaluation of ABCD constants of long lines, Equivalent-T and equivalent-Pie representation of long lines	CO 3	T1: 5.4, R1:4.5
20	Ferranti effect, charging current, effect on regulation of the transmission line	CO 4	T1:5.6, R1: 4.6
21	Surge impedance and SIL of long lines, wave length and velocity of propagation of waves.	CO 4	T1:5.5, R1:4.4
22	Introduction to power system transients: types, causes and effects of transients	CO 5	T5:12.1, R1: 12.1
23	Travelling or propagation of surges/waves and their specifications	CO 5	T5:12.5-12.8, R1: 12.4
24	Reflection and refraction coefficients of a line in open circuit and short circuit conditions	CO 5	T5:12.9-12.10, R1: 12.4
25	Reflection and refraction coefficients of a line terminated by passive elements and with T-junction (Forked line)	CO 5	T5:12.12, R1: 12.4

26	Attenuation and distortion of travelling waves	CO 5	T5:12.15, R1: 12.5
27	Reflection and refraction coefficients of a line terminated by lumped passive elements	CO 5	T5:12.13, R1: 12.4
28-29	Bewley's lattice diagrams for all types of lines	CO 5	T5:12.14, R1: 12.4
30	Corona, description of the phenomenon, factors affecting corona, critical voltages and power loss	CO 4	T2:14.1-14.9, R1: 6.1 & 6.2
31	Radio interference, Electrostatic and electromagnetic interference with communication lines	CO 4	T3: 14.10, R1: 6.5 & 6.6
32	Underground cables: Construction, types of insulating materials	CO 2	T2: 11.1 -11.5, R1: 9.1&9.9
33	Types of cables	CO 2	T2: 11.1 -11.5, R1: 9.1&9.9
34	Calculation of insulation resistance and capacitance in insulation of a single core cable	CO 6	T2:11.7-11.10, R1: 9.4 & 9.5
35	Calculation of Dielectric stress on single core cables	CO 6	T2:11.7-11.10, R1: 9.4 & 9.5
36	Capacitance of 3-core belted cables	CO 6	T2:11.7-11.10, R1: 9.4 & 9.5
37	Grading of cables: description of capacitance grading and inter-sheath grading	CO 6	T2:11.11-11.13
38	Need of EHV transmission systems, comparison of AC and DC transmission with advantages and disadvantages	CO 6	T4:1.4, R1:5.4
39	Comparision of AC and DC tranmission systems	CO 6	T4:1.2, R1: 5.16
40	HVDC transmission and HVDC links	CO 6	T4:1.2, R1: 5.16
41	HVDC systems in India	CO 6	T4:1.2, R1: 5.16
PROBLEM SOLVING/ CASE STUDIES			
42	Numerical Problems to calculate inductance of single phase and three phase line	CO 1	T1: 3.4, R1: 3.4
43	Numerical Problems to calculate inductance of bundled conductor line and double circuit line	CO 1	T1: 3.5, R1: 3.5
44	Numerical Problems to calculate capacitance of single phase and three phase line	CO 1	T1: 3.9, R1: 3.6
45	Numerical Problems to calculate capacitance of bundled conductor line	CO 1	T1: 3.7, R1: 3.7
46	Numerical Problems to calculate capacitance of double circuit line	CO 1	T1: 3.1-3.7, R1: 3.1-3.7

47	Numerical problems to calculate string efficiency	CO 3	T2: 8.7, R1: 8.2
48	Numerical problems to calculate sag and tension	CO 3	T2: 8.4-8.7, R1: 8.1-8.2
49	Numerical problems to evaluate performance of short and medium transmission lines	CO 3	T1:5.1-5.3, R1:4.1-4.3
50	Numerical problems to evaluate performance of long lines	CO 3	T1:5.1-5.3, R1:4.1-4.3
51	Problems on Ferranti effect, surge impedance and SIL of long lines	CO 6	T1: 5.4 -5.10, R1:4.4-4.6
52	Numerical problems on power system transients	CO 5	T5:12.1-12.15, R1: 12.1-12.4
53	Numerical Problems on corona	CO 4	T2: 14.1-14.10, R1: 6.1-6.6
54	Numerical problems on resistance, capacitance of cables	CO 6	T2: 11.7-11.10, R1: 9.1-9.5
55	Numerical problems on dielectric stress of cables	CO 6	T2: 11.7-11.10, R1: 9.1-9.5
56	Numerical problems on grading of cables	CO 6	T2:11.11-11.13
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Skin effect, Proximity effect, inductive reactance spacing factor, transposition of lines	CO 6	T1: 2.1-2.10
58	String efficiency, safety factor of insulators, sag and tension on lines, sag template, stringing chart	CO 3	T2: 8.4-8.7
59	Propagation constant, characteristic impedance, surge impedance and surge impedance loading, wave length, velocity of propagation of waves	CO 3	T1: 5.1-5.7
60	Incident and reflected waves, attenuation and distortion, corona, critical disruptive voltage	CO 5	T5:12.1-12.14
61	Insulation resistance, dielectric stress, capacitance grading, inter sheath grading	CO 6	T2:11.1-11.13
DISCUSSION OF QUESTION BANK			
62	Module I: Transmission line parameters	CO 1	T1: 2.1-2.10
63	Module II: Mechanical design of transmission lines	CO 2	T2: 8.4-8.7
64	Module III: Performance of transmission lines	CO 3	T1: 5.1-5.7
65	Module IV: Power system transients	CO 5	T5:12.1-12.14
66	Module V: Underground cables	CO 6	T2:11.1-11.13

Signature of Course Coordinator **HOD,EEE**

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

ANNEXURE - II

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	PSO Statement / Key Competencies Features (KCF)	No. of KCF(s)
PSO 1	Design, develop, fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization. 1. Operate, control and protect electrical power system. 2. Validate the interconnected power system. 3. Ensure reliable, efficient and compliant operation of electrical systems. 4. Familiarize the safety, legal and health norms in electrical system. 5. Adopt the engineering professional code and conduct.	**5**
PSO 2	Focus on the components of electrical drives with its converter topologies for energy conversion, management and auditing in specific applications of industry and sustainable rural development. 1. Control the electric drives for renewable and non-renewable energy sources. 2. Fabricate converters with various components and control topologies. 3. Synthesis, systematic procedure to examine electrical components/machines using software tools. 4. Inspect, survey and analyze energy flow. 5. Control and manage the power generation and utilization. 6. Familiarize the safety, legal and health norms in electrical system. 7. Adopt the engineering professional code and conduct. 8. Explore autonomous power 9. Evolve into green energy and assess results 10. Realize energy policies and education 11. Potential contribution of clean energy for rural development.	**11**
PSO 3	Gain the hands-on competency skills in PLC automation, process controllers, HMI and other computing tools necessary for entry level position to meet the requirements of the employer. 1. Explicit software and programming tools for electrical systems. 2. Adopt technical library resources and literature search. 3. Model, program for operation and control of electrical systems. 4. Constitute the systems employed for motion control. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

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

COURSE DESCRIPTION

Department	**Electrical and Electronics Engineering**				
Course Title	**Power Electronics**				
Course Code	AEEC16				
Program	B.Tech				
Semester	V				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	3	2
Course Coordinator	Dr. Ranjith kumar Gatla, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEC05	III	Network Analysis
B.Tech	AECC07	III	Analog Electronic

II COURSE OVERVIEW:

The course focuses on presenting concepts for conversion, control and monitoring of electrical energy using power semiconductor devices. Methods for analyzing power electronic converters suitable for DC/AC, DC/DC, AC/AC and AC/DC electrical energy conversions including regulators are presented. Additionally, principles for designing power electronic converters, including their power semiconductors and passive elements are established. The applications of power electronics in the fields of sustainable energy technologies, switched mode power supplies and uninterruptible power supplies as well as application of power electronic converters for transmission, distribution and control in the power systems is described.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Power Electronics	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

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

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

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

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

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

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

VI COURSE OBJECTIVES:

The students will try to learn:

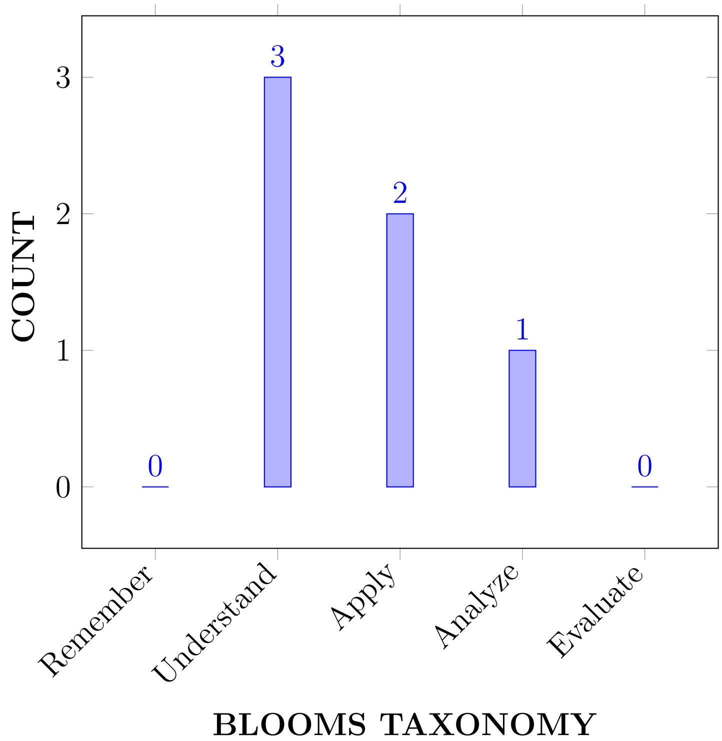
I	The concepts on power semiconductor devices related to its characteristics, ratings, and protection to select these devices for various applications.
II	The fundamental principles and control techniques of power electronic converters for analyzing AC/DC, DC/DC, AC/AC and DC/AC power conversion circuits.
III	The application of power electronic converters in the fields of battery management system, industrial drive applications and enhancement of power quality.

VII COURSE OUTCOMES:

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

CO 1	**Explain** the static and dynamic characteristics of power semiconductor devices used for power conversion in converter circuits.	Understand
CO 2	**Summarize** the various firing circuits and commutation techniques useful for accurate switching function of the SCR.	Understand
CO 3	**Analyze** the performance parameters of ac-dc converters under various loading conditions.	Analyze
CO 4	**Identify** the switching techniques and control strategies in switched mode regulators and perform steady state analysis in the chopper circuit.	Apply
CO 5	**Demonstrate** single phase ac voltage controllers and cyclo converter used for converting fixed ac supply into variable ac output	Understand
CO 6	**Apply** modulation and switching topologies in inverters for output voltage control.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

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

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

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

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

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involving Power generation, Transmission, Distribution and Utilization.	2	AAT
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	1	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	✓	✓	-	-	-	-	-	-	-	-	-	✓	✓	✓	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO(s)		
	PO 1	PO 2	PO 3	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	Power semi conductor devices are described (Knowledge) through **mathematically** sound and **physics-based models** and circuits made with these devices, capacitor and inductor are analyzed by the **application of first order differential equations**.	3
	PO 2	Understand the given **problem** and **choose** appropriate devices to achieve **desired output** based on performance characteristics of devices.	3
	PO 6	**Understand** the characterstics of power semiconductor devices used in converters for assessment of societial and safety issues **with responsibilities relevant to the professional engineering practice**	1
	PO 12	**Recognize** the need for and having the preparation and ability to engage in independent and life-long learning in the context of optimal selection of power devices.	2
	PSO 1	Make use of semiconductor devices for **fabricating** the power electronic systems used in various stages of utilization of electrical energy.	1
CO 2	PO 1	**Identify** the suitable commutation technique, protection and the isolation techniques of thyristors and understand their operation by applying the **principles of mathematics science and engineering fundamentals**. Principles of **energy efficiency** and **heat transfer** are also addressed.	3
	PO 2	Understand problems associated with SCRs during turn on/off and apply this knowledge in design and analysis of protection circuits and commutation circuits by using **first principles of mathematics and engineering sciences**.	3
	PO 12	**Recognize** the need for and having the preparation and ability to engage in independent and life-long learning in the context of energy conversion systems.	2
	PSO 1	Make use of the protection and commutation techniques for the circuits associated with power electronic devices for smooth operation while **energy conversion**.	1

CO 3	PO 1	AC-DC converters comprises of semiconductor devices, resistors, capacitors and inductors. The principle of operation and characteristics of such devices are explained by **applying engineering fundamentals including device physics** and deduce the expressions using **mathematical principles**.	3
	PO 2	Design (formulate) ac-dc converter for power electronics systems to meet given objectives (problem statement & formulation) under realistic constraints. Designs are tested (validation) through numerical simulation or hardware implementation (experimental design), and modifications are implemented as needed (interpretation of results) using **first principles of mathematics and engineering sciences**.	5
	PO 12	**Recognize** the need for and having the preparation and ability to engage in independent and life-long learning in the context of optimal selection of power devices to design rectifier.	4
	PSO 1	**Design and simulate** converter circuits to rectify electrical energy in various applications. .	1
	PSO 2	Utilize DC-DC converters to constant and reliable energy for **applications** includes mobile chargers, electric vehicles and **industrial drives**.	1
CO 4	PO 1	Identify (Knowledge) suitable switching techniques and control strategies to operate DC-DC converters with the **Knowledge of mathematics, science and engineering fundamentals related to electrical engineering**.	3
	PO 2	Design (formulate) dc-dc converter for power electronics systems to meet given objectives (problem statement & formulation). Designs are tested (validation) through numerical simulation or hardware implementation (experimental design), and modifications are implemented as needed (interpretation of results) **using first principles of science and mathematics**	6
	PO 4	**Identify the Various switching techniques** to apply the different control stratagies and understand the corresponding **context of engineering knowledge related** to the performance indicators and measures in the switched mode regulators	6
	PO 12	**Recognize** the need for and having the preparation and ability to engage in independent and life-long learning in the context of designing the regulated power supplies using chopper circuits.	4
	PSO 1	**Design** the converter circuits to perform DC-DC conversion and interpret the results through **simulation** and hardware implementation.	1
	PSO 2	Make use of ac-dc converters for **energy conversion** to operate electrical drives in various **applications**.	1

CO 5	PO 1	Analyze AC voltage controller circuits using **fundamentals of engineering and science** including the application of **first order differential equations** in the roles of capacitance and inductance in power electronics circuits.	3
	PO 2	Identify the problems associated with conversion of fixed AC supply into variable output and apply suitable control to achieve desired output. The developed models and control strategies are validated through numerical simulation or hardware implementation and modifications are implemented as needed (interpretation of results) **using first principles of science and mathematics**	5
	PO 12	**Recognize** the need for and having the preparation and ability to engage in independent and life-long learning in the context of designing the AC voltage cotroller.	4
	PSO 1	**Design** the converter circuits to perform AC-AC conversion to achieve desired voltage output and interpret the results through **simulation** and hardware implementation.	1
	PSO 2	Make use of ac-ac converters for **energy conversion** to control the speed of electrical drives used in **industrial applications**.	1
CO 6	PO 1	Explain the concepts and working principle involved in inverter circuits with **the knowledge of mathematics, science and engineering fundamentals related basic electrical and electronics**.	3
	PO 2	Select a suitable switching technique for inverter to obtain **desired** output voltage. The techniques and corresponding models are **validated** through numerical simulation or hardware implementation and results are **interpreted using first principles of mathematics and engineering fundamentals**.	5
	PO 3	The **design** of inverter systems includes interfacing with alternate energy sources and improvement of **energy efficiency**, both of which are tied into the **global, economic, environmental and societal context**.	4
	PO 12	**Recognize** the need for and having the preparation and ability to engage in independent and life-long learning in the context of designing the Inverter circuit.	4
	PSO 1	**Design** the inverter circuit to perform DC-AC conversion and interpret the results through **simulation** and hardware implementation.	1
	PSO 2	Make use of inverters to drive the **appliances** and other **devices** connected to it by energy conversion.	1

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO(s)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	-	-	-	1	-	-	-	-	-	2	1	-	-
CO 2	3	3	-	-	-	-	-	-	-	-	-	4	1	-	-
CO 3	3	5	-	-	-	-	-	-	-	-	-	4	1	1	-
CO 4	3	6	-	6	-	-	-	-	-	-	-	4	1	1	-
CO 5	3	5	-	-	-	-	-	-	-	-	-	4	1	1	-
CO 6	3	5	4	-	-	-	-	-	-	-	-	4	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	100	30	-	-	-	20	-	-	-	-	-	25	50	-	-
CO 2	100	30	-	-	-	-	-	-	-	-	-	50	50	-	-
CO 3	100	50	-	-	-	-	-	-	-	-	-	50	50	33.3	-
CO 4	100	60	-	54.5	-	-	-	-	-	-	-	50	50	33.3	-
CO 5	100	50	-	-	-	-	-	-	-	-	-	50	50	33.3	-
CO 6	100	50	40	-	-	-	-	-	-	-	-	50	50	33.3	-

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	1	-	-	-	1	-	-	-	-	-	1	2	-	-
CO 2	3	1	-	-	-	-	-	-	-	-	-	2	2	-	-
CO 3	3	2	-	-	-	-	-	-	-	-	-	2	2	1	-
CO 4	3	3	-	2	-	-	-	-	-	-	-	2	2	1	-
CO 5	3	2	-	-	-	-	-	-	-	-	-	2	2	1	-
CO 6	3	2	1	-	-	-	-	-	-	-	-	2	2	1	-
TOTAL	18	11	1	2	-	1	-	-	-	-	-	11	12	4	-
AVERAGE	3	2	1	1	-	1	-	-	-	-	-	2	2	1	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

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

XVII ASSESSMENT METHODOLOGY-INDIRECT:

	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**POWER SWITCHING DEVICES**
	Thyristor, MOSFET, IGBT: I-V Characteristics; R, RC and UJT firing circuit for thyristor; Gate drive circuits for MOSFET and IGBT. Series and parallel operation of thyristors, ratings, protection against dv/dt and di/dt, design of Snubber circuit, forced commutation circuits, other devices in thyristor family: TRIAC, GTO and their characteristics, numerical problems.
MODULE II	**PHASE CONTROLLED RECTIFIERS**
	Single phase half wave and single phase full wave (Mid-Point and Bridge configurations) thyristor rectifier with R- load and highly inductive load; derivation of average load voltage and current, effect of freewheeling diode, effect of source inductance
MODULE III	**CHOPPERS**
	Basic chopper operation, control strategies, step up chopper, derivation of load voltage and load currents with R and RL loads, chopper configurations. Power circuit of a buck, boost and buck-boost converters: Analysis and waveforms at steady state.
MODULE IV	**AC VOLTAGE CONTROLLER AND CYCLO CONVERTERS**
	Single phase AC voltage controllers - two SCRs in anti-parallel with R and RL loads, derivation of rms load voltage and load current, numerical problems, Cyclo converters - single phase midpoint and bridge type (step-up and step-down operations) with R and RL loads.
MODULE V	**INVERTERS**
	Single phase inverters: Basic operation, voltage source inverters, basic series and parallel inverters, current source inverter, modified Mc Murray and Mc Murray-Bedford half bridge inverters (operation and waveforms), voltage control by pulse width modulation techniques (single pulse, multiple pulse and sinusoidal), numerical problems. Three phase bridge Inverters - 180^0 and 120^0 conduction modes of operation.

TEXTBOOKS

1. Dr. P S Bimbhra, “Power Electronics”, Khanna Publishers, 5th Edition, 2012.
2. M H Rashid, “Power Electronics, Circuits, Devices and Applications”, Pearson, 3rd Edition, 2001.

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1. L Umanand, "Power Electronics: Essentials and Applications", Wiley India, 3rd Edition, 2009.
2. N Mohan and T M Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2nd Edition, 2007.
3. R. W. Erickson and D Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2nd Edition, 2007.

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2. https://nptel.ac.in/courses/108/102/108102145/
3. https://www.electronicsforu.com/videos-slideshows/power-electronic-devices
4. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334-power-electronics- spring-2007/lecture-notes/

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	Course Description on Outcome Based Education (OBE)		
CONTENT DELIVERY (THEORY)			
2	Basic elements of power electronics and devices	CO1	T2: 1.1 R2: 1.1
3	Thyristors (SCR's) characteristics	CO1	T2: 1.1 R2: 1.1
4	Two transistor analogy of SCR	CO1	T2: 1.1 R2: 1.1
5	Operation of SCR and Turn on methods	CO2	T2: 1.1 R2: 1.1
6	Turn off method of SCR class A and Class B commutation	CO2	T2: 1.1 R2: 1.1
7	Turn off method of SCR class C, Class D, class E commutation and natural commutation	CO2	T2: 5.5 R2: 1.7
8	Dynamic characteristics of SCR and Operation of UJT firing circuit	CO1	T2: 5.5 R2: 1.7 T2: 5.5 R2: 1.7
9	Series and parallel connections of SCR's	CO2	T2: 5.5 R2: 1.7
10	Snubber circuit for SCR	CO2	T2: 5.5 R2: 1.7
11	Characteristics of BJT and Power MOSFET	CO1	T2: 5.5 R2: 1.7
12	Characteristics of Power IGBT and GTO	CO1	T2: 5.5 R2: 1.7

13	Specifications and ratings: Ratings of SCR, BJT and IGBT	CO1	T2: 5.5 R2: 1.7
14	Phase controlled rectifiers (1ph) and Operation of half converter with R, RL and RLE loads	CO3	T2: 5.5 T2:6.1.1 R2: 1.7
15	Fully controlled converter with R, RL and RLE loads	CO3	T2: 6.3.1 T2: 6.3.2 R2: 5.2 R2: 5.4
16	Effect of source inductance on converter	CO3	T2: 6.3.2 R2:5.5
17	Effect of source inductance in three phase rectifiers	CO3	T2: 6.7.2 R2: 4.11
18	Introduction to Dual Converters and operation of Single phase, three phase dual converter operation	CO3	T2: 6.8 T2: 6.9 R2: 6.11 R2: 6.11
19	Principle of operation of single phase AC voltage controller	CO5	T2: 9.1 T2: 9.2 R2: 8.5 R2: 8.1
20	Modes of operation of Triac	CO1	T2: 9.3.2 R2: 8.12
21	Principle of operation and control strategies of Cyclo converters	CO5	T2: 10.1 R2: 9.41
22	Single phase midpoint Cyclo converters with resistive load	CO5	T2: 10.1.1 R2: 9.42
23	Single phase Cyclo converter Bridge configuration Waveforms	CO5	T2: 10.1.2 R2: 9.42.1
24	Principle and control strategies of choppers	CO4	T2: 7.1 R2: 9.40
25	Operation of Step up and step down choppers	CO4	T2: 7. R2: 9.40.1
26	Operation of class A chopper	CO4	T2: 7.4.1, R2: 9.40.3
27	Operation of class B and class C chopper	CO4	T2: 7.4.2 R2: 9.40.4
28	Operation of Class D and class E chopper	CO4	T2: 7.4.4 R2: 9.40.5
29	Operation of Switched mode regulators	CO4	T2: 7. R2: 10.3

30	Single Phase inverter and operation of Single phase half bridge inverter	CO6	T2: 8.1.1, R2: 9.1
31	Single phase full bridge inverter and series inverter	CO6	T2: 8.9 R2: 9.2
32	Parallel Capacitor inverter	CO6	T2: 8.10 R2: 9.6
33	Three phase Voltage source inverter 180 dergee conduction mode	CO6	T2: 8.4.1 R2: 9.32
34	Three phase Voltage source inverter 120 dergee conduction mode	CO6	T2: 8.4.2 R2: 9.33
35	Voltage control and PWM techniques for inverters	CO6	T2: 8.5 R2: 9.36
36	Sinusoidal pulse width modulation	CO6	T2: 8.6.3 R2: 9.37
37	Current source inverter with ideal switches	CO6	T2: 8.8.1 R2: 9.38
38	Operation of commutated type CSI	CO6	T2: 8.8.2 R2: 9.17
PROBLEM SOLVING/ CASE STUDIES			
39	Numerical problems on Series and parallel connections of SCR's	CO2	T2: 4.9 R2: 1.10
40	Numerical problems on half controlled converters	CO3	T2: 6.1.2 R2: 5.1.2
41	Numerical problems on fully controlled converters	CO3	T2: 6.9 R2:5.4
42	Numerical problems on fully controlled converters with RL load	CO3	T2: 6.9 R2:5.4
43	Numerical problems on dual converters	CO3	T2: 6.8 T2: 6.9
44	Problems on three phase half controlled converters	CO3	T2: 6.6.2 R2:6.1
45	Problems on three phase full controlled converters	CO3	T2: 6.6.2 R2:6.1
46	Problems on three phase full controlled converters with RL loads	CO3	T2: 6.6.3 R2:6.2
47	Problems on three phase full controlled converters with RL loads	CO3	T2: 6.6.3 R2:6.2
48	Numerical problems on AC voltage controller	CO5	T2: 9.3.2 R2: 8.4
49	Numerical problems on AC voltage controller with RL loads	CO5	T2: 9.3.2 R2: 8.4
50	Numerical problems on cycloconverters	CO5	T2: 10.1.2 R2: 9.42.2
51	Numerical problems on choppers	CO4	T2: 7.7 R2: 9.40.1

52	Numerical problems on step down and step up choppers	CO4	T2: 7.7 R2: 9.40.1
53	Numerical problems on switched mode regulators	CO4	T2: 7.5 R2: 10.5
DISCUSSION OF DEFINITION AND TERMINOLOGY			
54	Power electronic devices, SCR characteristics, turn on and turn off methods for SCRs	CO1, CO2	T2: 1.1 T2: 5.1 R2: 1.7 R2: 1.1
55	Phase controlled rectifiers with different loads and dual converters	CO3	T2: 6.1 R2: 5.1
56	AC voltage regulators and cycloconverters	CO5	T2: 9.1 T2: 10.1 R2: 9.41 R2: 8.1
57	Choppers and switched mode regulators	CO4	T2: 7.1 T2: 7.6 R2: 10.3 R2: 9.40
58	Voltage source inverters and current source inverters	CO6	T2: 8.8.1 T2: 8.1.1 R2: 9.1 R2: 9.38
DISCUSSION OF QUESTION BANK			
59	Power Switching Devices and Commutation Circuit	CO1,CO2	-
60	Single Phase Controlled Rectifiers	CO3	-
61	AC Voltage controllers and Cyclocoverters	CO5	-
62	DC - DC Converters	CO4	-
63	Inverters	CO6	-

Signature of Course Coordinator **HOD,EEE**

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

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

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

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

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

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

ANNEXURE - II

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	PSO Statement / Key Competencies Features (KCF)	No. of KCF(s)
PSO 1	Design, develop, fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization. 1. Operate, control and protect electrical power system. 2. Validate the interconnected power system. 3. Ensure reliable, efficient and compliant operation of electrical systems. 4. Familiarize the safety, legal and health norms in electrical system. 5. Adopt the engineering professional code and conduct.	**5**
PSO 2	Focus on the components of electrical drives with its converter topologies for energy conversion, management and auditing in specific applications of industry and sustainable rural development. 1. Control the electric drives for renewable and non-renewable energy sources. 2. Fabricate converters with various components and control topologies. 3. Synthesis, systematic procedure to examine electrical components/machines using software tools. 4. Inspect, survey and analyze energy flow. 5. Control and manage the power generation and utilization. 6. Familiarize the safety, legal and health norms in electrical system. 7. Adopt the engineering professional code and conduct. 8. Explore autonomous power 9. Evolve into green energy and assess results 10. Realize energy policies and education 11. Potential contribution of clean energy for rural development.	**11**
PSO 3	Gain the hands-on competency skills in PLC automation, process controllers, HMI and other computing tools necessary for entry level position to meet the requirements of the employer. 1. Explicit software and programming tools for electrical systems. 2. Adopt technical library resources and literature search. 3. Model, program for operation and control of electrical systems. 4. Constitute the systems employed for motion control. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

COURSE DESCRIPTION

Course Title	**INTELLECTUAL PROPERTY RIGHTS**				
Course Code	AHSC19				
Program	B.Tech				
Semester	VII	EEE			
Course Type	Open Elective				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr. Ranjith kumar Gatla, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	-	-	-

II COURSE OVERVIEW:

This course provides the trade related intellectual property rights and investment measures. This course emphesis on how to avail the intellectual property rights of the inventors or owners for their assets like patents on innovative design, copy rights on literary and artistic works, trademark on goods & services and geographical indiactions on products famous for specific geographical areas.This course makes use of the potential future economic benefits to the intellectual property owner or authorized user.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Intellectual Property Rights	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

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

Percentage of Cognitive Level	Blooms Taxonomy Level
0%	Remember
85 %	Understand
15 %	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

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

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

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

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

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

VI COURSE OBJECTIVES:

The students will try to learn:

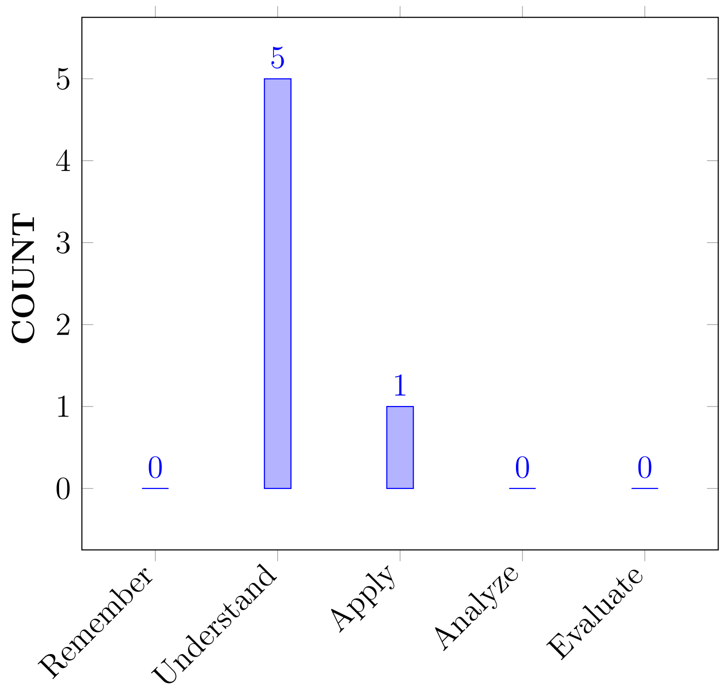
I	The knowledge on world trade organization, trade agreements and investments.
II	The importance of intellectual property rights to develop trade mark law, copy right law and patent law.
III	The new developments in the law of intellectual property rights in order to bring progressive changes towards a free market society and international trade practices under the Trade Related Intellectual Property Rights Agreement (TRIPS)

VII COURSE OUTCOMES:

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

CO 1	**Summerize** the general agreement on tariffs and trade (GATT) eight rounds for the substantial reduction of tariffs and other barriers of trade.	Understand
CO 2	**Relate** the world trade organization agreements for trade related intellectual property rights and investments.	Understand
CO 3	**Elaborate** the involvement of World Intellectual Property Organization to promote the protection of intellectual property throughout the world.	Understand
CO 4	**Demonstrate** the legal procedure and document for claiming patent of invention.	Understand
CO 5	**Illustrate** the different geographical Indications of products which corresponding to specific location for aviling brand of location to products .	Understand
CO 6	**Identify** different types of intellectual properties,the right of ownership,scope of protection to create and extract value from IP.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



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 6	**The engineer and society:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/Quiz/AAT

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	3	Seminar
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear.	2	Seminar
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	1	Seminar

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	-	-
PSO 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.	-	-
PSO 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 = High; 2 = Medium; 1 = Low

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

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

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

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Identify** different types of Intellectual Properties (IPs), the right of ownership in **scientific principles and methodolgy** , scope of protection as well as the ways to create and to extract value from IP	1
	PO 10	**Describe** the intellectual property rights of ownership and **communicate effectivly(speaking style)** in concept video or tech talk	1
CO 2	PO 6	**Explain** WTO agreements helpful for **engineering activities to promot sustainable development** and **legal requirements** in new product and service development.	2
	PO 10	**Describe** the importance of WTO agreements for trade related intellectual property rights **communicate effectively(speaking style)** in tech-talk	1
CO 3	PO 8	**Demonstrate the ethical behaviour** and **responsibilities** of world intellectual property organization and its **degree of trust and integrity** to protect intellectual property rights of the owner	3
	PO 10	**Describe** the support of WIPO in connection with intellectual property rights and **communicate effectivly(speaking style)** in tech-talk	1
CO 4	PO 6	**Explore the knowledge and understanding of commercial** management of IP and **identify the highlevel of professional conduct** of intellectual property management for claiming patent of invention	2
	PO 8	**Explain** how to prepare the **ethical** document for patent of invention by following **legal belief** and **high degree of trust and integrity**	3
	PO 10	**Describe** the steps involved in patent filing in india namely drafting, filing the patent application**(writing)** and **communicate effectivly(speaking style)** in concept video and tech-talk.	2
	PO 12	**Understand** the need of **advanced engineering concepts** interms of **ongoing learning** which is suitable to intellectual work.	2
CO 5	PO 1	**Explore** on the **engineering scientific principles** and **mathematical principles** which are helpful for availing geographical indication and procedure for applying geographical indications of products of specific locations	2
	PO 8	**Extend** on various IPR components to **make ethical production** and process of filing a document for geographical indication by following **professional ethics** and **integrity of resourse of region** .	3
	PO 10	**Describe** the geographical indiaction for famous products in a given location and **communicate effectively(speaking style)** in tech-talk.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 12	**Understand** the need of **advanced engineering concepts** interms of **ongoing learning** which is suitable to get permission for geographical indication of products.	2
CO 6	**PO 1**	**Explore** the **engineering knowledge** which is useful for preparing the trademark and then **apply methodology** for trade mark based on trademark and merchandise act 1958 which prevents misuse of marks.	2
	PO 6	**Illustrate** international copyright law with respect to ownership and registration of copyright by following the awareness of **legal requirements**. Understand the **professional and ethical conduct** to get copy right for literary and artistic works	2
	PO 8	**Summarize** the trade mark and trade secrets **with knowledge of professional ethics** and **integrity** protection before submitting application to trademark office. **Demonstrate the ethical behaviour**of stoping illegal trademark	3
	PO 10	**Describe** the IPR to get trademark for unique marks and copy right**(for literature writing)** for new artistic works and and **communicate effectively(speaking style)** in tech-talk.	2
	PO 12	**Analyze** the the **project mangement** for international developments in trademarks law , copyright law and patent law. **Significant skills** are applied to get intellectual property rights.	2

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

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

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

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	33.3	-	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 2	-	-	-	-	-	40	-	-	-	20	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	100	-	20	-	-	-	-	-
CO 4	-	-	-	-	-	40	-	100	-	40	-	25	-	-	-
CO 5	66.7	-	-	-	-	-	-	100	-	40	-	25	-	-	-
CO 6	66.7	-	-	-	-	40	-	100	-	40	-	25	-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

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

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

1 - $5 < C \leq 40\%$ – Low/ Slight

2 - $40\% < C < 60\%$ –Moderate

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	-	-	-	-	-	2	-	-	-	1	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	3	-	1	-	-	-	-	-
CO 4	-	-	-	-	-	2	-	3	-	2	-	1	-	-	-
CO 5	3	-	-	-	-	-	-	3	-	2	-	1	-	-	-
CO 6	3	-	-	-	-	2	-	3	-	2	-	1	-	-	-
Total	7	-	-	-	-	6	-	12	-	9	-	3	-	-	-
Average	**2.3**	-	-	-	-	**2**	-	**3**	-	**1.5**	-	**1**	-	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

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

XVII ASSESSMENT METHODOLOGY-INDIRECT:

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

XVIII SYLLABUS:

MODULE I	INTRODUCTION
	General agreement on tariffs and trade (GATT) eight rounds: Uruguay round, world trade organization: structure, technology transfer, dispute resolution mechanism, Doha declaration world trade organization agreements including trade related intellectual properties rights and trade related investment measures.
MODULE II	WORLD INTELLECTUAL PROPERTY ORGANIZATION
	Paris convention, Bern convention, Budapest treaty, Madrid agreement, huge agreement.
MODULE III	PATENTS
	Historical background of intellectual property rights, introduction, definition and classification of intellectual property, patents, patentable and non-patentable inventions. Legal requirements for patents, types of patent applications, patent document: specification and claims, important procedural aspects, management of intellectual property rights assets and intellectual property portfolio, commercial exploitation of intellectual property.
MODULE IV	DESIGNS AND GEOGRAPHICAL INDICATIONS
	Designs: basic requirements, procedure, convention application term, date, geographical indication: definition, what can be registered, who can apply, rights, term, restrictions.
MODULE V	TRADEMARK AND COPYRIGHTS
	Definition, classification of trademarks, classifications of goods and services, Vienna classification, trademarks procedure, trademarks enforcement: infringement and passing off, remedies, copyrights, term of copyrights, and procedure of copyright assignment of copyright, copyright infringement remedies.

TEXTBOOKS

1. P. K. Vasudeva,World Trade Organization: Implications on Indian Economy, Pearson Education,2015.

2. P.KrishnaRao, WTO, Text and cases, Excel Books, 2015.

3. Carlos M.Correa- Intellectual property rights, The WTO and Developing countries-Zed books

REFERENCE BOOKS:

1. Yuan S W, “Foundations of fluid Mechanics”, Prentice-Hall, 2nd Edition, 1987.

WEB REFERENCES:

1. Caves, Frankel, Jones, World Trade and Payments-An Introduction, Pearson4. Education, 2015.

2. Carlos M.Correa- Intellectual property rights, The WTO and Developing countries-Zed books.

3. Peter-Tobias stoll, Jan busche, Katrianarend- WTO- Trade –related aspects of IPR-Library of Congress

COURSE WEB PAGE:

https://lms.iare.ac.in/index?route=course/details&course_id=367

XIX COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping		
CONTENT DELIVERY (THEORY)			
1	General agreement on tariffs and trade (GATT) eight rounds	CO 1	T1:1.4-1.5
2	Uruguay round	CO 1	T1:1.4-1.5
3	World trade organization: structure	CO 1	T1:2.4-2.5
4	Technology transfer	CO 1	T1:2.4-2.5
5	Dispute resolution mechanism	CO 1	T1:2.4-2.5
6	Doha declaration	CO 2	T1:2.6-2.6.8; R2: 5.8-5.10
7	world trade organization agreements	CO 2	T1:2.6-2.6.8; R2: 5.8-5.10
8	Trade related intellectual properties rights	CO 2	T1:3.1-3.6
9	Paris convention	CO 2	T1:3.1-3.6
10	Bern convention	CO 2	T1:3.1-3.6
11	Budapest treaty	CO 2	T1:3.1-3.6
12	Madrid agreement	CO 3	T1:3.1-3.6
13	Hague agreement	CO 3	T1:3.1-3.6
14	Historical background of intellectual property rights	CO 3	T1:3.1-3.8
15	introduction, definition and classification of intellectual property	CO 3	T1:3.1-3.8
16	Patents, patentable and non-patentable inventions	CO 3	T1:3.1-3.8
17	Legal requirements for patents	CO 3	T1:3.1-3.8; R2: 7.4-7.5
18	Types of patent applications	CO 3	T1:3.1-3.8; R2: 7.4-7.5

19	patent document: specification and claims	CO 3	T1:3.1-3.8; R2: 7.4-7.5
20	important procedural aspects	CO 3	T1:3.1-3.8; R2: 7.4-7.5
21	management of intellectual property rights assets	CO 4	T1:4.1-4.6
22	intellectual property portfolio	CO 4	T1:4.1-4.6
23	Commercial exploitation of intellectual property	CO 4	T1:4.1-4.6
24	Designs: basic requirements	CO 4	T1:4.1-4.6
25	Designs: Procedure	CO 4	T1:4.1-4.6
26	Designs: Convention application term, date	CO 5	T1:10.1-10.6
27	Geographical indication: definition	CO 5	T1:10.1-10.6
28	What can be registered	CO 5	T1:10.1-10.6
29	Who can apply	CO 5	T1:10.1-10.6
30	Rights, term, restrictions	CO 5	T1:10.1-10.6 ; T1:9.1-9.6
31	TRADEMARK AND COPYRIGHTS: Definition, classification of trademarks	CO 5	T1:10.1-10.6; T1:9.1-9.6
32	Classifications of goods and services	CO 5	T1:9.1-9.6
33	Vienna classification	CO 5	T1:9.1-9.6
34	Trademarks procedure	CO 5	T1:9.1-9.6
35	Trademarks enforcement: infringement and passing off , remedies	CO61	T1:8.1-8.3 ; R2: 7.4-7.5
36	copyrights, term of copyrights	CO 6	T1:8.1-8.3; R2: 7.4-7.5
37	procedure of copyright	CO 6	T1:8.1-8.3; R2: 7.4-7.5
38	Assignment of copyright	CO 6	T1-8.1-8.1.7

39	Copyright infringement remedies	CO 6	T1-8.1-8.1.7
40	Copyright infringement remedies	CO 6	T1-8.1-8.1.7
PROBLEM SOLVING/ CASE STUDIES			
1	Trademarks	CO 2	T1:2.6-2.6.8; R2: 5.8-5.10
2	Copyrights	CO 3	T1:3.1-3.6
3	Which are the types of geographical indication/?	CO 2	T1:3.1-3.6
4	How many geographical indications are there in India/?	CO 2	T1:3.1-3.6
5	What means intellectual property/?	CO 3	T1:3.1-3.6
6	What is IPR and its features/?	CO 3	T1:3.1-3.8
7	What is a violation of intellectual property/?	CO 3	T1:3.1-3.8
8	What is trademark with example/?	CO 3	T1:4.1-4.6
9	What are the two categories of intellectual property/?	CO 3	T1:4.1-4.6
10	What happened in the Uruguay Round/?	CO 4	T1:4.1-4.6
11	What was a result of the Uruguay Round quizlet/?	CO 5	T1:10.1-10.6
12	What is the purpose of WIPO/?	CO 5	T1:10.1-10.6
13	How many countries are in WIPO/?	CO5	T1:10.1-10.6
14	What is the difference between a geographical indication and a trademark/?	CO 6	T1:8.1-8.3; R2: 7.4-7.5
15	What trademark means/?	CO 6	T1:8.1-8.3; R2: 7.4-7.5
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	What is World Trade Organization (WTO)/?	CO 1	T1:1.4-1.5
2	What is the purpose of WIPO/?	CO 3	T1:3.1-3.8
3	What means intellectual property/?	CO 4	T1:4.1-4.6
4	What do you mean by geographical indications/?	CO 5	T1:10.1-10.6

5	What trademark means/?	CO 6	T1:8.1-8.3; R2: 7.4-7.5
DISCUSSION OF QUESTION BANK			
1	Explain why agencies responsible for intellectual property registration with any two examples.	CO 2	T1:1.4-1.5
2	What is patent/? How the patents are related with intellectual property rights/?	CO 3	T1:3.1-3.8
3	Explain with one real time example the patentable and non-patentable inventions.	CO 4	T1:3.1-3.8; R2: 7.4-7.5
4	How intellectual property is helpful to the society and what are the legal requirements are needed for patents/?	CO 5	T1:10.1-10.6
5	What is the most important criteria for an applicant who seek to register a geographical indication/?	CO 6	T1:8.1-8.3; R2: 7.4-7.5

Signature of Course Coordinator **HOD,EEE**
Dr. Ranjith kumar Gatla, Associate Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES/ PROGRAM SPECIFIC OUTCOMES

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

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

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

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

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**
PSO 1	Build Embedded Software and Digital Circuit Development platformfor Robotics, Embedded Systems and Signal Processing Applications. 1. Analyze and solve real time problems in Robotics. 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications 3. Develop embedded systems modules using Real Time Operating System. 4. Undertake research and development projects in the field of Embedded Systems. 5. Adopt the engineering professional code and conduct	**5**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototypedesigns, Virtual Instrumentation and System on Chip (SOC) designs.. 1. Inspect, survey and analyze types of ASIC chip designs. 2. Design ASIC prototypes using Verilog and VHDL languages. 3. Analyze microprocessor subsystems with memories and I/O interfacs for SOC designs 4. Explore hardware components for designig SOC 5. Adopt the engineering professional code and conduct 6. Designing prototypes of SOC using programming tools like MATLAB, LabVIEW. 7. Familiarize with the design flow of ASIC prototypes. 8. Realize SOC using Register Transfer-Level designs 9. Analyse and develop models for system level descriptions for synthesis of SOC 10. Inspect and survey the abstractions and principles for the specification, simulation, verification, and synthesis of systems on chip (SoC) 11. Programming and hands-on skills to meet requirements of global environment.	**11**

PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications. 1. Explicit software and programming tools for antenna design. 2. Adopt technical library resources and literature search. 3. Explore smart antennas. 4. Model, program for operation and control of smart antennas for wireless communication applications. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

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

COURSE DESCRIPTION

Department	**Electrical and Electronics Engineering**				
Course Title	**Business Economics and Financial Analysis**				
Course Code	AHSC13				
Program	B.Tech				
Semester	V				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr.M.Sindu,Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

II COURSE OVERVIEW:

The present course is designed in such a way that it gives an overview of concepts of Economics. Managerial Economics enables students to understand micro environment in which markets operate how price determination is done under different kinds of competitions. Financial Analysis gives clear idea about concepts, conventions and accounting procedures along with introducing students to fundamentals of ratio analysis and interpretation of financial statements. Break Even Analysis is very helpful to the Business Concern for Decision Making, controlling and forward Strategic Planning. Ratio analysis gives an idea about financial forecasting, financial planning, controlling the business and decision making.

III MARKS DISTRIBUTION:

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

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

V EVALUATION METHODOLOGY:

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

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

Percentage of Cognitive Level	Blooms Taxonomy Level
16.67%	Remember
16.67%	Understand
16.67%	Apply
50 %	Analyze
0 %	Evaluate
0 %	Create

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

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

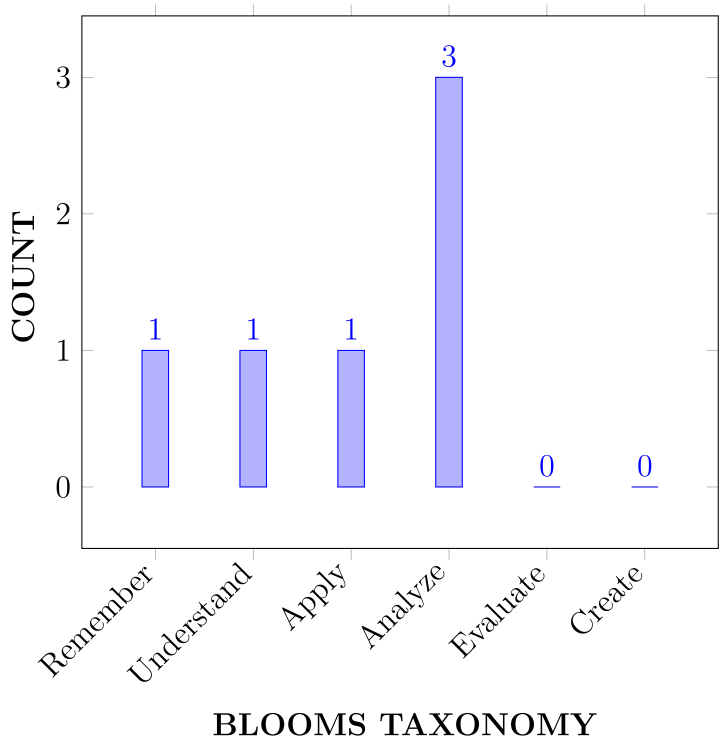
I	The concepts of business economics and demand analysis helps in optimal decision making in business environment
II	The functional relationship between Production and factors of production and able to compute breakeven point to illustrate the various uses of breakeven analysis.
III	The features, merits and demerits of different forms of business organizations existing in the modern business environment and market structures.
IV	The concept of capital budgeting and allocations of the resources through capital budgeting methods and compute simple problems for project management.
V	Various accounting concepts and different types of financial ratios for knowing financial positions of business concern.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**List** the basic concepts of managerial economics and analysis, measurement of demand and its forecasting to know the current status of goods and services.	Remember
CO 2	**Examine** to know the current status of goods and services. to know the economies and diseconomies of scale in manufacturing sector.	Analyze
CO 3	**Summarize** the four basic market models like perfect competition, monopoly, monopolistic competition, and oligopoly to know the price and quantity are determined in each model.	Understand
CO 4	**Compare** various types of business organizations and discuss their implications for resource allocation to strengthen the market environment.	Analyze
CO 5	**Analyze** different project proposals by applying capital budgeting techniques to interpret the solutions for real time problems in various business projects.	Analyze
CO 6	**Develop** the ability to use a basic accounting system along with the application of ratios to create (record, classify, and summarize) the data needed to know the financial position of the organization.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Program Outcomes	
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/Quiz/AAT
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice	1	Seminar/ Conferences
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	3	Assignments/ Discussion
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	3	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization	-	-
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development .	-	-
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	✓	✓	-	✓	-	-	-	-
CO 2	✓	✓	-	-	-	-	-	✓	✓	-	✓	-	-	-	-
CO 3	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-
CO 5	✓	-	-	-	-	-	-	-	-	-	✓	-	-	-	-
CO 6	-	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Recall** (knowledge) the scientific fundamentals of economic activities performed by the businessmen in the business for profit earning.	2
	PO 2	**Interpret** and identify the demand and its analysis with the mathematical and natural principles of demand forecasting methods.	6
	PO 8	**Define** (knowledge) the responsibilities of the engineering practices by knowing the best economical practices.	1
	PO 9	**Match** (knowledge) the economical implication to effectively function as a team member, and as a member or leader in diverse teams.	5

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 11	**Relate** (knowledge) the knowledge and understanding of the economic principles and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	6
CO 2	PO 1	**Recall** (Knowledge) the knowledge of mathematics, science in the production function through Different Combination of variable inputs with Economies of Scale.	2
	PO 2	**Demonstrate** the different cost concepts and determine the significance of Break Even Analysis.	5
	PO 8	**Relate** (Knowledge) (Knowledge) the ethical principles and commit to professional ethics and responsibilities and norms of the production management	2
	PO 9	**Show** (Fundamentals) the production function implications for effective implementation of gang compositions in a team work and in multidisciplinary settings.	6
	PO 11	**Define** the economies of scale in production function and Break Even Analysis knowledge applied in one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	5
CO 3	PO 8	**List** (Knowledge) (Knowledge) different structures of market and how price is determined under different market structures commit to professional ethics and responsibilities and norms of the engineering practice.	2
	PO 9	**Match** the market structures and the market entry strategies as an individual, and as a member in diverse teams.	6
CO 4	PO 8	**Categorize** the ethical principles and commit to professional ethics and responsibilities belongs to different forms of business organizations existing in the modern business.	2
	PO 9	**Classify** various business organizations and their functioning as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	6
CO 5	PO 1	**Explain** the ethical issues involved in the allocation of funds under the concept of capital budgeting.	1
	PO 11	**Summarize** the concept of capital budgeting and allocations of the resources through capital budgeting methods of the management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	8
CO 6	PO 2	**Explain** the GAAP principles and ratios to analyse complex engineering problems reaching substantiated conclusions using first principles of accounts and profitability and efficiency of the organization.	6

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 11	**Illustrate**the accounting methods and procedures and accounting principles to manage the financial aspects in a project.	8

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	6	-	-	-	-	-	1	5	-	6	-	-	-	-
CO 2	2	5	-	-	-	-	-	2	6	-	5	-	-	-	-
CO 3	-	-	-	-	-	-	-	2	6	-	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	2	6	-	-	-	-	-	-
CO 5	1	-	-	-	-	-	-	-	-	-	8	-	-	-	-
CO 6	-	2	-	-	-	-	-	-	-	-	8	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	66.7	60.0	-	-	-	-	-	33.3	41.6	-	50.0	-	-	-	-
CO 2	66.7	50.0	-	-	-	-	-	66.7	50.0	-	41.6	-	-	-	-
CO 3	-	-	-	-	-	-	-	66.7	50.0	-	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	66.7	50.0	-	-	-	-	-	-
CO 5	33.3	-	-	-	-	-	-	-	-	-	75.0	-	-	-	-
CO 6	-	20.0	-	-	-	-	-	-	-	-	75.0	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 - $5 < C \leq 40\%$ – Low/ Slight

2 - $40\ \% < C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	-	-	-	-	-	1	2	-	2	-	-	-	-
CO 2	3	2	-	-	-	-	-	3	2	-	2	-	-	-	-
CO 3	-	-	-	-	-	-	-	3	2	-	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	3	2	-	-	-	-	-	-
CO 5	1	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO 6	-	1	-	-	-	-	-	-	-	-	3	-	-	-	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
TOTAL	7	7	-	-	-	-	-	10	8	-	-	-	-	-	-
AVERAGE	2.3	2.3	-	-	-	-	-	2.5	2	-	2.5	-	-	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	✓
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	✓				

XVII ASSESSMENT METHODOLOGY-INDIRECT:

X	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**INTRODUCTION&DEMAND ANALYSIS**
	Introduction to Business Economics: Definition, Nature and Scope of Managerial Economics – Demand Analysis: Demand Determinants, Law of Demand and its exceptions. Elasticity of Demand: Definition, Types, Measurement and Significance of Elasticity of Demand. Demand Forecasting, Factors governing demand forecasting, methods of demand forecasting
MODULE II	**PRODUCTION & COST ANALYSIS**
	Theory of Production and Cost Analysis: Production Function – Iso-quants and Iso-costs, MRTS, Least Cost Combination of Inputs, Cobb-Douglas Production function, Laws of Returns, Internal and External Economies of Scale. Cost Analysis: Cost concepts; Break-even analysis, Determination of Break – Even point (Simple Problems) , Managerial Significance of BEA.
MODULE III	**MARKETS & NEW ECONOMIC ENVIRONMENT**
	LMarket structures: Types of competition, Features of perfect competition, Monopoly and monopolistic competition. Price determination & Price Statistics: Price Output determination in case of perfect competition and monopoly. Features and evaluation of different forms of Business organization: Sole proprietorship, partnership, Joint Stock Company, public enterprises and their types.
MODULE IV	**CAPITAL BUDGETING**
	Capital and its significance, types of capital, estimation of fixed and working capital requirements, methods and sources of raising capital- Trading Forecast, Capital budget, Cash Budget. Features of capital budgeting proposals, methods of capital budgeting – payback method, Accounting rate of return(ARR), Net Present Value Method (simple problems).

MODULE V	**INTRODUCTION TO FINANCIAL ACCOUNTING AND FINANCIAL ANALYSIS**
	Financial accounting objectives, functions, importance; Accounting concepts and accounting conventions - double-entry book keeping, journal, ledger, trial balance; Final accounts: Trading account, profit and loss account and balance sheet with simple adjustments; Financial analysis: Analysis and interpretation of liquidity ratios, activity ratios, capital structure ratios and profitability ratios (simple problems), Du Pont chart.

TEXTBOOKS

1. Aryasri, "Managerial Economics and Financial Analysis", TMH publications, 4thEdition,2012.
2. M. KasiReddy, Saraswathi, "Managerial Economics and Financial Analysis", PHI Publications, New Delhi, 2ndEdition,2012.
3. Varshney, Maheswari, "Managerial Economics", Sultan Chand Publications, 11thEdition,2009.

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1. D.N. Dwivedi, "Managerial Economics", Vikas Publication House Pvt.Ltd, 2ndEdition,2012.
2. S.N. Maheshwari & S.K.Maheshwari, "Financial Accounting", Vikas Publication House Pvt.Ltd,4thEdition, 2012.
3. R.NarayanaSwamy, "Financial Accounting- A managerial Perspective", Pearson publications, 1stIndian Reprint Edition,2012.

WEB REFERENCES:

1. https://courses.lumenlearning.com/boundless-marketing/chapter/demand-analysis/
2. https://theintactone.com/2019/10/01/me-u3-topic-2-cost-output-relationship-in-short-run-long-run-cost-curves/
3. https://corporatefinanceinstitute.com/resources/knowledge/modeling/break-even-analysis/
4. https://corporatefinanceinstitute.com/resources/knowledge/economics/market-structure/#: :text=The%20four%20popular%20types%20of,monopoly%20market%2C%20and%20mo
5. https://www.vedantu.com/commerce/various-forms-of-business-organisations
6. https://courses.lumenlearning.com/boundless-finance/chapter/introduction-to-capital-budgeting/
7. https://jkbhardwaj.com/20-transactions-with-their-journal-entries-ledger-and-trial-balance/
8. https://www.iedunote.com/write-accounting-ledger
9. https://opentextbc.ca/principlesofaccountingv1openstax/chapter/prepare-a-trial-balance/
10. https://caknowledge.com/how-to-prepare-final-accounts/
11. https://corporatefinanceinstitute.com/resources/knowledge/finance/ratio-analysis/

COURSE WEB PAGE:

https://lms.iare.ac.in/index?route=publicprofile&id=5201

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Discussion on Course Outcomes and how these COs mapped with POs and PSOs.		
CONTENT DELIVERY (THEORY)			
2-3	Explain about managerial economics according to the business	CO 1	T1- 1.3-1.8 R1-1.5-1.7
4-5	Describe about demand analysis, the Law of Demand and Demand Function.	CO 1	T1-2.2-2.11 R1-3.3-3.20
6-7	Understand elasticity of the demand of the product, different types, Measurement of Elasticity of Demand and Factors influencing on Elasticity of Demand.	CO 1	T1-3.3-3.20 R1- 5.29-6.8
8	State different methods of Demand Forecasting and the factors governing Demand Forecasting.	CO 1	T1-4.6-4.19
9-10	Demonstrate the Production function, features of Iso-Quants and Iso-Costs, different types of Internal Economies, External Economies and Law of Returns.	CO 2	T1- 5.3-5.18 R1- 5.29-6.8
11-13	Different types of Internal Economies, External Economies ad Law of Returns with appropriate examples.	CO 2	T1- 5.3-5.18
14-15	Illustrate different types of costs	CO 2	T1- 5.29-6.8
16-17	Explain the Significance and Limitations of Break-Even Analysis	CO 2	T1- 7.13-7.14
18-19	Calculate Break-Even Point (Simple Problems)	CO 2	T1- 7.1-7.12
20-21	Illustrate the features, price-output determination under Perfect Competition, Monopoly and Monopolistic competition Markets.	CO 3	T1- 8.4-8.16 R2- 5.29-6.8
22-24	Demonstrate the Objectives, Policies and Methods of Pricing Strategies and Price Methods.	CO 3	T1- 8.21-8.25
25-26	Describe Features of business, Definitions of Various forms of Business Units.	CO 4	T1-9.3-9.15
27-30	State the Merits & Demerits of Different types of Public Enterprises and Changing Business Environment to Post Liberalization Scenario.	CO 4	T1-9.2-10.23 R1- 8.21-8.25
31-32	Explain the significance and classification of capital, Methods and Sources of Raising Finance.	CO 6	T1-9.2-10.23
33-34	Demonstrate the concept of capital budgeting and allocations of the resources through capital budgeting methods and compute simple problems.	CO 6	T1-11.3-11.5 R2-12.3-12.5
35-37	Illustrate the Significance of Financial Accounting, Double Entry, Accounts, Accounting Concepts and Conventions	CO 6	T1-12.1-12.26
38-40	Explain the meaning, advantages and Limitations of the Journal, Ledger and Trial Balance and Final Accounts and Solve simple Problems.	CO 6	T1-13.4-13.15 R2-11.3-11.5
41-42	Describe Meaning, Definitions and Limitations of Ratio Analysis	CO 6	T1-13.4-13.15 R2-11.7-11.8

43-45	Compute different types of Financial Ratios (Problems)	CO 6	T1-13.5-13.68
PROBLEM SOLVING/ CASE STUDIES			
46	Problems relating to Demand elasticty measurement and Forecasting	CO 1	T1: 1.1 - 2.8, R1:2.1
47	Problems relation to Break Even Point	CO 2	T2: 3.0 to 3.6, 5.0 to5.5 , R2:4.4
48	Problems in determining the price in different types of markets	CO 3,4	T3: 6.0 to 6.4, R1:5.1
49	Problems relating to Capital Budgeting Decisions	CO 5	R2:7.5
50	Problems relating to Final Accounts and Calculation of Ratios	CO 6	R3: 4.1
DISCUSSION OF DEFINITION AND TERMINOLOGY			
51	Introduction and Demand Analysis	CO 1	T1: 1.1 - 2.8, R1:2.1
52	Production and Cost Analysis	CO 2	T2: 3.0 to 3.6, 5.0 to5.5 , R2:4.4
53	Markets and New Environment	CO 3,4	T3: 6.0 to 6.4, R1:5.1
54	Capital Budgeting	CO 5	R2:7.5
55	Introduciton to Financial Accounting and Financial Analysis	CO 6	R3: 4.1
DISCUSSION OF QUESTION BANK			
56	Introduction and Demand Analysis	CO 1	T1: 1.1 - 2.8, R1:2.1
57	Production and Cost Analysis	CO 2	T2: 3.0 to 3.6, 5.0 to5.5 , R2:4.4
58	Markets and New Environment	CO 3,4	T3: 6.0 to 6.4, R1:5.1
59	Capital Budgeting	CO 5	R2:7.5
60	Introduciton to Financial Accounting and Financial Analysis	CO 6	R3: 4.1

Signature of Course Coordinator **HOD,MBA**
Dr. M Sindu, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTION

<table>
<tr><td>Course Title</td><td colspan="5">MICROPROCESSORS AND MICROCONTROLLERS LABORATORY</td></tr>
<tr><td>Course Code</td><td colspan="5">AECC31</td></tr>
<tr><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>Semester</td><td>V</td><td colspan="4">EEE</td></tr>
<tr><td>Course Type</td><td>Core</td><td colspan="4"></td></tr>
<tr><td>Regulation</td><td>UG-20</td><td colspan="4"></td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>3</td><td>2</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Dr. B. Surekha Reddy, Assistant Professor</td></tr>
</table>

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECC07	III	Analog Electronics
B.Tech	AECC16	IV	Digital Electronics

II COURSE OVERVIEW:

This laboratory course will facilitates the students to program 8086 microprocessor and 8051 microcontroller. Win862 software will be used for writing and debugging assembly language programs. The course includes performing arithmetic and logical operations, string manipulations, code conversions and interfacing of I/O devices to processor/controller. The hands-on experience acquired by the student's during the course makes them to carry out processor/controller based projects and extend their knowledge on the latest trends and technologies in the field of embedded system.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Microprocessors and Microcontrollers Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks for internal assessment and 70 marks for semester end lab examination. Out of 30 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end lab examination for 70 marks shall be conducted by two examiners, one of them being Internal Examiner and the other being External Examiner, both nominated by the Principal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
1	1	1	1	1	05

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
1	1	1	1	1	05

VI COURSE OBJECTIVES:

The students will try to learn:

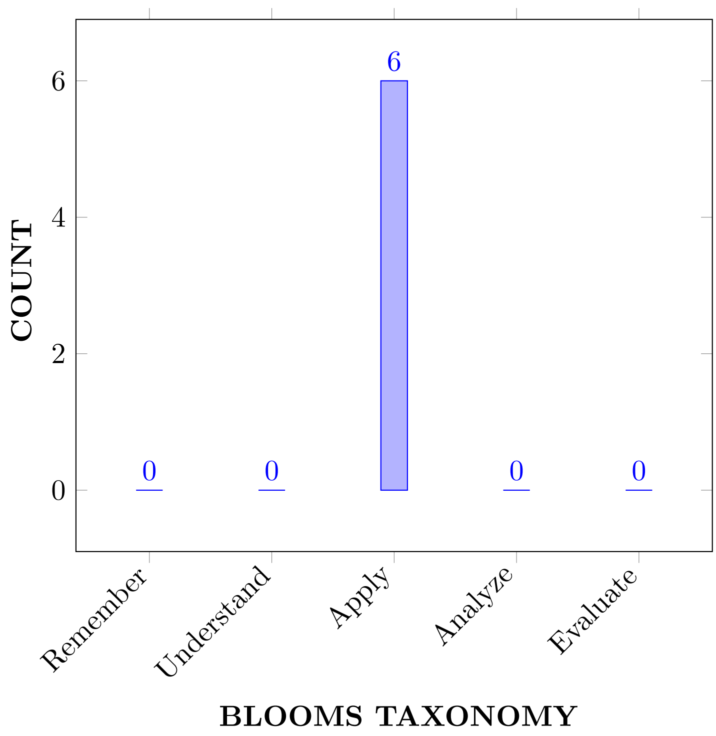
I	Assembly language programming skills ranging from simple arithmetic operations to interfacing real time systems.
II	The usage of software tools to design, debug and test microprocessor/microcontroller based projects using assembly language programming.
III	The design of microcomputer and microcontroller based real-time applications in the fields of communication systems, home based automation systems, automobiles and unmanned applications.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Make use of** emulators and assemblers for writing, compiling and running an assembly language programs on training boards.	Apply
CO 2	**Develop** Assembly language programs for accomplishing code conversions, string manipulations and sorting of numbers.	Apply
CO 3	**Choose** serial or parallel communication for transmitting the data between microprocessor or microcontroller and peripherals.	Apply
CO 4	**Utilize** Analog to Digital and Digital to Analog converters with processor or controller for data conversion.	Apply
CO 5	**Select** suitable registers of microcontroller and write assembly language program to verify timer or counter operations.	Apply
CO 6	**Build** an interface between processor or controller and peripherals to provide solutions to the real world problems.	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 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.	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 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for **entry level position to meet the Requirements of the Employer.**	2
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 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for **entry level position to meet the Requirements of the Employer.**	2
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 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for **entry level position to meet the Requirements of the Employer.**	2
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 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for **entry level position to meet the Requirements of the Employer.**	2
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 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for **entry level position to meet the Requirements of the Employer.**	2

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 3
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 directio
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 subraction	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 **HOD,EEE**
Dr. B. Surekha Reddy, Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**

	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**

	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PSO 1	Design, develop, fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization. 1. Operate, control and protect electrical power system. 2. Validate the interconnected power system. 3. Ensure reliable, efficient and compliant operation of electrical systems. 4. Familiarize the safety, legal and health norms in electrical system. 5. Adopt the engineering professional code and conduct.	5
PSO 2	Focus on the components of electrical drives with its converter topologies for energy conversion, management and auditing in specific applications of industry and sustainable rural development. 1. Control the electric drives for renewable and non-renewable energy sources. 2. Fabricate converters with various components and control topologies. 3. Synthesis, systematic procedure to examine electrical components/machines using software tools. 4. Inspect, survey and analyze energy flow. 5. Control and manage the power generation and utilization. 6. Familiarize the safety, legal and health norms in electrical system. 7. Adopt the engineering professional code and conduct. 8. Explore autonomous power 9. Evolve into green energy and assess results 10. Realize energy policies and education 11. Potential contribution of clean energy for rural development.	**11**

PSO 3	Gain the hands-on competency skills in PLC automation, process controllers, HMI and other computing tools necessary for entry level position to meet the requirements of the employer. 1. Explicit software and programming tools for electrical systems. 2. Adopt technical library resources and literature search. 3. Model, program for operation and control of electrical systems. 4. Constitute the systems employed for motion control. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING
COURSE DESCRIPTION

Course Title	**POWER ELECTRONICS LABORATORY**				
Course Code	AEEC21				
Program	B.Tech				
Semester	V	EEE			
Course Type	Core				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Mr. S. Srikanth, Assistant Professor				

I COURSE OVERVIEW:
This course is intended for practical experience by conducting experiments on rectifiers, inverters, choppers, AC voltage controllers and cycloconverters. It provides hands-on experience by examining the electrical characteristics of various power converters. The power electronic converter applications have been analyzed with simulation tools.

II COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AECC05	III	Electronic Devices and Circuits Laboratory

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Power Electronics Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:
Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	-
20 %	Analysis	-
20 %	Design	-
20 %	Conclusion	-
20 %	Viva	-

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
-	-	-	-	-	-

VI COURSE OBJECTIVES:

The students will try to learn:

I	The engineering skills by way of electrical circuit design with power electronic devices and components.
II	Simulation and testing the different power converter circuits using simulation tools.
III	The demonstration of basic power electronic circuits for developing complex power converter modules.

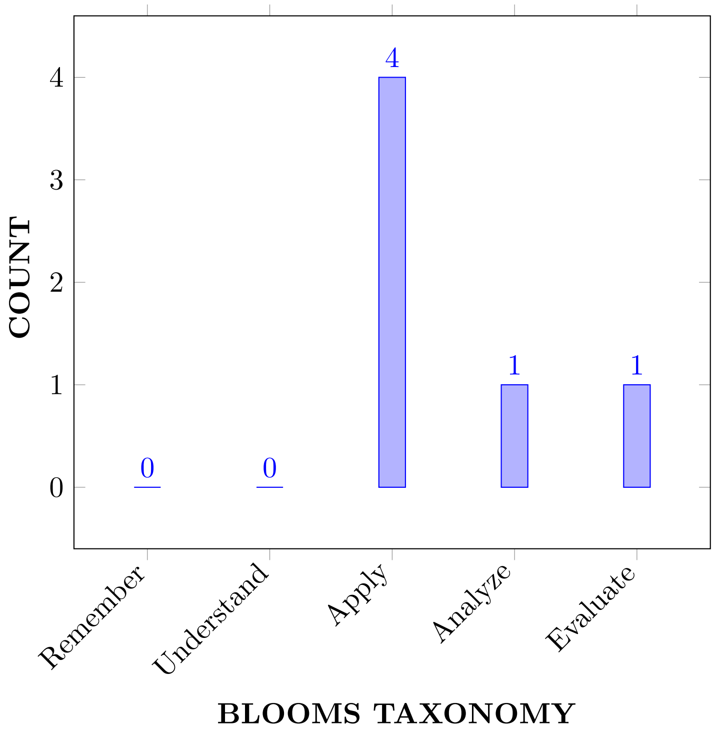
VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Experiment** the operation of SCR, MOSFET and IGBT for obtaining static voltage - current characteristics. .	Apply
CO 2	**Utilize** the forced commutation circuits and gate firing circuits for turning off and on of the SCR.	Apply
CO 3	**Analyze** the input and output waveforms of controlled rectifier circuits for determining the output voltages.	Analyze

CO 4	**Construct** the various inverter circuits for direct current to Alternating current conversion.	Apply
CO 5	**Determine** the performance characteristics of ac to ac converters for getting variable output voltage using hard ware and modern tools.	Evaluate
CO 6	**Develop** the chopper circuits for measuring output voltage and current .	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Program Outcomes	
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Lab Exercises
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 Exercises
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	Lab Exercises
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	3	Lab Exercises

PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	2	Lab Exercises
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	2	Lab Exercises
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	3	Lab Exercises
PO 9	**Individual and 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 having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	3	Lab Exercises

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involving Power generation, Transmission, Distribution and Utilization.	2	Lab Exercises
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	2	Lab Exercises
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.	3	Lab Exercises

3 = High; 2 = Medium; 1 = Low

XI JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Observe the functionality of power electronic components for static voltage current characteristics using **principles of mathematics and engineering science**	2
	PO 2	Understand the given power electronic components application **with problem statement by analyzing complex engineering problems.**	6
	PO 3	Demonstrate the given power electronic components voltage current characteristics **for design solutions of complex engineering problems**	6
	PO 4	Understand the given power electronic components characteristics **with analysis and interpretation of data**	6
	PO 6	Illustrate the given power electronic component operation **for safety issues in professional engineering practice**	4
	PO 8	Understand the given power electronic components characteristics **with ethical principles, professional ethics and responsibilities**	2
	PO 9	Demonstarte the given power electronic components operation **to function effectively as an individual and as a member in team**	8
	PO 10	Interpret the power electronic components operation **with communication of complex engineering practices**	3
	PO 12	Understand the given power electronic components application **in life long learning in technological change**	6
	PSO 1	Demonstrate the given power electronic components application **in the electrical systems involved in power genration, transmikssion and distribution**	3
	PSO 2	Understand the given power electronic components application **in electrical drives with converter topologies for energy conversion and management**	7
	PSO 3	Illustrate the given power electronic components application **in automation process using PLC and process controllers**	4
CO 2	PO 1	Observe the functionality of forced commutation circuits and gate firing circuits using **principles of mathematics and engineering sciences**	2
	PO 2	Understand the forced commutation circuits and gate firing circuits with**problem statement by analyzing complex engineering problems.**	6
	PO 3	Develop the forced commutation circuits and gate firing circuits **for design solutions of complex engineering problems**	6

	PO 4	Understand the forced commutation circuits and gate firing circuits operation **with analysis and interpretation of data**	6
	PO 6	Illustrate the forced commutation circuits and gate firing circuits **for safety issues in professional engineering practice**	4
	PO 8	Understand the forced commutation circuits and gate firing circuits **with ethical principles, professional ethics and responsibilities**	2
	PO 9	Demonstarte the forced commutation circuits and gate firing circuits **to function effectively as an individual and as a member in team**	8
	PO 10	Interpret the turn on and turn off methods of SCR **with communication of complex engineering practices**	3
	PO 12	Understand the forced commutation circuits and gate firing circuits **in life long learning in technological change**	6
	PSO 1	Demonstrate the forced commutation circuits and gate firing circuits **in the electrical systems involved in power genration, transmikssion and distribution**	3
	PSO 2	Understand the forced commutation circuits and gate firing circuits **in electrical drives with converter topologies for energy conversion and management**	7
	PSO 3	Illustrate the forced commutation circuits and gate firing circuits **in automation process using PLC and process controllers**	4
CO 3	PO 1	Observe the input and output waveforms of controlled rectifier circuits using **principles of mathematics and engineering science**	2
	PO 2	Understand the operation of controlled rectifier circuits **with problem statement by analyzing complex engineering problems.**	6
	PO 3	Demonstrate the controlled rectifier circuits **for design solutions of complex engineering problems**	6
	PO 4	Understand the input and output waveforms of controlled rectifier circuits **with analysis and interpretation of data**	6
	PO 5	Understand the controlled rectifier circuits **modelling using IT tools such as MATLAB**	6
	PO 6	Illustrate the input and output waveforms of controlled rectifier circuits **for safety issues in professional engineering practice**	4
	PO 8	Understand the input and output waveforms of controlled rectifier circuits **with ethical principles, professional ethics and responsibilities**	2
	PO 9	Demonstarte the controlled rectifier circuits operation **to function effectively as an individual and as a member in team**	8

	PO 10	Interpret the input and output waveforms of controlled rectifier circuits **with communication of complex engineering practices**	3
	PO 12	Understand the controlled rectifier circuits operation **in life long learning in technological change**	6
	PSO 1	Demonstrate the input and output waveforms of controlled rectifier circuits **in the electrical systems involved in power genration, transmikssion and distribution**	3
	PSO 2	Understand the controlled rectifier circuits applications **in electrical drives with converter topologies for energy conversion and management**	7
	PSO 3	Illustrate the operation of controlled rectifier circuits **in automation process using PLC and process controllers**	4
CO 4	PO 1	Observe the various inverter circuits for direct current to Alternating current conversion using **principles of mathematics and engineering science**	2
	PO 2	Understand the operation of various inverter circuits **with problem statement by analyzing complex engineering problems.**	6
	PO 3	Demonstrate the inverter circuits **for design solutions of complex engineering problems**	6
	PO 4	Understand the various inverter circuits for direct current to Alternating current conversion **with analysis and interpretation of data**	6
	PO 5	Understand the inverter circuits **modelling using IT tools such as MATLAB**	6
	PO 6	Illustrate the various inverter circuits for direct current to Alternating current conversion **for safety issues in professional engineering practice**	4
	PO 8	Understand the various inverter circuits for direct current to Alternating current conversion **with ethical principles, professional ethics and responsibilities**	2
	PO 9	Demonstarte the inverter circuits operation **to function effectively as an individual and as a member in team**	8
	PO 10	Interpret the various inverter circuits for direct current to Alternating current conversion **with communication of complex engineering practices**	3
	PO 12	Understand the inverter circuits operation **in life long learning in technological change**	6
	PSO 1	Demonstrate the operation of inverter circuits **in the electrical systems involved in power genration, transmikssion and distribution**	3
	PSO 2	Understand the inverter circuits applications **in electrical drives with converter topologies for energy conversion and management**	7

	PSO 3	Illustrate the operation of inverter circuits **in automation process using PLC and process controllers**	4
CO 5	PO 1	Observe the performance characteristics of ac to ac converters using **principles of mathematics and engineering science**	2
	PO 2	Understand the operation of AC voltage controllers and cycloconverters **with problem statement by analyzing complex engineering problems.**	6
	PO 3	Demonstrate the operation of AC voltage controllers and cycloconverters **for design solutions of complex engineering problems**	6
	PO 4	Understand the operation of AC voltage controllers and cycloconverters **with analysis and interpretation of data**	6
	PO 6	Illustrate the performance characteristics of ac to ac converters **for safety issues in professional engineering practice**	4
	PO 8	Understand the performance characteristics of ac to ac converters **with ethical principles, professional ethics and responsibilities**	2
	PO 9	Demonstarte the operation of AC voltage controllers and cycloconverters **to function effectively as an individual and as a member in team**	8
	PO 10	Interpret the operation of AC voltage controllers and cycloconverters **with communication of complex engineering practices**	3
	PO 12	Understand the AC voltage controllers and cycloconverters applications **in life long learning in technological change**	6
	PSO 1	Demonstrate the AC voltage controllers and cycloconverters applications **in the electrical systems involved in power genration, transmikssion and distribution**	3
	PSO 2	Understand the AC voltage controllers and cycloconverters applications **in electrical drives with converter topologies for energy conversion and management**	7
	PSO 3	Illustrate the operation AC voltage controllers and cycloconverters applications **in automation process using PLC and process controllers**	4
CO 6	PO 1	Observe the chopper circuits operation using **principles of mathematics and engineering science**	2
	PO 2	Understand the operation of chopper circuits **with problem statement by analyzing complex engineering problems.**	6
	PO 3	Demonstrate the chopper circuits **for design solutions of complex engineering problems**	6
	PO 4	Understand the various chopper circuits for dc to variable dc conversion **with analysis and interpretation of data**	6

	PO 5	Understand the chopper circuits **modelling using IT tools such as MATLAB**	6
	PO 6	Illustrate the chopper circuits for dc to varible dc conversion **for safety issues in professional engineering practice**	4
	PO 8	Understand the chopper circuits for dc to varible dc conversion **with ethical principles, professional ethics and responsibilities**	2
	PO 9	Demonstarte the chopper circuits operation **to function effectively as an individual and as a member in team**	8
	PO 10	Interpret the the chopper circuits for dc to varible dc conversion **with communication of complex engineering practices**	3
	PO 12	Understand thechopper circuits operation **in life long learning in technological change**	6
	PSO 1	Demonstrate the operation of chopper circuits **in the electrical systems involved in power genration, transmikssion and distribution**	3
	PSO 2	Understand the chopper applications **in electrical drives with converter topologies for energy conversion and management**	7
	PSO 3	Illustrate the operation of chopper circuits **in automation process using PLC and process controllers**	4

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	PSO 1	PSO 2	PSO 3
CO 1	3	3	3	3	-	2	-	3	2	2	-	2	2	3	3
CO 2	3	3	3	3	-	2	-	3	2	2	-	2	2	3	3
CO 3	3	3	3	3	3	2	-	3	2	2	-	2	2	3	3
CO 4	3	3	3	3	3	2	-	3	2	2	-	2	2	3	3
CO 5	3	3	3	3	-	2	-	3	2	2	-	2	2	3	3
CO 6	3	3	3	3	3	2	-	3	2	2	-	2	2	3	3

XIII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIV ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XV SYLLABUS:

WEEK I	**SCR, MOSFET AND IGBT**
	Problem statement Design the circuits for gate firing of SCR for getting detailed operation and waveforms. **Solutions expected** 1. Calculate the firing angles for different values of resistance in RC triggering circuit 2. Calculate the firing angles for different values of resistance in UJT triggering circuit 3. Draw the output voltages for different firing angles between 0 to 180 degrees
WEEK II	**GATE FIRING CIRCUITS**
	Problem statement Design the circuit for analyzing the characteristics of SCR, MOSFET and IGBT **Solutions expected** 1. From the SCR characteristics calculate breakdown voltage, latching current and holding current 2. In MOSFET characteristics mention cut off region, ohmic or linear region and saturation region 3. In IGBT characteristics calculate breakdown voltage
WEEK III	**HALF CONTROLLED CONVERTER**
	Problem statement Design single-phase half-controlled converter with R and RL loads to analyze the performance characteristics. **Solutions expected** 1. Calculate the average and RMS voltage for different firing angles between 0 to 180 degrees 2. Draw the output voltages for different firing angles between 0 to 180 degrees
WEEK IV	**FORCED COMMUTATION CIRCUITS**
	Problem statement Design the commutation circuits for SCR and observe the turn off characteristics with different frequency levels between 0 to 150Hz. **Solutions expected** 1. Calculate the turn off time from the output waveforms with different frequency levels between 0 to 150Hz. 2. Draw the output waveforms with different frequency levels between 0 to 150Hz.

WEEK V	**FULLY CONTROLLED BRIDGE CONVERTER**
	Problem statement Design single-phase full-controlled converter with R and RL loads to analyze the performance characteristics. **Solutions expected** 1. Calculate the average and RMS voltage for different firing angles between 0 to 180 degrees 2. Draw the output voltages for different firing angles between 0 to 180 degrees
WEEK VI	**SERIES INVERTER**
	Problem statement Design single-phase series inverter circuit and operate with different frequencies. **Solutions expected** 1. Observe the output waveforms at all frequencies between 0 to 200Hz 2. Calculate the RMS output voltage at all frequencies 0 to 200Hz
WEEK VII	**PARALLEL INVERTER**
	Problem statement Design single-phase parallel inverter circuit and operate with different frequencies. **Solutions expected** 1. Observe the output waveforms at all frequencies between 0 to 200Hz 2. Calculate the RMS output voltage at all frequencies 0 to 200Hz
WEEK VIII	**VOLTAGE CONTROLLER**
	Problem statement Design the Single-phase AC voltage controller circuit and operate with different loads, power factors. **Solutions expected** 1. Calculate average output voltages with different firing angles between 0 to 180 degrees 2. Calculate RMS output voltages with different firing angles between 0 to 180 degrees 3. Draw the output voltage waveforms with different firing angles between 0 to 180 degrees
WEEK IX	**DUAL CONVERTER**
	Problem statement Design the single-phase dual converter circuit with R and RL loads to analyze the performance characteristics. **Solutions expected** 1. Calculate the average and RMS voltage for different firing angles between 0 to 180 degrees 2. Draw the output voltages for different firing angles between 0 to 180 degrees
WEEK X	**CYCLOCONVERTER**
	Problem statement Design the Single-phase cycloconverter circuit and operate with different loads, frequencies between 0 to 50Hz.

	Solutions expected 1. Calculate the average and RMS voltage for different frequencies between 0 to 50Hz 2. Draw the output voltages for different frequencies between 0 to 50Hz
WEEK XI	**THREE PHASE CONVERTERS**
	Problem statement Design three phase half converter with R load to analyze the performance characteristics. **Solutions expected** 1. Calculate the average and RMS voltage for different firing angles between 0 to 180 degrees 2. Draw the output voltages for different firing angles between 0 to 180 degrees
WEEK XII	**MOSFET BASED CHOPPERS**
	Problem statement Design the step-down chopper using MOSFET for the performance analysis. **Solutions expected** 1. Calculate the output voltages, duty ratios between 0 to 1 with time ratio control 2. Calculate the output voltages, duty ratios between 0 to 1 with frequency control
WEEK XIII	**SIMULATION OF THREE PHASE FULL CONVERTER AND PWM INVERTER**
	Problem statement Design the three phase full converter and PWM inverter circuits with R and RL loads by using MATLAB. **Solutions expected** 1. Calculate the average and RMS voltage for different firing angles between 0 to 180 degrees 2. Draw the output voltages for different firing angles between 0 to 180 degrees
WEEK XIV	**SIMULATION OF BUCK – BOOST CHOPPER**
	Problem statement Design the boost, buck, buck boost converter with R and RL loads by using MATLAB. **Solutions expected** 1. Calculate the output voltages, duty ratios between 0 to 1 with time ratio control 2. Calculate the output voltages, duty ratios between 0 to 1 with frequency control

TEXTBOOKS

1. M D Singh, K B Kanchandhani, “Power Electronics”, Tata Mc Graw Hill Publishing Company, 2nd Edition, 1998.
2. Dr. P S Bimbhra, “Power Electronics”, Khanna Publishers, 5th Edition, 2012.

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1. Vedam Subramanyam, “Power Electronics”, New Age International Limited, 2nd Edition, 2006.
2. G K Dubey, S R Doradra, A Joshi, R M K Sinha, “Thyristorised Power Controllers”, New Age International Limited, 2nd Edition, 2008.
3. V R Moorthi, “Power Electronics Devices”, Oxford University Press, 4th Edition, 2005.

XVI COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Study the characteristics of SCR, MOSFET and IGBT..	CO 1	T1:3.1
2	Study the operation of gate firing circuits of SCR..	CO 2	T1:3.11
3	Study the performance characteristics of single phase half controlled converter with R and RL loads.	CO 3	T1:4.8
4	Plot the characteristics of forced commutation circuits (Class A, Class B, Class C, Class D and Class E).	CO 2	T1:4.8
5	Study the characteristics of single phase fully controlled bridge converter with R and RL loads. .	CO 3	T1.5.5
6	Study the characteristics of single phase series inverter with different loads.	CO 4	T1:5.6
7	Study the characteristics of single phase parallel inverter with different loads..	CO 4	T1:8.3
8	Plot the characteristics of Single phase AC voltage controller with R and RL loads..	CO 5	T1:8.3
9	Study the characteristics of single phase dual converter with R and RL loads..	CO 3	T1:9.2
10	Study the characteristics of single phase cycloconverter with R and RL loads. .	CO 5	T1:9.3
11	Plot the characteristics of three phase half converter with R and RL loads..	CO 3	T1:10.6
12	Study the principle of operation of step down chopper using MOSFET.	CO 6	T1:10.7
13	Simulation of three phase full converter and PWM inverter with R and RL loads by using MATLAB.	CO 3	T1:10.7
14	Simulation of boost, buck, buck boost converter with R and RL loads by using MATLAB.	CO 6	T1:10.8

Signature of Course Coordinator **HOD, EEE**

Mr. S. Srikanth, Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**

PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 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**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

ANNEXURE - II

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	PSO Statement / Key Competencies Features (KCF)	No. of KCF(s)
PSO 1	Design, develop, fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization. 1. Operate, control and protect electrical power system. 2. Validate the interconnected power system. 3. Ensure reliable, efficient and compliant operation of electrical systems. 4. Familiarize the safety, legal and health norms in electrical system. 5. Adopt the engineering professional code and conduct.	**5**
PSO 2	Focus on the components of electrical drives with its converter topologies for energy conversion, management and auditing in specific applications of industry and sustainable rural development. 1. Control the electric drives for renewable and non-renewable energy sources. 2. Fabricate converters with various components and control topologies. 3. Synthesis, systematic procedure to examine electrical components/machines using software tools. 4. Inspect, survey and analyze energy flow. 5. Control and manage the power generation and utilization. 6. Familiarize the safety, legal and health norms in electrical system. 7. Adopt the engineering professional code and conduct. 8. Explore autonomous power 9. Evolve into green energy and assess results 10. Realize energy policies and education 11. Potential contribution of clean energy for rural development.	**11**
PSO 3	Gain the hands-on competency skills in PLC automation, process controllers, HMI and other computing tools necessary for entry level position to meet the requirements of the employer. 1. Explicit software and programming tools for electrical systems. 2. Adopt technical library resources and literature search. 3. Model, program for operation and control of electrical systems. 4. Constitute the systems employed for motion control. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**				
Course Title	**COMPUTER ARCHITECTURE**				
Course Code	ACSC24				
Program	B.Tech				
Semester	VI				
Course Type	Open Elective				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	1	4	-	-
Course Coordinator	Mr.B. Santhosh Kumar, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	ACSCO4	II	Programing for Problem Soloving

II COURSE OVERVIEW:

This course introduces the principles of basic computer organization, CPU organization, and the basic architecture concepts. The course emphasizes performance and cost analysis, instruction set design, register transfer languages, arithmetic, logic and shift micro-operations, pipelining, memory technology, memory hierarchy, virtual memory management, and I/O organization of computer, parallel processing and inter process communication and synchronization.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Computer Organization and Architecture	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	✓	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Remember
45 %	Understand
18 %	Apply
27 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

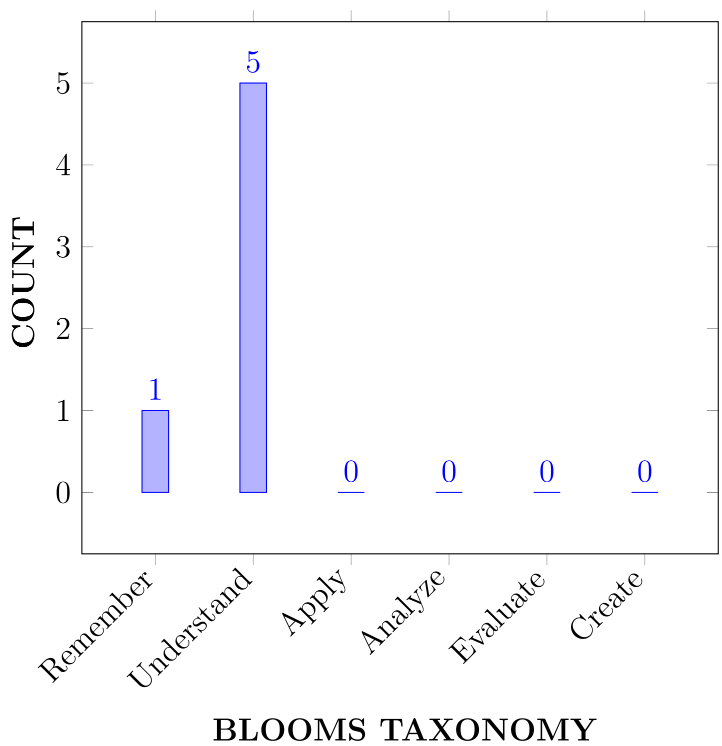
I	The basic concepts of the various functional units and characteristics of computer systems.
II	The concepts of central processing unit design and perform basic operations with signed and unsigned integers in decimal and binary number systems.
III	The function of each element of a memory hierarchy and compare the different methods for computer input and output.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Explain** the structure, characteristics of computer systems and the various functional unitsfor understanding the components of computers.	Understand
CO 2	**Demonstrate** the computer languages, machine, symbolic and assembly levels for understanding execution of program.	Understand
CO 3	**Recall** the number system their representations and conversion for the usage of instructions in digital computers.	Remember
CO 4	**Demonstrate** the register transfer language, represent memory and Arithmetic/ Logic/ Shift operations s for implementation of micro operations.	Understand
CO 5	**Illustrate** the basics of hardwired and micro-programmed control of the CPU which generates the control signals to fetch and execute instructions.	Understand
CO 6	**Compare** e different types of addressing modes for specifying the location of an operand.	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.	1	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 engineeringactivities 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.	3	SEE / CIE / AAT
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	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	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	3	CIE/Quiz/ AAT
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	2	CIE/Quiz/ AAT
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.	3	CIE/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	Explain the various functional units of Computer with computer science principles.	1
	PO 2	Explore the types of programming languages for problem identification and to formulate computer science and Engineering Problems.	2
	PO 3	Evaluate the instruction set architecture based on the cost drivers, integration, manage design process and understand customer needs..	4
	PSO 1	Understand levels of programming languages related to Software.	1
	PSO 2	Develop micro programs using instruction set architecture with a major focus on improving software reliability and information retrieval systems.	1

CO 2	PO1	Explore taxonomy of microoperations and RTL for micro program development by using the mathematical and computer science principles.	2
	PSO 1	Understand the notations of RTL related to Software.	4
	PSO 2	Develop assembly language programs with a major focus on improving software reliability and information retrieval systems.	3
CO 3	PO 1	Select appropriate addressing mode for finding effective address of operand using mathematical and computer science principles	2
	PO 2	Choose appropriate addressing mode for information and data collected from various sources memory locations or registers and perform microoperations and validation the results for interpretation	1
	PO 3	Classify the addressing modes in terms of defining various problems and understanding appropriate codes of practice.	3
	PO 4	Utilize Instruction set architecture of processors for designing assembly language programs through laboratory skills and technical literature.	2
	PO 10	Make use of variety of addressing modes to fetch operands for the development of assembly language program with clarity and semantics or grammar of the assembly language.	2
	PSO 1	Develop applications for specific problems by including huge volume of data and related to Software.	1
CO 4	PO 1	Explain the concept of data representation by applying mathematical and computer science principles.	3
	PO 2	Understand the data representation and computer arithmetic for understanding of appropriate codes to formulate, solve problem, document and interpretation of results.	6
	PO 3	Identify the appropriate representation of data suitable for customer needs, investigation of a problem, identify and manage architecture design process.	4
	PO 4	Communicate effectively in orally and written by comprehend and write effective reports and design documentation with the engineering community by having major focus on clarity on content, Grammar/Punctuation, appropriate References, good Speaking style and depth in subject matter.	2
	PO 10	Recognize the need for advanced concepts in binary arithmetic and algorithms for developing applications through continuing education efforts with ongoing learning – stays up with industry trends/ new technology and continued personal development in the broadest context of technological change	3
	PSO 1	Explain the technologies used to represent data and computer arithmetic related to Algorithms and architecture.	1

CO 5	PO 1	Design control unit by considering various issues and types risk assessment and analysis activity to identify and analyze root causes using computer science principles.	1
	PO 2	Design and develop hardwired and micro programmed control units with knowledge and uncertainty of commercial engineering process and management.	2
	PO 3	Design a control memory of system by investigating and defining various problems, understanding user needs.	3
	PO 4	Utilize micro instructions for designing assembly language programs through laboratory skills, technical literature, technical uncertainty and quality issues.	3
	PO 5	Experiment the design of control unit with Computer software or simulation packages.	2
	PO 10	Recognize the need for advanced concepts of control memory design and micro instructions based on micro architecture for developing applications through continuing education efforts with ongoing learning – stays up with industry trends/ new technology and continued personal development in the broadest context of technological change.	4
	PSO 1	Explain the design issues of control memory and micro instruction format used to develop micro program related to Algorithms and architecture.	1
	PSO 3	Develop micro programs and support design of control memory by using modern computer software and simulation tools for creating innovative career paths, to be an entrepreneur and desire for higher studies.	1
CO 6	PO 1	Understand the concept of pipelining to improve performance of the system by applying mathematical principles and computer science methodologies.	2
	PO 10	Communicate in written form by comprehending and writing effective reports and design documentation advanced micro architectures with the engineering community by having major focus on clarity on content, Grammar/Punctuation, good Speaking style	2
	PO 12	Recognize the need for advanced concepts for developing applications through continuing education efforts with ongoing learning – stays up with industry trends/ new technology and continued personal development in the broadest context of technological change.	4
	PSO 1	Develop MIMD architecture for optimizing the performance related to Algorithms, Software and Networking.	1
	PSO 3	Recognize importance of pipelining, inter process communication of advanced micro processors for creating innovative career paths, to be an entrepreneur and desire for higher studies.	1

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	2	4	-	-	-	-	-	-	-	-	-	1	1	-
CO 2	2	-	-	-	-	-	-	-	-	-	-	-	1	2	-
CO 3	2	2	1	3	-	-	-	-	-	2	-	2	1	-	-
CO 4	3	6	-	4	-	-	-	-	-	2	-	3	1	-	-
CO 5	1	2	3	3	-	-	-	-	-	2	-	4	1	-	1
CO 6	2	-	-	-	-	-	-	-	-	2	-	4	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	33.4	20	40	-	-	-	-	-	-	-	-	-	16.6	50	-
CO 2	66.6	-	-	-	-	-	-	-	-	-	-	-	16.6	100	-
CO 3	66.6	20	10	27.3	-	-	-	-	-	20	-	16.6	16.6	-	-
CO 4	100.0	60	-	36.4	-	-	-	-	-	20	-	25	16.6	-	-
CO 5	33.4	20	30	27.3	-	-	-	-	-	20	-	33.4	16.6	-	50
CO 6	66.6	-	-	-	-	-	-	-	-	20	-	33.4	66.7	-	50

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 - $0 \leq C \leq 5\%$ – No correlation
1 - $5 < C \leq 40\%$ – Low/ Slight
2 - $40\% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	1	2	-	-	-	-	-	-	-	-		1	-	3
CO 2	3	-	-	-	-	-	-	-	-	-	-	-	1	-	3
CO 3	3	1	1	1	-	-	-	-	-	1	-	1	1	-	-
CO 4	3	3	-	1	-	-	-	-	-	1	-	1	3	-	-
CO 5	1	1	1	1	-	-	-	-	-	1	-	1	1	-	3
CO 6	3	-	-	-	-	-	-	-	-	1	-	1	1	-	3
TOTAL	14	6	4	3	-	-	-	-	-	4	-	4	8	-	12
AVERAGE	2.3	1.5	2.6	1	-	-	-	-	-	1	-	1	1.33	-	3

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Seminars	✓	Student Viva	-	Certification	-
Laboratory Practices	-	Student viva	-	Mini projects	-
Term Paper	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION TO COMPUTER ORGANIZATION**
	Basic computer organization, CPU organization, memory subsystem organization and interfacing, input or output subsystem organization and interfacing, simple computer levels of programming languages, assembly language instructions, a simple instruction set architecture. .
MODULE II	**ORGANIZATION OF A COMPUTER**
	Register transfer: Register transfer language, register transfer, bus and memory transfers, arithmetic micro operations, logic micro operations, shift micro operations; Control memory.
MODULE III	**CPU AND COMPUTER ARITHMETIC**
	CPU design: Instruction cycle, data representation, memory reference instructions, input-output, and interrupt, addressing modes, data transfer and manipulation, program control. Computer arithmetic: Addition and subtraction, floating point arithmetic operations, decimal arithmetic unit.
MODULE IV	**INPUT-OUTPUT ORGANIZATION**
	Input or output organization: Input or output Interface, asynchronous data transfer, modes of transfer, priority interrupt, direct memory access.
MODULE V	**MEMORY ORGANIZATION**
	Memory organization: Memory hierarchy, main memory, auxiliary memory, associative memory, cache memory, virtual memory; Pipeline: Parallel processing, Instruction pipeline.

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1. M. Morris Mano, "Computer Systems Architecture", Pearson, 3 rd Edition, 2015.
2. John D. Carpinelli, "Computer Systems Organization and Architecture", Pearson, 1 st Edition, 2001.
3. Patterson, Hennessy, "Computer Organization and Design: The Hardware/Software Interface", Morgan Kaufmann, 5 th Edition, 2013.

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1. John. P. Hayes, “Computer System Architecture”, McGraw-Hill, 3 rd Edition, 1998.
2. Carl Hamacher, Zvonko G Vranesic, Safwat G Zaky, “Computer Organization”, McGraw-Hill, 5 th Edition, 2002.
3. William Stallings, “Computer Organization and Architecture”, Pearson Edition, 8 th Edition, 2010

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1. http://www.web.stanford.edu/class/cs103x

COURSE WEB PAGE:

1. https://lms.iare.ac.in/index?route=course/details & course_id=528

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	In Outcome-Based Education (OBE), we discussed about course delivery assessment that are planned to achieve stated objectives and outcomes. We will focuses on measuring student performance i.e. outcomes at different levels. Course outcomes(CO),Program Outcomes(PO)and Program Specific Outcomes(PSO) and also mapping of CO's to PO's PSO's and their attainments are discussed.		
	CONTENT DELIVERY (THEORY)		
1	Understand the basic computer organization	CO1	T1: 4.1-4.2,T1: 4.1
2	Outline the Components of computer organization	CO1	T1: 4.1-4.2,T1: 4.1
3	Understand the CPU organization, memory subsystem organization and interfacing	CO 1	T1: 4.3-4.4
4	Analyze the input or output subsystem organization and interfacing	CO 1,CO2	T1: 3.1-3.2
5	Understand a simple computer levels of programming languages	CO 1	T2: 2.5-2.6,
6	Understand a programming language basic computer systems.	CO 1	T2: 2.5-2.6,
7	Explain assembly language instructions	CO 2, CO 3	T1:1.5, 1.4.2,1.4.3
8	Outline the types of assembly language instructions.	CO 2, CO 3	T1:1.5, 1.4.2,1.4.3
9	Determine the simple instruction set architecture	CO 2	T2: 7.4
10	Understand the register transfer language, register transfer.	CO 2	T2: 5.6-5.7
11	Remember the process of register transfer language.	CO 2	T2: 5.6-5.7

12	Analyze bus and memory transfers	CO 2	T1: 6.7-6.8
13	Explain the arithmetic micro-operations, logic micro-operations, shift micro-operations	CO 2	T2: 8.5-8.7
14	Demonstrate the arithmetic-operations and logic operations.	CO 2	T2: 8.5-8.7
15	Explain the arithmetic micro-operations, logic micro-operations, shift micro-operations	CO 2	T2: 8.5-8.7
16	Understand the control memory	CO 3	T2: 8.6
17	Explain the instruction cycle	CO 2	T2: 10.1-10.5
18	Outline the types of instruction cycle and their performance.	CO 2	T2: 10.1-10.5
19	Outline the data representation, memory reference instructions	CO 3	T2: 12.1
20	Understand the memory and data representation and instructions	CO 3	T2: 12.1
21	Analyze input-output, and interrupt, addressing modes	CO 3	T2: 11.2
22	Discuss the data transfer and manipulation, program control	CO 3	T2: 11.3-11.4
23	Determine the Addition and subtraction, floating point arithmetic operations, decimal arithmetic unit	CO 4	T2: 11.5
24	Outline the arithmatic operations and logica gates.	CO 4	T2: 11.5
25	Determine the Addition and subtraction, floating point arithmetic operations, decimal arithmetic unit	CO 4	T2: 11.5
26	Need of Input or output organization	CO5	R1: .3.1
27	Discuss the Input or output Interface	CO5	R1: 3.3-9.5
28	Demonstrate the peripherals of Input or output Interface and their modules.	CO5	R1: 3.3-9.5
29	Discuss the interconnections of Input or output mode of opeartions.	CO5	R1: 3.3-9.5
30	Understand the asynchronous data transfer, modes of transfer	CO5	T2: 9.4
31	Outline the synchronous data transfer, modes of transfer	CO5	T2: 9.4
32	Analyze the priority interrupt, direct memory access	CO5	T2:13.1
33	Outline the synchronous and asynchronous data transfer, modes of transfer	CO5	T2: 9.4
34	Understand the memory organization	CO5	T2:13.2
35	Discuss Memory hierarchy, main memory, auxiliary memory, associative memory, cache memory, virtual memory	CO 5	T2: 13.3
36	Understand the memory organization	CO5	T2:13.2
37	Understand the Pipeline: Parallel processing, Instruction pipeline	CO6	T2: 13.
38	Understand the memory organization	CO5	T2:13.2
39	Characteristics of multiprocessors	CO6	T2: 13.1
40	Outline the Inter connection structures	CO6	T2: 13.2
41	Demonstrate the process of connections	CO 3,CO6	T2: 13.3

PROBLEM SOLVING/ CASE STUDIES			
42	Problems on BCD conversions	CO1	T2:2.1
43	Problems on BCD conversions	CO1	T2:2.3
44	Problems on Addition and substraction	CO3	T2:2.3.1
45	Problems on Multiplication	CO3	T2:7.2,7.3
46	Problems on Booths multiplication	CO3	T2:10.3.1
47	Problems on Booths Algorithm	CO3	T2:13.3.2, 13.4.1
48	Problems on Division	CO3	T2:17.1.1, 17.1.3
49	Problems on Data presentation	CO3	T2:18.3.4, 18.3.4.1
50	Problems on Data presentation	CO3	T2:22.12, 19.1.2
51	Problems on Data presentation	CO3	T2:18.4, 18.4.3
52	Problems on floating point arithmetic operations	CO3	T2:19.2, 18.4.4
53	Problems on Decimal arithmatic unit	CO3	T2:23.1.1, 23.1.3
54	Problems on logic gate design and operations	CO3	T2:19.2, 14.4.4
55	Problems on K maps and logic gate operations	CO3	T2:19.2, 18.4.4
56	Problems on memory organization allocation and design	CO3	T2:19.2, 16.4.4
DISCUSSION ON DEFINITION AND TERMINOLOGY			
57	Define register transfer language,fixed point number,instruction format,data Processing instruction,data Processing instruction	CO 1	T2:18.3.4, 18.3.4.1
58	Define miscellaneous Instructions, addressing mode,micro operation.	CO 2	T2:22.12, 19.1.2
59	Define arithmetic micro operations,arithmetic micro operations,logical shift operation	CO 3	T2:18.4, 18.4.3
60	Define data bus,metropolitan area network,network topology,star topology,bus tropology	CO4, CO 5	T2:19.2, 18.4.4
61	define vecto,pipeline cycle time, arithmetic pipeline,optimal number of pipeline stages	CO 6	T2:23.1.1, 23.1.3
DISCUSSION ON QUESTION BANK			
62	Illustrate the input and output operations with a neat diagram.	CO 1	T2:18.3.4, 18.3.4.1
63	List the various instruction formats and illustrate with an example.	CO 2	T2:22.12, 19.1.2
64	Identify micro programexample and build a computer hardware configuration	CO3,CO4	T2:18.4, 18.4.3

65	Illustrate the belowaddressing modes withexamples a. Implied Modeb. Immediate Mode c. Autoincrement and Auto,decrement Mode d. Direct and Indirect Address Mode.	CO5	T2:19.2, 18.4.4
66	Define parallel processing and explain the flynn's classification of computer with suitable diagram	CO 6	T2:23.1.1, 23.1.3

Course Coordinator **HOD,EEE**
Mr.B Santhosh Kumar, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Electrical and Electronics Engineering**					
Course Title	**Electric Drives and Static Control**					
Course Code	AEEC23					
Program	B.Tech					
Semester	VI					
Course Type	Core					
Regulation	UG-20					
Course Structure	Theory			Practical		
	Lecture	Tutorials	Credits	Laboratory	Credits	
	3	-	3	-	-	
Course Coordinator	Mr. S. Srikanth, Asistant Professor					

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEC11	IV	AC Machines
B.Tech	AEEC16	V	Power Electronics

II COURSE OVERVIEW:

This course deals with the basic theory, construction, operation, performance characteristics and application of electromechanical energy conversion devices such as synchronous and asynchronous machines. It also facilitates the study of the alternating machines which are the major part of industrial drives and agricultural pump sets

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Electrical drives and static control	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with ”either” or ”choice” will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
50.0%	Understand
33.3%	Apply
16.6%	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	-

VI COURSE OBJECTIVES:

The students will try to learn:

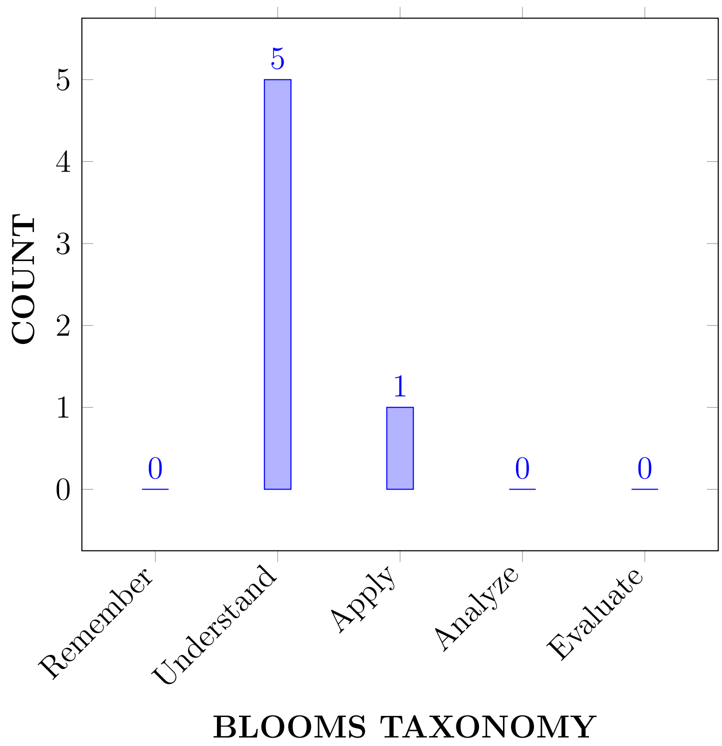
I	The steady state behavior and transient dynamics of the converter/chopper fed DC drive.
II	The steady state behavior and transient dynamics of the converter/chopper fed DC drive
III	The performance of different industrial drives considering issues such as energy efficiency, power quality, economic justification, environmental issues and practical liabilities.
IV	Starting, braking, and speed control arrangements for electric motors and their applications.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Illustrate** the speed control of DC motors with single phase and three phase-controlled rectifiers for verification of speed torque characteristics	Understand
CO 2	**Explain** the four-quadrant chopper fed dc motor drives for verification of speed torque characteristics	Understand
CO 3	**Describe** the working of stator voltage control of induction motor for speed control of the drive.	Understand
CO 4	**Identify** the variable frequency control methods for induction motor drive applications.	Apply
CO 5	**Summarize** the slip power recovery schemes, direct and indirect vector control methods for speed control of induction motors.	Understand
CO 6	**Demonstrate** the working of voltage source and current source inverter fed synchronous motor dive for speed control 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.	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

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 Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development	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 speed control of DC motors with single phase and three phase-controlled rectifiers using science and engineering fundamentals.	3
	PO 2	Understand speed torque characteristics of dc motor using first principles of mathematics and engineering sciences	6
	PSO 2	Demonstrate the speed control of dc drives using rectifiers topologies for energy conversion and specific applications of industry	7
CO 2	PO 1	Demonstrate the fourquadrant chopper fed dc motor using science and engineering fundamentals	2
	PO 2	Illustrate thechopper controlled drives using first principles of mathematics and engineering sciences.	6
	PO 4	Demonstrate the speed torque characteristics of chopper fed drives	6
	PSO 2	Demonstrate the speed control of dc drives using rectifiers topologies for energy conversion and specific applications of industry	6
CO 3	PO 1	Understand stator voltage control of induction motor using engineering fundamentals	3
	PO 2	Illustrate speed control of induction motor drives using first principles of mathematics and engineering sciences	6
	PSO 2	Demonstrate stator voltage control of induction motor drive using AC voltage controller for energy conversion and specific controller applctions of industry needs	7
CO 4	PO 1	Understand v/f control of induction motor drive using engineering funda	3
	PO 2	Demonstrate v/f control of ac using first principles of mathematics and engineering sciences	7
	PSO 2	Illustrate operation of AC drives with v and f using different control topologies for energy conversion andspecific applications of induction motor	6
CO 5	PO 1	Understand slip power recovery schemes and vectror controlled drives using knowledge of science and engineering fundamentals	3
	PO 2	Understand understand slip power recovery schemes and vectror controlled of induction motor with knowledge of science and engineering fundamentals	7
	PSO 2	Demonstrate speed control of induction motor with static rotor resistance controlling different control topologies for energy conversion andspecific applications of induction motol	6

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 6	PO 1	Voltage source inverter and current source inverter fed drives with knowledge of science and engineering fundamentals	3
	PO 2	Describe the control of synchronous motor drive using science and engineering fundamentals	6
	PO 4	Develop self and separately control of ac drives with analysis and innterpretition of data	6
	PSO 2	Illustrate synchronous motor drives with converter topologies voltage and current source inverter	7

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	6	-	-	-	-	-	-	-	-	-		-	7	-
CO 2	2	6	-	6	-	-	-	-	-	-	-	-	-	6	-
CO 3	3	6	-	-	-	-	-	-	-	-	-	-	-	7	-
CO 4	3	7	-	-		-	-	-	-	-	-		-	6	-
CO 5	3	6	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	5	-	6	-	-	-	-	-	-	-		-	7	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	60	-	-	-	-	-	-	-	-	-		-	63.6	-
CO 2	66	60	-	60	-	-	-	-	-	-	-	-	-	54.5	-
CO 3	100	70	-	-	-	-	-	-	-	-	-	-	-	63.6	-
CO 4	100	70	-	-		-	-	-	-	-	-		-	63.6	-
CO 5	100	70	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	100	60	-	60		-	-	-	-	-	-		-	63.6	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - 0 $\leq$ C$\leq$ 5% – No correlation

1 -5 <C$\leq$ 40% – Low/ Slight

2 - 40 % <C < 60% –Moderate

3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	-	-	-	-	-	-	-	-	-	-	3	
CO 2	2	2	-	2	-	-	-	-	-	-	-	-	-	2	-
CO 3	3	2	-	-	-	-	-	-	-	-	-	-	-	3	-
CO 4	3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO 5	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	2	-	2	-	-	-	-	-	-	-	-	-	3	-
TOTAL	17	14	2	-	-	-	-	-	-	-	-	-	3	11	6
AVERAGE	2.8	2.33	-	2	-	-	-	-	-	-	-	-	3	2.2	3

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	-
Quiz	-	Tech-Talk	✓	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practice	-	5 Minutes Video / Concept Video	✓	Open Ended Experiments	-
Micro Projects	-	-	-	-	

XVII ASSESSMENT METHODOLOGY-INDIRECT:

	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**CONTROL OF DC MOTORS THROUGH PHASE CONTROLLED RECTIFIERS**
	Introduction to thyristor controlled drives: Single phase semi and fully controlled converters connected to DC separately excited and dc series motors, continuous current operation, output voltage and current waveforms, speed and torque expressions, speed torque characteristics, problems on converter fed DC motors; Three phase semi and fully controlled converters connected to DC separately excited and DC series motors, output voltage and current waveforms, speed and torque expressions, speed torque characteristics and problems.

MODULE II	SPEED CONTROL OF DC MOTORS
	Introduction to four quadrant operation: Motoring operations, electric braking, plugging, dynamic and regenerative braking operations; Four quadrant operation of DC motors by dual converters, closed loop operation of DC motor; Chopper fed DC drives: Single quadrant, two quadrant and four quadrant chopper fed DC separately excited and series excited motors, continuous current operation output voltage and current wave forms, speed torque expressions, speed torque characteristics, problems on chopper fed DC motors and closed loop operation.
MODULE III	SPEED CONTROL OF INDUCTION MOTORS THROUGH VARIABLE VOLTAGE AND FREQUENCY
	Variable voltage characteristics: Control of induction motor by AC voltage controllers, waveforms, speed torque characteristics. Variable frequency characteristics: Variable frequency characteristics, variable frequency control of induction motor by voltage source and current source inverter and cycloconverters, pulse with modulation control, comparison of voltage source inverter and current source inverter operations, speed torque characteristics, numerical problems on induction motor drives, closed loop operation of induction motor drives.
MODULE IV	SPEED CONTROL OF INDUCTION MOTORS THROUGH ROTOR RESISTANCE AND VECTOR CONTROL
	Static rotor Resistance control: Slip power recovery schemes, static Scherbius drive, static Kramer drive, their performance and speed torque characteristics, advantages and applications, vector control of induction motor drives: Principles of vector control, vector control methods, direct methods of vector control, indirect methods of vector control and problems.
MODULE V	SPEED CONTROL OF SYNCHRONOUS MOTORS
	Separate control and self-control of synchronous motors, operation of self-controlled synchronous motors by voltage source inverter and current source inverter cyclo converters. Load commutated CSI fed synchronous motor, operation, waveforms, speed torque characteristics, applications, advantages and numerical problems, closed loop control operation of synchronous motor drives (block diagram only), variable frequency control, cycloconverter, PWM, variable frequency inverter and current source inverter.

TEXTBOOKS

1. PV Rao, "Power Semiconductor Drives", BS Publications, 1st Edition, 2014.
2. G K Dubey, "Fundamentals of Electric Drives", Narosa Publications, 2nd Edition, 2001.

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2. https://www.freevideolectures.com

COURSE WEB PAGE:

1. https://lms.ac.in

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Presentation on Outcome based education		
CONTENT DELIVERY (THEORY)			
2	Understand the principle of thyristor controlled drives	CO1	T2:2.3,
3	Describe the operation of Single phase semi controlled converters connected to DC separately excited motors	CO1	T1: 5.2
4	Understand the operation Single phase semi controlled converters connected to DC series motors	CO1	T2:2.2 R2:1.1-1.8
5	Discuss the operation of Single phase fully controlled converters connected to DC separately excited motors	CO1	T1: 5.7 R2:2.3
6	Describe the operation of Single phase fully controlled converters connected to DC series motors	CO1	T1: 5.7.1 R2:3.2
7	Demonstrate the operation of Three phase semi controlled converters connected to DC separately excited motors	CO1	T2:6.6 R2:2.9
8	Understand the operation of Three phase semi controlled converters connected to DC series motors	CO1	T2:5.7 R2:2.9
9	Describe the operation of Three phase fully controlled converters connected to DC separately excited motors	CO1	T1:6.2 R2:2.11
10	Discuss the operation of Three phase fully controlled converters connected to DC series motors	CO1	T1:6.2 R2:2.11
11	Understand the four quadrant operation of DC motors	CO2	T1:6.1.2 R2:3.5
12	Describe the electric braking operations	CO2	T1:6.1.2 R2:3.7
13	Demonstrate the Regenerative braking operations of DC Motors	CO2	T1:13.1 R2:3.7
14	Discuss the Four quadrant operation of DC motors by dual Converters	CO2	T1:13.2 R2:3.7
15	Describe the closed loop operation of DC motor with four quadrant operations	CO2	T1:13.2 R2:3.7
16	Understand the operation of Single quadrant chopper fed DC separately excited and series motors	CO2	T1:8.2 R2:3.7
17	Describe the operation of Two quadrant chopper fed DC separately excited and series motors	CO2	T1:11.3 R2:2.11
18	Discuss the operation of Four quadrant chopper fed DC separately excited and series motors	CO2	T2:4.6 R2:5.1
19	Demonstrate the Closed loop operation of chopper fed DC motors	CO2	T1:11.2 R2:5.4

20	Understand the variable voltage characteristics of induction Motor	CO3	T2:4.6 R2:4.3-4.4
21	Discuss the speed control of induction motor by AC voltage Controllers	CO3	T2:4.6.2 R2:4.3-4.4
22	Describe the Speed torque characteristics of induction motor with variable voltage	CO3	T2:4.6.3 R2:4.5
23	Demonstrate the variable frequency characteristics of induction motor	CO4	T1:12.3 R2:5.2
24	Understand the operation of voltage source inverter fed induction motor	CO4	T1:12.3 R2:6.1
25	Discuss the operation of current source inverter fed induction Motor	CO3	T1:12.1 R2:6.2
26	Describe the operation of cycloconverter fed induction motor	CO4	T111.4: R2:7.1-7.2
27	Apply the pulse width modulation control for variable frequency control of induction motor	CO4	T2:3.3 R2:7.4
28	Distinguish voltage source inverter and current source inverter	CO4	T2:3.1 R2:7.4
29	Demonstrate the Closed loop operation of induction motor drives	CO3	T1:13.3 R2:7.4
30	Understand the operation of rotor resistance control of induction motors	CO5	T1:12.4 R2:7.3
31	Discuss the Static rotor Resistance control of induction motors	CO5	T1:12.4 R2:7.4
32	Demonstrate the Slip power recovery schemes of induction motor	CO5	T2:7.1
33	Describe the operation of static Scherbius drive	CO5	T1:12.4.1
34	Understand the operation of static Kramer drive	CO5	T2:12.4.2 R2:7.4
35	List the advantages and applications of slip power recovery Schemes	CO5	T2:7.2 R2:6.3
36	Understand the principles of vector control of induction motor	CO5	T1:12.4.3 R2:7.8
37	Describe the vector control methods of induction motor	CO5	T1:12.4.4 R2:7.8
38	Demonstrate the direct methods of vector control	CO5	T2:7.1 R2:6.3
39	Understand the Separate control of synchronous motors	CO6	T2:7.1 R2:6.3
40	Describe the Self control of synchronous motors	CO6	T2:7.1 R2:6.3
PROBLEM SOLVING/ CASE STUDIES			
1	Analyze the problems on Single phase semi controlled converters fed DC motors	CO1	T1: 5.6 R2:2.3

2	Analyze the problems on Single phase fully controlled converters fed DC motors	CO1	T1:5.8 R2:3.2
3	Analyze the problems on three phase semi controlled converters fed DC motors	CO1	T1:6.1 R2:2.9-2.10
4	Analyze the problems on three phase fully controlled converters fed DC motors	CO1	T1:6.3 R2:3.5
5	Analyze the problems on Four quadrant operation of DC motor drives	CO1	T1:6.3 R2:3.5
6	Analyze the problems on Chopper fed DC motors	CO2	T2:4.5 R2:4.1
7	Analyze the problems on Chopper fed DC drives.	CO2	T2:4.7 R2:5.2
8	Analyze the problems on DC drives with four quadrant operation using choppers.	CO2	T2:4.7 R2:5.2
9	Analyze the numerical problems on static control ofinduction motor drives	CO4	T1:13.2 R2:7.4
10	Analyze the numerical problems on induction motor drives	CO4	T1:12.1, R2:7.3
11	Analyze the numerical problems on slip power recovery schemes	CO5	T1:12.1, R2:7.3
12	Analyze the numerical problems on static control of induction motor drives	CO5	T1:12.1, R2:7.3
13	Analyze the numerical problems on synchronous motor drives	CO6	T1:12.1, R2:7.3
14	Describe the operation of Load commutated CSI fed synchronous motor and problems	CO6	T2:7.1 R2:6.3
15	Demonstrate the closed loop control operation of synchronous motor drives with block diagram and problems	CO6	T2:7.1 R2:6.3
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Electric drive,Power Modulator and critical speed	CO1	T1: 5.2 -5.9
2	Dynamic braking,plugging in DC motor and Define chopper	CO2	T1:6.1-6.6
3	soft start, slip, base speed	CO3,4	T1:8.1-8.6
4	VSI and CSI plugging in induction motor drives	CO5	T1:12.1-12.8
5	self control,separate control and power factor control	CO6	T1:13.1-13.9
DISCUSSION OF QUESTION BANK			
1	Control of dc motors through phase controlled rectifiers	CO1	T2: 3.2-3.3
2	Speed control of dc motors	CO2	T3: 6.9-6.14

3	Speed control of induction motors through variable voltage and frequency	CO3,4	T2: 5.1-5.20
4	Speed control of induction motors through rotor resistance and vector control	CO5	T2: 7.1-7.20
5	Speed control of synchronous motors	CO6	T3:36.8

Course Coordinator **HOD,EEE**
Mr. S. Srikanth, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

<table>
<tr><td>Department</td><td colspan="5">ELECTRICAL AND ELECTRONICS ENGINEERING</td></tr>
<tr><td>Course Title</td><td colspan="5">ELECTRICAL MEASUREMENTS AND INSTRUMENTATION</td></tr>
<tr><td>Course Code</td><td colspan="5">AEEC24</td></tr>
<tr><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>Semester</td><td colspan="5">VI</td></tr>
<tr><td>Course Type</td><td colspan="5">Core</td></tr>
<tr><td>Regulation</td><td colspan="5">IARE-UG20</td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>3</td><td>-</td><td>3</td><td>-</td><td>-</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Dr. A Naresh kumar, Assistant Professor</td></tr>
</table>

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEC09	III	Network Analysis
B.Tech	AEEC10	III	Electromagnetic Field

II COURSE OVERVIEW:

This course introduces and develops the basic understanding of measurement principles and measuring instruments used in numerous electrical applications. The course provides the concept of measurement, analysis of errors and various specification parameters used to judge and compare measuring instruments. It provides an insight to develop advanced instruments in industries.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Electrical Measurements and Instrumentation	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
30%	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) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

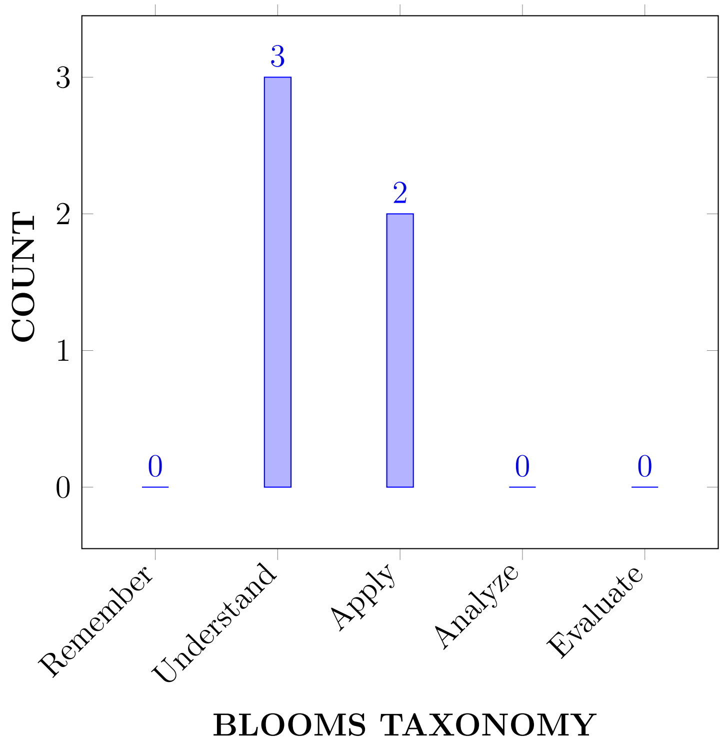
I	The types and characteristics of instruments employed for measuring electrical quantities.
II	The construction, operation and maintenance of different types of instruments.
III	The concepts of Cathode Ray Oscilloscope and transducers to measure the physical quantities in the field of science, engineering and technology.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Illustrate** the working of PMMC, MI and electrostatic voltmeter in view of principle of operation, construction, extension of range and various errors.	Understand
CO 2	**Make use of** potentiometer and instrument transformers in view of construction, extension of range and various errors.	Understand
CO 3	**Demonstrate** the construction and operation of wattmeter and energy meter for obtaining power and energy in single phase and three phase networks.	Understand
CO 4	**Select** the DC and AC bridges suitable for the measurement of passive parameters.	Apply
CO 5	**Summarize** various working models, features and applications of transducers and oscilloscopes.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Program Outcomes	
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	AAT/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	AAT/CIE/SEE

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	AAT/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	AAT/CIE/SEE

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	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	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-

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 instruments used for measuring electrical quantities,Faraday's laws of electromagnetic induction, the concept of torque and error,phenomenon of electrostatic effect using the principles of mathematics, science and engineering fundamentals.	3

	PO 2	Determine the expressions for torque in PMMC, MI and electrostatic instruments to solve complex engineering problems problems using principles of mathematics and engineering sciences. .	5
	PO 3	Design the solution for problems to minimize errors in PMMC, MI and electrostatic instruments.	5
	PO 10	Demonstrate the ability to communicate effectively in writing /orally to obtain the solutions for problems to minimize errors in PMMC, MI and electrostatic instruments.	2
	PSO 1	Understand the characteristics of different measuring instruments for the operation and control of electrical power system.	1
CO 2	PO 1	Recall the working of potentiometer the principle of electromagnetic induction which helps in structuring the principles of instrument transformer with the fundamentals of mathematics, science, and engineering fundamentals. .	3
	PO 2	Derive the expression for the different types of errors encountered in instrument transformers to analyze complex engineering problems using principles of mathematics and engineering sciences.	4
	PO 3	Illustrate the expression for phase angle error and ratio error to operate at desired specifications of electrical components in power systems.	3
	PO 10	Demonstrate the ability to communicate effectively in writing /orally for minimizing phase angle error and ratio error to operate at desired specifications of electrical components in power systems.	2
	PSO 1	Understand the importance of current transformer and potential transformer for protection in power system.	3
CO 3	PO 1	Understand the behavior of current carrying conductor placed in magnetic field and the principle of induction effect with the help of basic fundamentals of mathematics science and engineering fundamentals.	3
	PO 2	Derive the expression for torque in wattmeter to solve complex engineering problems using basic mathematics and engineering principles.	6
	PO 3	Determine power losses in power system to reduce these losses in power system.	2
	PO 10	Demonstrate the ability to communicate effectively in writing /orally to find solutions to power system problems.	2
	PSO 1	Understand the principle of power balance to ensure efficient operation of electrical system.	3
CO 4	PO 1	Explain the concept of null deflection with the help of fundamentals of mathematics, science, and engineering fundamentals.	3

	PO 2	Derive the expression for balanced bridge with the help of fundamentals of mathematics, science, and engineering fundamentals.	5
	PO 3	Determine the resistance, inductance and capacitance of different electrical components to design electrical components.	2
	PO 10	Demonstrate the ability to communicate effectively in writing /orally to understand the problems based on passive parameters.	2
CO 5	PO 1	Identify the different non-electrical parameters and recall the working of cathode ray oscilloscope applying basic knowledge of science and engineering fundamentals.	3
	PO 2	Illustrate the different methods for the measurement of non-electrical parameters which helps to solve complex engineering problems	5
	PO 10	Demonstrate the ability to communicate effectively in writing /orally to understand non-electrical parameter measurement.	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	5	-	-	-	-	-	-	2	-	-	1	-	-
CO 2	3	4	3	-	-	-	-	-	-	2	-	-	3	-	-
CO 3	3	6	2	-	-	-	-	-	-	2	-	-	3	-	-
CO 4	3	5	2	-	-	-	-	-	-	2	-	-	-	-	-
CO 5	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	50	-	-	-	-	-	-	40	-	-	20	-	-
CO 2	100	40	30	-	-	-	-	-	-	40	-	-	60	-	-
CO 3	100	60	20	-	-	-	-	-	-	40	-	-	60	-	-
CO 4	100	50	20	-	-	-	-	-	-	40	-	-	-	-	-
CO 5	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% ≤ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	-	-	-	-	-	-	1	-	-	1	-	-
CO 2	3	1	1	-	-	-	-	-	-	1	-	-	3	-	-
CO 3	3	3	1	-	-	-	-	-	-	1	-	-	3	-	-
CO 4	3	2		-	-	-	-	-	-	1	-	-	-	-	-
CO 5	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
TOTAL	15	10	4	-	-	-	-	-	-	5	-	-	7	-	-
AVERAGE	3	2	1.25	-	-	-	-	-	-	1	-	-	2.3	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments					

XVII ASSESSMENT METHODOLOGY-INDIRECT:

	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**INTRODUCTION TO MEASURING INSTRUMENTS**
	Introduction: Classification of measuring instruments, deflecting, damping and control torques, types of errors, ammeter and voltmeter: PMMC, MI instruments, expression for deflection and control torque, errors and compensation, extension of range using shunts and series resistances; Electro static voltmeter: attracted type, disc type, extension of range of voltmeters, electro dynamic type voltmeters
MODULE II	**POTENTIOMETERS AND INSTRUMENT TRANSFORMERS**
	DC Potentiometers: Principle and operation of Crompton potentiometer, standardization, measurement of unknown resistance, current, voltage; AC potentiometers: polar and coordinate type, standardization, applications; Instrument transformers: CT and PT, ratio and phase angle error.

MODULE III	**MEASUREMENT OF POWER AND ENERGY**
	Measurement of Power: Single phase dynamometer type wattmeter, LPF and UPF, double elements and three elements dynamometer wattmeter; Expression for deflection and control torque, extension of range of wattmeter by using instrument transformers, measurement of active and reactive power for balanced and unbalanced Systems. Measurement of Energy: Single phase induction type energy meter, driving and braking torques, errors and compensations, testing by phantom loading using RSS meter, three phase energy meter, introduction to net energy metering (web ref: 4 and 5), maximum demand meters.
MODULE IV	**DC AND AC BRIDGES**
	Measurement of Resistance: Methods of measuring low, medium, high resistance, Wheatstone bridge, carry foster, Kelvin's double bridge, loss of charge method; Measurement of Inductance: Maxwell's bridge, Hay's bridge, Anderson's bridge, Owen's bridge; Measurement of Capacitance: Desauty's bridge, Wein's bridge, Schering bridge.
MODULE V	**TRANSDUCERS AND OSCILLOSCOPES**
	Transducers: Definition of transducers, classification of transducers, advantages of electrical transducers, characteristics and choice of transducers, principle of operation of LVDT and capacitor transducers, LVDT applications, strain gauge and its principle of operation, gauge factor, thermistors, thermocouples, synchros, piezo-electric transducers, photovoltaic, photo conductive cells, photo diodes; Cathode ray oscilloscope: Cathode ray tube, time base generator, horizontal and vertical amplifiers, CRO probes, applications of CRO, measurement of phase and frequency, Lissajous patterns, sampling oscilloscope, analog oscilloscope, tubeless oscilloscopes, digital storage oscilloscope (web ref: 6).

TEXTBOOKS

1. A K Sawhney, —Electrical and Electronic measurement and instruments, Dhanpat Rai and Sons Publications, 2002

2. E W Golding and F C Widdis , Electrical measurements and measuring instruments,Wheeler publishing, 2006

REFERENCE BOOKS:

1. Buckingham and Price, —Electrical measurements, Prentice Hall

2. D V S Murthy, Transducers and Instrumentation, Prentice Hall of India, London, 2009.

3. A S Morris, Principles of measurement of instrumentation, Pearson/Prentice Hall of India, 1994.

4. H S Kalsi,Electronic Instrumentation, Tata McGraw-Hill Publications, 1995.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/105/108105153/

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	Presentation on Outcome based education		
CONTENT DELIVERY (THEORY)			
2	Classification of measuring instruments	CO 1	T1: 6.1
3	Types of torques	CO 1	T1: 6.4
4	PMMC instruments	CO 1	T1: 8.5
5	MI instruments	CO 1	T1: 8.1
6	Extension of range using shunt resistances	CO 1	T1: 8.8
7	Extension of range using series resistances	CO 1	T1: 8.8
8	Electro static voltmeter	CO 1	T1: 8.67
9	Crompton potentiometer	CO 2	T1: 14.1
10	Crompton potentiometer	CO 2	T1: 14.1
11	Applications of DC potentiometers	CO 2	T1: 14.12
12	Applications of DC potentiometers	CO 2	T1: 14.12
13	Applications of AC potentiometersor	CO 2	T1: 14.21
14	Applications of AC potentiometersor	CO 2	T1: 14.21
15	Current transformer	CO 2	T1: 9.5
16	Potential transformer	CO 2	T1: 9.17
17	Errors in Instrument transformers	CO 2	T1:9.7
18	Single phase dynamometer type wattmeter	CO 3	T1: 10.3
19	Measurement of active power for balanced and unbalanced systems.	CO 3	T1: 10.19
20	Measurement of active power for balanced and unbalanced systems.	CO 3	T1: 10.19
21	Measurement of reactive power for balanced and unbalanced systems.	C0 3	T1: 10.21
22	Single phase induction type energy meter	CO 3	T1: 11.6
23	Three phase energy meter	CO 3	T1: 11.15
24	Measurement of low resistance	CO 4	T1: 13.12
25	Measurement of medium resistance	CO 4	T1: 13.2
26	Measurement of high resistance	CO 4	T1: 13.19
27	Measurement of Inductance	CO 4	T1: 16.5
28	Measurement of Inductance	CO 4	T1: 16.5
29	Measurement of Capacitance	CO 4	T1: 16.11
30	Measurement of Capacitance	CO 4	T1: 16.11
31	Classification of transducers	CO 5	T1: 25.11
32	Principle of operation of LVDT	CO 5	T1: 25.1
33	Thermistors, Thermocouples	CO 5	T1: 25.22
34	Photovoltaic,Photoconductive cells and Photo Diodes	CO 5	T1: 25.1

35	Measurement of Strain, Gauge Sensitivity	CO 5	T1: 25.18
36	Piezo-electric transducers	CO 5	T1: 25.31
37	Cathode ray oscilloscope	CO 5	T1: 21.11
38	Sampling oscilloscopes	CO 5	T1: 21.17
39	Analog oscilloscopes	CO 5	T1: 21.1
40	Digital storage oscilloscopes	CO 5	T1: 21.21
41	Lissajous pattern	CO 5	T1: 21.14
PROBLEM SOLVING/ CASE STUDIES			
42	A moving-coil instrument gives a full scale deflection. When the current is 40 mA and its resistance is 25Ohms. Calculate the value of the shunt to be connected in parallel with the meter to enable it to be used as an ammeter for measuring currents up to 50 A.	CO 1	T1:8.1
43	A meter of resistance 50 ohm has a full scale deflection of 4 mA. Determine the value of shunt resistance required in order that full scale deflection should be i) 15 mA ii) 20 A iii) 100 A	CO 1	T1:8.1
44	The capacity of an electrostatic voltmeter ranging from 0 to 2000 V increases from 80 to 90pF as the pointer moves from zero to full scale deflection. Calculate the value of external capacitor used to increase its range to 20 kV. If the capacitor is adjusted to make the full scale reading correct, what will be the error at half scale reading	CO 1	T1:8.1
45	A potential transformer ratio 2000/100 V has the following constants: Primary resistance = 105 ohms, secondary resistance = 0.7Ω, primary reactance = 75.2Ω, total equivalent reactance = 0.087Ω, no-load current at 0.03 A at 0.36 power factor lagging. Solve for phase angle error on no load , phase angle error on a load of 5 A at 0.92 lagging power factor and burden in VA at unity power factor at which the phase angle will be zero.	CO 2	T1:9.1
46	Develop a volt- ratio box with a resistance of 20 ohms/V and ranges 3 V, 10V, 30 V, 100 V. the volt-ratio box is to be used with a potentiometer having a measuring range of 1.5 V	CO 2	T1:9.1
47	A current transformer with bar primary has 300 turns in its secondary winding. The resistance and reactance of the secondary circuit are 1.5ohm and 1.0ohm respectively, including the transformer winding. With 5A flowing in the secondary winding, the magnetizing mmf is 100AT and the core loss is 1.2 W. Identify the ratio and phase angle errors	CO 2	T1:9.1
48	A wattmeter has a current coil of 0.1 ohms resistance and a pressure coil of 6500Ω resistance. Calculatethepercentageer-rors,duetoresistanceonlywitheachofthetwomethodsofconnection of wattmeter when reading the input to an apparatus which takes i) 12 A at 250 V with unity power factor and ii) 12 A at 250 V and 0.4 power factor.	CO 2	T1:10.1

49	A 500V,20A dynamometer instrument is used as a wattmeter. Its current coil has 0.1ohm resistance and pressure coil has 25kohm resistance with 0.1 H inductance. The meter was calibrated on DC supply. Solve for the error in the instrument if it is used to measure the power in a circuit with supply voltage of 500 V, load current of 24 A at 0.2 P.f. assume that pressure coil is connected across load?	CO 3	T1:10.1
50	An energy meter is designed to make 100 revolutions of the disc for one unit of energy. Solve for the number of revolutions made by it when connected to a load carrying 20 A at 230 V at 0.8 p.f. for an hour. If it actually makes 360 revolutions, find the percentage error?	CO 3	T1:11.1
51	The four arms of the Hay's bridge at balances are: Arm AB: Coil of unknown impedance. Arm BC : A non-reactive resistance of 100 ohms,Arm CD : A non-reactive resistance of 833 ohms in series with 0.38 uF capacitor. Arm DA : A non-reactive resistance of 16800 ohms. If the supply frequency is 50 Hz, Solve for the inductance and resistance at the balance condition	CO 4	T1:16.1
52	A Kelvin's double bridge is balanced with the following constants. Outer ratio = 100 ohms and 1000 ohms, Inner ratio arms = 99.92 ohms and 1000.6 ohms, resistance of link = 0.1 ohms, Standard resistance = 0.00377 ohms, calculate the value of unknown resistance.	CO 4	T1:16.1
53	The four arm bridge ABCD, supplied with a sinusoid voltage, have the following values: AB = 330 ohms resistance in parallel with 0.2 uF capacitor.BC = 400 ohms resistance, CD = 800 ohms resistance: DA R in series with a 1.5 uF capacitor. Identify the value of R and supply frequency at which bridge will be balanced.	CO 4	T1:16.1
13	A CRT has anode voltage of 2000V and parallel deflecting plates 1.5 cm long and 5 mm apart. The screen is 50 cm from the center of the plates. Solve for i) beam speed (ii) deflection sensitivity (iii) deflection factor of the tube	CO 5	T1:21.1
54	A parallel plate capacitive transducer has a plates of 600 mm2 area which are separated by air by a distance of 0.2mm. The resistance of the transducer is 20x106ohm.Calculate the time constant of the transducer and fined the attenuation of the output at 1000Hz. The resistivity of air is 8.85x10^{-12} F/m.	CO 5	T1:21.1
55	A Lissajous pattern on the CRT screen is stationary and has 2 vertical tangencies and 5 horizontal tangencies. If the frequency of horizontal input is1000 Hz. Calculate the frequency of the vertical input.	CO 5	T1:21.1
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Measurement, Instrument,Measurand, Absolute instrument, Secondary instrument, Indicating instrument, Recording instrument,Static srror, Range	CO 1	T1:1.1,6.1, 8.1
57	Potentiometer, Volt ratio box, Standardization,burden, ratio correction factor, nominal ratio, transformation ratio	CO 2	T1:14.1, 19.1

58	Two-element wattmeter,Pressure coil, Creeping error , net energy metering,maximum demand, Phantom Loading	CO 3	T1:10.1, 11.1
59	DC bridge, AC bridge, Loss of Charge Method	CO 4	T1:13.1, 16.1
60	Transducer, Pressure transducer,Thermocouple, piezoelectric sensor,Photodiode, Photocell,sampling oscilloscope,Sweep time, Lissajous pattern	CO 5	T1:25.1, 21.1
DISCUSSION OF QUESTION BANK			
61	Module I	CO 1	T1:1.1,6.1, 8.1
62	Module II	CO 2	T1:14.1, 19.1
63	Module III	CO 3	T1:10.1, 11.1
64	Module IV	CO 4	T1:13.1, 16.1
65	Module V	CO 5	T1:25.1, 21.1

Signature of Course Coordinator **HOD, EEE**
Dr. A Naresh kumar, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

<table>
<tr><td>Department</td><td colspan="5">Electrical and Electronics Engineering</td></tr>
<tr><td>Course Title</td><td colspan="5">Power System Analysis</td></tr>
<tr><td>Course Code</td><td colspan="5">AEEC22</td></tr>
<tr><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>Semester</td><td colspan="5">VI</td></tr>
<tr><td>Course Type</td><td colspan="5">Core</td></tr>
<tr><td>Regulation</td><td colspan="5">UG-20</td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>2</td><td>1</td><td>3</td><td>-</td><td>-</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Dr. Sayanti Chatterjee, Associate Professor</td></tr>
</table>

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEC05	III	Network Analysis
B.Tech	AEEC15		Electrical Power Transmission Systems

II COURSE OVERVIEW:

Power System Analysis course enables students to study the performance of interconnected power system under steady state and transient stability conditions. The course deals with formation of impedance and admittance matrices for various configurations, finding unknown electrical quantities at various buses, symmetrical and unsymmetrical fault analysis, power system using per unit representation. The course helps in selecting the protective devices to gain back normal operation of power system.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Power System Analysis	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Remember
45 %	Understand
18 %	Apply
27 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

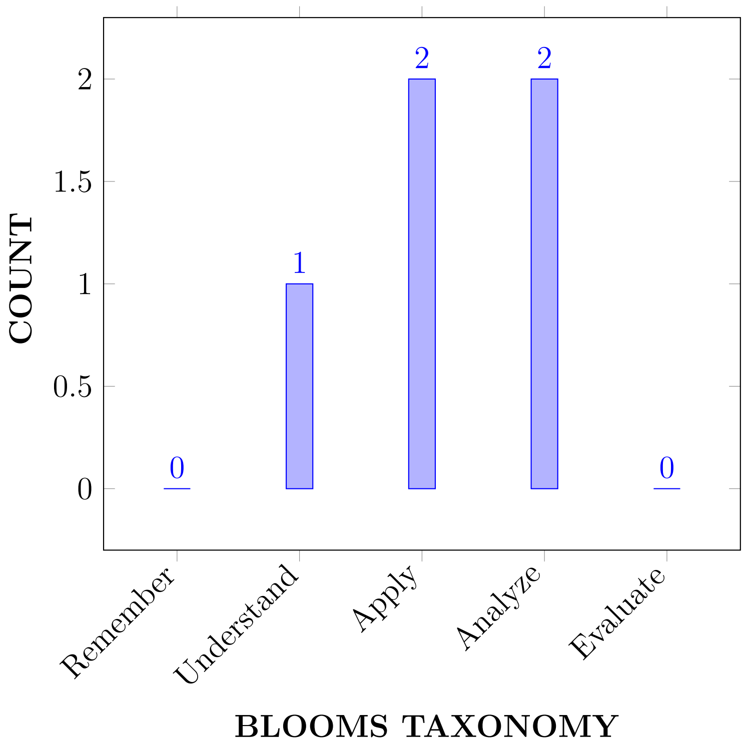
I	The methods to build the bus impedance and bus admittance matrices for primitive and non-primitive networks..
II	The numerical methods for load flow analysis of n bus interconnected power system.
III	The concepts of Cathode Ray Oscilloscope and transducers to measure the physical quantities in the field of science, engineering and technology.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Apply** the basic terminology of graph theory for formation of bus impedance and admittance matrices.	Apply
CO 2	**Build** the algorithms to form the bus impedance and admittance matrices for various configuration of primitive network.	Analyze
CO 3	**Make use of** Thevenin's theorem and sequence component theory for the analysis of power system under symmetrical and unsymmetrical faults.	Apply
CO 4	**Illustrate** the steady state and transient stability conditions of interconnected power system to obtain required specifications for normal operation.	Understand
CO 5	**Analyze** the load flow studies, fault analysis and stability of power system helps to structure switchgear protection considering real world constraints and work in team or individual to carry research work.	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/CIA
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/CIA
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/CIA
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	SEE/CIA

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involving Power generation, Transmission, Distribution and Utilization.	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	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-

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 instruments used for measuring electrical quantities,Faraday's laws of electromagnetic induction, the concept of torque and error,phenomenon of electrostatic effect using the principles of mathematics, science and engineering fundamentals.	3
	PO 2	Determine the expressions for torque in PMMC, MI and electrostatic instruments to solve complex engineering problems problems using principles of mathematics and engineering sciences. .	5
	PO 3	Design the solution for problems to minimize errors in PMMC, MI and electrostatic instruments.	5
	PO 10	Demonstrate the ability to communicate effectively in writing /orally to obtain the solutions for problems to minimize errors in PMMC, MI and electrostatic instruments.	2
	PSO 1	Understand the characteristics of different measuring instruments for the operation and control of electrical power system.	1
CO 2	PO 1	Recall the working of potentiometer the principle of electromagnetic induction which helps in structuring the principles of instrument transformer with the fundamentals of mathematics, science, and engineering fundamentals. .	3
	PO 2	Derive the expression for the different types of errors encountered in instrument transformers to analyze complex engineering problems using principles of mathematics and engineering sciences.	4
	PO 3	Illustrate the expression for phase angle error and ratio error to operate at desired specifications of electrical components in power systems.	3
	PO 10	Demonstrate the ability to communicate effectively in writing /orally for minimizing phase angle error and ratio error to operate at desired specifications of electrical components in power systems.	2
	PSO 1	Understand the importance of current transformer and potential transformer for protection in power system.	3
CO 3	PO 1	Understand the behavior of current carrying conductor placed in magnetic field and the principle of induction effect with the help of basic fundamentals of mathematics science and engineering fundamentals.	3
	PO 2	Derive the expression for torque in wattmeter to solve complex engineering problems using basic mathematics and engineering principles.	6
	PO 3	Determine power losses in power system to reduce these losses in power system.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 10	Demonstrate the ability to communicate effectively in writing /orally to find solutions to power system problems.	2
	PSO 1	Understand the principle of power balance to ensure efficient operation of electrical system.	3
CO 4	PO 1	Explain the concept of null deflection with the help of fundamentals of mathematics, science, and engineering fundamentals.	3
	PO 2	Derive the expression for balanced bridge with the help of fundamentals of mathematics, science, and engineering fundamentals.	5
	PO 3	Determine the resistance, inductance and capacitance of different electrical components to design electrical components.	2
	PO 10	Demonstrate the ability to communicate effectively in writing /orally to understand the problems based on passive parameters.	2
CO 5	PO 1	Identify the different non-electrical parameters and recall the working of cathode ray oscilloscope applying basic knowledge of science and engineering fundamentals.	3
	PO 2	Illustrate the different methods for the measurement of non-electrical parameters which helps to solve complex engineering problems	5
	PO 10	Demonstrate the ability to communicate effectively in writing /orally to understand non-electrical parameter measurement.	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	5	-	-	-	-	-	-	2	-	-	1	-	-
CO 2	3	4	3	-	-	-	-	-	-	2	-	-	3	-	-
CO 3	3	6	2	-	-	-	-	-	-	2	-	-	3	-	-
CO 4	3	5	2	-	-	-	-	-	-	2	-	-	-	-	-
CO 5	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	50	-	-	-	-	-	-	40	-	-	20	-	-
CO 2	100	40	30	-	-	-	-	-	-	40	-	-	60	-	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 3	100	60	20	-	-	-	-	-	-	40	-	-	60	-	-
CO 4	100	50	20	-	-	-	-	-	-	40	-	-	-	-	-
CO 5	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	2	-	-	-	-	-	-	1	-	-	1	-	-
CO 2	3	1	1	-	-	-	-	-	-	1	-	-	3	-	-
CO 3	3	3	1	-	-	-	-	-	-	1	-	-	3	-	-
CO 4	3	2		-	-	-	-	-	-	1	-	-	-	-	-
CO 5	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
TOTAL	15	10	4	-	-	-	-	-	-	5	-	-	7	-	-
AVERAGE	3	2	1.25	-	-	-	-	-	-	1	-	-	2.3	-	-

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	-

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	**POWER SYSTEM NETWORK MATRICES**
	Graph Theory: Definitions, bus incidence matrix, Y bus formation by direct and singular transformation methods, numerical problems; Formation of Z Bus: Partial network, algorithm for the modification of Z bus matrix for addition of element from a new bus to reference bus, addition of element from a new bus to an old bus, addition of element between an old bus to reference bus and addition of element between two old busses (Derivations and Numerical Problems), modification of Z bus for the changes in network (Numerical Problems).
MODULE II	**POWER FLOW STUDIES AND LOAD FLOWS**
	Load flows studies: Necessity of power flow studies, data for power flow studies, derivation of static load flow equations; Load flow solutions using Gauss Seidel method: Acceleration factor, load flow solution with and without PV buses, algorithm and flowchart; Numerical load flow solution for simple power systems (Max. 3 buses): Determination of bus voltages, injected active and reactive powers (Sample one iteration only) and finding line flows / losses for the given bus voltages; Newton Raphson method in rectangular and polar coordinates form: Load flow solution with or without PV busses derivation of Jacobian elements, algorithm and flowchart, decoupled and fast decoupled methods, comparison of different methods, DC load flow study.
MODULE III	**SHORT CIRCUIT ANALYSIS PER UNIT SYSTEM OF REPRESENTATION**
	Per unit system: Equivalent reactance network of a three phase power system, numerical problems; Symmetrical fault analysis: Short circuit current and MVA calculations, fault levels, application of series reactors, numerical problems; Symmetrical component theory: Symmetrical component transformation, positive, negative and zero sequence components, voltages, currents and impedances. Sequence networks: Positive, negative and zero sequence networks, numerical problems; Unsymmetrical fault analysis: LG, LL, LLG faults with and without fault impedance, numerical problems.
MODULE IV	**STEADY STATE STABILITY ANALYSIS**
	Steady state stability: Elementary concepts of steady state, dynamic and transient stabilities, description of steady state stability power limit, transfer reactance, synchronizing power coefficient, power angle curve and determination of steady state stability and methods to improve steady state stability.
MODULE V	**TRANSIENT STATE STABILITY ANALYSIS**
	Swing equation: Derivation of swing equation, determination of transient stability by equal area criterion, application of equal area criterion, critical clearing angle calculation, solution of swing equation, point by point method, methods to improve stability, application of auto reclosing and fast operating circuit breakers.

TEXTBOOKS

1. D P Kothari and I J Nagrath, "Power System Engineering", McGraw-Hill Education, 2nd Edition, 2007.

2. M A Pai, “Computer Techniques in Power System Analysis”, TMH Publications, 2nd edition, 2005.

3. B R Guptha, “Power system analysis and Design” S. Chand Publishing, 2nd edition, 1998.

4. K Umarao, “Computer techniques and models in power systems”, I K International Pvt. Ltd., 2nd edition, 2006.

REFERENCE BOOKS:

1. Buckingham and Price, —Electrical measurements, Prentice Hall

2. D V S Murthy, Transducers and Instrumentation, Prentice Hall of India, London, 2009.

3. A S Morris, Principles of measurement of instrumentation, Pearson/Prentice Hall of India, 1994.

4. H S Kalsi,Electronic Instrumentation, Tata McGraw-Hill Publications, 1995.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/105/108105153/

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)		
OBE DISCUSSION			
1	Introduction to graph theory.	CO 1	T4:9.41, R1:3.1-3.2
2	Solve numerical problems on graph theory.	CO 1	T4:9.4.1, R1:3.1-3.2
3	Building bus incidence matrix.	CO 1	T4:9.4.3, R1:3.3-3.5
4	Forming Y bus formation by direct method.	CO1	T4:9.2, R1:3.3-3.5
5	Forming Y bus formation by singular transformation. methods,	CO 1	T4:9.2, R1:3.3-3.5
6	Solve numerical problems on bus matrices.	CO 2	T4:9.2, R1:3.3-3.5
7	Formation of ZBUS: Partial network.	CO 3	T4:9.4, R1:4.1

8	Algorithm for the Modification of Z Bus Matrix for addition element from a new bus to reference.	CO 2	T4:9.3-9.5, R1:4.2
9	Algorithm for the Modification of Z Bus Matrix for addition element from a new bus to an old bus.	CO 3	T4: 9.3-9.5, R1:4.3-4.4
10	Algorithm for the Modification of Y Bus Matrix for addition element from a new bus to an old bus.	CO 3	T4: 9.3-9.5, R1:4.3-4.4
11	Algorithm for the Modification of Z Bus Matrix for addition element between an old bus to reference Addition of element between two old busses (Derivations and Numerical Problems without mutual coupling).	CO 2	T4: 9.3-9.5, R1:4.3-4.4
12	Study of necessity of power flow studies – Data for power flow studies – derivation of static load flow equations.	CO 2	T4:9.1, R1:8.1
13	Solution of load flow solutions using Gauss Seidel Method: Acceleration Factor.	CO 2	T4:9.8, R1:8.2
14	Load flow solution with and without P- V buses, Algorithm and Flowchart.	CO 2	T4:9.9.1, R1:9.2
15	Find numerical load flow solution for simple power systems (Max. 3- Buses): Determination of bus voltages, injected active and reactive powers (Sample One Iteration only).	CO 4	T4:9.8, R1:9.2
16	Discuss on newton raphson method in rectangular form: load flow, solution with or without PV busses- Derivation of jacobian elements.	CO 4	T4:9.10, R1:9.2
17	Discussion newton raphson method in polar co- ordinates form: load flow solution with or without pv busses-Derivation of jacobian elements.	CO 4	T4:9.11.2, R1:9.2
18	Study on decoupled and fast decoupled methods for load flow solution.	CO 4	T4:9.12, R1:9.2
19	Comparison of Different Methods – DC load Flow.	CO 4	T4:9.4.12, R1:9.2
20	Short Circuit Analysis: Short Circuit Current and MVA Calculations.	CO 3	T4:10.3, R1:6.1-6.3
21	Solving numerical problems (Symmetrical fault Analysis).	CO 6	T4:10.4, R1:6.4
22	Understand symmetrical component transformation, positive, negative and zero sequence components.	CO 4	T4:10.5, R1:6.4
23	Draw sequence networks.	CO 5	T4:10.6, R1:6.3
24	Derive sequence voltages, currents and impedances.	CO 6	T4:10.7, R1:6.3
25	Solving numerical problems on symmetrical components.	CO 4	T4:10.5, R1:6.3
26	Understand LG fault with and without fault impedance and numerical problems.	CO 4	T4:10.13, R1:6.3

27	Study fault with and without fault impedance and numerical problems.	CO 4	T4:10.13, R1:6.1-6.3
28	Study unsymetrical fault with and without fault impedance and numerical problems.	CO 4	T4:10.13, R1:6.1-6.3
29	Determine LLG fault with and without fault impedance and numerical problems.	CO 4	T4:10.16, R1:6.1-6.3
30	Compare LG, LL, LLG faults with and without fault impedance and numerical problems.	CO 4	T4:10.17, R1:6.1-6.3
31	Introduction to steady state, dynamic and transient stabilities.	CO 3	T4:13.1, R1:10.1
32	Description of steady state stability power limit, transfer reactance, synchronizing power coefficient.	CO 3	T4:13.2, R1:10.3
33	Plot Power Angle Curve and determination of steady state,. stability.	CO 4	T4:13.2, R1:6.4
34	Explain methods to improve steady state stability.	CO 5	T4:13.2, R1:10.3
35	Derivation of swing equation.	CO 8	T4:13.3, R1:10.2
36	Determination of transient stability by equal area criterion.	CO 5	T4:13.6, R1:10.5
37	Application of equal area criterion to different cases.	CO 5	T4:13.7, R1:10.5
38	Discuss importance of critical clearing angle calculation.	CO 5	T4:13.6, R1:10.5
39	Solving numerical problems on equal area criteria.	CO 5	T4:13.7, R1:10.5
40	Solution of swing equation: point-by- point method.	CO 5	T4:13.7, R1:10.5
PROBLEM SOLVING/ CASE STUDIES			
41	Problems on graph theory	CO 1	T1:8.1
42	Problems on Bus admittance matrix	CO 1	T1:8.1
43	Problems on Z bus calculation	CO 1	T1:9.1
44	Problems on power flow studies	CO 2	T1:9.1
45	Problems on Gauss-Seidal method	CO 2	T1:9.1
46	Problem on Newton Raphson method	CO 2	T1:10.1
47	Problem on load flow	CO2	T1:10.1
48	Problems on per unit system	CO 3	T1:11.1
49	Problems on fault analysis-I	CO 3	T1:16.1
50	Problems on fault analysis-2	CO z	T1:16.1
51	Problems on steady state analysis	CO 4	T1:16.1
52	Problems on power angle	CO 4	T1:21.1
53	Problems on swing equation-1	CO 5	T1:21.1
54	Problems on swing equation-2	CO 5	T1:21.1

55	Problems on transient stability	CO 5	T1:21.1
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Module I	CO 1	T1:1.1,6.1, 8.1
57	Module II	CO 2	T1:14.1, 19.1
58	Module III	CO 3	T1:10.1, 11.1
59	Module IV	CO 4	T1:13.1, 16.1
60	Module V	CO 5	T1:25.1, 21.1
DISCUSSION OF QUESTION BANK			
61	Module I	CO 1	T1:1.1,6.1, 8.1
62	Module II	CO 2	T1:14.1, 19.1
63	Module III	CO 3	T1:10.1, 11.1
64	Module IV	CO 4	T1:13.1, 16.1
65	Module V	CO 5	T1:25.1, 21.1

Signature of Course Coordinator **HOD,EEE**
Dr.Sayanti Chatterjee, Associate Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	**10**

PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**

PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project. 6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	**12**

PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

ANNEXURE - II

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	PSO Statement / Key Competencies Features (KCF)	No. of KCF(s)
PSO 1	Design, develop, fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization. 1. Operate, control and protect electrical power system. 2. Validate the interconnected power system. 3. Ensure reliable, efficient and compliant operation of electrical systems. 4. Familiarize the safety, legal and health norms in electrical system. 5. Adopt the engineering professional code and conduct.	**5**
PSO 2	Focus on the components of electrical drives with its converter topologies for energy conversion, management and auditing in specific applications of industry and sustainable rural development. 1. Control the electric drives for renewable and non-renewable energy sources. 2. Fabricate converters with various components and control topologies. 3. Synthesis, systematic procedure to examine electrical components/machines using software tools. 4. Inspect, survey and analyze energy flow. 5. Control and manage the power generation and utilization. 6. Familiarize the safety, legal and health norms in electrical system. 7. Adopt the engineering professional code and conduct. 8. Explore autonomous power 9. Evolve into green energy and assess results 10. Realize energy policies and education 11. Potential contribution of clean energy for rural development.	**11**
PSO 3	Gain the hands-on competency skills in PLC automation, process controllers, HMI and other computing tools necessary for entry level position to meet the requirements of the employer. 1. Explicit software and programming tools for electrical systems. 2. Adopt technical library resources and literature search. 3. Model, program for operation and control of electrical systems. 4. Constitute the systems employed for motion control. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Electrical and Electronics Engineering**				
Course Title	**Principles of Signals and Systems**				
Course Code	AEEC26				
Program	B. Tech				
Semester	VI				
Course Type	ELECTIVE				
Regulation	UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Ms.V. Bindusree, Assistant professor.				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSB11	III	Mathematical Transform Techniques

II COURSE OVERVIEW:

This course integrates the basic concepts of both continuous and discrete time signals and systems. It covers the linear time invariant systems and their analysis in time and frequency domain, mathematical tools, correlation and convolution of signals, sampling techniques. It provides the necessary background needed for understanding the signal processing and communications.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Signals and Systems	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could

be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
20%	Remember
50 %	Understand
30 %	Apply
0 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

<table>
<tr><th colspan="2">Component</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td rowspan="4">CIA</td><td>Continuous Internal Examination – 1 (Mid-term)</td><td>10</td><td rowspan="4">30</td></tr>
<tr><td>Continuous Internal Examination – 2 (Mid-term)</td><td>10</td></tr>
<tr><td>AAT-1</td><td>5</td></tr>
<tr><td>AAT-2</td><td>5</td></tr>
<tr><td>SEE</td><td>Semester End Examination (SEE)</td><td>70</td><td>70</td></tr>
<tr><td colspan="3">Total Marks</td><td>100</td></tr>
</table>

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	-

VI COURSE OBJECTIVES:

The students will try to learn:

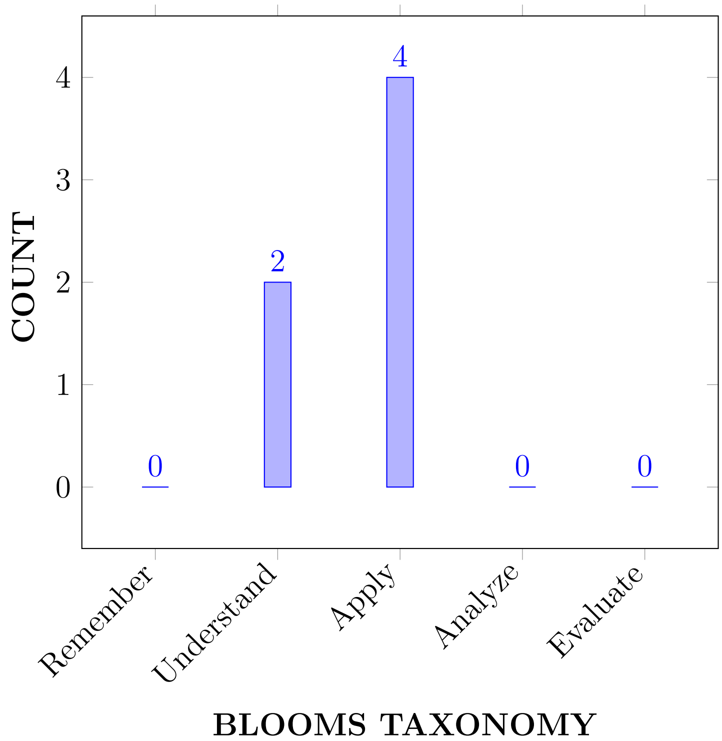
I	The representation, classification and analysis of continuous, discrete time signals in time and frequency domains.
II	The Fourier transform, Laplace and Z- transforms and their properties to analyze the signals and systems
III	The temporal and spectral characteristics of Random process and the extraction of Signal from noise by filtering.
IV	The signal processing concepts to analyse signals from diverse information sources such as audio, image, medical, and remote sensing.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Describe** the concept of signals and signal properties for performing mathematical operations on signals.	Understand
CO 2	**Make use of** Fourier transforms for calculating spectral characteristics of periodic and aperiodic signals.	Apply
CO 3	**Utilize** the concept of convolution and correlation to determine the response of an LTI system.	Apply
CO 4	**Illustrate** the ideal lowpass,high pass,bandpass,ban stop filters for obtaining the behaviour of linear time invarinat system.	Understand
CO 5	**Describe** the linear time invariant systems using linear constant coefficient differential equations and their impulse response.	Apply
CO 6	**Compute** discrete fourier transform and inverse discrete Fourier transform of a discrete signal using fast fourier transform algorithms.	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/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	SEE / CIE / AAT
PO 5	**Conduct Investigations of Complex Problems:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	2	Lab related Exercises

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	2	Seminars

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	-	-	-	-	-	-	-	✓	-		-	-	-
CO 2	-	✓	-	-	✓	-	-	-	-	✓	-	-	✓	-	-
CO 3	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 4	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 5	-	✓	✓	-	✓	-	-	-	-	✓	-		✓	-	-
CO 6	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	PO 1	**Classify (knowledge)** basic concepts of signals such as exponential, sinusoidal, impulse, unit step and signum for performing mathematical operations on signals **mathematical operations on signals** by applying the **principles of science for engineering problems.**	2
	PO 2	**Understand** the given **problem statement** and **formulate** the orthogonal signals from the vector algebra using **principles of mathematics and engineering science.**	4
	PO 10	Demonstrate the ablility to communicate effectively in **writing** design documentation and make effective presentation	1
CO 2	PO 2	**Understand** the given **problem statement** and **identification** of the Fourier transform and apply the **problem formulation**of spectral characteristics of continuous time aperiodic signals and **design** the frequency response of the given system.	4
	PO 5	**Develop** the Fourier transform of magnitude and phase using **Modern tools and analyze to complex engineering problems.**	3
	PO 10	Demonstrate the ablility to communicate effectively in **writing** design documentation and make effective presentation	1
	PSO 1	**Design**, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 3	PO 1	**Extend** (knowledge, understand, apply) the linearity and time invariance concepts to linear time invariant system for **analyzing** the behavior of LTI system in both time and frequency domains by applying the **principles of mathematics** and **science for engineering problems.**	3
	PO 2	**Demonstrate** and **develop** the given problem statement, **identification** and **formulate** to **design** simple LTI system in both time and frequency domains. 5	2
	PO 10	**Demonstrate** the ablility to communicate effectively in **writing** design documentation and make effective presentation	1
CO 4	PO 2	**Understand** the given **problem statement and formulate** the (Complex) engineering problems of continuous time and discrete time systems such as Laplace and Z transform from the provided information and data.	2
	PO 5	**Design** various transform techniques like Laplace and Z transform using **modern tools** such as MATLAB software	1
	PO 10	Demonstrate the ablility to communicate effectively in **writing** design documentation and make effective presentation	1
	PSO 1	**Design**, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	2
CO 5	PO 1	**Understand** the sampling theorem for band limited and bandpass signals and reconstruction of samples by filtering methods by applying the the **principles of mathematics** and science for **engineering problems**.	2
	PO 10	**Demonstrate** the ablility to communicate effectively in **writing** design documentation and make effective presentation	2
CO 6	PO 1	**Understand** the sampling theorem for band limited and bandpass signals and reconstruction of samples by filtering methods by applying the the **principles of mathematics** and science for **engineering problems**.	2
	PO 10	Demonstrate the ablility to communicate effectively in **writing** design documentation and make effective presentation	1

Note: For Key Attributes refer **Annexure - I**

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	Program Outcomes												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	2	4	-	-	-	-	-	-	-	1	-		-	-	-
CO 2	-	4	-	-	1	-	-	-	-	1	-	-	2	-	-
CO 3	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 5	-	2	2	-	1	-	-	-	-	1	-		2	-	-
CO 6	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	Program Outcomes												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	2	2	2
CO 1	66.7	40	-	-	-	-	-	-	-	10	-		-	-	-
CO 2	-	40	-	-	20	-	-	-	-	10	-	-	100	-	-
CO 3	100	40	-	-	-	-	-	-	-	10	-	-	-	-	-
CO 4	66.7	-	-	-	-	-	-	-	-	10	-	-	-	-	-
CO 5	-	40	40	-	100	-	-	-	-	10	-		100	-	-
CO 6	40	-	-	-	-	-	-	-	-	10	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -5 $< C \leq 40\%$ – Low/ Slight

2 - 40 % $< C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	Program Outcomes												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	-	-	-	-	-	-	1	-	-	-	-	
CO 2	-	2	-	-	1	-	-	-	-	1	-	-	3	-	-
CO 3	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 5	-	2	2	-	3	-	-	-	-	1	-	-	3	-	-
CO 6	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-
TOTAL	8	8	2	-	4	-	-	-	-	6	-	-	6	-	-

COURSE OUTCOMES	Program Outcomes												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
AVERAGE	2.6	2	2	-	2	-	-	-	-	1	-	-	2	-	-

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	✓
Quiz	-	Tech - Talk	✓	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	✓	Open Ended Experiments	✓
Micro Projects	-	-	-	-	-

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities / Modeling and Experimental Tools in Engineering by Experts		

XVIII SYLLABUS:

MODULE I	**SIGNAL ANALYSIS**
	Signal Analysis: Analogy between Vectors and Signals, Orthogonal Signal Space, Signal approximation using Orthogonal functions, Mean Square Error, Closed or complete set of Orthogonal functions, Orthogonally in Complex functions, Exponential and Sinusoidal signals, Concepts of Impulse function, Unit Step function, Signum function.
MODULE II	**FOURIER TRANSFORM**
	Deriving Fourier Transform from Fourier series, Fourier Transform of arbitrary signal, Fourier Transform of standard signals, Fourier Transform of Periodic Signals, Properties of Fourier Transform
MODULE III	**SIGNAL TRANSMISSION THROUGH LINEAR SYSTEMS**
	Linear System, Impulse response, Response of a Linear System, Linear Time Invariant (LTI) System, Linear Time Variant (LTV) System, Transfer function of a LTI system, Filter characteristics of Linear Systems,Distortion less transmission through a system, Signal bandwidth, System bandwidth, Ideal LPF, HPF and BPF characteristics. Convolution and Correlation of Signals: Concept of convolution in Time domain and Frequency domain,Graphical representation of Convolution, Convolution property of Fourier Transforms, Cross Correlation and Auto Correlation of functions, Properties of Correlation function, Relation between Convolution and Correlation.

MODULE IV	**INTRODUCTION TO DIGITAL SIGNAL PROCESSING**
	Discrete Time Signals Sequences, conversion of continuous to discrete signal, Normalized Frequency, Linear Shift Invariant Systems, Stability, and Causality, linear differential equation to difference equation, Linear Constant Coefficient Difference Equations, Frequency Domain Representation of Discrete Time Signals and Systems
MODULE V	**FAST FOURIER TRANSFORMS**
	Fast Fourier transforms (FFT) - Radix-2 decimation-in-time and decimation-in-frequency FPT Algorithms, Inverse FFT and FFT with general Radix-N

TEXTBOOKS

1. Signals, Systems Communications, B.P. Lathi, BS Publications, 2009.
2. Signals and Systems, A.V. Oppenheim, A.S. Willsky and S.H. Nawab ,PHI, 2nd Edition 2009.
3. Digital Signal Processing, Principles, Algorithms, and Applications, John G. Proakis, Dimitris G. Manolakis, Pearson Education / PHI. 2007.

REFERENCE BOOKS:

1. Signals and Systems, Simon Haykin and Van Veen, Wiley, 2nd Edition, 2009.
2. Signals and Signals, Iyer and K. Satya Prasad, Cengage Learning, 2 nd Edition, 2009.
3. Discrete Time Signal Processing, A. V. Oppenheim and R.W. Schaffer, PHI, 2009.
4. Fundamentals of Digital Signal Processing, Loney Ludeman. John Wiley, PHI, 2009.

WEB REFERENCES:

1. https://nptel.ac.in/courses/117/101/117101055/

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
0	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	CO 1	T1:4.1

CONTENT DELIVERY (THEORY)			
1	Introduction to signals and systems	CO 1	T1:4.2
2	Concepts of Impulse function, Unit Step function, Signum function, in continuous time	CO 1	T1: 5.1
3	Concepts of Impulse function, Unit Step function, Signum function, in continuous time	CO 1	R3: 1.7
4	Analogy between Vectors and Signals.	CO 1	T1: 6.1-6.6
5	Orthogonal Signal Space, Signal approximation using Orthogonal functions.	CO 1	T1: 6.1-6.6
6	Mean Square Error.	CO 1	T1: 6.1-6.6
7	Closed or complete set of Orthogonal functions.	CO 1	T1: 6.1-6.6
8	Orthogonally in Complex functions	CO 1	T1: 7.5
9	Continuous time periodic signals.	CO 1	T1: 7.7-7.12
10	Continuous time periodic signals.	CO 1	T1: 7.8
11	Derive Fourier transform of a continuous time aperiodic signal from Fourier series.	CO 2	T1: 10.2
12	Explain the Fourier transform of an arbitrary signal.	CO 2	T1:7.7
13	Find the Fourier transform of standard signals such as impulse, unit step, unit ramp and sketch their spectra.	CO 2	T1: 7.8-7.10
14	Fourier Transform of Periodic Signals, Properties of Fourier Transform	CO 2	T1: 7.12
15	Find the Fourier transform of standard signals such as exponential, sinusoidal, cosine and sketch their spectra.	CO 2	R4: 4.2
16	Find the Fourier transform of standard signals such as rectangular pulse, triangular, signum, sinc and sketch their spectra.	CO 2	R4: 4.2
17	Find the Fourier transform of Periodic Signals and explain Properties of Fourier transform.	CO 2	T1: 10.4
18	Understand linear system, Impulse response and response of a linear system.	CO 2	T1: 10.5
19	Explain linear time invariant (LTI) system and linear time variant (LTV) system.	CO 3	T3: 1.5
20	Find transfer function of a LTI system and draw the spectrum of a given LTI system.	CO 3	T3: 1.6
21	Understand filter characteristics of linear systems and distortion less transmission through a system.	CO 3	T3: 1.7
22	Explain signal bandwidth, system bandwidth, ideal LPF, HPF and BPF characteristics.	CO 3	T3:1.8
23	Explain the concept of convolution in time domain and frequency domain and represent convolution using graph	CO 3	T3: 2.7 R3: 4.4
24	Understand the convolution property of Fourier transforms.	CO 3	T3: 2.8 R3: 4.4

25	Determine cross correlation and auto correlation of functions of signals.	CO 3	T3: 2.7 R3: 4.4
26	Summarize the properties of correlation function and relation between convolution and correlation.	CO 3	T3: 2.8 R3: 4.4
27	Compare discrete time signals and sequences.	CO 3	T3: 8.9
28	Explain conversion of continuous to discrete signal and normalized frequency.	CO 3	T3: 2.7 R3: 4.4
29	Analyze linear shift invariant (LTI) systems.	CO 3	T3: 2.8 R3: 4.4
30	Determine the stability, and causality of a given system.	CO 3	T3: 8.9
31	Apply the linear differential equation to difference equation of an LTI system.	CO 3	T3: 2.7 R3: 4.4
32	Find the solution of an LTI system represented by linear constant coefficient difference equations.	CO 3	T3: 8.12-8.13
33	40 Analyze discrete time signals in frequency domain Representation using discrete time Fourier transform.	CO 3	T3: 9.1-9.2
34	Analyze discrete time systems in frequency domain Representation using discrete time Fourier transform.	CO 3	T3: 9.3.
35	Apply radix-2 decimation-in-time fast Fourier transforms (FFT) method to find discrete time Fourier transform.	CO 5	T3: 8.12-8.13
36	Apply radix-2 decimation-in-frequency fast Fourier transforms (FFT) method to find discrete time Fourier transform.	CO 5	T3: 9.1-9.2
37	Apply radix-2 decimation-in-time and frequency fast Fourier transforms (FFT) methods to find inverse discrete time Fourier transform.	CO 5	T3: 9.3.
38	Apply radix-N fast Fourier transforms (FFT) method to find discrete time Fourier transform.	CO 11	T3: 8.12-8.13
39	Detection of Periodic Signals in the presence of Noise by Correlation, Extraction of Signal from Noise by filtering	CO 5	T3: 9.1-9.2
PROBLEM SOLVING/ CASE STUDIES			
40	Concepts of Impulse function, Unit Step function, Signum function, in continuous time	CO 1	T1: 5.1
41	Orthogonal Signal Space, Signal approximation using Orthogonal functions, Mean Square Error.	CO 1	R3: 1.7
42	Fourier transform of a standard signals.	CO 2	T1: 6.1-6.6
43	Fourier Transform of Periodic Signals, Properties of Fourier Transform	CO 2	T1: 6.1-6.6
44	Linear System, Impulse response, Response of a Linear System, Linear Time Invariant (LTI) System, Linear Time Variant (LTV) System.	CO 3	T1: 7.7-7.12
45	Signal bandwidth, System Bandwidth, Ideal LPF, HPF, and BPF characteristics.	CO 4	T1: 7.7-7.12
46	Convolution and Correlation of Signals, Concept of convolution in Time domain and Frequency domain, Graphical representation of Convolution	CO 5	T1: 7.7-7.12

47	Properties of L.T, Relation between L.T and F.T of a signal, Laplace Transform of certain signals using waveform synthesis.	CO 5	T1: 7.7-7.12
48	Laplace Transforms (L.T), Inverse Laplace Transform, Concept of Region of Convergence (ROC) for Laplace Transforms.	CO 6	T3: 1.7
49	Region of Convergence in Z-Transform, Constraints on ROC for various classes of signals, Inverse Z-transform, Properties of Z-transforms.	CO 6	T3: 1.7
50	Apply radix-2 decimation-in-time fast Fourier transforms (FFT) method to find discrete time Fourier transform.	CO 7	R4: 4.2
DISCUSSION OF DEFINITION AND TERMINOLOGY			
51	Signal analysis	CO 1	T1:4.1
52	Fourier transform	CO 2	T2:4.1
53	signal transmission through linear systems	CO 3	T3:2.1
54	Laplace and Z transform	CO 4	R4: 4.2
55	Fast fourier transform	CO 5	T2:6.1
DISCUSSION OF QUESTION BANK			
56	Derive the expression for component vector of approximating the function f1(t) over f2(t) and also prove that the component vector becomes zero if the f1(t) and f2(t) are orthogonal.	CO 1	T1:4.1
57	Find the Fourier transform of the signal x(t) = 5cos 5t+10 sin 15t and sketch its magnitude and phase spectra.	CO 2	T2:4.1
58	Compute the output y(t) for a continuous LTI system whose impulse response h(t) and the input x(t) are given by h(t)= e$^{-at} u(t) and x(t) = e^{at} u(-t)$.	CO 3	T3:2.1
59	Determine the initial value and final value of Laplace transform of signal	CO 4	R4: 4.2
60	A filter has an input x(t)= u(t) and transfer function, H(w)=1/(1+jw). Find the ESD of the output?	CO 5	T2:6.1

Signature of Course Coordinator **HOD,ECE**
Ms.V.Bindusree,Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences **(Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations **(Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	**10**

PO 4.	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**

PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project. 6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	**12**
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**

PO11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTION

Department	ELECTRICAL AND ELECTRONICS ENGINEERING				
Course Title	DISASTER MANAGEMENT				
Course Code	ACEC31				
Program	B.Tech				
Semester	VI				
Course Type	Open Elective				
Regulation	IARE-UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr. P. Sreekanth Reddy, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
UG	-	-	-

II COURSE OVERVIEW:

The Disaster management provides a fundamental understanding of different aspects. It deals with the concepts and functions of disaster management to build competencies of professionals and development practitioners. It provides effective supporting environment by the governmental locating substantial resources for effective mitigation of disasters. It helps learners to apply the disaster mitigation strategies, preparedness for reducing damage intensity, loss of life and property.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Disaster Management	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in Table: 1.

Percentage of Cognitive Level	Blooms Taxonomy Level
17%	Remember
83 %	Understand
0%	Apply
0 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered. **Alternative Assessment Tool (AAT)**

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	**Tech-talk**	**Complex Problem Solving**
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

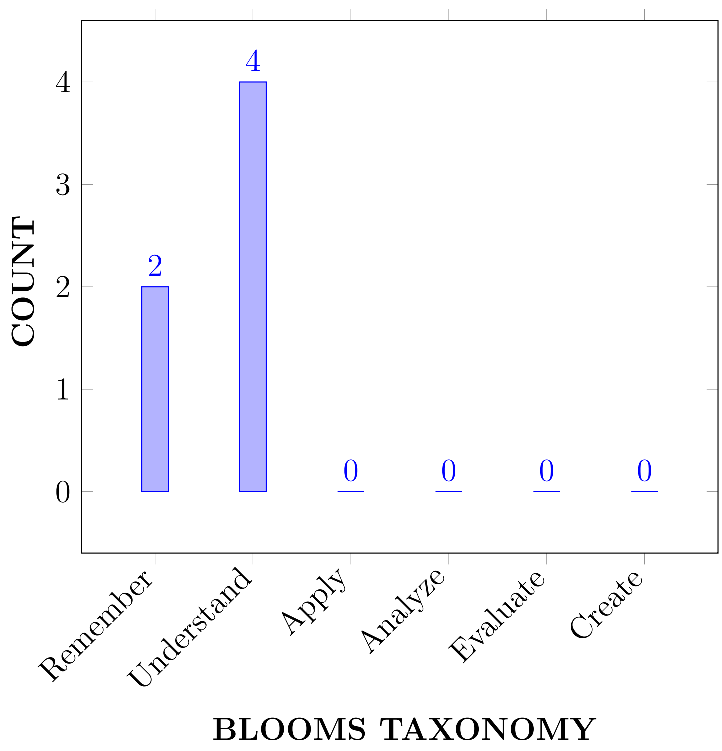
I	The concept of environmental hazards, disasters and various approaches dealing with the mitigation of disasters.
II	The knowledge on various types of environmental disasters and their impacts on human beings and nature.
III	The Different types of endogenous and exogenous hazards and their influence on human life and nature.
IV	The immediate response and damage assessment with information reporting and monitoring tools.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Classify** Environmental hazards for developing modern disaster management system.	Remember
CO 2	**Illustrate** various approches for reducing the level of risk associated with Disasters.	Understand
CO 3	**Compare** natural and manmade disasters for finding out intensity of damage loss occurred by them.	Understand
CO 4	**List** various hazards and their effects for evaluating their impact on society and Environment.	Remember
CO 5	**Outline** human adjustments and perception towards hazards for mitigation of disasters.	Understand
CO 6	**Summarize** disaster phenomenon and its different contextual aspects for implementing the Disaster Risk Reduction Strategy.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/SEE/AAT
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	3	CIE/SEE/AAT
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	3	CIE/SEE/AAT
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	1	CIE/SEE/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	-	-
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	-	-
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	✓	-	-	-	-	-	✓	-	-	-	-	-	-	-	-
CO 2	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
CO 4	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
CO 5	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-	-
CO 6	✓	-	-	-	-	✓	-	-	✓	-	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Apply the knowledge and principals of mathematics to engineering problems in determining an area enclosed by irregular boundary line using the knowledge of **mathematics and science fundamentals**	2
	PO 7	Understand the disaster management by considering Environmental impacts on the livelihood and their effect on Socio economic issues for sustainable development.	2
CO 2	PO 1	Apply the knowledge on various disaster mitigation approaches in **engineering disciplines** and and use their application in geographical researches.	1
	PO 6	Apply the engineering knowledge in disaster management to **promote sustainable development** and build **Awareness on health, safety,** and **risk issues** associated with Disasters.	4
CO 3	PO 6	Identify **engineering activities including personnel, health, safety, and risk and effective disaster management strategies** for implementing, analyzing disaster impacts on human life and environment.	4
	PO 7	Understand intensity of disasters and their impact on **environment** and influence on **socio economic** parameter for assessment of intensity of risk.	2
CO 4	PO 6	Identify **engineering activities including personnel, health, safety, and risk** for analyzing hazard impacts on environment.	4
	PO 7	Identify the impact of various hazards in **socio economic and environmental** aspects for developing modern disaster management system.	2

CO 5	PO 1	Understand the **methodology and scientific principal towards** hazards for human adjustments and perception by sharing technological knowledge from **other engineering branches.**	2
	PO 6	Understanding of the need for a **high level of professional and ethical conduct in engineering** for human adjustments, perception with effective **management strategies**for disaster mitigation.	4
CO 6	PO 1	Understand the **knowledge of scientific principal and methodology** in disaster phenomenon for minimizing impact by implementing the Disaster Risk Reduction Strategy.	2
	PO 6	**Appropriate management strategies** are to be applied to reduce the level of risk in disaster mitigation.	1
	PO 9	Apply disaster risk reduction strategy using vrious organizations and **work effetively as an individual** and **as a member** or **a leader** are to be applied to reduce the level of risk in disaster mitigation.	3

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	Program Outcomes/ No. of Key Competencies Matched												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	1	2	3
CO 1	2	-	-	-	-	-	2	-	-	-	-		-	-	-
CO 2	1	-	-	-	-	4	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	4	2	-	-	-	-		-	-	-
CO 4	-	-	-	-	-	4	2	-	-	-	-	-	-		-
CO 5	2	-	-	-	-	4	-	-	-	-	-	-	-	-	-
CO 6	2	-	-	-	-	1	-	-	3	-	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	1	2	3
CO 1	66.6	-	-	-	-	-	66.6	-	-	-	-	-	-	-	-
CO 2	33.3	-	-	-	-	80	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	80	66.6	-	-	-	-	-	-		-
CO 4	-	-	-	-	-	80	66.6	-	-	-	-	-	-	-	-
CO 5	66.6	-	-	-	-	80	-	-	-	-	-	-	-	-	-
CO 6	66.6	-	-	-	-	20	-	-	25	-	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - 0≤ C≤ 5% – No correlation
1 - 5≤ C≤ 40% – Low/ Slight
2 - 40 % <C < 60% –Moderate
3 - 60% ≤ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	1	2	3
CO 1	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO 2	1	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-
CO 4	-	-	-	-	-	3	3	-	-	-	-	-	-		-
CO 5	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO 6	3	-	-	-	-	1	-	-	1	-	-	-	-	-	-
TOTAL	10	-	-	-	-	13	9	-	1	-	-	-	-	-	-
AVERAGE	3	-	-	-	-	3	3	-	1	-	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Term Paper	-	Concept Video	✓	Open Ended Experiments	-
Assignments	-	Mini project	-	Tech Talk	✓

XVII ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of mini projects by Experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	ENVIRONMENTAL HAZARDS AND DISASTERS
	Environmental hazards and disasters: meaning of environmental hazards, environmental disasters and environmental stress; concept of environmental hazards, environmental stress and environmental disasters, different approaches and relation with human ecology, landscape approach, ecosystem approach, perception approach, human ecology and its application in geographical researches.

MODULE II	**TYPES OF ENVIRONMENTAL HAZARDS AND DISASTERS**
	Types of environmental hazards and disasters: Natural hazards and disasters, man induced hazards and disasters, natural hazards, planetary hazards/ disasters, extra planetary hazards/ disasters, planetary hazards, endogenous hazards, exogenous hazards.
MODULE III	**ENDOGENOUS HAZARDS**
	Endogenous hazards, volcanic eruption, earthquakes, landslides, volcanic hazards/ disasters, causes and distribution of volcanoes, hazardous effects of volcanic eruptions, environmental impacts of volcanic eruptions. Earthquake hazards/ disasters, causes of earthquakes, distribution of earthquakes, hazardous effects of, earthquakes, earthquake hazards in India,human adjustment, perception and mitigation of earthquake.
MODULE IV	**EXOGENOUS HAZARDS**
	Exogenous hazards/disasters, infrequent events, cumulative atmospheric hazards/disasters; Infrequent events: Cyclones , lightning , hailstorms; Cyclones: Tropical cyclones and local storms, destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation); Cumulative atmospheric hazards/ disasters: Floods, droughts, cold waves, heat waves floods; Causes of floods, flood hazards India, flood control measures (human adjustment, perception and mitigation); Droughts:Impacts of droughts, drought hazards in India, drought control measures,extra planetary hazards/ disasters, man induced hazards /disasters, physical hazards/ disasters, soil erosion, Soil erosion: Mechanics and forms of soil erosion, factors and causes of soil erosion, conservation measures of soil erosion; Chemical hazards/ disasters: Release of toxic chemicals, nuclear explosion, sedimentation processes; Sedimentation processes: Global sedimentation problems regional sedimentation problems, sedimentation and environmental problems, corrective measures of erosion and sedimentation,biological hazards/ disasters, population explosion.
MODULE V	**EMERGING APPROACHES IN DISASTER MANAGEMENT**
	Emerging approaches in Disaster Management, Three Stages 1. Pre, disaster stage(preparedness) 2. Emergency Stage 3. Post Disaster stage, Rehabilitation.

TEXTBOOKS

1. PardeepSahni, “Disaster Mitigation: Experiences and Reflections”, PHI Learning Pvt. Ltd., 1 st Edition, 2001.
2. J.Glynn, GaryW.HeinKe, “Environmental Science and Engineering”,Prentice Hall Publishers, 2 nd Edition, 1996.

REFERENCE BOOKS:

1. R.B.Singh (Ed), “Environmental Geography”, 2nd Edition, 1990.
2. R.B. Singh (Ed), “Disaster Management”, 2nd Edition, 2006.
3. Donald Hyndman “Natural Hazards and Disasters” - 5th edition, 2017.

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be a changes.

S.No	Topics to be covered	CO's	Reference T1: 4.1
OBE DISCUSSION			
1	Course Objectives, Course Outcomes, Program Outcomes, CO-PO Mapping		
CONTENT DELIVERY (THEORY)			
2	Classify Environmental Hazards & Disasters	CO 1	T2:26.3, R2: 3.1
3	Understand the Meaning of Environmental Hazards	CO 1	T2:2.2.2
4	Understand Environmental Stress	CO 1	T2:2.2.2, R3:3.7
5	Understand Environmental stress.	CO 2	T2:2.2.2
6	Obtain knowledge on Concept of Environmental Hazards	CO 2	T1:8.1
7	Capacity to analyze Environmental stress & Environmental Disasters	CO 2	T1:7.1, R2: 1.2
8	Capacity to analyze Ecology concept	CO 2	T2:3.2.3, R2: 1.3
9	Understand Different Approaches	CO 3	T2:4.2.3
10	Understand Landscape Approach -.	CO 3	T2:4.5.2
11	Explain Ecosystem approach -Perception approach.	CO 3	T2:4.7.9
12	Understand Human ecology & its application in geographical researches	CO 4	T2:5.2.1, R2: 6.4
13	Understand Human ecology & its application in geographical researches	CO 4	T2:5.2.1, R2: 6.4
14	Understand Types of Environmental hazards & Disasters	CO 4	T2:5.4
15	Capacity to analyze and evaluate Natural hazards and Disasters	CO 3	T2:5.5.3
16	Capacity to analyze and evaluate Natural hazards and Disasters	CO 3	T2:5.5.3
17	Understand Man induced hazards & Disasters	CO 3	T2:6.2.2
18	Understand Man induced hazards & Disasters	CO 3	T2:6.2.2
19	Obtain knowledge on Natural Hazards- Planetary Hazards/ Disasters	CO 4	R1:2.5, R2: 8.2
20	Obtain knowledge on Natural Hazards- Planetary Hazards/ Disasters	CO 4	R1:2.5, R2: 8.2
21	Analyze the Planetary Hazards-Endogenous Hazards - Exogenous Hazards	CO 4	R2:2.2.5, R2: 9.2
22	Analyze the Planetary Hazards-Endogenous Hazards - Exogenous Hazards	CO 4	R2:2.2.5, R2: 9.2

23	Understand Volcanic Eruption – Earthquakes – Landslides	CO 4	R3:5.4.8, R2: 9.6
24	Understand Volcanic Eruption – Earthquakes – Landslides	CO 4	R3:5.4.8, R2: 9.6
25	Volcanic Hazards/Disasters- Causes and distribution of Volcanoes	CO 4	T2:8.1.2
26	Volcanic Hazards/Disasters- Causes and distribution of Volcanoes	CO 4	T2:8.1.2
27	Explain the Hazardous effects of volcanic eruptions	CO 4	T2:8.3.5, R2: 5.3
28	Explain the Hazardous effects of volcanic eruptions	CO 4	T2:8.3.5, R2: 5.3
29	Understand Environmental impacts of volcanic eruptions - Earthquake Hazards/ disasters - Causes of Earthquakes	CO 4	T2:8.5
30	Understand Environmental impacts of volcanic eruptions - Earthquake Hazards/ disasters - Causes of Earthquakes	CO 4	T2:8.5
31	Distribution of earthquakes - Hazardous effects of - earthquakes - Earthquake Hazards in India	CO 4	T2:8.9.2
32	Explain the Droughts: Impacts of droughts, Drought hazards in India	CO 5	T2:9.2, R3: 4.6
33	Explain the Droughts: Impacts of droughts, Drought hazards in India	CO 5	T2:9.2, R3: 4.6
34	Understand Extra Planetary Hazards/ Disasters- Man induced Hazards /Disasters	CO 5	T2:9.2, R3: 4.7
35	Understand Extra Planetary Hazards/ Disasters- Man induced Hazards /Disasters	CO 5	T2:9.2, R3: 4.7
36	Understand the Infrequent events: Cyclones, Lightning, Hailstorms, Cyclones: Earthquake Hazards in India	CO 5	T2:9.5.3
37	Understand the Infrequent events: Cyclones, Lightning, Hailstorms, Cyclones: Earthquake Hazards in India	CO 5	T2:9.5.3
38	Analyze the Tropical cyclones and Local storms	CO 5	T2:9.6.2, R3: 8.5
39	Understand the Destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation)	CO 5	T2:9.7.5, R3: 8.12
40	Understand the Destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation)	CO 5	T2:9.7.5, R3: 8.12
41	Analyze the Cumulative atmospheric hazards/ disasters : Floods, Droughts, Cold waves, Heat waves Floods	CO 5	T2:9.5.4
42	Analyze the Cumulative atmospheric hazards/ disasters : Floods, Droughts, Cold waves, Heat waves Floods	CO 5	T2:9.5.4
43	Identification of Flood control measures (Human adjustment, perception and mitigation),	CO 6	T2:9.5.4

44	Identification of Flood control measures (Human adjustment, perception and mitigation),	CO 6	T2:9.5.4
45	Analyze the Exogenous hazards/ disasters - Infrequent events- Cumulative atmospheric hazards/ disasters	CO 6	T2:9.5.6
PROBLEM SOLVING/ CASE STUDIES			
1	Case study on modern disaster management system	CO 1	T2:2.2.2
2	Case study on natural disaster	CO 2	T2:2.2.2
3	Case study on manmade disaster	CO 3	T2:2.2.2
2	Case study on Latur earthquake	CO 4	T2:2.2.2
4	Case study on Fukushima Nuclear disaster	CO 4	T2:2.2.2, R3:3.7
5	Case study on tsunami occurred in Japan	CO 5	T2:2.2.2
6	Case study on Hiroshima and Nagasaki	CO 4	T1:8.1
7	Case study on Russian Siberia oil spill	CO 4	T1:7.1, R2: 1.2
8	Case study on Hudhud Cyclone 2014	CO 5	T2:3.2.3, R2: 1.3
9	Case study on South India Floods 2015	CO 5	T2:4.2.3
10	Case study on Bihar Heat Wave 2019	CO 5	T2:4.5.2
11	Case study on Bihar Floods 2019	CO 5	T2:4.7.9
12	Case study on Oil Spillage in Russia 2020	CO 4	T2:5.4
13	Case study on Yellow River Flood in china	CO 4	T2:5.5.3
14	Case study on Bhola Cyclone Bangladesh	CO 5	T2:6.2.2
15	Causes of wildfires and effects	CO 4	T2:9.5.4
16	pre-disaster activities to reduce the impact of cyclones	CO 5	T2:9.5.4
17	Tectonic plate theory	CO 4	T2:9.5.6
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Different approaches and relation with human ecology, landscape approach, ecosystem approach, perception approach	CO 1	T2:2.2.2
2	Natural hazards, planetary hazards/ disasters, extra planetary hazards/ disasters, planetary hazards, endogenous hazards, exogenous hazards	CO 2	T2:2.2.2, R3:3.7
3	Effects of volcanic eruptions, environmental impacts of volcanic eruptions	CO 3, CO 4	T2:2.2.2
4	Lightning , hailstorms; Cyclones: Tropical cyclones and local storms, destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation); Cumulative atmospheric hazards/ disasters:	CO 5	T1:8.1
5	Emerging approaches in Disaster Management, Three Stages 1. Pre, disaster stage(preparedness), 2. Emergency Stage ,3. Post Disaster stage, Rehabilitation.	CO 6	T1:7.1, R2: 1.2

DISCUSSION OF QUESTION BANK			
1	Environmental hazards and disasters	CO 1	R1:2.1
2	Types of environmental hazards and disasters	CO 2	T4:7.3
3	Endogenous hazards, volcanic eruption, earthquakes, landslides, volcanic hazards/ disasters, causes and distribution of volcanoes, hazardous effects of volcanic eruptions, and their environmental impacts.	CO 3, CO 4	R2:5.1
4	Global sedimentation problems regional sedimentation problems, sedimentation and environmental problems, corrective measures of erosion and sedimentation,biological hazards/ disasters, population explosion.	CO 5	T1:7.5
5	Emerging approaches in disaster management	CO 6	T1: 4.1

Signature of Course Coordinator **HOD,CE**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043
ELECTRICAL AND ELECTRONICS ENGINEERING
COURSE DESCRIPTION

<table>
<tr><td>Course Title</td><td colspan="5">Electrical Measurements and Instrumentation Laboratory</td></tr>
<tr><td>Course Code</td><td colspan="5">AEEC33</td></tr>
<tr><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>Semester</td><td>VI</td><td colspan="4">EEE</td></tr>
<tr><td>Course Type</td><td>Core</td><td colspan="4"></td></tr>
<tr><td>Regulation</td><td>IARE-UG20</td><td colspan="4"></td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>2</td><td>1</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Dr. A Naresh kumar, Assistant Professor</td></tr>
</table>

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEB11	III	Electrical Machines Laboratory - I
B.Tech	AEEB12	III	Network Analysis Laboratory

II COURSE OVERVIEW:

The objective of this laboratory course is to learn about the electrical measurement methods, operational principles with suitable software and hardware. It provides an opportunity for the students to identify and calibrate the various electrical instruments for obtaining errors. The lab emphasizes on the practical skills to design and realize the use of instruments for different electrical applications.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Electrical Measurements and Instrumentation Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

Percentage of Cognitive Level	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:

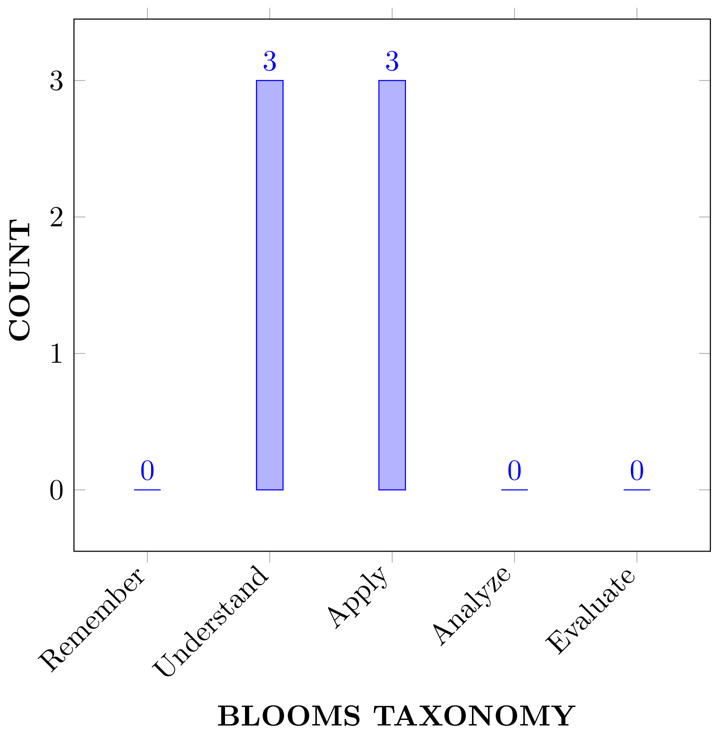
I	The calibration and testing methods of different electrical measuring instruments used for the measurement of voltage, current, power, energy.
II	The different transducers for measurement of physical quantities like pressure, temperature, level.
III	The simulation models in Labview to measure passive electrical parameters.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Make use of** transducers like thermocouple, thermistorand resistance temperature detector for measuring temperature.	Apply
CO 2	**Choose** appropriate transducers for the measurement of strain, pressure, position and level.	Apply
CO 3	**Examine** the errors in measuring instrument by calibrating voltmeter, ammeter, LPF wattmeter, single phase energy meter,dynamometer power factor meter.	Analyze
CO 4	**Develop** Labview programs for displaying electrical waveforms and Lissajous patterns .	Analyze
CO 5	**Build** simulation models in digital environment forthe measurement of passive parameters like inductance, capacitance and resistance.	Apply
CO 6	**Analyze** the quantities like turns ratio, reactive power, errors associated with current transformer for reducing the errors in measuring instruments.	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		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Lab Exercises
PO 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
PO 3	**Design/development of solutions:** : Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Lab Exercises
PO 4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	Lab Exercises
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations	1	Lab Exercises

PO 9	**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
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

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involving Power generation, Transmission, Distribution and Utilization.	2	Lab Exercises

3 = High; 2 = Medium; 1 = Low

XI JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Recall the instruments used for measuring physical parameters using the **knowledge of mathematics, science, and engineering fundamentals.**	3
	PO 9	**Develop** the attitude to get along with each other to function effectively.	2
	PO 10	**Make use of** oral, written and visual means to critique, negotiate, create and communicate understanding	2
	PO 12	**Recognize the need for** the importance of temperature in measuring devices to calibrate at specific temperature.	1
CO 2	PO 1	**Recall** the working of transducers with the help of **fundamentals of science and engineering fundamentals.**	2
	PO 3	**Design** solutions for measurement of physical parameters with economic perspective.	2
	PO 4	**Make use of** engineering knowledge of different transducers to solve engineering problems.	2

	PO 9	**Identify** and define an appropriate team negotiates solutions, ideas, roles and responsibilities.	2
	PO 10	**Use** communication as a tool for clarity	1
	PO 12	**Develop** significant skills and find learning resources to develop a Lab VIEW application.	1
CO 3	PO 1	Recall the basic electrical parameters with the help of **fundamentals of mathematics, science, and engineering fundamentals.**	1
	PO 5	**Make use of** the application specific instrument for measurement of electrical parameters.	2
	PO 3	**Understand customer and user needs of** power and energy requirements and understand economic context of engineering processes.	3
	PO 4	**Recognize (Knowledge) the characteristics of** wattmeter, ammeter, power factor meter with appropriate codes of practice and apply to analyse key engineering processes in laboratory	3
	PO 9	**Develop** ability to Work well with a team and get along with others.	2
	PO 10	**Make use of** communication as a tool helps in negotiating and creating new understanding, interacting with others, and furthering their own learning	2
	PO 12	**Identify** new technology in measuring electrical parameters	1
	PSO 1	Quantify the errors in power systems to ensure **efficient operation of electrical system.**	1
CO 4	PO 1	Recall the electrical parameters using the **engineering scientific principles and methodology.**	2
	PO 2	**Identify** the phase and frequency of waveforms using Lissajous patterns.	2
	PO 5	**Develop** simulation program in **Labview software** to analyse voltage and current waveforms, Lissajous patterns	2
	PO 3	**Use** LabVIEW for engineering activities to establish innovative solutions	2
	PO 4	**Develop** laboratory skills of simulation models and computer software relevant to engineering disciplines	2
	PO 10	**Share** knowledge and skills with colleagues using oral, written, and visual communication to further their own learning	2
	PO 12	**Identify** significant skills for advanced engineering concepts.	2
CO 5	PO 1	**Recall** the electrical parameters using the **engineering scientific principles and methodology.**	2
	PO 2	**Understand** the purpose of using bridges and **identify and apply the information** to measure inductance and capacitance.	4
	PO 5	**Develop** Labview program **in Labview software** to measure passive parameters	1

	PO 3	**Use** LabVIEW for engineering activities to establish innovative solutions	2
	PO 4	**Develop** laboratory skills of simulation models and computer software relevant to engineering disciplines.	2
	PO 9	**Develop** ability to Work well with a team and get along with others.	2
	PO 10	Share knowledge and skills with colleagues using oral, written, and visual communication to further their own learning.	2
	PO 12	**Identify** significant skills for advanced engineering concepts	2
CO 6	PO 1	**Remember** the measuring principles of reactive power, turns ratio etc., using the **principles of mathematics and engineering science.**	3
	PO 2	**Identify** the problem of power system and analyze it to select a particular method **using the principles of engineering.**	1
	PO 3	**Develop** solutions to reduce errors in instrument transformers	1
	PO 4	**Develop** laboratory skills to work with technical uncertainty to solve engineering problems.	3
	PO 9	**Experiment with** hands-on labs enable the students to complete the assignments	2
	PO 10	**Demonstrate** the ability to communicate effectively in writing and orally	2
	PO 12	**Identify** industry trends/ new technology relevant to instrument transformers.	1
	PSO 1	**Interface** current transformer **for protection in power system.**	3

XII MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

COURSE	PROGRAM OUTCOMES								PSO'S
OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO9	PO10	PO12	PSO1
CO 1	3	-	-	-	-	2	2	1	-
CO 2	2	-	2	2	-	2	1	1	-
CO 3	1	-	3	3	2	2	2	1	1
CO 4	2	2	2	2	2		2	2	-
CO 5	2	3	2	2	1	2	2	2	-
CO 6	3	1	1	3	-	2	2	1	3

XIII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIV ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XV SYLLABUS:

WEEK I	**SENSING OF TEMPERATURE AND SPEED**
	Measurement of temperature using transducers like thermocouple, thermistors and resistance temperature detector with signal conditioning; speed measurement using proximity sensor.
WEEK II	**MEASUREMENT OF RESISTANCE**
	Measurement of low resistance using Kelvins double bridge.
WEEK III	**MEASUREMENT OF STRAIN AND PRESSURE**
	Measurement of strain using strain gauge and measurement of pressure using differential pressure transducer.
WEEK IV	**MEASUREMENT OF POSITION AND LEVEL**
	Measurement of position using encoders and measurement of level using capacitive transducer.
WEEK V	**PHANTOM LOADING ON LPF WATTMETER**
	Calibration of electrodynamometer type LPF wattmeter using phantom loading.
WEEK VI	**CALIBRATION OF SINGLE PHASE ENERGY METER AND POWER FACTOR METER**
	Calibration of single phase energy meter using resistive load and dynamometer power factor meter.
WEEK VII	**MEASUREMENT OF TURNS RATIO AND APPLICATIONS OF CTs**
	Measurement of turns ratio using AC bridge; the extension of range of wattmeter to measure three phase power using two CTs and one single phase wattmeter.
WEEK VIII	**MEASUREMENT OF REACTIVE POWER**
	Measurement of reactive power using one single phase wattmeter
WEEK IX	**CT TESTING USING MUTUAL INDUCTOR MEASUREMENT OF PERCENTAGE RATIO ERROR AND PHASE ANGLE OF GIVEN CT BY NULL METHOD**
	Measurement of percentage ratio error and phase angle of given ct by null method.

WEEK X	**CROMPTON DC POTENTIOMETER**
	Calibration of PMMC ammeter and PMMC voltmeter.
WEEK XI	**ANALYSIS OF WAVE FORMS, FREQUENCY AND THD USING DIGITAL SIMULATION**
	Measurement and display of voltage, current wave forms, frequency Lissajeous patterns and THD using LabVIEW.
WEEK XII	**MEASUREMENT OF THREE PHASE POWER**
	Measurement of three phase power with single wattmeter and two numbers of current transformer.
WEEK XIII	**WORKING OF STATIC ENERGY METER USING DIGITAL SIMULATION**
	Measurement of energy using static energy meter and verification with LabVIEW.
WEEK XIV	**MEASUREMENT OF PASSIVE PARAMETERS USING DIGITAL SIMULATION**
	Inductance measurement using Anderson bridge and capacitance measurement using Schering bridge and verification with LabVIEW.

TEXTBOOKS

1. A K Sawhney, —Electrical and Electronic measurement and instruments, Dhanpat Rai and Sons Publications, 2002
2. E W Golding and F C Widdis , Electrical measurements and measuring instruments,Wheeler publishing, 2006
3. D V S Murthy, Transducers and Instrumentation, Prentice Hall of India, London, 2009.

REFERENCE BOOKS:

1. https://www.gnindia.dronacharya.info/EEEDept/Downloads/Labmanuals/EMI-Lab.pdf
2. https://www.scribd.com/doc/25086994/electrical-measurements-lab

XVI COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Measurement of temperature using transducers like thermocouple, thermistors and resistance temperature detector with signal conditioning; speed measurement using proximity sensor.	CO 1	R3:7.1
2	Measurement of low resistance using Kelvins double bridge.	CO 5	R3:6.1
3	Measurement of strain using strain gauge and measurement of pressure using differential pressure transducer.	CO 2	R3:6.1
4	Measurement of position using encoders and measurement of level using capacitive transducer.	CO 2	R3:6.3
5	Calibration of electrodynamometer type LPF wattmeter using phantom loading.	CO 3	R1:11.6

6	Calibration of single phase energy meter using resistive load and dynamometer power factor meter.	CO 3	R1:11.6
7	Measurement of turns ratio using AC bridge; the extension of range of wattmeter to measure three phase power using two CTs and one single phase wattmeter.	CO 5	R1:9.7
8	Measurement of reactive power using one single phase wattmeter.	CO 6	R1:10.21
9	Measurement of percentage ratio error and phase angle of given ct by null method.	CO 6	R1:9.7
10	Calibration of PMMC ammeter and PMMC voltmeter.	CO 3	R1:8.5
11	Measurement and display of voltage, current wave forms, frequency Lissajeous patterns and THD using LabVIEW.	CO 4	R1:21.14
12	Measurement of three phase power with single wattmeter and two numbers of current transformer.	CO 63	R1:10.9
13	Measurement of energy using static energy meter and verification with LabVIEW.	CO 5	R1:11.15
14	Inductance measurement using Anderson bridge and capacitance measurement using Schering bridge and verification with LabVIEW.	CO 5	R1:16.5

XVII EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	**Tri-vector meter** Use Tri-vector meter for measuring kW, kVar and kVA of a power line.
2	**MEASUREMENT OF PASSIVE PARAMETERS USING DIGITAL SIMULATION** Measurement of self-inductance by Maxwell's inductance bridge using digital simulation.
3	**MEASUREMENT OF PASSIVE PARAMETERS USING DIGITAL SIMULATION** Measurement of self-inductance by Hay's bridge using digital simulation.
4	**MEASUREMENT OF PASSIVE PARAMETERS USING DIGITAL SIMULATION** Measurement of capacitance by Wein's bridge using digital simulation.
5	**MEASUREMENT OF PASSIVE PARAMETERS USING DIGITAL SIMULATION** Measurement of capacitance by Wein's bridge using digital simulation.

Signature of Course Coordinator **HOD,EEE**
Dr. A Naresh kumar, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTION

Course Title	**PLC AND INDUSTRIAL AUTOMATION LABORATORY**				
Course Code	AEEC32				
Program	B.Tech				
Semester	VI	EEE			
Course Type	Core				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	2.5
Course Coordinator	Ms. T Saritha Kumari, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEB15	IV	Electrical Machines – II
B.Tech	AEEB24	VI	Electrical Measurements and Instrumentation

II COURSE OVERVIEW:

The objective of this laboratory course is to measure the physical input variables and to analyze and control and output variables in an industrial automation process using programmable logic controllers (PLCs). The lab emphasizes on the software and hardware skills to design and realize an automation process. The lab is mainly intended to implement the software timers, counters and their usage in traffic signal control, sequential control, speed control of motors etc.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
PLC and Aautomation Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner, both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
-	-	-	-	-	-

2. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

VI COURSE OBJECTIVES:

The students will try to learn:

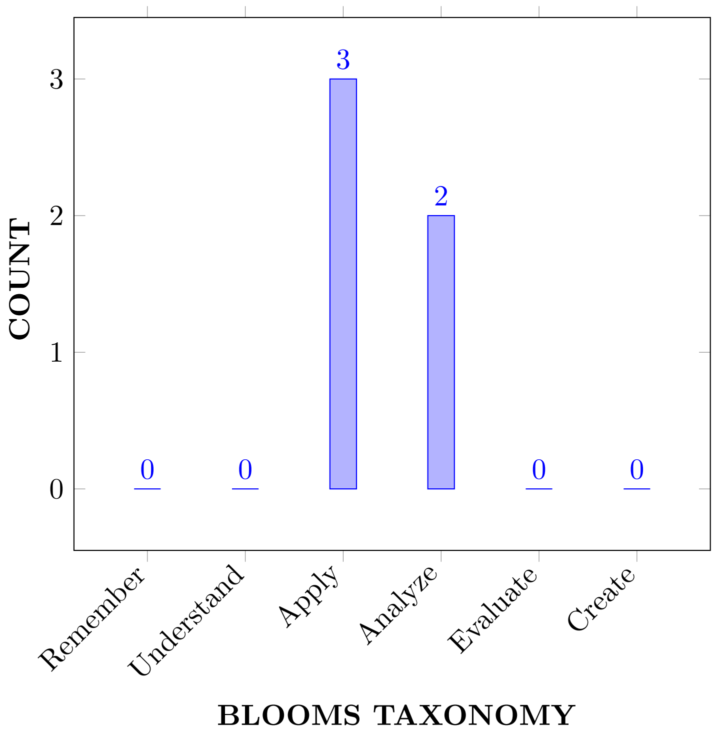
I	The operation of PLCs, its ladder diagram programming and wiring of hardware equipment with PLC.
II	The measurement and control of digital, analog input/output variables using PLC.
III	The use of Human Machine Interface (HMI) to monitor and control the operation of a process.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Use** PLC logic gates,timers and Counters for delaying a particular control process and counting the production rate in an industrial system.. .	Analyze
CO 2	**Design** a system for starting, speed control and braking of DC/AC motors using PLC digital module.	Apply
CO 3	**Measure** the temperature, speed, voltage and current using PLC analog module to control the operation of motors, relays and circuit breakers.	Analyze
CO 4	**Construct** PLC based automatic traffic signal system to control the vehicle congestion at a three-way or four-way road junction.	Apply
CO 5	**Develop** the ladder diagram logic programs for lift control, water level monitoring and fault annunciation systems.	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 PROGRAM SPECIFIC OUTCOMES:

Program Specific Outcomes	
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.

X HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Lab Exercises /CIE / SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	Lab 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	Hands on practice /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	Hands on practice /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 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	2	Lab Exercises / CIE / SEE
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	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.	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.	3	Lab Exercises / CIE / SEE
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	2	Lab Exercises / CIE / SEE

3 = High; 2 = Medium; 1 = Low

XI HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	2	Hands on practice /CIE / SEE
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	2	Hands on practice /CIE / SEE
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.	3	Hands on practice /CIE / SEE

3 = High; 2 = Medium; 1 = Low

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	**Classify** the various software timers and counters according to their usage by basic **mathematical principles** and **apply** them in an industrial process.	3
	PO 2	**Use** the Delta make WPLsoft software for writing the ladder diagram for on-delay, off-delay and up and updown counters for a particular process in an industry.	4
	PO 4	**Design** the real time experiments using the software timers and counters by applying the principles of engineering sciences	4
	PO 5	**Use** the Delta make WPLsoft software for writing the ladder diagram for on-delay, off-delay used for delaying a particular operation of a process in an industry and counters for counting the number of products produced.	1

	PO 6	**Apply** the timers and counters for protecting a system in an industry and provide the safety to the people and industry personnel.	2
	PO 8	**Write** the worksheets after completion of an experiment in laboratory by following the ethical principles	2
	PO 9	**Make use of** a team of members and function effectively and do the experiment in the laboratory .	8
	PO 10	**Wrtie** the worksheets for a particulary laboratory experiment and asnwers theviva voce questions asked by the laboratory incharge and some times even give a seminar on a topic given by the subject teacher.	4
	PO 12	**Recognize** the need of programmable logic controllers in an industrial automation system and gain the knowledge in the laboratory and use it in life long technical change.	5
	PSO 3	**Explicit** the software timers in Delta make WPLsoft software and **adopt** them to **program** a PLC used in an industrial automation process	5
CO 2	PO 1	**Remember** the starting methods, speed control methods and braking methods of an induction motor using the **electrical engineering scientific principles and methodologies** and **apply** them to control the motor.	3
	PO 2	**Understand** the purpose of using a motor in an industrial process and **state the problem** and **identify and apply** the appropriate solution either to start or brake the motor or to control the speed of motor.	4
	PO 3	**Analyze** the starting, speed control and braking of induction motor using programmable logic controllers	3
	PO 5	**Write** a ladder diagram program in WPLSoft software using relevant contactors and timers to start, control and brake the three phase induction motor.	1
	PO 6	**Apply** the timers and counters for protecting a system in an industry and provide the safety to the people and industry personnel.	2
	PO 8	**Write** the worksheets after completion of an experiment in laboratory by following the ethical principles	2
	PO 9	**Make use of** a team of members and function effectively and do the experiment in the laboratory .	8
	PO 10	**Wrtie** the worksheets for a particulary laboratory experiment and asnwers theviva voce questions asked by the laboratory incharge and some times even give a seminar on a topic given by the subject teacher.	4
	PSO 2	**Focus** on the components required for designing a speed control or braking method for a motor using the principles of engineering sciences and mathematics..	4
	PSO 3	**Gain** the Hands-on skills on PLc and HMI and how to interface them with the motor and control the motor accordingly	5

CO 3	PO 1	**Understand** the measuring principles of temperature, speed, current, voltage etc., using the **engineering principles** and **appl**y them to control a certain process in an industry.	3
	PO 2	**Identify the problem** of a process in an industry and **analyze** it to select a suitable motor using the **principles of engineering.**	4
	PO 4	**investigate** a process in an industry and **analyze** it to select a suitable starting or braking method for a motor using the **principles of engineering.**	6
	PO 5	**Develop** a ladder diagram program to start, control or brake a three phase induction motor using a WPLSoft software.	1
	PO 6	**Apply** the timers and counters for protecting a system in an industry and provide the safety to the people and industry personnel.	2
	PO 8	**Write** the worksheets after completion of an experiment in laboratory by following the ethical principles	2
	PO 9	**Make use of** a team of members and function effectively and do the experiment in the laboratory .	8
	PO 10	**Wrtie** the worksheets for a particulary laboratory experiment and asnwers theviva voce questions asked by the laboratory incharge and some times even give a seminar on a topic given by the subject teacher.	4
	PO 12	**Recognize** the need of programmable logic controllers in an industrial automation system and gain the knowledge in the laboratory and use it in life long technical change.	5
	PSO 1	**Design** a control system for control of voltage, current, temperature and speed of motro with in the prescribed limits	2
	PSO 2	**Focus** on the components required or sensors required for controlling of different physical parameters like temperature, speed etc.	5
	PSO 3	**Interface** the various types of sensors with PLC to measure the analog input quantities like temperature, speed, voltage, current etc., **analyze** the working of software tools and get the hands-on skills of using them.	5
CO 4	PO 1	**Understand** the traffic signal control process using **basic scientific principles.**	3
	PO 2	**Anlayze** the traffic at a particular location, **understand** the need of traffic signals and **design** a system that controls the traffic lights at a three way or four way road junctions to ensure the **safety of public.** .	4
	PO 5	**Use** the Delta make WPLsoft software and write the ladder diagram program to control the traffic lights at a road junction with more accurately and precisely.	1
	PO 6	**Apply** the timers and counters for protecting a system in an industry and provide the safety to the people and industry personnel.	2

	PO 8	**Write** the worksheets after completion of an experiment in laboratory by following the ethical principles	2
	PO 9	**Make use of** a team of members and function effectively and do the experiment in the laboratory .	8
	PO 10	**Wrtie** the worksheets for a particulary laboratory experiment and asnwers theviva voce questions asked by the laboratory incharge and some times even give a seminar on a topic given by the subject teacher.	4
	PSO 3	**Gain** the hands-on skills on PLC, HMI and construct a traffic signal control system for a three way or four way juction	5
CO 5	PO 1	**Understand** the operation of a temperature control system, solar tracking system and electrical fault detection system using the **electrical engineering principles and methodologies.**	3
	PO 2	**Analyze** the operation of a temperature control system, solar tracking system and electrical fault detection system using the **electrical engineering principles and methodologies.** and solve the problems associated with those systems	4
	PO 3	**Identify** the purpose of a temperature control system in an industry and **design** a system which maintains the temperature within specified limits. Also, **measure** and **analyze** the electrical current and voltage taken by the equipment in industry and **develop** a system which makes these variables within limits.	3
	PO 5	**Interface** the temperature sensor, proximity sensor, potential transformer and current r transformer with PLC and write a relay ladder logic in WPLsoft software to measure temperature, speed, voltage and currents.	1
	PO 6	**Apply** the timers and counters for protecting a system in an industry and provide the safety to the people and industry personnel.	2
	PO 8	**Write** the worksheets after completion of an experiment in laboratory by following the ethical principles	2
	PO 9	**Make use of** a team of members and function effectively and do the experiment in the laboratory .	8
	PO 10	**Wrtie** the worksheets for a particulary laboratory experiment and asnwers theviva voce questions asked by the laboratory incharge and some times even give a seminar on a topic given by the subject teacher.	4
	PSO 2	**Use** the thyristror drive for conversion of AC to DC and feed it to DC motor for controlling the speed of DC motor.	5
	PSO 3	**Gain** the hands-on skills PLC, HMI and opertion of temperature control system, fault annuonciation system and solar tracking system	5

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
CO 1	3	2	-	1	3	2	-	3	3	3	-	3	-	-	3
CO 2	3	2	1	-	3	2	-	3	3	3	-	-	-	1	3
CO 3	3	2	-	2	3	2	-	3	3	3	-	3	2	2	3
CO 4	3	2	-	-	3	2	-	3	3	3	-	-	-	-	3
CO 5	3	2	1	-	3	2	-	3	3	3	-	-	-	2	3

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	**LOGIC - GATES**
Implementation of logic gates using programmable logic controller.	
WEEK II	**TIMERS**
Implementation of software timers in programmable logic controller.	
WEEK III	**COUNTERS**
Implementation of software counters in programmable logic controller.	
WEEK IV	**SEQUENTIAL CONTROL**
Starting of three motors sequentially with some time delay using programmable logic controller.	
WEEK V	**DIRECT ONLINE (DOL) AND STAR DELTA STARTERS**
Design of direct online (DOL) and star-delta starters for three phase induction motor using PLC.	
WEEK VI	**AUTOMATIC FORWARD AND REVERSE CONTROL OF MOTOR**
Automatic forward and reverse control of three phase squirrel cage induction motor for milling operation using programmable logic controller	
WEEK VII	**REVERSE CURRENT BREAKING OF THREE PHASE INDUCTION MOTOR**
Implementation of reverse current braking method for three phase induction motor using PLC.	

WEEK VIII	SPEED CONTROL OF DC MOTOR
Implementation of field control and armature control methods of speed control for DC motor using PLC.	
WEEK IX	**WATER LEVEL MONITORING AND CONTROL**
Development of automatic water level monitoring system for an overhead tank using PLC.	
WEEK X	**TRAFFIC SIGNAL CONTROL**
Design of a traffic signal control system for a 3- way junction road using PLC.	
WEEK XI	**TEMPERATURE CONTROL IN A ROOM**
Design a temperature control system to monitor the temperature of a room using PLC.	
WEEK XII	**OVER VOLTAGE AND UNDER VOLTAGE PROTECTION**
Design of over voltage and under voltage protection system for home appliance using PLC.	

TEXTBOOKS

1. John R. Hack Worth, Frederick D. Hack Worth, Jr., "Programmable logic controllers: programming methods and applications", Pearson Education, 4th edition, 2008.

2. W. Bolton "Programmable logic controllers", Newnes Elsevier , 4th edition, 2006.

REFERENCE BOOKS:

1. Luis A. Bryan, E. A. Bryan, "Programmable Controllers theory and implementation", American technical publisher, 4th edition, 2002.

2. Frank D. Petruzella, "Programmable logic controllers", Tata McGraw hill, 3th edition, 2010.

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	Logic Gates	CO 1	T1: 11.2
2	Timers	CO 1	T1: 11.1 -11.5
3	Counters	CO 1	T2: 13.3
4	Sequential Control	CO 2	T1:14.1
5	Direct Online(DOL) and Star delta starters	CO 2	T1: 11.3
6	Automatic forward and Reverse control of motor	CO 3	T1: 11.1 -11.5
7	Reverse current breaking of three phase induction motor	CO 3	T2: 9.1-9.4
8	Speed control of DC motor	CO 2	T2: 9.1-9.4
9	Water level monitoring and control	CO 5	T1:14.4
10	Traffic signal control	CO 4	T1: 11.1
11	Temperature control in a room	CO 5	T2:10.3
12	Over voltage and under voltage protection	CO 5	T2:10.1-10.5

XVIII EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	**Motor Control:** Speed control of three phase induction motor
2	**Line Protecton:** Over Current Protection
3	**Motor Control:**Speed control of induction motor using PLC and VFD

Signature of Course Coordinator **HOD,EEE**
Ms. T Saritha Kumari

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**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

ANNEXURE - II

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	PSO Statement / Key Competencies Features (KCF)	No. of KCF(s)
PSO 1	Design, develop, fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization. 1. Operate, control and protect electrical power system. 2. Validate the interconnected power system. 3. Ensure reliable, efficient and compliant operation of electrical systems. 4. Familiarize the safety, legal and health norms in electrical system. 5. Adopt the engineering professional code and conduct.	**5**
PSO 2	Focus on the components of electrical drives with its converter topologies for energy conversion, management and auditing in specific applications of industry and sustainable rural development. 1. Control the electric drives for renewable and non-renewable energy sources. 2. Fabricate converters with various components and control topologies. 3. Synthesis, systematic procedure to examine electrical components/machines using software tools. 4. Inspect, survey and analyze energy flow. 5. Control and manage the power generation and utilization. 6. Familiarize the safety, legal and health norms in electrical system. 7. Adopt the engineering professional code and conduct. 8. Explore autonomous power 9. Evolve into green energy and assess results 10. Realize energy policies and education 11. Potential contribution of clean energy for rural development.	**11**
PSO 3	Gain the hands-on competency skills in PLC automation, process controllers, HMI and other computing tools necessary for entry level position to meet the requirements of the employer. 1. Explicit software and programming tools for electrical systems. 2. Adopt technical library resources and literature search. 3. Model, program for operation and control of electrical systems. 4. Constitute the systems employed for motion control. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

<table>
<tr><td>Department</td><td colspan="5">Electrical and Electronics Engineering</td></tr>
<tr><td>Course Title</td><td colspan="5">Power System Operation and Control</td></tr>
<tr><td>Course Code</td><td colspan="5">AEEC35</td></tr>
<tr><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>Semester</td><td colspan="5">VII</td></tr>
<tr><td>Course Type</td><td colspan="5">Core</td></tr>
<tr><td>Regulation</td><td colspan="5">UG-20</td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>3</td><td>-</td><td>3</td><td>-</td><td>-</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Mr.G.Viswanath, Assistant Professor</td></tr>
</table>

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEB22	VI	Power System Analysis

II COURSE OVERVIEW:

This course deals with the concept of power system management to meet load demand at optimal operating cost and various ways in controlling electrical power generation of Thermal and Hydrothermal plants and modeling of electrical and hydraulic. This course also gives the knowledge of Load Frequency Control in multi areas and classification of Loads and its Compensation. This course address the various real time issues like Power Factor and its improvement.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Power System Operation and Control	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
16%	Remember
50%	Understand
33%	Apply
0%	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc.

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

I	The economic operation of Thermal and Hydro Power Systems.
II	The solid foundation in mathematical and engineering fundamentals required to control the governing system in Turbine models.
III	The optimization techniques used in the power system and Load Frequency Control (LFC).
IV	The Power Factor Control and Reactive Power Control in Transmission Systems.

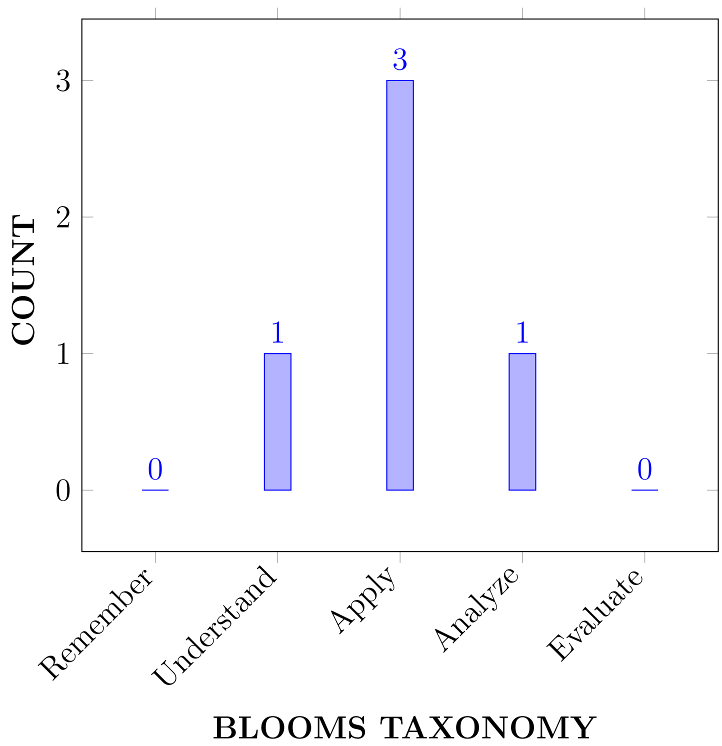
V	The Load Compensation technique for different Loads.

VI COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Solve** the optimum load scheduling with various constraints in Thermal and Hydro power Stations using conventional optimization techniques and general transmission line loss formula.	Apply
CO 2	**Develop** the mathematical models of the mechanical and electrical components in the power generation for deriving the transfer function of the power system.	Apply
CO 3	**Distinguish** single area and two area load frequency control for minimizing the transient and steady state deviations using various controllers.	Analyze
CO 4	**Choose** different types of compensating equipment for controlling voltage, reactive power and power factor for improving the reliability in compensated and uncompensated transmission lines.	Apply
CO 5	**Interpret** the types of loads in the power systems from their characteristic factors.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

Program Outcomes	
PO 2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

VIII 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	AAT/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	AAT/CIE/SEE

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	AAT/CIE/SEE
PO4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	AAT/CIE/SEE
PO 6	**The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	1	AAT/CIE/SEE

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Design, develop fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization.	2	AAT/CIE/SEE
PSO 2	Focus on the components of electrical drives with its converter topologies, for energy conversion, management and auditing in specific applications of industry and sustainable rural development.	1	AAT/CIE/SEE

3 = High; 2 = Medium; 1 = Low

X MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO(s)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	✓	-
CO 2	✓	✓	-	-	-	-	-	-	-	-	-	-	✓	-	-
CO 3	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
CO 4	✓	✓	✓	✓	-	-	-	-	-	-	-	-	-	✓	-
CO 5	✓	✓	-	-	-	-	-	-	-	-	-	-	-	✓	-

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	**Recollect** (knowledge) the basic concept of generation of electricity from Thermal and Hydrothermal power stations and (understand) the importance fundamentals of optimal operation of Generating plants by applying the principles of **mathematics and science**.	3
	PO 2	**Identify** the optimum problem and analyse heat rate curve, cost curve, incremental fuel and production costs, input-output characteristic **using the first principles of mathematics and engineering sciences**.	6
	PO 3	**Design** the solution for optimal operation of the power system to meet the specified needs with appropriate consideration **for societal and environmental considerations**.	2
	PO 4	**Analyze** and interpret the data of optimal scheduling of thermal and hydro power stations obtained by various research methods and knowledge to conduct **investigation of complex problems**.	2
	PO 6	**Apply** the knowledge of optimal scheduling of power stations for assessment of societial and safety issues **with responsibilities relevant to the professional engineering practice**.	1
	PSO 1	**Develop**(understand) the optimal scheduling of thermal and hydro power stations **involving power generation**.	4
	PSO 2	**Understands** the Unit Commitment **and** conventional optimization techniques by **focus on the components of system in specific applications of industry and academia**	2
CO 2	PO 1	**Recall** the knowledge on the various Components in generating plants **engineering fundamentals**.	3
	PO 2	**Describe** the mechanical and electrical components involved in the operation of power systems using the **first principles of mathematics and engineering sciences**.	6
	PSO 1	**Develop** the mathematical models of the mechanical and electrical components in operation of power systems **to derive the transfer function of systems involved in power generation**.	1
CO 3	PO 1	**Understand** the modeling of excitation systems system **knowledge of engineering fundamentals related to electrical machines**.	2
	PO 2	**Describe** the fundamental characteristics of an excitation system **using the first principles of mathematics and engineering sciences**.	2

Course Outcomes	PO(s) PSO(s)	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 3	**Design** the mathematical models of the mechanical and electrical components and develop the **solutions using complex Engineering**.	3
	PO 4	**Analyze** the mathematical models of the mechanical and electrical components and develop the **solutions using complex Engineering**.	3
	PSO 1	**Design** the load frequency control for single area and two area **to minimize deviations and errors involving power transmission and distribution**.	4
CO 4	PO 1	Understanding the concepts of voltage, powerfactor and reactive power control in the power systems using **basic fundamentals of mathematics, electrical engineering**.	2
	PO 2	**Analyze** the importance of controlling voltage and reactive power for stable operation of the power system **using first principles of science and mathematics**	7
	PO 3	Design the compensating equipment for control of voltage and reactive power problem and develop **solutions using complex Engineering**.	2
	PO 4	**Analyze** the need for reactive power in the power system and associated problems on power delivery and develop the **solutions using complex Engineering**.	2
	PSO 2	**Identify** various reactive power compensating equipment and topologies **for specific applications of industry and energy management**	2
CO 5	PO 1	**Illustrate** different types of loads and their characteristics using the **knowledge of Electrical Engineering fundamentals**	2
	PO 2	**Analyze** the voltage drop and power loss in a distribution system using the **solutions for complex engineering problems**.	5
	PSO 2	**Identify** various reactive power load compensating mathods and topologies **for specific applications of industry and energy management**	2

XII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO(s)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	6	2	2	-	1	-	-	-	-	-	-	4	2	-
CO 2	3	6	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 3	2	2	3	3	-	-	-	-	-	-	-	-	4	-	-
CO 4	2	7	2	2	-	-	-	-	-	-	-	-	-	2	-
CO 5	2	5	-	-	-	-	-	-	-	-	-	-	-	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
CO 1	100	60	20	18.2	-	20	-	-	-	-	-	-	80	18.2	-
CO 2	100	60	-	-	-	-	-	-	-	-	-	-	20	-	-
CO 3	66.7	20	30	27.3	-	-	-	-	-	-	-	-	80	-	-
CO 4	66.7	70	20	18.2	-	-	-	-	-	-	-	-	-	18.2	-
CO 5	66.7	50	-	-	-	-	-	-	-	-	-	-	-	18.2	-

XIV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 -$5 < C \leq 40\%$ – Low/ Slight

2 - $40\ \% < C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO(s)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	1	1	-	1	-	-	-	-	-	-	3	1	-
CO 2	3	3	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 3	3	1	1	1	-	-	-	-	-	-	-	-	3	-	-
CO 4	3	3	1	1	-	-	-	-	-	-	-	-	-	1	-
CO 5	3	2	-	-	-	-	-	-	-	-	-	-	-	1	-
TOTAL	15	12	3	3	-	1	-	-	-	-	-	-	7	3	-
AVERAGE	3	2.4	1	1		1							2.3	1	

XV ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	-
Quiz	-	Tech - Talk	✓	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	✓	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY-INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities/ Modeling & Experimental Tools in Engineering by Experts		

XVII SYLLABUS:

UNIT I	**ECONOMIC OPERATION OF POWER SYSTEMS**
	Optimal scheduling of thermal power system: Optimal operation of generators in thermal power stations, heat rate curve, cost curve, incremental fuel and production costs, input output characteristics, optimum generation allocation without and with transmission line losses coefficients, general transmission line loss formula, unit commitment; Optimal scheduling of hydrothermal system: Hydroelectric power plant models, scheduling problems, short term hydro thermal scheduling problem.
UNIT II	**MODELING OF GOVERNOR, TURBINE AND EXCITATION SYSTEMS**
	Modeling of governor: Mathematical modeling of speed governing system, derivation of small signal transfer function; Modeling of turbine: First order turbine model, block diagram representation of steam turbines and approximate linear models; Modeling of excitation system: Fundamental characteristics of an excitation system, transfer function, block diagram representation of IEEE type-1 model.
UNIT III	**SINGLE AREA AND TWO AREA LOAD FREQUENCY CONTROL**
	Load frequency control of single area system: Necessity of keeping frequency constant, definitions of control area, single area control, block diagram representation of an isolated power system, steady state analysis, dynamic response, uncontrolled case. Load frequency control of two area system: Uncontrolled case and controlled case, tie line bias control; Load frequency controllers: Proportional plus integral control of single area and its block diagram representation, steady state response, load frequency control and economic dispatch.
UNIT IV	**COMPENSATION FOR POWER FACTOR IMPROVEMENT AND REACTIVE POWER CONTROL**
	Voltage control: Equipment for voltage control, effect of series capacitors, line drop compensation, effect of AVR, power factor control using different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (fixed and switched), power factor correction, capacitor allocation, economic justification, procedure to determine the best capacitor location; Reactive power control: Reactive power compensation in transmission systems, advantages and disadvantages of different types of compensating equipment for transmission systems; Uncompensated and compensated transmission lines: Shunt and series compensation.
UNIT V	**LOAD COMPENSATION**
	Load Compensation: characteristics of loads, factors associated with loads, relation between the load factor and loss factor; specifications of load compensator; Classification of loads: Residential, commercial, agricultural and industrial and their characteristics.

TEXTBOOKS

1. Sivanagaraju, S., et al.,Power system operation and control, Pearson Education India, 2009
2. Turan Gonen, Electric Power Distribution system, Engineering, McGraw-hill Book Company, 2007

3. Timothy J. E. Miller, Reactive power control in Electrical systems, Wiley-Interscience Publication, 1982

4. V K Mehta & Rohit Mehta, Principles of Power System, S Chand, 2015.

REFERENCE BOOKS:

1. Singh S. N., Electric Power Generation, Transmission and Distribution, Prentice Hall of India Pvt. Ltd., New Delhi, Second Edition, 2002.

2. Turan Gonen, Electrical Power Distribution System Engineering, CRC Press, Third Edition, 2014.

3. Kamaraju V., Electrical Power Distribution Systems, TMH, Publication, Edition, 2009.

4. Elgerd O. I., Electrical Energy Systems Theory, Tata McGraw-Hill, Second Edition, 2007.

WEB REFERENCES:

1. https://nptel.ac.in/courses/108/104/108104052/

2. https://nptel.ac.in/courses/108/101/108101040/

COURSE WEB PAGE:

XVIII COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO(s)	Reference
	OBE DISCUSSION		
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	-
	CONTENT DELIVERY (THEORY)		
1	Introduction to power system operations and control	CO 1	T1:5-6
2	Optimal scheduling of thermal power system	CO 1	T1: 25-26
3	Characteristic Curves (heat rate curve, cost curve, Incremental fuel and production costs)	CO 1	T1: 26-28
4	Input-Output characteristics and Optimum generation allocation without transmission line losses coefficients	CO 1	T1: 26-28
5	Optimum generation allocation with transmission line losses coefficients	CO 1	T1: 26-28
6	General transmission line loss formula and Unit commitment.	CO 1	T1: 30-32
7	Hydroelectric power plant models	CO 1	T1: 30-32
8	Short term hydro thermal scheduling problem.	CO 1	T1: 30-32
9	Mathematical modeling of speed governing system	CO 2	T3:312-318
10	Derivation of small signal transfer function	CO 2	T3:312-318
11	Modeling of steam turbine	CO 2	T3:312-318

12	Block diagram representation of steam turbines	CO 2	T3:312-318
13	First order turbine model	CO 2	T3:312-318
14	Modeling of excitation system	CO 2	T3:322-326
15	Fundamental characteristics of an excitation system and Transfer function.	CO 2	T3:319
16	Block diagram representation of IEEE type-1 model.	CO 2	T2:11.5 R2:17.5
17	Load frequency control of single area system	CO 3	T1:84-85
18	Necessity of keeping frequency constant and Definitions of control areas (Single area & Two-area)	CO 3	T1:327-330
19	Block diagram representation of an isolated power system.	CO 3	T1:327-330
20	Steady-State and Dynamic response Analysis for uncontrolled case.	CO 3	T1:327-330
21	Load frequency control of two area system controlled and uncontrolled case	CO 3	T1:327-330
22	Load frequency control of a two area system: tie line bias control	CO 3	T1:58-59
23	Proportional plus integral control of single area control	CO 3	T1:58-59
24	Two area control block diagram representation	CO 3	T1 :60-62
25	Steady-state response in a two area system	CO 3	T1 :63-64
26	Load frequency control in a two area system	CO 3	T1 :65-68
27	Economic Dispatch	CO 4	T1:296
28	Equipment for voltage control	CO 4	T2:383 – 385
29	Impact of series capacitors and Automatic Voltage Regulators	CO 4	T2:383 – 385
30	Power factor control using different types of power capacitors (shunt and series capacitors)	CO 4	T2:383
31	Impact of switched and fixed shunt capacitors	CO 4	T1: 330-345
32	Power factor correction	CO 4	T2:337
33	Optimum location of capacitor and economic justification	CO 4	T2:342-345
34	Reactive power control	CO 4	T2:342-345
35	Different types of compensating equipment for transmission systems	CO 4	T2:337
36	Difference between compensated and uncompensated transmission lines.	CO 4	T2:325-327
37	Shunt and series reactive power compensation	CO 4	T2:325-327

38	Load Compensation	CO 5	T2:325-327
39	Characteristics of loads and factors associated with loads	CO 5	T2:25
40	Load factor and Loss factor, Classification of loads and their characteristics.	CO 5	T2:26-28
PROBLEM SOLVING/ CASE STUDIES			
41	Problems on incremental fuel cost and production cost.	CO 1	T1: 52-83
42	Problems on load sharing between the units based on governor droop characteristics	CO 1	T1: 282-286
43	Problems on optimum generation allocation with transmission line loss coefficients	CO 1	T1: 52-83
44	Problems on optimum generation allocation without transmission line loss coefficients	CO 1	T1: 108-135
45	Problems on transmission loss formula in terms of B-coefficients	CO 1	T1: 124-135
46	Mathematical models of turbine, generator and governing system	CO 2	T1: 310-313
47	Problems on single area and two area control	CO 3	T1: 346-358
48	Problems on change in generation levels of the units.	CO 4	T1: 346-358
49	Problems on change in steady state frequency and line losses in single area system	CO 4	T1: 282-286
50	Problems on deviation in frequency of the units.	CO 4	T1: 282-286
51	Problems on change in steady state frequency and line losses in two-area system	CO 4	T1: 346-358
52	Problems based on power factor improvement	CO 4	T1:405-414
53	Problems on defining the most economical power factor	CO 4	T1:405-414
54	Problems on the requirement of the capacitor ratings for power factor correction	CO 5	T1:405-414
55	Problems on annual power losses in the distribution systems	CO 5	T1:435-438
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Definitions on optimal scheduling of power plants	CO 1	T1-26 to 28
57	Definitions on mathematical modeling	CO 2	T3-321 to 318
58	Definitions on load frequency control	CO 3	T1-327 to 330
59	Definitions on voltage and reactive power control	CO 4	T2-342 to 345
60	Definitions on load compensation	CO 5	T2-206 to 208

DISCUSSION OF QUESTION BANK			
61	Economic operation of power systems	CO 1	R4:2.1
62	Modeling of governor, turbine and excitation systems	CO 2	T4:7.3
63	Economic operation of power systems	CO 3	R4:5.1
64	Compensation for power factor improvement and reactive power control	CO 4	T1:7.5
65	Load compensation	CO 5	T1: 4.1

Course Coordinator **HOD,EEE**
Mr.G.Viswanath,
Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF(s)
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**

	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**

	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

ANNEXURE - II

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	PSO Statement / Key Competencies Features (KCF)	No. of KCF(s)
PSO 1	Design, develop, fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization. 1. Operate, control and protect electrical power system. 2. Validate the interconnected power system. 3. Ensure reliable, efficient and compliant operation of electrical systems. 4. Familiarize the safety, legal and health norms in electrical system. 5. Adopt the engineering professional code and conduct.	**5**
PSO 2	Focus on the components of electrical drives with its converter topologies for energy conversion, management and auditing in specific applications of industry and sustainable rural development. 1. Control the electric drives for renewable and non-renewable energy sources. 2. Fabricate converters with various components and control topologies. 3. Synthesis, systematic procedure to examine electrical components/machines using software tools. 4. Inspect, survey and analyze energy flow. 5. Control and manage the power generation and utilization. 6. Familiarize the safety, legal and health norms in electrical system. 7. Adopt the engineering professional code and conduct. 8. Explore autonomous power 9. Evolve into green energy and assess results 10. Realize energy policies and education 11. Potential contribution of clean energy for rural development.	**11**

PSO 3	Gain the hands-on competency skills in PLC automation, process controllers, HMI and other computing tools necessary for entry level position to meet the requirements of the employer. 1. Explicit software and programming tools for electrical systems. 2. Adopt technical library resources and literature search. 3. Model, program for operation and control of electrical systems. 4. Constitute the systems employed for motion control. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Electrical and Electronics Engineering**				
Course Title	**Power System Stability**				
Course Code	AEEC36				
Program	B.Tech				
Semester	VII				
Course Type	Professional Elective III				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Ms.A.Manasa, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEC22	VI	Power System Analysis
B.Tech	AEEC07	III	DC Machines and Transformers

II COURSE OVERVIEW:

This course gives an insight into the various problems encountered in power systems related to reliability, stability and quality power. The course involves assessment of stability of a power system, improvement in stability and prevention of the system becoming unstable. The course would enable the students to figure out power system problems. This course deals with the development of detailed models of power system components and their application in the analysis of the dynamic behavior of interconnected power systems in response to small and large disturbances.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Power System Stability	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
16%	Remember
50%	Understand
33%	Apply
0%	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc.

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:
The students will try to learn:

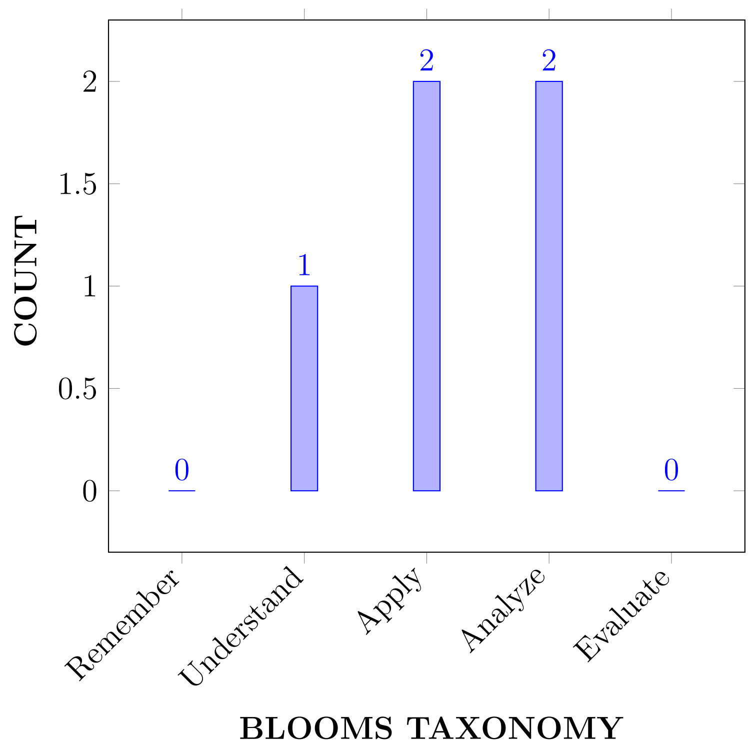
I	The state of estimation into different types.
II	How to monitor security and contingency evaluation.
III	The need of automation in power systems.
IV	The importance of voltage stability and voltage stability indices.
V	The artificial intellegence and artificial neural networks to power system analysis.

VI COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Illustrate** the significance of power system stability and approach for analysis of multi machine system. using conventional optimization techniques and general transmission line loss formula.	Understand
CO 2	**Develop** the equivalent circuits for mathematical analysis of the synchronous machines.	Apply
CO 3	**Explain** the methods to enhance the small signal stability of the power system.	Analyze
CO 4	**Choose** different solving Techniques for improving transient stability.	Apply
CO 5	**Explain** various methods to enhance the voltage stability.	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VII 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

VIII 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	AAT/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	AAT/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	1	AAT/CIE/SEE

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
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.	1	AAT/CIE/SEE
PO 6	**The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	1	AAT/CIE/SEE

3 = High; 2 = Medium; 1 = Low

IX HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Design, develop fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization.	2	AAT/CIE/SEE
PSO 2	Focus on the components of synchronous machines and its modeling , for energy conversion, management and auditing in specific applications of industry and sustainable rural development.	1	AAT/CIE/SEE

3 = High; 2 = Medium; 1 = Low

X MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO(s)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	✓	-
CO 2	✓	✓	-	-	-	-	-	-	-	-	-	-	✓	-	-
CO 3	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
CO 4	✓	✓	✓	✓	-	-	-	-	-	-	-	-	-	✓	-
CO 5	✓	✓	-	-	-	-	-	-	-	-	-	-	-	✓	-

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	**Recollect** (knowledge) the basic concept of Power systems and (understand) the important fundamentals of stability by applying the principles of **mathematics and science**.	3
	PO 2	**Identify** the optimum problem and analyse rotar angle ,frequency and voltage stability of synchronous machine **using the first principles of mathematics and engineering sciences**.	6
	PO 3	**Design** the solution for stability of the power system to meet the specified needs with appropriate consideration **for societal and environmental considerations**.	2
	PO 4	**Analyze** the dynamic behaviour of interconnected power systems by **investigation of complex problems**.	2
	PO 6	**Apply** the knowledge of stability of power stations for assessment of societial and safety issues **with responsibilities relevant to the professional engineering practice**.	1
	PSO 1	**Develop**(understand) the optimal scheduling of thermal and hydro power stations **involving power generation**.	4
	PSO 2	**Understands** the Unit Commitment **and** conventional optimization techniques by **focus on the components of system in specific applications of industry and academia**	2
CO 2	PO 1	**Recall** the knowledge on the various Components of power systems **engineering fundamentals**.	3
	PO 2	**Describe** the various methods of representing synchronous machine in stability analysis of power systems using the **first principles of mathematics and engineering sciences**.	6
	PSO 1	**Develop** the mathematical models of the electrical components in operation of power systems **to derive the transfer function of systems involved in power generation**.	1
CO 3	PO 1	**Understand** the modeling of excitation systems system **knowledge of engineering fundamentals**.	2
	PO 2	**Describe** the fundamental characteristics of an excitation system **using the first principles of mathematics and engineering sciences**.	2
	PO 3	**Design** the mathematical models of the mechanical and electrical components and develop the **solutions using complex Engineering**.	3

Course Outcomes	PO(s) PSO(s)	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 4	**Analyze** the mathematical models of the mechanical and electrical components and develop the **solutions using complex Engineering**.	3
	PSO 1	**Design** the power system stabilizer **to minimize deviations and errors involving power transmission and distribution**.	4
CO 4	PO 1	Understanding the concepts of transient stability and unbalanced faults in the power systems using **basic fundamentals of mathematics, electrical engineering**.	2
	PO 2	**Analyze** the importance of controlling voltage in multimachine power systems for stable operation of the power system **using first principles of science and mathematics**	7
	PO 3	Design the compensating equipment for control of voltage and reactive power problem and develop **solutions using complex Engineering**.	2
	PO 4	**Analyze** the need for voltage stability in the power system and associated problems on power delivery and develop the **solutions using complex Engineering**.	2
	PSO 2	**Identify** various compensating methods of transient stability of power systems**for specific applications of industry and energy management**	2
CO 5	PO 1	**Illustrate** the concept of voltage stability using the **knowledge of Electrical Engineering fundamentals**	2
	PO 2	**Analyze** the modeling requirements using the **solutions for complex engineering problems**.	5
	PSO 2	**Identify** various static and dynamic methods for the prevention of voltage collapse **for specific applications of industry and energy management**	2

XII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO(s)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	6	2	2	-	1	-	-	-	-	-	-	4	2	-
CO 2	3	6	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 3	2	2	3	3	-	-	-	-	-	-	-	-	4	-	-
CO 4	2	7	2	2	-	-	-	-	-	-	-	-	-	2	-
CO 5	2	5	-	-	-	-	-	-	-	-	-	-	-	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
CO 1	100	60	20	18.2	-	20	-	-	-	-	-	-	80	18.2	-
CO 2	100	60	-	-	-	-	-	-	-	-	-	-	20	-	-
CO 3	66.7	20	30	27.3	-	-	-	-	-	-	-	-	80	-	-
CO 4	66.7	70	20	18.2	-	-	-	-	-	-	-	-	-	18.2	-
CO 5	66.7	50	-	-	-	-	-	-	-	-	-	-	-	18.2	-

XIV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq$ C$\leq$ 5% – No correlation
1 -5 <C$\leq$ 40% – Low/ Slight
2 - 40 % <C < 60% –Moderate
3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO(s)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	1	1	-	1	-	-	-	-	-	-	3	1	-
CO 2	3	3	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 3	3	1	1	1	-	-	-	-	-	-	-	-	3	-	-
CO 4	3	3	1	1	-	-	-	-	-	-	-	-	-	1	-
CO 5	3	2	-	-	-	-	-	-	-	-	-	-	-	1	-
TOTAL	15	12	3	3	-	1	-	-	-	-	-	-	7	3	-
AVERAGE	3	2.4	1	1		1							2.3	1	

XV ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	-
Quiz	-	Tech - Talk	✓	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practices	-	5 Minutes Video / Concept Video	✓	Open Ended Experiments	-
Micro Projects	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY-INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of activities/ Modeling & Experimental Tools in Engineering by Experts		

XVII SYLLABUS:

UNIT I	**INTRODUCTION TO POWER SYSTEM STABILITY PROBLEMS**
	Definition of stability, classification of stability, rotor angle stability, frequency stability, voltage stability, midterm and long-term stability, classical representation of synchronous machine in a single machine infinite bus system (SMIB), equal area criterion to asses stability of a single machine infinite bus system, limitations of classical model of synchronous machines.
UNIT II	**MODELING OF POWER SYSTEM COMPONENTS FOR STABILITY ANALYSIS**
	Synchronous machine modeling: Sub transient model, two axis model, one axis (flux decay) model, classical model; Excitation systems modeling: DC excitation, AC excitation and static excitation, prime mover and energy supply systems modeling, transmission line modeling, load modeling, methods of representing synchronous machines in stability analysis.
UNIT III	**SMALL SIGNAL STABILITY**
	Fundamental concepts, state space representation, modal analysis: Eigen properties, participation factors, stability assessment, effects of excitation system on stability. Power system stabilizer and its design, angle and voltage stability of multi machine power systems and phenomenon of sub synchronous resonance.
UNIT IV	**TRANSIENT STABILITY**
	Fundamentals of transient stability, numerical solution of algebraic differential equations, simultaneous implicit and partitioned explicit methods, analysis of unbalanced faults, direct method of transient stability, methods of improving transient stability.
UNIT V	**VOLTAGE STABILITY**
	Classification of voltage stability, voltage stability analysis, modeling requirements, static and dynamic, prevention of voltage collapse.

TEXTBOOKS

1. P Kundur, —Power system Stability and Control‖, Tata McGraw Hill, 1st Edition, 2001.

2. M A Pai and Peter W Sauer, —Power System Stability‖, Pearson Education, 1st Edition, 2000.

REFERENCE BOOKS:

1. M A Pai, K Sengupta and K R Padiyar, —Topics on Small Signal Stability Analysis‖, Tata McGraw- Hill, 1st Edition, 2005.

2. K R Padiyar, —Power system dynamics‖, BSP Publications, 2nd Edition, 2010.

3. Paul M Anderson and A Fouad, —Power System Stability‖, Wiley-inter science, 1st Edition, 2002.

WEB REFERENCES:

1. https://www.researchgate.net

2. https://www.aar.faculty.asu.edu/classes

3. https://www.facstaff.bucknell.edu/

4. https://www.electrical4u.com
5. https://www.iare.ac.in

COURSE WEB PAGE:

XVIII COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO(s)	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO - PO Mapping	-	-
CONTENT DELIVERY (THEORY)			
1	Understand the definition of Stability and classification of stability	CO 1	T1:5-6
2	Different types of stability:Rotor angle stability	CO 1	T1: 25-26
3	Concept of Frequency Stablity	CO 1	T1: 26-28
4	Concept of Midterm and long-term stability	CO 1	T1: 26-28
5	Concept of voltage stability	CO 1	T1: 26-28
6	Classical representation of synchronous machine in a single machine infinite bus system (SMIB).	CO 1	T1: 30-32
7	Equal area criterion to asses stability of a single machine infinite bus system.	CO 1	T1: 30-32
8	Limitations of classical model of synchronous machines.	CO 1	T1: 30-32
9	Understand the concept of Synchronous machine modelling.	CO 2	T2:312-318
10	Subtrancient model of synchronous machine modeling.	CO 2	T2:312-318
11	Understand the concept Two axis model of synchronous machine modelling.	CO 2	T2:312-318
12	One axis(Flux decay) model, classical model of synchronous machine modelling.	CO 2	T2:312-318
13	Understand the concept of Excitation system modeling.	CO 2	T2:312-318
14	Dc Excitation.	CO 2	T2:322-326
15	AC Excitation and Static Excitation.	CO 2	T3:319
16	Understand the concept of prime mover and energy supply systems modeling.	CO 2	T2:11.5 R2:17.5
17	Concept of Transmission line modelling and load modeling.	CO 2	T1:84-85
18	Methods of representing synchronous machines in stability analysis.	CO 2	T1:327-330
19	Fundamental concepts of small signal stability.	CO 3	T1:327-330

20	State space representation of smal signal stablity analysis.	CO 3	T1:327-330
21	Model analysis of small signal stablity.	CO 3	T1:327-330
22	Understand the eigen properties of small signal stability.	CO 3	T1:58-59
23	Participation factors of small signal stability.	CO 3	T1:58-59
24	Stability Assesment of small signal stability.	CO 3	T1 :60-62
25	Effects of Excitation of stability.	CO 3	T1 :63-64
26	Concept of power system stabilizer and design.	CO 3	T1 :65-68
27	Steady state response in two area systems.	CO 3	T1:296
28	Angle and voltage stability of multi machine power systems .	CO 3	T2:383 – 385
29	characteristics of small-signal stability problems	CO 3	T2:383 – 385
30	small-signal stability of a single-machine infinite bus system	CO 3	T2:383
31	system state matrix with amortizes	CO 3	T1: 330-345
32	Effects of Excitation system	CO 3	T2:337
33	power system stabilizer	CO 3	T2:342-345
34	stability assesment	CO 3	T2:342-345
35	Fundamentals of transient stability.	CO 4	T2:337
36	Understand the phenomenon of subsynchronous resonance.	CO 4	T2:325-327
37	Numerical solutions of algebraic differential equations.	CO 4	T2:325-327
38	Simultaneous implicit and partitioned explicit methods.	CO 4	T2:325-327
39	Voltage stability analysis, modeling requirements	CO 5	T2:25
40	Static and dynamic prevention of voltage collapse	CO 5	T2:26-28
PROBLEM SOLVING/ CASE STUDIES			
41	Problems on stability of a single machine infinite bus system	CO 1	T1: 52-83
42	Solve the problems on rotor angle stability	CO 1	T1: 282-286
43	Solve the different types of numerical problems Frequency stability	CO 1	T1: 52-83
44	Problems on subtrancient problems	CO 2	T1: 108-135
45	Solve different numerical problems related to small singal stability	CO 3	T1: 124-135
46	Solve the different types of numerical problems related angle and voltage stability	CO 3	T1: 310-313
47	Solve the Numerical solution of algebraic differential equations	CO 4	T1: 346-358

48	Solve the problems on trancient stability	CO 4	T1: 346-358
49	Solve the different types of numerical problems on subsynchronous resonance	CO 4	T1: 282-286
50	Solve the problems on modeling requirements	CO 5	T1: 282-286
51	Solve the voltage stability problems	CO 5	T1: 346-358
52	Problems based on sub synchronous resonance	CO 4	T1:405-414
53	Problems on synchronous machine modeling	CO 2	T1:405-414
54	Problems on equal area criterion	CO 2	T1:405-414
55	Problems on voltage stability	CO 5	T1:435-438
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Definitions on power system stability	CO 1	T1-26 to 28
57	Definitions on mathematical modeling	CO 2	T2-321 to 318
58	Definitions on small signal stability	CO 3	T1-327 to 330
59	Definitions on transient stability	CO 4	T2-342 to 345
60	Definitions on voltage stablility	CO 5	T2-206 to 208
DISCUSSION OF QUESTION BANK			
61	Classical representation of synchronous machine	CO 1	R4:2.1
62	Modeling of synchronous machine	CO 2	T4:7.3
63	Power system stabilizer and its design	CO 3	R4:5.1
64	Methods of improving transent stability	CO 4	T1:7.5
65	Voltage stability analysis	CO 5	T1: 4.1

Course Coordinator **HOD,EEE**
Ms. A. Manasa
Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF(s)
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**

	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**

	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

ANNEXURE - II

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	PSO Statement / Key Competencies Features (KCF)	No. of KCF(s)
PSO 1	Design, develop, fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization. 1. Operate, control and protect electrical power system. 2. Validate the interconnected power system. 3. Ensure reliable, efficient and compliant operation of electrical systems. 4. Familiarize the safety, legal and health norms in electrical system. 5. Adopt the engineering professional code and conduct.	**5**
PSO 2	Focus on the components of electrical drives with its converter topologies for energy conversion, management and auditing in specific applications of industry and sustainable rural development. 1. Control the electric drives for renewable and non-renewable energy sources. 2. Fabricate converters with various components and control topologies. 3. Synthesis, systematic procedure to examine electrical components/machines using software tools. 4. Inspect, survey and analyze energy flow. 5. Control and manage the power generation and utilization. 6. Familiarize the safety, legal and health norms in electrical system. 7. Adopt the engineering professional code and conduct. 8. Explore autonomous power 9. Evolve into green energy and assess results 10. Realize energy policies and education 11. Potential contribution of clean energy for rural development.	**11**

PSO 3	Gain the hands-on competency skills in PLC automation, process controllers, HMI and other computing tools necessary for entry level position to meet the requirements of the employer. 1. Explicit software and programming tools for electrical systems. 2. Adopt technical library resources and literature search. 3. Model, program for operation and control of electrical systems. 4. Constitute the systems employed for motion control. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Electrical and Electronics Engineering**				
Course Title	**Wind and Solar Energy Systems**				
Course Code	AEEC43				
Program	B.Tech				
Semester	VII				
Course Type	Elective				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr.V.C.Jagan Mohan, Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
-	-	-	-

II COURSE OVERVIEW:

The present course is designed in such a way that it gives an overview of concepts of Economics. Managerial Economics enables students to understand micro environment in which markets operate how price determination is done under different kinds of competitions. Financial Analysis gives clear idea about concepts, conventions and accounting procedures along with introducing students to fundamentals of ratio analysis and interpretation of financial statements. Break Even Analysis is very helpful to the Business Concern for Decision Making, controlling and forward Strategic Planning. Ratio analysis gives an idea about financial forecasting, financial planning, controlling the business and decision making.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
WSES	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	✓	Seminars	x	Mini Project	✓	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
16.67%	Remember
16.67%	Understand
16.67%	Apply
50 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

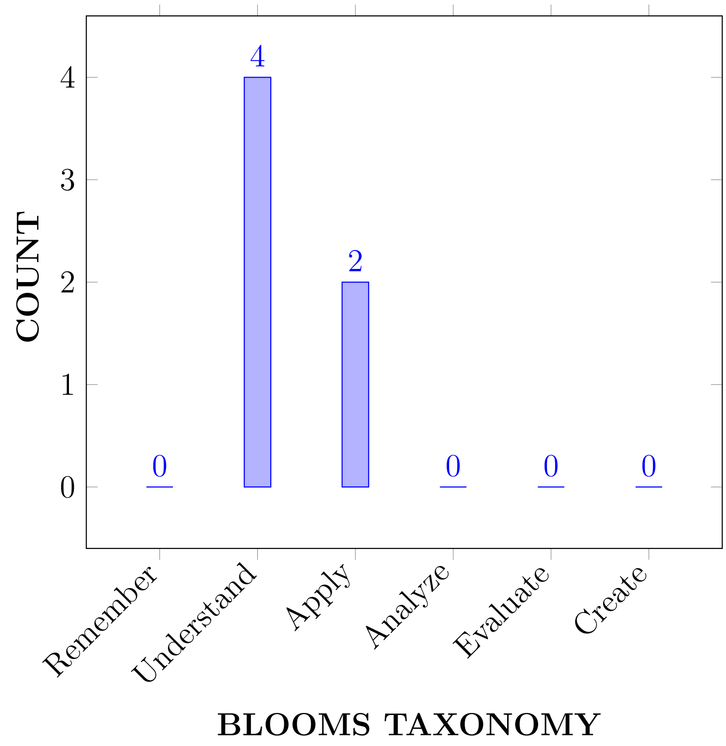
I	Analyze the environmental aspects of renewable energy sources.
II	Familiarize on the availability of renewable energy sources for sustainable conversion of energy.
III	To impart knowledge on energy conversion systems in solar, wind and facilitate developing systems for different applications.
IV	The present energy scenario and need for energy conversion.
V	The power quality issues in integration of renewable energy resources.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Outline** various components and their functionality in production of electricity from wind and solar power plants.	Understand
CO 2	**Outline** the characteristics and classification of solar photovoltaic modules for design of solar arrays.	Understand
CO 3	**Demonstrate** the functioning of various components involved in solar thermal systems for designing commercial solar power plants.	Understand
CO 4	**Develop** the suitable scheme for extracting maximum power from solar photovoltaic module using maximum power point tracking algorithms.	Apply
CO 5	**Make use of** AC voltage controllers for power factor improvement and harmonic reduction in isolated induction generators.	Apply
CO 6	**Outline** the control and protection of renewable energy systems using custom power devices for stable operation of power systems.	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.

Program Outcomes	
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	CIE/Quiz/AAT
PO 2	**Problem analysis:**Focus on the components of power system, its analysis, operation, control and protection; electrical drives with its converter topologies for energy conversion, management and auditing in specific applications of industry and academia.	2	CIE/Quiz/AAT
PO 3	**Design/Development of Solution:** 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	Seminar/ Conferences

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 components of power system, its analysis, operation, control and protection; electrical drives with its converter topologies for energy conversion, management and auditing in specific applications of industry and academia.	-	-

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** various components involved and their functionality using principles of mathematics, science and engineering fundamentals.	2
	PO 2	**Get knowledge** on operations of modern energy sources with wind and solar plants using principles of mathematics and engineering sciences.	2
	PO 3	**Design** solutions for variable speed operation, system design features for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration.	2
	PSO 2	**Get knowledge** on operations of modern energy sources with wind and solar plants using principles of mathematics and engineering sciences.	1
CO 2	PO 1	**Equip** with required skills to for the design PV cell and arrays with thefundamentals of mathematics, science, and engineering fundamentals.	2
	PO 2	**Derive** the solutions for the characteristics of PV cell using basics of mathematics and engineering sciences.	2
	PO 3	**Design** the solution for problems of PV cells, modules and arrays	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 3	PO 1	**Summarize** various operating modes of solar thermal systems with the knowledge of mathematics, science and engineering fundamentals.	2
	PO 2	**Derive** the solution for generating electrical power commercially using basic mathematics and engineering principles.	2
	PSO 2	**Recognize** the importance of various operating modes of solar thermal systems in generation, transmission and distribution of power.	1
CO 4	PO 1	**Use the basics of mathematics, science and engineering fundamentals**for obtaining maximum power tracking algorithms.	2
	PO 2	**Develop** maximum power point tracking algorithms and knowing the importance of maximum power tracking in solving complex engineering problems.	2
	PSO 2	**Understand** the maximum power point tracking algorithms used in generation of electrical power with PV system.	1
CO 5	PO 1	**Distinguish** different AC voltage controllers for power factor improvement by applying basic knowledge of science and engineering fundamentals.	2
	PO 2	**Understanding** the harmonic reduction in induction generators according to the necessities.	2
	PSO 2	**Understand** the solar energy collection and generation of electrical power with PV system.	1
CO 6	PO 1	**Outline** the control and protection and their impact on renewable energy systems with the help of apply the knowledge of engineering fundamentals.	2
	PO 2	**Determine** the protection equipment used in the renewable energy systems using basics of mathematics and engineering sciences.	2
	PSO 2	**Focus** on the custom power devices for operation and control of different modes of power system.	1

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	-	-	-	-	-	-	-	-	-	-	2	-
CO 2	2	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO 3	2	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO 4	2	1	-	-	-	-	-	-	-	-	-	-	-	2	-
CO 5	1	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO 6	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	66.7	60.0	-	-	-	-	-	-	-	-		-	-	33.3	-
CO 2	66.7	50.0	-	-	-	-	-	-	-	-	-	-	-	33.3	-
CO 3	50.0	50.0	-	-	-	-	-	-	-	-	-	-	-	33.3	-
CO 4	50.0	50.0	-	-	-	-	-	-	-	-	-	-	-	33.3	-
CO 5	33.3	50.0	-	-	-	-	-	-	-	-	-	-	-	33.3	-
CO 6	50.0	20.0	-	-	-	-	-	-	-	-	-	-	-	33.3	-

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	-	-	-	-	-	-	-	2	-	-	2	-
CO 2	3	2	-	-	-	-	-	-	-	-	2	-	-	2	-
CO 3	2	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO 4	2	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO 5	1	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO 6	2	1	-	-	-	-	-	-	-	-	-	-	-	2	-
TOTAL	7	7	-	-	-	-	-	-	-	-	-	-	-	2	-
AVERAGE	2.3	2.3	0.5	-	-	-	-	-	-	-	-	-	-	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:

X	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**DESIGN AND OPERATION OF WIND POWER SYSTEM**
	Wind Power System: Components, turbine rating, electrical load matching, variable-speed operation, system design features, maximum power operation, system control requirements, speed control, rate control and environmental aspects, wind energy conversion systems and their classification.
MODULE II	**DESIGN AND OPERATION OF PV SYSTEM**
	Solar Photovoltaic Power System: The PV Cell, module and array, equivalent electrical circuit, open circuit voltage and short circuit current, I-V and P-V curves, array design, peak power point operation, PV system components; Solar Thermal System: Energy collection, synchronous generator, equivalent electrical circuit, excitation methods, electrical power output, transient stability limit, commercial power plants.
MODULE III	**POWER CONDITIONING SCHEMES FOR SOLAR ENERGY SYSTEMS**
	Switching devices for solar energy conversion: DC power conditioning converters, maximum power point tracking algorithms. AC Power conditioners, Line commutated inverters, synchronized operation with grid supply, Harmonic reduction.
MODULE IV	**WIND ENERGY CONVERSION SYSTEMS**
	Wind energy Conversion system (WECS): Performance of Induction generators for WECS, Self-excited induction generator (SEIG) for isolated power generators. Controllable DC power from SEIGs, system performance, Grid related problems, generator control, AC voltage controllers, Harmonic reduction and Power factor improvement.
MODULE V	**POWER QUALITY ISSUES IN INTEGRATION OF RENEWABLE ENERGY RESOURCES**
	Stand alone and Grid connected systems, Power Quality issues, Impact of power quality problems on DG, Mitigation of power quality problems, and Role of custom power devices in Distributed Generation.

TEXTBOOKS

1. Mukund R Patel, “Wind and Solar Power Systems”, CRC Press, 1stEdition, 1999.
2. G D Rai, “Non- Conventional Energy Resources”, Khanna Publishers, 1stEdition, 2002.

REFERENCE BOOKS:

1. Daniel, Hunt. V Wind Power, A Hand Book of WECS, Van Nostrend Co., Newyork, 2ndEdition, 1998.
2. ArindamGhosh, Gerard Ledwich, “Power Quality Enhancement Using Custom Power Devices”, Springer, 1stEdition, 2002.
3. Roger C Dugan, Mark E Mc. Granaghan, Surya Santosh and H. Wayne Beaty, “Electrical Power Systems Quality”, TATA McGraw Hill, 2ndEdition, 2010.

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Discussion on Course Outcomes and how these COs mapped with POs and PSOs.		
CONTENT DELIVERY (THEORY)			
2	Wind Power System Components.	CO 1	T1- 1.3-1.8 R1-1.5-1.7
3	Wind Turbine rating, electrical load matching.	CO 1	T1- 1.3-1.8 R1-1.5-1.7
4	Wind turbine Variable-speed operation, system design features.	CO 1	T1-2.2-2.11 R1-3.3-3.20
5	Maximum power operation in wind turbines.	CO 1	T1-2.2-2.11 R1-3.3-3.20
6	Wind power system control requirements.	CO 1	T1-3.3-3.20 R1- 5.29-6.8
7	Speed control, rate control of wind turbines.	CO 1	T1-3.3-3.20 R1- 5.29-6.8
8	Environmental aspects of wind power stations.	CO 1	T1-4.6-4.19
9	Wind energy conversion systems and their classification.	CO 2	T1- 5.3-5.18 R1- 5.29-6.8
10	Review of wind energy systems.	CO 2	T1- 5.3-5.18 R1- 5.29-6.8
11	PV Cell, module and array ,equivalent electrical circuit.	CO 2	T1- 5.3-5.18
12	Open circuit voltage and short circuit current in solar system.	CO 2	T1- 5.3-5.18
13	Solar plate I-V and P-V curves, array design.	CO 2	T1- 5.3-5.18
14	PV system components of solar power plant.	CO 2	T1- 5.29-6.8
15	Solar Thermal System, energy collection of solar plates.	CO 2	T1- 5.29-6.8
16	Synchronous generator used in solar power stations.	CO 2	T1- 7.13-7.14
17	Equivalent electrical circuit of synchronous generator.	CO 2	T1- 7.13-7.14
18	Excitation methods, electrical power output of synchronous generator.	CO 2	T1- 7.1-7.12
19	Transient stability limit in synchronous generator.	CO 2	T1- 7.1-7.12
20	Commercial solar power plants.	CO 3	T1- 8.4-8.16 R2- 5.29-6.8
21	Overview of solar thermal power plants.	CO 3	T1- 8.4-8.16 R2- 5.29-6.8
22	Switching devices for solar energy conversion.	CO 3	T1- 8.21-8.25
23	DC power conditioning converters used in solar power plant.	CO 3	T1- 8.21-8.25
24	Maximum power point tracking algorithms in solar power system.	CO 3	T1- 8.21-8.25
25	AC Power conditioners used in solar power plants.	CO 4	T1-9.3-9.15

26	Line commutated inverters used in solar power generation.	CO 4	T1-9.3-9.15
27	State the Merits & Demerits of Sole Proprietorship.	CO 4	T1-9.2-10.23 R1- 8.21-8.25
28	Synchronized operation of solar plant with grid supply.	CO 4	T1-9.2-10.23 R1- 8.21-8.25
29	Importance of Cooperative societies .	CO 4	T1-9.2-10.23 R1- 8.21-8.25
30	Harmonic reduction in solar power stations..	CO 5	T1-9.2-10.23 R1- 8.21-8.25
31	Overview of power switching devices used in solar thermal plant.	CO 5	T1-9.2-10.23
32	Introduction wind energy Conversion system.	CO 5	T1-9.2-10.23
33	Performance of Induction generators used for WECS.	CO 5	T1-11.3-11.5 R2-12.3-12.5
34	Self-excited induction generator (SEIG) for isolated power generators.	CO 6	T1-11.3-11.5 R2-12.3-12.5
35	Controllable DC power from SEIGs.	CO 6	T1-12.1-12.26
36	Wind energy conversion system performance.	CO 6	T1-12.1-12.26
37	Grid related problems with wind power plants.	CO 6	T1-12.1-12.26
38	Induction Generator control in wind power stations.	CO 6	T1-13.4-13.15 R2-11.3-11.5
39	AC voltage controllers used in wind power stations.	CO 6	T1-13.4-13.15 R2-11.3-11.5
40	Harmonic reduction in AC voltage controllers used in wind farms.	CO 6	T1-13.4-13.15 R2-11.3-11.5
PROBLEM SOLVING/ CASE STUDIES			
41	Overview AC power conditioners used in wind power plants	CO 1	T1: 1.1 - 2.8, R1:2.1
42	Power factor improvement in wind power plants.	CO 2	T2: 3.0 to 3.6, 5.0 to5.5 , R2:4.4
43	Stand alone and Grid connected systems of wind power stations.	CO 3,4	T3: 6.0 to 6.4, R1:5.1
44	Power Quality issues in integration of renewable energy systems.	CO 5	R2:7.5
45	Impact of power quality problems on Distributed Generation.	CO 5	R2:7.5
46	Mitigation of power quality problems.	CO 5	R2:7.5
47	Role of custom power devices in Distributed Generation.	CO 5	R2:7.5
48	Review of power quality issues in wind and solar power plants.	CO 5	R2:7.5
49	Solar stand-alone system	CO 6	R3: 4.1
50	The power quality issues	CO 6	R3: 4.1
51	Grid connected renewable energy resource	CO 6	R3: 4.1
52	Distributed generation	CO 6	R3: 4.1

53	Various mitigation techniques used for the commanding of power quality in distribution generation.	CO 6	R3: 4.1
54	The custom power devices used in distributed generation and discuss about their functioning.	CO 6	R3: 4.1
55	The operation of DVR(Dynamic Voltage Restorer)	CO 6	R3: 4.1
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	What is wind energy?	CO 1	T1: 1.1 - 2.8, R1:2.1
57	What is solar energy?	CO 2	T2: 3.0 to 3.6, 5.0 to5.5 , R2:4.4
58	What are the common uses of solar energy?	CO 3,4	T3: 6.0 to 6.4, R1:5.1
59	How does a wind power plant affect its power quality?	CO 5	R2:7.5
60	What are the problems caused by solar and wind energy?	CO 6	R3: 4.1
DISCUSSION OF QUESTION BANK			
61	What are power quality issues?	CO 1	T1: 1.1 - 2.8, R1:2.1
62	How does wind energy affect the grid?	CO 2	T2: 3.0 to 3.6, 5.0 to5.5 , R2:4.4
63	What are the problems caused by solar and wind energy?	CO 3,4	T3: 6.0 to 6.4, R1:5.1
64	How does a wind power plant affect its power quality?	CO 5	R2:7.5
65	How does wind energy affect the grid?	CO 6	R3: 4.1

Signature of Course Coordinator **HOD,EEE**
Dr. V Chandra Jagan Mohan, Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043
COURSE DESCRIPTION

Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**				
Course Title	**ELECTRICAL AND HYBRID VEHICLES**				
Course Code	AEEB54				
Program	B.Tech				
Semester	VII	EEE			
Course Type	Accelerated Course				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Ms Shaik Ruksana Begam, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
UG	AEEC11	III	Electrical Machines – I
UG	AEEC15	IV	Electrical Machines – II
UG	AEEC20	V	Power Electronics

II COURSE OVERVIEW:

Electric and Hybrid Vehicles course deals with technical knowledge and practical expertise in commercial automobile technologies. As a part of this course, design, component selection and sizing at both system and vehicle level with a special focus on drives, battery modeling and control has been elaborated. A comprehensive overview of Electric and Hybrid Vehicles is emphasized on configuration, main issues and energy management strategies. This course also concludes with different control schemes used in motor drives and energy management systems.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Electrical and Hybrid Vehicles	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	PPT	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	✓	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Remember
35%	Understand
55%	Apply

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in below table

AAT-II	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

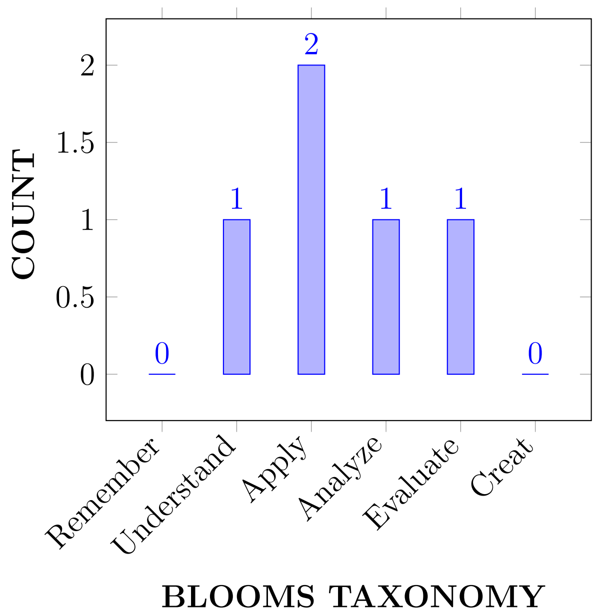
I	The concepts of modeling, design, and development of energy storage systems in hybrid electric vehicles.
II	The importance of hybrid electric vehicles to address the issues associated with environmental pollution and energy crisis.
III	The need of rapid control prototyping techniques to design and validate HEV high level and low level control system.
IV	The Know-how and aptitude towards future trends in Hybrid Electric Vehicles.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Summarize** the various topologies and modeling techniques used in electric and hybrid vehicles for performance analysis.	Understand
CO 2	**Analyze** cost-effectiveness of different types of hybrid drive-trains for transmitting power to driving wheels.	Analyze
CO 3	**Demonstrate** the configuration and control of Electric motor drives for maximizing speed and torque.	Evaluate
CO 4	**Choose** the hybridization of Energy Storage Systems for reducing size.	Apply
CO 5	**Select** suitable Energy Storage Systems and drive train components for optimizing energy management.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	CIE/Quiz/AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIE/Quiz/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	CIE/Quiz/AAT
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	3	CIE/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	3	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Design, develop, fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization.	1	CIE / SEE / AAT
PSO 2	Focus on the components of electrical drives with its converter topologies for energy conversion, management and auditing in specific applications of industry and sustainable rural development.	3	CIE / SEE / AAT
PSO 3	Gain the hands-on competency skills in PLC automation, process controllers, HMI and other computing tools necessary for entry level position to meet the requirements of the employer	3	CIE / SEE / AAT

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	✓	✓	-	-	-	-	-	-	-	-	-	✓	-	✓	-

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	**Apply** hybrid electric vehicles concepts in **Engineering knowledge, understanding and applications.**	1
	PO 2	Problem Analysis of hybrid electric vehicle concepts by identification, and system definition.	4
	PO 7	Understand the impact of the social and Environmental impacts of Hybrid and Electric vehicles for Environment and sustainability	2
CO 2	PO 1	Apply the impact of modern drive-trains on Engineering knowledge, understanding and applications	4
	PO 2	Problem Analysis of modern drive-trains by identification, definition, formulation, information and validation for decarburization of energy supply.	1
	PSO 2	Focus on electrical drives with its converter topologies on energy conversion, management and auditing in specific applications.	1
CO 3	PO 1	Apply modeling techniques in hybrid electric vehicles for Engineering knowledge, understanding and applications.	1
	PO 2	Problem Analysis for modeling and performing analysis in hybrid electric vehicles by problem identification, system definition, formulation, data collection, model translation and validation	1
	PO 3	Design Solution for modeling and performance analysis of electric vehicles by defining problem, understand user needs, identify cost drivers, manage design process and evaluate outcomes	1
	PO 5	Use of MATLAB software in modeling and simulation of hybrid electric vehicles.	1
	PSO 1	Simulate and/or fabricate/commission the electrical systems involving utilization of electrical energy.	1
	PSO 3	Gain the hands-on competency skills in use of computing tools necessary for entry level position to meet the requirements.	1

CO 4	PO 1	Develop electric drive-trains in hybrid electric vehicles for Engineering knowledge, understanding and applications.	1
	PO 2	Problem Analysis in identifying electric drive-trains by problem identification, system definition, formulation.	1
	PO 7	Understand the impact of Fuel efficiency for Hybrid storage systems in social and environmental contexts, and need for sustainable development.	2
	PO 12	Analyze vehicle load force for sizing drive system in utilization of electrical energy.	1
	PSO 2	Focus on the components of electrical drives with its converter topologies for energy management and auditing in transmitting power to driving wheels.	2
CO 5	PO 1	Develop electric drive-trains in hybrid electric vehicles for Engineering knowledge, understanding and applications.	1
	PO 2	Problem Analysisin identifying electric drive-trains by problem identification, system definition, formulation.	6
	PO 12	Analyze vehicle load force for sizing drive system in utilization of electrical energy.	1
	PSO 2	Focus on the components of electrical drives with its converter topologies for energy management and auditing for fuel efficiency.	2

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	2	-	-	-	-	3	-	-	-	-		-	-	-
CO 2	1	5	-	-	-	-	-	-	-	-	-	-	-	2	-
CO 3	1	6	4	-	1	-	-	-	-	-	-	-	1	-	1
CO 4	1	3	-	-	-	-	3	-	-	-	-	2	-	2	-
CO 5	1	3	-	-	-	-	-	-	-	-	-	2	-	2	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	33	20	-	-	-	-	30	-	-	-	-		-	-	-
CO 2	33	50	-	-	-	-	-	-	-	-	-	-	-	100	-
CO 3	33	60	40	-	100	-	-	-	-	-	-	-	16	-	-
CO 4	33	30	-	-	100	-	30	-	-	-	-	20	-	100	-
CO 5	33	30	-	-	-	-	-	-	-	-	-	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≤ C≤ 5% – No correlation
2 - 40 % <C < 60% –Moderate
1-5 <C≤ 40% – Low/ Slight
3 - 60% ≤ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	1	-	-	-	-	3	-	-	-	-		-	-	-
CO 2	1	2	-	-	-	-	-	-	-	-	-	-	-	3	-
CO 3	1	3	2	-	3	-	-	-	-	-	-	-	1	-	3
CO 4	1	1	-	-	3	-	3	-	-	-	-	2	-	3	-
CO 5	1	1	-	-	-	-	-	-	-	-	-	2	-	3	-
TOTAL	13	18	4	-	6	-	6	-	-	-	-	4	4	21	6
AVERAGE	1.2	1.6	2	-	3	-	3	-	-	-	-	2	1	3	3

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	
Laboratory Practices		Student Viva		Certification	
Term Paper	✓	5 Minutes Video	✓	Open Ended Experiments	
Assignments					

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS

MODULE I	**INTRODUCTION**
	Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies; Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.
MODULE II	**HYBRID ELECTRIC DRIVE TRAINS**
	Hybrid Electric Drive trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive train topologies, fuel efficiency analysis; Electric Drive trains: Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive train topologies, fuel efficiency analysis.

MODULE III	**ELECTRIC MOTORS FOR HYBRID ELECTRIC VEHICLES**
	Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, configuration and control of DC motor drives, configuration and control of Induction Motor drives. Configuration and control of permanent magnet motor drives, configuration and control of switch reluctance motor drives, drive system efficiency.
MODULE IV	**ENERGY STORAGE**
	Energy Storage: Introduction to energy storage requirements in hybrid and electric vehicles, Battery based energy storage and its analysis, fuel cell based energy storage and its analysis, super capacitor based energy storage and its analysis, flywheel based energy storage and its analysis, hybridization of different energy storage devices; sizing the drive system: matching the electric machine and the internal combustion engine (ICE), sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, communications, supporting subsystems.
MODULE V	**ENERGY MANAGEMENT STRATEGIES**
	Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: design of a hybrid electric vehicle (HEV), design of a battery electric vehicle (BEV).

TEXTBOOKS

1. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2ndEdition,2003.

2. James Larminie, John Lowry, "Electric Vehicle Technology", Wiley publications, 1stEdition,2003.

3. Mehrdad Ehsani, YimiGao, Sebastian E Gay, Ali Emadi," Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals Theory and Design", CRC Press, 2ndEdition,2004.

REFERENCE BOOKS:

1. B D McNicol, D A J Rand, "Power Sources for Electric Vehicles", Elsevier publications, 1 stEdition,1998.

2. Seth Leitman, "Build Your Own Electric Vehicle" McGraw-Hill, 1 stEdition,2013.

3. Jeffrey Gonder, Tony Markel, "Energy Management Strategies for Plug-In Hybrid Electric Vehicles", 2007-01- 0290, National Renewable Energy Laboratory

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	Course Objectives, Course Outcomes, CO-PO Mapping, Blooms Taxonomy, CO Articulation Matrix		

CONTENT DELIVERY (THEORY)			
1	Introduction to Hybrid Electric Vehicles	CO1	T1: 1.1, 1.2
2	History of hybrid and electric vehicles	CO1	T1: 1.1, 1.2
3	Social and environmental import hybrid and electric vehicles.	CO1	T1: 1.1, 1.2
4	impact of modern drive-trains on energy supplies	CO2	T1: 1.2
5	Conventional Vehicles: Basics of performance, vehicle power source characterization	CO1	T1: 1.2
6	Transmission characteristics	CO1	T1: 1.3
7	Mathematical models to vehicle performance	CO1	T1: 3.6
8	Hybrid Electric Drive trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies	CO2	T1: 1.1
9	Power flow control in hybrid drive train topologies, fuel efficiency analysis	CO2	T1: 1.1, T1: 3.8
10	Electric Drive trains: Basic concept of electric traction, introduction to various electric drive train topologies	CO2	T1: 4.2,4.3
11	Power flow control in electric drive train topologies	CO3	T1: 4.2,4.3 T2:26.10
12	Fuel efficiency analysis	CO3	T1: 4.4
13	Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles	CO3	R2: 4.7
14	Configuration and control of DC motor drives	CO3	T1: 4.9
15	Configuration and control of Induction Motor drives	CO3	T1: 4.9
16	Configuration and control of permanent magnet motor drives	CO3	T1: 5.1,5.4
15	Configuration and control of switch reluctance motor drives	CO3	T1: 5
17	Drive system efficiency	CO3	T1: 5.1
18	Sizing the drive system: matching the electric machine and the internal combustion engine (ICE)	CO3	T1: 5.1
19	Sizing the propulsion motor, sizing the power electronics	CO3	T1: 5.1
20	Energy Storage: Introduction to energy storage requirements in hybrid vehicles	CO4	T1: 6.1,6.4,6.5
21	Energy Storage: Introduction to energy storage requirements in electric vehicles	CO4	T1: 6.1,6.4,6.5
22	Battery based energy storage and its analysis	CO4	T1: 6.1
23	Fuel cell based energy storage and its analysis	CO4	T1: 6.1
24	Super capacitor based energy storage and its analysis	CO4	T1: 6.1
25	Flywheel based energy storage and its analysis	CO4	T1: 6.1
26	Hybridization of different energy storage devices;,	CO4	T1: 6.13
27	Classification of different storage devices	CO4	R1: 6.14
28	Selecting the energy storage technology	CO4	T1 : 9
29	Communications	CO5	T1: 9.5

30	supporting subsystems	CO5	T1: 9.5
31	Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles	CO5	R2: 9.6 R3: 1.5, 1.9
32	Classification of different energy management strategies	CO5	T1: 9.1 R3: 2.6
33	Comparison of different energy management strategies	CO5	T1: 9.1 R3: 4.3, 4.8
34	Management strategies	CO5	R1: 9.9 R3:5.8, 5.11
35	Introduction to energy management strategies used in hybrid vehicles	CO5	T1 : 9.1
36	Introduction to energy management strategies used in electric vehicles	CO5	T1 : 9.1
37	Classification of different energy management strategies	CO5	T1 : 9.1
38	Implementation issues of energy management strategies	CO5	T1 : 9.1
39	comparison of different energy management strategies	CO5	T1 : 9.1
40	Case Studies: design of a hybrid electric vehicle (HEV)	CO5	T1 : 9.1
41	Design of a battery electric vehicle (BEV).	CO5	T1 : 9.1
PROBLEM SOLVING/ CASE STUDIES			
1	Mathematical models to describe vehicle performance	CO1	R2:7.5
2	Fuel efficiency analysis in hybrid drive trains	CO2	R2:7.5
3	Fuel efficiency analysis in electric drive trains	CO2	T1 : 9
4	Drive system efficiency	CO3	R2:7.5
5	Battery based energy storage system analysis	CO4	T1: 6.1,6.4,6.5
6	Fuel cell based energy storage system analysis	CO4	T1: 6.13
7	Super capacitor based energy storage system analysis	CO4	T1 : 9
8	Flywheel based energy storage system analysis	CO4	T1: 6.1,6.4,6.5
9	Sizing the drive system	CO4	T1: 6.1,6.4,6.5
10	Sizing the power electronics	CO4	T1: 6.1,6.4,6.5
11	Sizing the propulsion motor	CO4	T1: 6.1,6.4,6.5
12	Selecting the energy storage technology	CO4	T1: 6.1,6.4,6.5
13	Implementation issues of energy management strategies	CO5	T1: 9.1,9.1
14	Design of a battery electric vehicle (BEV)	CO5	T1: 9.1,9.1
15	Design of a hybrid electric vehicle (HEV)	CO5	T1: 9.1,9.1

DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Introduction to Electric and Hybrid Vehicles	CO1	T1: 9.5
2	Hybrid electric drive trains	CO2	R4:2.1
3	Electric motors for hybrid electric vehicles	CO3	T1: 9.5
4	Energy Stotage Systems	CO4	R4:2.1
5	Energy Mangement Stratergies	CO5	T1 : 9
DISCUSSION OF QUESTION BANK			
1	Mathematical models to vehicle performance	CO1	R4:2.1
2	Hybrid Electric Drive trains	CO2	T4:7.3
3	Induction motor	CO3	R4:5.1
4	Electric Battery	CO4	T1:7.5
5	Energy management	CO5	T1: 4.1

Signature of Course Coordinator **HOD,EEE**
Ms. Shaik Ruksana Begam Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Course Title	**INTELLECTUAL PROPERTY RIGHTS**				
Course Code	AHSC19				
Program	B.Tech				
Semester	VII	EEE			
Course Type	Open Elective				
Regulation	IARE - UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Dr. Ranjith Kumar Gatla, Associate Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	-	-	-

II COURSE OVERVIEW:

This course provides the trade related intellectual property rights and investment measures. This course emphesis on how to avail the intellectual property rights of the inventors or owners for their assets like patents on innovative design, copy rights on literary and artistic works, trademark on goods & services and geographical indiactions on products famous for specific geographical areas.This course makes use of the potential future economic benefits to the intellectual property owner or authorized user.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Intellectual Property Rights	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Remember
20 %	Understand
60 %	Apply
10 %	Analyze

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

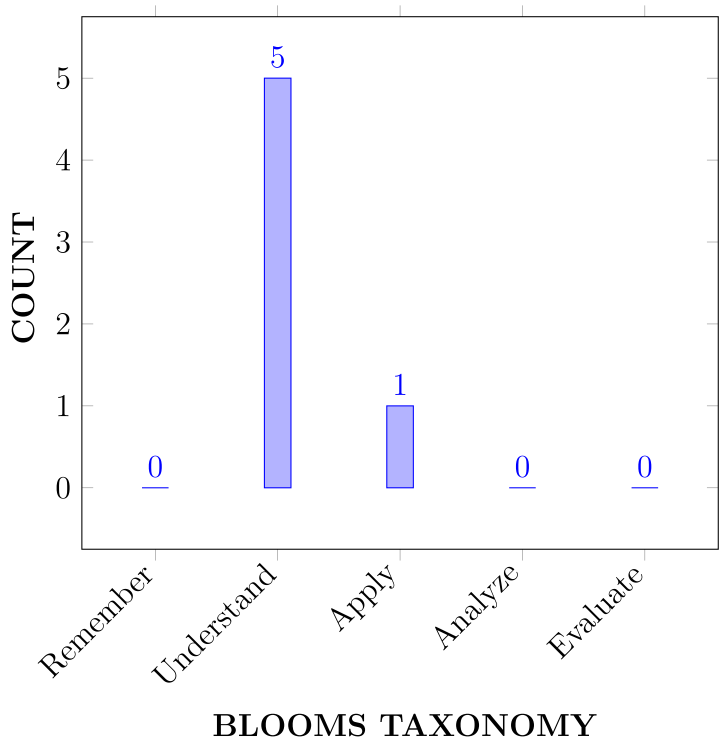
I	The knowledge on world trade organization, trade agreements and investments.
II	The importance of intellectual property rights to develop trade mark law, copy right law and patent law.
III	The new developments in the law of intellectual property rights in order to bring progressive changes towards a free market society and international trade practices under the Trade Related Intellectual Property Rights Agreement (TRIPS)

VII COURSE OUTCOMES:

After successful completion of the course, students will be able to:

CO 1	**Summerize** the general agreement on tariffs and trade (GATT) eight rounds for the substantial reduction of tariffs and other barriers of trade.	Understand
CO 2	**Relate** the world trade organization agreements for trade related intellectual property rights and investments.	Understand
CO 3	**Elaborate** the involvement of World Intellectual Property Organization to promote the protection of intellectual property throughout the world.	Understand
CO 4	**Demonstrate** the legal procedure and document for claiming patent of invention.	Understand
CO 5	**Illustrate** the different geographical Indications of products which corresponding to specific location for aviling brand of location to products .	Understand
CO 6	**Identify** different types of intellectual properties,the right of ownership,scope of protection to create and extract value from IP.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 6	**The engineer and society:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	CIE/Quiz/AAT
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	3	Seminar
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear.	2	Seminar
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change	1	Seminar

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	-	-
PSO 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 SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 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 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	✓	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO 2	-	-	-	-	-	✓	-	-	-	✓	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	✓	-	✓	-	-	-	-	-
CO 4	-	-	-	-	-	✓	-	✓	-	✓	-	✓	-	-	-
CO 5	✓	-	-	-	-	-	-	✓	-	✓	-	✓	-	-	-
CO 6	✓	-	-	-	-	✓	-	✓	-	✓	-	✓	-	-	

XII JUSTIFICATIONS FOR CO – PO/ PSO MAPPING -DIRECT:

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 1	**PO 1**	**Identify** different types of Intellectual Properties (IPs), the right of ownership in **scientific principles and methodolgy** , scope of protection as well as the ways to create and to extract value from IP	1
	PO 10	**Describe** the intellectual property rights of ownership and **communicate effectivly(speaking style)** in concept video or tech talk	1
CO 2	**PO 6**	**Explain** WTO agreements helpful for **engineering activities to promot sustainable development** and **legal requirements** in new product and service development.	2
	PO 10	**Describe** the importance of WTO agreements for trade related intellectual property rights **communicate effectively(speaking style)** in tech-talk	1
CO 3	**PO 8**	**Demonstrate the ethical behaviour** and **responsibilities** of world intellectual property organization and its **degree of trust and integrity** to protect intellectual property rights of the owner	3
	PO 10	**Describe** the support of WIPO in connection with intellectual property rights and **communicate effectivly(speaking style)** in tech-talk	1

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
CO 4	PO 6	**Explore the knowledge and understanding of commercial** management of IP and **identify the highlevel of professional conduct** of intellectual property management for claiming patent of invention	2
	PO 8	**Explain** how to prepare the **ethical** document for patent of invention by following **legal belief** and **high degree of trust and integrity**	3
	PO 10	**Describe** the steps involved in patent filing in india namely drafting, filing the patent application**(writing)** and **communicate effectivly(speaking style)** in concept video and tech-talk.	2
	PO 12	**Understand** the need of **advanced engineering concepts** interms of **ongoing learning** which is suitable to intellectual work.	2
CO 5	PO 1	**Explore** on the **engineering scientific principles** and **mathematical principles** which are helpful for availing geographical indication and procedure for applying geographical indications of products of specific locations	2
	PO 8	**Extend** on various IPR components to **make ethical production** and process of filing a document for geographical indication by following **professional ethics** and **integrity of resourse of region** .	3
	PO 10	**Describe** the geographical indiaction for famous products in a given location and **communicate effectively(speaking style)** in tech-talk.	2
	PO 12	**Understand** the need of **advanced engineering concepts** interms of **ongoing learning** which is suitable to get permission for geographical indication of products.	2
CO 6	PO 1	**Explore** the **engineering knowledge** which is useful for preparing the trademark and then **apply methodology** for trade mark based on trademark and merchandise act 1958 which prevents misuse of marks.	2
	PO 6	**Illustrate** international copyright law with respect to ownership and registration of copyright by following the awareness of **legal requirements**. Understand the **professional and ethical conduct** to get copy right for literary and artistic works	2
	PO 8	**Summarize** the trade mark and trade secrets **with knowledge of professional ethics** and **integrity** protection before submitting application to trademark office. **Demonstrate the ethical behaviour**of stoping illegal trademark	3
	PO 10	**Describe** the IPR to get trademark for unique marks and copy right**(for literature writing)** for new artistic works and and **communicate effectively(speaking style)** in tech-talk.	2

Course Outcomes	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key competencies matched.
	PO 12	**Analyze** the the **project mangement** for international developments in trademarks law , copyright law and patent law. **Significant skills** are applied to get intellectual property rights.	2

Note: For Key Attributes refer **Annexure - I**

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	-	-	-	-	-	2	-	-	-	1	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	3	-	1	-	-	-	-	-
CO 4	-	-	-	-	-	2	-	3	-	2	-	2	-	-	-
CO 5	2	-	-	-	-	-	-	3	-	2	-	2	-	-	-
CO 6	2	-	-	-	-	2	-	3	-	2	-	2	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – PO/ PSO

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	33.3	-	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 2	-	-	-	-	-	40	-	-	-	20	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	100	-	20	-	-	-	-	-
CO 4	-	-	-	-	-	40	-	100	-	40	-	25	-	-	-
CO 5	66.7	-	-	-	-	-	-	100	-	40	-	25	-	-	-
CO 6	66.7	-	-	-	-	40	-	100	-	40	-	25	-	-	-

XV COURSE ARTICULATION MATRIX (PO / PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - $0 \leq C \leq 5\%$ – No correlation

1 - $5 < C \leq 40\%$ – Low/ Slight

2 - $40\ \% < C < 60\%$ –Moderate

3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	3	10	10	11	1	5	3	3	12	5	12	8	5	11	7
CO 1	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	-	-	-	-	-	2	-	-	-	1	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	3	-	1	-	-	-	-	-
CO 4	-	-	-	-	-	2	-	3	-	2	-	1	-	-	-
CO 5	3	-	-	-	-	-	-	3	-	2	-	1	-	-	-
CO 6	3	-	-	-	-	2	-	3	-	2	-	1	-	-	-
Total	7	-	-	-	-	6	-	12	-	9	-	3	-	-	-
Average	**2.3**	-	-	-	-	**2**	-	**3**	-	**1.5**	-	**1**	-	-	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments					

XVII ASSESSMENT METHODOLOGY-INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
✓	Assessment of mini projects by experts		

XVIII SYLLABUS:

MODULE I	**INTRODUCTION**
	General agreement on tariffs and trade (GATT) eight rounds: Uruguay round, world trade organization: structure, technology transfer, dispute resolution mechanism, Doha declaration world trade organization agreements including trade related intellectual properties rights and trade related investment measures.
MODULE II	**WORLD INTELLECTUAL PROPERTY ORGANIZATION**
	Paris convention, Bern convention, Budapest treaty, Madrid agreement, huge agreement.
MODULE III	**PATENTS**
	Historical background of intellectual property rights, introduction, definition and classification of intellectual property, patents, patentable and non-patentable inventions. Legal requirements for patents, types of patent applications, patent document: specification and claims, important procedural aspects, management of intellectual property rights assets and intellectual property portfolio, commercial exploitation of intellectual property.

MODULE IV	DESIGNS AND GEOGRAPHICAL INDICATIONS
	Designs: basic requirements, procedure, convention application term, date, geographical indication: definition, what can be registered, who can apply, rights, term, restrictions.
MODULE V	TRADEMARK AND COPYRIGHTS
	Definition, classification of trademarks, classifications of goods and services, Vienna classification, trademarks procedure, trademarks enforcement: infringement and passing off, remedies, copyrights, term of copyrights, and procedure of copyright assignment of copyright, copyright infringement remedies.

TEXTBOOKS

1. P. K. Vasudeva,World Trade Organization: Implications on Indian Economy, Pearson Education,2015.
2. P.KrishnaRao, WTO, Text and cases, Excel Books, 2015.
3. Carlos M.Correa- Intellectual property rights, The WTO and Developing countries-Zed books

REFERENCE BOOKS:

1. Yuan S W, "Foundations of fluid Mechanics", Prentice-Hall, 2nd Edition, 1987.

WEB REFERENCES:

1. Caves, Frankel, Jones, World Trade and Payments-An Introduction, Pearson4. Education, 2015.
2. Carlos M.Correa- Intellectual property rights, The WTO and Developing countries-Zed books.
3. Peter-Tobias stoll, Jan busche, Katrianarend- WTO- Trade –related aspects of IPR-Library of Congress

COURSE WEB PAGE:

https://lms.iare.ac.in/index?route=course/details&course_id=367

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping		
CONTENT DELIVERY (THEORY)			
1	General agreement on tariffs and trade (GATT) eight rounds	CO 1	T1:1.4-1.5
2	Uruguay round	CO 1	T1:1.4-1.5
3	World trade organization: structure	CO 1	T1:2.4-2.5

4	Technology transfer	CO 1	T1:2.4-2.5
5	Dispute resolution mechanism	CO 1	T1:2.4-2.5
6	Doha declaration	CO 2	T1:2.6-2.6.8; R2: 5.8-5.10
7	world trade organization agreements	CO 2	T1:2.6-2.6.8; R2: 5.8-5.10
8	Trade related intellectual properties rights	CO 2	T1:3.1-3.6
9	Paris convention	CO 2	T1:3.1-3.6
10	Bern convention	CO 2	T1:3.1-3.6
11	Budapest treaty	CO 2	T1:3.1-3.6
12	Madrid agreement	CO 3	T1:3.1-3.6
13	Hague agreement	CO 3	T1:3.1-3.6
14	Historical background of intellectual property rights	CO 3	T1:3.1-3.8
15	introduction, definition and classification of intellectual property	CO 3	T1:3.1-3.8
16	Patents, patentable and non-patentable inventions	CO 3	T1:3.1-3.8
17	Legal requirements for patents	CO 3	T1:3.1-3.8; R2: 7.4-7.5
18	Types of patent applications	CO 3	T1:3.1-3.8; R2: 7.4-7.5
19	patent document: specification and claims	CO 3	T1:3.1-3.8; R2: 7.4-7.5
20	important procedural aspects	CO 3	T1:3.1-3.8; R2: 7.4-7.5
21	management of intellectual property rights assets	CO 4	T1:4.1-4.6
22	intellectual property portfolio	CO 4	T1:4.1-4.6
23	Commercial exploitation of intellectual property	CO 4	T1:4.1-4.6
24	Designs: basic requirements	CO 4	T1:4.1-4.6

25	Designs: Procedure	CO 4	T1:4.1-4.6
26	Designs: Convention application term, date	CO 5	T1:10.1-10.6
27	Geographical indication: definition	CO 5	T1:10.1-10.6
28	What can be registered	CO 5	T1:10.1-10.6
29	Who can apply	CO 5	T1:10.1-10.6
30	Rights, term, restrictions	CO 5	T1:10.1-10.6 ; T1:9.1-9.6
31	TRADEMARK AND COPYRIGHTS: Definition, classification of trademarks	CO 5	T1:10.1-10.6; T1:9.1-9.6
32	Classifications of goods and services	CO 5	T1:9.1-9.6
33	Vienna classification	CO 5	T1:9.1-9.6
34	Trademarks procedure	CO 5	T1:9.1-9.6
35	Trademarks enforcement: infringement and passing off , remedies	CO61	T1:8.1-8.3 ; R2: 7.4-7.5
36	copyrights, term of copyrights	CO 6	T1:8.1-8.3; R2: 7.4-7.5
37	procedure of copyright	CO 6	T1:8.1-8.3; R2: 7.4-7.5
38	Assignment of copyright	CO 6	T1-8.1-8.1.7
39	Copyright infringement remedies	CO 6	T1-8.1-8.1.7
40	Copyright infringement remedies	CO 6	T1-8.1-8.1.7
PROBLEM SOLVING/ CASE STUDIES			
1	Trademarks	CO 2	T1:2.6-2.6.8; R2: 5.8-5.10
2	Copyrights	CO 3	T1:3.1-3.6
3	Which are the types of geographical indication/?	CO 2	T1:3.1-3.6
4	How many geographical indications are there in India/?	CO 2	T1:3.1-3.6

5	What means intellectual property/?	CO 3	T1:3.1-3.6
6	What is IPR and its features/?	CO 3	T1:3.1-3.8
7	What is a violation of intellectual property/?	CO 3	T1:3.1-3.8
8	What is trademark with example/?	CO 3	T1:4.1-4.6
9	What are the two categories of intellectual property/?	CO 3	T1:4.1-4.6
10	What happened in the Uruguay Round/?	CO 4	T1:4.1-4.6
11	What was a result of the Uruguay Round quizlet/?	CO 5	T1:10.1-10.6
12	What is the purpose of WIPO/?	CO 5	T1:10.1-10.6
13	How many countries are in WIPO/?	CO5	T1:10.1-10.6
14	What is the difference between a geographical indication and a trademark/?	CO 6	T1:8.1-8.3; R2: 7.4-7.5
15	What trademark means/?	CO 6	T1:8.1-8.3; R2: 7.4-7.5
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	What is World Trade Organization (WTO)/?	CO 1	T1:1.4-1.5
2	What is the purpose of WIPO/?	CO 3	T1:3.1-3.8
3	What means intellectual property/?	CO 4	T1:4.1-4.6
4	What do you mean by geographical indications/?	CO 5	T1:10.1-10.6
5	What trademark means/?	CO 6	T1:8.1-8.3; R2: 7.4-7.5
DISCUSSION OF QUESTION BANK			
1	Explain why agencies responsible for intellectual property registration with any two examples.	CO 2	T1:1.4-1.5
2	What is patent/? How the patents are related with intellectual property rights/?	CO 3	T1:3.1-3.8
3	Explain with one real time example the patentable and non-patentable inventions.	CO 4	T1:3.1-3.8; R2: 7.4-7.5

4	How intellectual property is helpful to the society and what are the legal requirements are needed for patents/?	CO 5	T1:10.1-10.6
5	What is the most important criteria for an applicant who seek to register a geographical indication/?	CO 6	T1:8.1-8.3; R2: 7.4-7.5

Signature of Course Coordinator **HOD,EEE**
Dr. Ranjith kumar Gatla, Associate Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES/ PROGRAM SPECIFIC OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences **(Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations **(Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**

	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**

	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**
PSO 1	Build Embedded Software and Digital Circuit Development platformfor Robotics, Embedded Systems and Signal Processing Applications. 1. Analyze and solve real time problems in Robotics. 2. Evaluate the design and provide optimal solutions of the digital circuits for signal processing applications 3. Develop embedded systems modules using Real Time Operating System. 4. Undertake research and development projects in the field of Embedded Systems. 5. Adopt the engineering professional code and conduct	**5**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototypedesigns, Virtual Instrumentation and System on Chip (SOC) designs.. 1. Inspect, survey and analyze types of ASIC chip designs. 2. Design ASIC prototypes using Verilog and VHDL languages. 3. Analyze microprocessor subsystems with memories and I/O interfacs for SOC designs 4. Explore hardware components for designig SOC 5. Adopt the engineering professional code and conduct 6. Designing prototypes of SOC using programming tools like MATLAB, LabVIEW. 7. Familiarize with the design flow of ASIC prototypes. 8. Realize SOC using Register Transfer-Level designs 9. Analyse and develop models for system level descriptions for synthesis of SOC 10. Inspect and survey the abstractions and principles for the specification, simulation, verification, and synthesis of systems on chip (SoC) 11. Programming and hands-on skills to meet requirements of global environment.	**11**

PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications. 1. Explicit software and programming tools for antenna design. 2. Adopt technical library resources and literature search. 3. Explore smart antennas. 4. Model, program for operation and control of smart antennas for wireless communication applications. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

ELECTRICAL AND ELECTRONICS ENGINEERING
COURSE DESCRIPTION

Department	**Electrical and Electronics Engineering**				
Course Title	**Power Systems Protection**				
Course Code	AEEC34				
Program	B.Tech				
Semester	VII				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mr. P. Shivakumar, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEC11	III	AC Machines
B.Tech	AEEC15	IV	Electrical Power Transmission System

II COURSE OVERVIEW:

The main objective of the course is to provide an overview of the principles and schemes for protecting power lines, transformers, buses, generators. It provides in depth knowledge of various types of relays and circuit breakers. It includes protection against over voltages in power system using lighting arrestors and insulation co-ordination.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Power Systems Protection	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in Table: 1.

Percentage of Cognitive Level	Blooms Taxonomy Level
16%	Remember
50%	Understand
33%	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).

<table>
<tr><th colspan="2">Component</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td rowspan="4">CIA</td><td>Continuous Internal Examination – 1 (Mid-term)</td><td>10</td><td rowspan="4">30</td></tr>
<tr><td>Continuous Internal Examination – 2 (Mid-term)</td><td>10</td></tr>
<tr><td>AAT-1</td><td>5</td></tr>
<tr><td>AAT-2</td><td>5</td></tr>
<tr><td>SEE</td><td>Semester End Examination (SEE)</td><td>70</td><td>70</td></tr>
<tr><td colspan="3">Total Marks</td><td>100</td></tr>
</table>

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Alternative Assessment Tool (AAT)
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

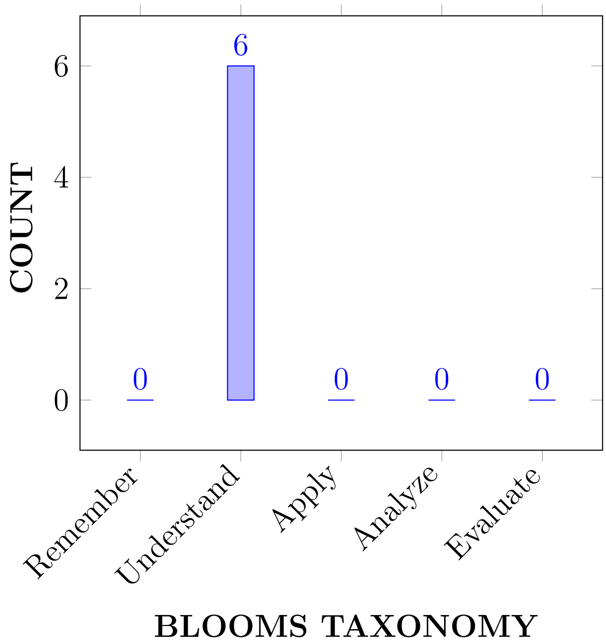
I	Theory, construction, applications of types circuit breakers, Relays for protection of generators, transformers and protection of feeders from over- voltages and other hazards.
II	Applications of the main components used in power system protection for electric machines, transformers, bus bars, overhead and underground feeders.
III	The skills to design the feasible protection systems needed for each main part of a power system.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Describe** types of existing circuit breakers, their design and constructional details used for the protection of power system under different mal condition.	Understand
CO 2	**Explain** construction and working of various types relays for detection of fault and disconnection of a faulty section.	Understand
CO 3	**Classify** substations based on operating voltages and their circuit elements helps in provide reliable supply for the consumers.	Understand
CO 4	**Summarize** protection schemes of feeder and bus-bars that plays an effective role in protection of transmission lines.	Understand
CO 5	**Outline** protection schemes of generator and transformer against open and short circuit faults for maintaining continuous supply.	Understand
CO 6	**Classify** types of lightening arrestors for the protection of power system network from over voltages in order to provide uninterruptable power supply.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	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.	1	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

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involving Power generation, Transmission, Distribution and Utilization.	3	AAT

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	✓	✓	-	-	-	-	-	-	-	-	-	-	✓	-	-
CO 2	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	✓	-	-	-	-	-	-	-	-	-	-	-	✓	-	-
CO 4	✓	✓	-	-	-	-	-	-	-	-	-		-	-	-
CO 5	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	✓	✓	✓	-	-	-	-	-	-	-	-	-	✓	-	-

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies.
CO 1	PO 1	**Apply the knowledge of Mathematics, Sciences and Engineering fundamentals principles** to classify various Learning Process: Error Correction Learning, Memory Based Learning, Hebbian Learning, Competitive, Boltzmann Learning	3
	PO 2	**Identify the problem statement** Single Layer Perceptron: Adaptive Filtering Problem, Unconstrained Organization Techniques, Linear Least Square Filters, Least Mean Square Algorithm	2
	PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involving Power generation, Transmission, Distribution and Utilization	2
CO 2	PO 1	**Apply the knowledge of Mathematics, Sciences and Engineering fundamentals principles** and derive the Back Propagation Learning and Accelerated Convergence formulae	3
	PO 2	Analyze the performance parameters of Back Propagation Algorithm XOR Problem, Heuristics, Output, Representation and Decision Rule, Computer Experiment, Feature Detection **first principles of Mathematics and engineering sciences.**	2
CO 3	PO 1	Identify various learning Rate Annealing Techniques, Perceptron: convergence theorem **using principles of mathematics, science, and engineering fundamentals.**	3
	PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involving Power generation, Transmission, Distribution and Utilization	2
CO 4	PO 1	Apply the knowledge of different for techniques (**scientific Principles and mathematical principles**) for Hessian Matrix, Generalization, Cross Validation and describe different performance parameters.	3
	PO 2	Determine the parameters and Network Pruning Techniques **using first principles and Mathematics and Engineering sciences.**	2
CO 5	PO 1	Understand the advantages of Bayes Classifier for a Gaussian Environment and Multilayer Perceptron **using the fundamentals of engineering and mathematical equations**	3
CO 6	PO 1	Analyze Recurrent Network Paradigm Hopfield Models **using fundamentals of science &and engineering fundamentals.**	3
	PO 2	Categorize the Adaptive Patter in **complex engineering problems.**	3

	PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involving Power generation, Transmission, Distribution and Utilization	2

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	100	-	-	-	-	-	-	-	-	-	-		80	-	-
CO 2	100	20	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	100	-	-	-	-	-	-	-	-	-	-	-	80	-	-
CO 4	100	80	-	-	80	-	-	-	-	-	-		-	-	-
CO 5	100		-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	100	70	60	-	-	-	-	-	-	-	-		80	-	-

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.

0 - 0$\leq$ C$\leq$ 5% – No correlation

2 - 40 % <C < 60% –Moderate

1-5 <C$\leq$ 40% – Low/ Slight

3 - 60% $\leq$ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 4	3	3		-	-	-	-	-	-	-	-		-	-	-
CO 5	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	3	2	-	-	-	-	-	-	-	-		2	-	-
TOTAL	18	10	2	-	-	-	-	-	-	-	-	-	6	-	-
AVERAGE	3	3	2	-	-		-	-	-	-	-	-	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	**CIRCUIT BREAKERS**
	Circuit Breakers: Elementary principles of arc interruption, restriking and recovery voltages, restriking phenomenon, average, maximum and rate of rise of restriking voltage, current chopping and resistance switching, circuit breaker ratings and specifications, auto reclosures, description and operation of various types of circuit breakers, minimum oil circuit breakers, air blast circuit breakers, vacuum and SF6 circuit breakers, numerical problems.
MODULE II	**ELECTROMAGNETIC, STATIC AND NUMERICAL RELAYS**
	Electromagnetic relays: Principle of operation and construction of attracted armature, balanced beam, induction disc and induction cup relays; Relays classification: instantaneous, definite minimum time and inverse definite minimum time relays over current / under voltage relays, direction relays, differential relays and percentage differential relays, universal torque equation; Distance relays: Impedance, reactance, mho and offset mho relays, characteristics of distance relays; Static relays: Overview of static relay, block diagram, operating principle and comparison, static relays versus electromagnetic relays; Numerical relays: Introduction, block diagram of numerical relay, sampling theorem, anti-aliasing filter, block diagram of phasor measurement unit and intelligent electronic device, data acquisition systems and numerical relaying algorithms, applications and numerical problems.

MODULE III	**SUBSTATIONS AND PROTECTION OF FEEDER / BUS BAR**
	Indoor and outdoor substations: Substations layout, bus bar arrangements like single, sectionalized, main and transfer bus bar system with relevant diagrams; Gas insulated substation (GIS): Types, single line diagram, constructional aspects of GIS, Installation, maintenance, advantages, comparison of GIS with air insulated substations. Indoor and outdoor substations: Substations layout, bus bar arrangements like single, sectionalized, main and transfer bus bar system with relevant diagrams; Gas insulated substation (GIS): Types, single line diagram, constructional aspects of GIS, Installation, maintenance, advantages, comparison of GIS with air insulated substations.
MODULE IV	**GENERATOR AND TRANSFORMER PROTECTION**
	Generator protection: Protection of generators against stator faults, rotor faults, and abnormal conditions, restricted earth fault and inter turn fault protection, numerical problems on percentage winding unprotected; Transformer protection: Percentage differential protections, numerical problem on design of current transformers ratio, buchholz protection.
MODULE V	**PROTECTION AGAINST OVER VOLTAGES**
	Neuro Dynamics: Dynamical Systems, Stability of Equilibrium States, Attractors, Neuro Dynamical Models, Manipulation of Attractors as a Recurrent Network Paradigm Hopfield Models – Hopfield Models, Computer Experiment

TEXTBOOKS

1. Sunil S Rao, "Switchgear and Protection", Khanna Publishers, 1st Edition, 2013.

REFERENCE BOOKS:

1. Paithankar, S R Bhide, "Fundamentals of Power System Protection", PHI, 1st Edition, 2003.
2. C LWadhwa, "Electrical Power Systems", New Age international (P) Limited, 6th Edition, 2010.
3. VK Mehta," Principles of power systems", S Chand Publications, 4th 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 T1: 4.1
OBE DISCUSSION			
1	Course Objectives, Course Outcomes, CO-PO Mapping, Blooms Taxonomy, CO Articulation Matrix		
CONTENT DELIVERY (THEORY)			
1	Understand the Elementary principles of arc interruption	CO 1	T1:5-6

2	Understand the concept restriking and recovery voltages.	CO 1	T1: 25-26
3	Understand the concept restriking phenomenon, average, maximum and rate of rise of restriking voltage	CO 1	T1: 25-26
4	Understand the concept ofthe current chopping	CO 1	T1: 26-28
5	Understand the principle of oil circuit breakers	CO 1	T1: 26-28
8	Understand the operation of minimum oil circuit breakers.	CO 1	T1: 26-28
6	Understand the operation Bulk oil circuit breakers.	CO 1	T1: 26-28
7	Understand the operation air blast circuit breakers	CO 1	T1: 30-32
8	Understand the operation of SF6 circuit breaker.	CO 1	T3:312-318
9	Understand the operation of vacuum circuit breaker.	CO 2	T3:312-318
10	Understand the Principle of electromagnetic relays	CO 2	T3:312-318
11	Understand the Principle of operationoperation of balanced beam. .	CO 2	T3:312-318
12	Understand the Principle of operationoperation of induction disc	CO 2	T3:312-318
13	Understand the Principle of operation and construction of attracted armature.	CO 1	T3:312-318
14	Understand the concept of over current / under voltage relays.	CO 2	T3:319
15	Understand the concept of direction relays.	CO 2	T3:319
16	Understand the concept of differential relays .	CO 2	T3:319
17	Derive universal torque equation; and discuss briefly on distance relay.	CO 2	T2:11.5 R2:17.5
18	Understand the concept of percentage differential relays.	CO 2	T2:11.5 R2:17.5
19	Understand the concept of Impedance relay Impedance relay	CO 2	T2:11.5 R2:17.5
20	Understand the operation and characteristics reactance relay	CO 2	T2:11.5 R2:17.5
21	Understand the concept of numerical relay	CO 3	T2:11.5 R2:17.5
22	Understand the concept of static relay	CO 2	T2:11.5 R2:17.5
21	Introduction of substations	CO 3	T1:84-85
22	Understand types of substations	CO 3	T1:84-85
23	Understand types of bus bar arrangements like single.	CO 3	T1:84-85
24	Main and transfer bus bar system with relevant diagrams	CO 3	T1:327-330
25	Understand the concept of sectionalized bus bar arrangement.	CO 3	T1:84-85

26	Understand the concept of gas insulated substations	CO 3	T1:327-330
27	Advantages of gas insulated substations	CO 3	T1:327-330
28	Differentiate GIS with air insulated substations	CO 3	T1:327-330
29	Understand the concept of gas insulated substations and , single line diagram.	CO 3	T1:327-330
30	Understand constructional aspects of GIS	CO 3	T1:327-330
31	Understand installation, maintenance of gas insulated substation.	CO 3	T1:58-59
32	Differentiate GIS with air insulated substations .	CO 3	T1:58-59
33	Understand limitations of GIS	CO 3	T1:58-59
34	Understand the concept of protection of lines over current	CO 3	T1:58-59
35	Protection of generators against stator faults and rotor faults.	CO 3	T1:58-59
36	Protection of generators against abnormal conditions	CO 3	T1:58-59
37	Overview on transformer protection and design of current transformers ratio	CO 3	T1 :60-62
38	Understandthe methods of neutral grounding .	CO 4	T2:383 – 385
39	Understand the concept restriking voltage.	CO 1	T2:383 – 385
40	Understand the concept recovery voltage.	CO 1	T2:383 – 385
PROBLEM SOLVING/ CASE STUDIES			
41	Understand the concept restriking phenomenon, average, maximum and rate of rise of restriking voltage	CO 1	T2:383
42	Understand the concept of resistance switching	CO 1	T1: 330-345
43	Understand the concept ofthe current chopping	CO 1	T2:337
44	Understand the Principle of operationoperation of balanced beam. .	CO 2	T3:312-318
45	Understand the concept of differential relays .	CO 2	
46	Understand the concept of percentage differential relays.	CO 2	T2:11.5 R2:17.5
47	Understand the concept of Impedance relay Impedance relay	CO 2	T2:11.5 R2:17.5
48	Understand types of bus bar arrangements like single.	CO 3	T1:84-85
49	Understand the concept of sectionalized bus bar arrangement.	CO 3	T1:84-85
50	Protection of generators against abnormal conditions	CO 3	T1:58-59
51	Understand working of buchholz protection	CO 3	T1 :65-68

52	Understand the concept restriking and recovery voltages.	CO 1	T2:383
53	Understand the concept ofthe current chopping	CO 1	T2:337
54	Understand the concept of percentage differential relays.	CO 2	T2:11.5 R2:17.5
55	Understand comparison between valve and zinc lightening arresters .	CO 5	T2:29-31
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Principles of arc interruption, restriking and recovery voltages.	CO 1	T1: 25-26
2	Analyze restriking phenomenon, average, maximum and rate of rise of restriking voltage.	CO 2	T3:319
3	Analysis of current chopping and resistance switching	CO 3	T2:11.5 R2:17.5
4	Analysis of Principle of operation and construction of attracted armature	CO 3	T1:84-85
5	Analysis of classification: instantaneous, definite minimum time and inverse definite minimum time relays	CO 3	T1:327-330
Discussion of Question Bank			
1	Operation of various types of circuit breakers	CO 1,2	T1: 25-26
2	Characteristics of mho and offset mho relays.	CO 3	T3:319
3	Iinstallation, maintenance of gas insulated substation.	CO 4	T2:11.5
4	protection of generators against stator faults, rotor faults, and abnormal conditions	CO 5	T2:342-345
5	Concept of standard impulse test wave	CO 6	T2:337

Signature of Course Coordinator **HOD,EEE**
Mr. P. Shivakumar, Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**

	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**

PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**

	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043
COURSE DESCRIPTION

Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**				
Course Title	**ELECTRICAL POWER SYSTEMS LABORATORY**				
Course Code	AEEC44				
Program	B.Tech				
Semester	VII	EEE			
Course Type	Core				
Regulation	UG 20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	-	-	-	3	1.5
Course Coordinator	Mr. P. Shiva kumar, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEC11	IV	AC Machines

II COURSE OVERVIEW:

Power system protection laboratory is to provide an overview of the principles of protection devices such as miniature circuit breaker, High rupturing fuse and relays. This course focuses on the functioning of protective circuits under fault conditions of transmission lines, feeders and analyze their performance. This course also includes protection of system components from overloads, the probability of fires and other catastrophic system failures can be minimized.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Electrical Power Systems Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner,

both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	-
20 %	Analysis	-
20 %	Design	-
20 %	Conclusion	-
20 %	Viva	-

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semeste.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:

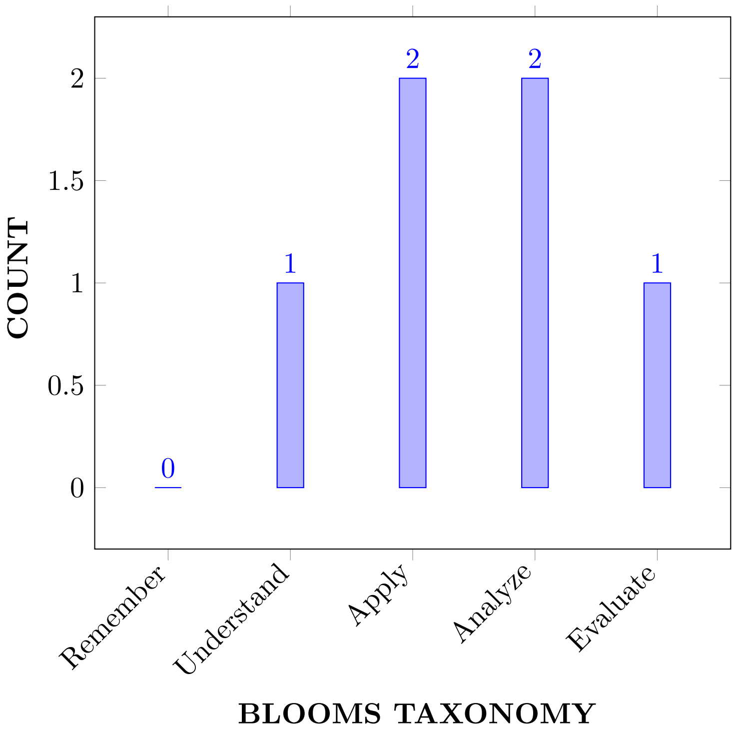
I	The importance of protection in electrical power system and working of fundamental protective devices.
II	The transmission line parameters, surge impedance loading, efficiency, voltage regulation, observe and minimize the Ferranti effect which occurs in voltage of a transmission lines operating conditions.
III	The various distance schemes in over current protection of feeders under three-phase faults.
IV	The necessity of finding sequence components of alternators by using direct and indirect methods.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Examine** the functioning of miniature circuit breaker (MCB) and fuse to plot time-current characteristics.	Analyze
CO 2	**Demonstrate** surge impedance loading and compensation technique to stabilize and mitigate ferranti effect in tranmission line in terms of input and output parameters to analyse performance of a transmission line.	Evaluate
CO 3	**Understand** the concept of voltage improvement by reactive power control using tap changing transformer.	Understand
CO 4	**Describe** the working of impedance relay, overcurrent relay during normal and abnormal fault conditions for protection of transmission line.	Apply
CO 5	**Explain** various earth fault detection schemes for protection of radial feeder.	Analyze
CO 6	**Calculate** sequence impedances of synchronous machine using fault analysis method for converting unbalanced to balanced system.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Program Outcomes	
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Lab Exercises
PO 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
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

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

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involving Power generation, Transmission, Distribution and Utilization.	2	Lab Exercises

3 = High; 2 = Medium; 1 = Low

XI JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Observe the functionality (knowledge) of protective devices for voltage current characteristics using **principles of mathematics and engineering science**	2
	PO 2	Understand the given power protective device application **problem statement by analyzing complex engineering problems.**	4
	PO 3	Identify the transmission line parameters and its the importance of for analyzing electrical networks using **environment, safety and risk**	2
CO 2	PO 1	Evaluate the transmission line parameters and its the importance of for analyzing electrical networks using **principles of mathematics and engineering sciences**	2
	PO 4	Understand the (given problem statement) effects of viscosity, and capillary rise for the bodies immersed in fluids. (from the provided information)**in solving analysis problems**	3
CO 3	PO 1	Understand (knowledge) the need of Shunt compensation circuits using textbfprinciples of **principles of mathematics and engineering science**	3
	PO 4	Recognizethe Ferranti effect by observing sending end and receiving end voltages and understand the corresponding context of the uncertainty **engineering knowledge, technical uncertaintyof the transmission line.**	3
	PSO 1	Compute the limits on type of transmission and contributed **to the power system protection**	2
CO 4	PO 1	Understand necessity of voltage profile improvement of transmission line **using the knowledge of mathematics and engineering fundamentals**	2

	PO 2	Demonstrate the operation tap changing transformer in voltage profile improvement using by **analyzing complex engineering problems.**	4
	PO 4	Formulate and Evaluate the inverter circuits with **Converter Topologies for Energy Conversion**	2
CO 5	PO 1	Calculate efficiency and voltage regulation of single phase transmission line by **analyzing complex engineering problems**	4
	PSO 1	Compute the **limits on type of transmission and contributed to the power system protection**	2
CO 6	PO 1	Apply (knowledge) the relay characteristics for the operation of relays by using the principles by **Mathematics and Engineering fundamentals.**	2
	PO 2	Understand the applications of relays in the protection by electrical system by **analyzing complex engineering problems.**	4
	PO 4	Understand the applications of relays in the protection by electrical system by **analyzing complex engineering problems.**	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	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	-	-	3	-	-	-	-	-	-	-	-	2	-	-
CO 4	3	3	-	2	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 6	3	3	-	3	-	-	-	-	-	-	-	-	-	-	-

XIII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIV ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XV SYLLABUS:

WEEK I	**CHARACTERISTICS OF AN MCB**
	Plotting the Characteristics of Miniature Circuit Breaker (MCB).
WEEK II	**CHARACTERISTICS OF FUSE AND THERMAL OVERLOAD PROTECTION**
	Study of characteristics of High Rupturing Capacity (HRC) fuse and tripping of bimetallic thermal overload protection and its characteristics.
WEEK III	**ABCD PARAMETERS OF TRANSMISSION LINE**
	Measurement of ABCD parameters of a transmission line.
WEEK IV	**FERRANTI EFFECT IN A TRANSMISSION LINE**
	Study of Ferranti effect in a the transmission line.
WEEK V	**SURGE IMPEDANCE LOADING**
	Study of Surge Impedance Loading (SIL) of a transmission line.
WEEK VI	**EFFECT OF SHUNT COMPENSATION**
	Determine shunt compensation to counteract the voltage rise on no load and zero regulation at different loads in a transmission line.
WEEK VII	**VOLTAGE PROFILE IMPROVEMENT USING TAP CHANGING TRANSFORMER**
	Study of voltage improvement by reactive power control using tap changing transformer.
WEEK VIII	**EFFICIENCY AND REGULATION OF A TRANSMISSION LINE**
	Determine the performance of a transmission line by calculating its efficiency and regulation.
WEEK IX	**PERFORMANCE OF IMPEDANCE RELAY**
	Study the working principle of impedance relay and its effect during faults in a transmissionline.
WEEK X	**PERFORMANCE OF OVER CURRENT RELAY**
	Study the working principle of over current relay and its effect during faults in a transmission line.
WEEK XI	**EARTH FAULT PROTECTION**
	Study of earth fault detection methods and various earth fault protection schemes.
WEEK XII	**FEEDER PROTECTION**
	Study the various protection schemes in radial feeder under various fault conditions.
WEEK XIII	**MEASURMENT OF SEQUENCE IMPEDANCES OF SYNCHRONOUS MACHINE**
	Measurement of positive, negative and zero sequence impedances of synchronous machine by using direct method and fault analysis method.
WEEK XIV	**STRING EFFICIENCY OF INSULATORS**
	Determination of string efficiency in a string of insulators.

TEXTBOOKS

1. Sunil S Rao, “Switchgear and Protection”, Khanna Publishers, 1st Edition, 2013.

2. Badari Ram, D N Viswakarma, “Power System Protection and Switchgear”, TMH Publications, 1 st Edition, 2001.

REFERENCE BOOKS:

1. Vedam Subramanyam, “Power Electronics”, New Age International Limited, 2nd Edition, 2006.

2. Paithankar, S R Bhide, “Fundamentals of Power System Protection”, PHI, 1st Edition, 2003.

XVI COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO's	Reference
1	Characteristics of Miniature Circuit Breaker.	CO 1	T1:3.1
2	Study of characteristics of High Rupturing Capacity (HRC) fuse and tripping of bimetallic thermal overload protection and its characteristics.	CO 1	T1:3.11
3	ABCD parameters of transmission line.	CO 2	T1:4.8
4	Ferranti effect of a transmission line.	CO 2	T1:4.8
5	Surge Impedance Loading (SIL) of transmission line.	CO 2	T1.5.5
6	Determine shunt compensation to counteract the voltage rise on no load and zero regulation at different loads in a transmission line.	CO 2	T1:5.6
7	Study of voltage improvement by reactive power control using tap changing transformer.	CO 3	T1:8.3
8	Determine the performance of a transmission line by calculating its efficiency and regulation.	CO 4	T1:8.3
9	Study the working principle of impedance relay and its effect during faults in a transmission line.	CO 4	T1:9.2
10	Understand the working principle of over current relay and its effect during faults in a transmission line.	CO 4	T1:9.3
11	Study of earth fault detection methods and various earth fault protection schemes.	CO 5	T1:10.6
12	Understand the various protection schemes in radial feeder under various fault conditions.	CO 5	T1:10.7
13	Measurement of positive, negative and zero sequence impedances of synchronous machine by using direct method and fault analysis method.	CO 6	T1:10.7
14	Determination of string efficiency in a string of insulators.	CO 6	T1:10.8

XVII EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	**Numerical and static relays:** Design numerical and static relays using MATLAB and PSCAD
2	**Relays:** Design and simulate transmission lines and induction relays using MATLAB software

Signature of Course Coordinator **HOD, EEE**
Mr. P. Shiva kumar, Assistant Professor

ANNEXURE - I

KEY ATTRIBUTES FOR ASSESSING PROGRAM OUTCOMES

PO Number	NBA Statement / Key Competencies Features (KCF)	No. of KCF's
PO 1	Apply the knowledge of mathematics, science, Engineering fundamentals, and an Engineering specialization to the solution of complex Engineering problems **(Engineering Knowledge).** Knowledge, understanding and application of 1. Scientific principles and methodology. 2. Mathematical principles. 3. Own and / or other engineering disciplines to integrate / support study of their own engineering discipline.	3
PO 2	Identify, formulate, review research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics natural sciences, and Engineering sciences (**Problem Analysis**). 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**

PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions 5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	**10**
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**

PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**

PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project. 6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	**12**
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**
PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**

PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

ANNEXURE - II

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	PSO Statement / Key Competencies Features (KCF)	No. of KCF(s)
PSO 1	Design, develop, fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization. 1. Operate, control and protect electrical power system. 2. Validate the interconnected power system. 3. Ensure reliable, efficient and compliant operation of electrical systems. 4. Familiarize the safety, legal and health norms in electrical system. 5. Adopt the engineering professional code and conduct.	**5**
PSO 2	Focus on the components of electrical drives with its converter topologies for energy conversion, management and auditing in specific applications of industry and sustainable rural development. 1. Control the electric drives for renewable and non-renewable energy sources. 2. Fabricate converters with various components and control topologies. 3. Synthesis, systematic procedure to examine electrical components/machines using software tools. 4. Inspect, survey and analyze energy flow. 5. Control and manage the power generation and utilization. 6. Familiarize the safety, legal and health norms in electrical system. 7. Adopt the engineering professional code and conduct. 8. Explore autonomous power 9. Evolve into green energy and assess results 10. Realize energy policies and education 11. Potential contribution of clean energy for rural development.	**11**
PSO 3	Gain the hands-on competency skills in PLC automation, process controllers, HMI and other computing tools necessary for entry level position to meet the requirements of the employer. 1. Explicit software and programming tools for electrical systems. 2. Adopt technical library resources and literature search. 3. Model, program for operation and control of electrical systems. 4. Constitute the systems employed for motion control. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043
ELECTRICAL AND ELECTRONICS ENGINEERING
COURSE DESCRIPTION

<table>
<tr><td>Course Title</td><td colspan="5">POWER SYSTEM SIMULATION LABORATORY</td></tr>
<tr><td>Course Code</td><td colspan="5">AEEC45</td></tr>
<tr><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>Semester</td><td>VII</td><td colspan="4">EEE</td></tr>
<tr><td>Course Type</td><td>Core</td><td colspan="4"></td></tr>
<tr><td>Regulation</td><td>UG20</td><td colspan="4"></td></tr>
<tr><td rowspan="3">Course Structure</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Laboratory</td><td>Credits</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>3</td><td>1.5</td></tr>
<tr><td>Course Coordinator</td><td colspan="5">Mr. G.Viswanath, Assistant Professor</td></tr>
</table>

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AEEC22	VI	Power System Analysis

II COURSE OVERVIEW:

The power system simulation laboratory introduces the program skills using PSCAD and MATLAB through experiments. This laboratory gives emphasis on single line diagram, load flow anlayis, different power protection schemes, fault analysis and various power quality issues using simulation. PSCAD provides key building custom models in any electrical engineering related applications.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Power System Simulation Laboratory	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

V EVALUATION METHODOLOGY:

Each laboratory will be evaluated for a total of 100 marks consisting of 30 marks forinternal assessment and 70 marks for semester end lab examination. Out of 30 marks ofinternal assessment, continuous lab assessment will be done for 20 marks for the day today performance and 10 marks for the final internal lab assessment.

Semester End Examination (SEE): The semester end labexamination for 70 marks shall be conducted by two examiners, one of them beingInternal Examiner and the other being External Examiner,

both nominated by thePrincipal from the panel of experts recommended by Chairman, BOS. The emphasis on the experiments is broadly based on the following criteria given in Table: 1

	Experiment Based	Programming based
20 %	Objective	Purpose
20 %	Analysis	Algorithm
20 %	Design	Programme
20 %	Conclusion	Conclusion
20 %	Viva	Viva

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 20 marks for continuous lab assessment during day to day performance, 10 marks for final internal lab assessment.

Component			Total Marks
Type of Assessment	**Day to day performance**	**Final internal lab assessment**	
CIA Marks	20	10	30

Continuous Internal Examination (CIE):

One CIE exams shall be conducted at the end of the 16th week of the semester. The CIE exam is conducted for 10 marks of 3 hours duration.

1. **Programming Based**

Objective	Analysis	Design	Conclusion	Viva	Total
2	2	2	2	2	10

2. **Experiment Based**

Objective	Analysis	Design	Conclusion	Viva	Total
-	-	-	-	-	-

VI COURSE OBJECTIVES:

The students will try to learn:

I	Simulate transmission lines using PSCAD software to analyze faults in transmission system.
II	Demonstrate load flow studies using static load flow methods using MATLAB.
III	Analyze transient state stability in power systems

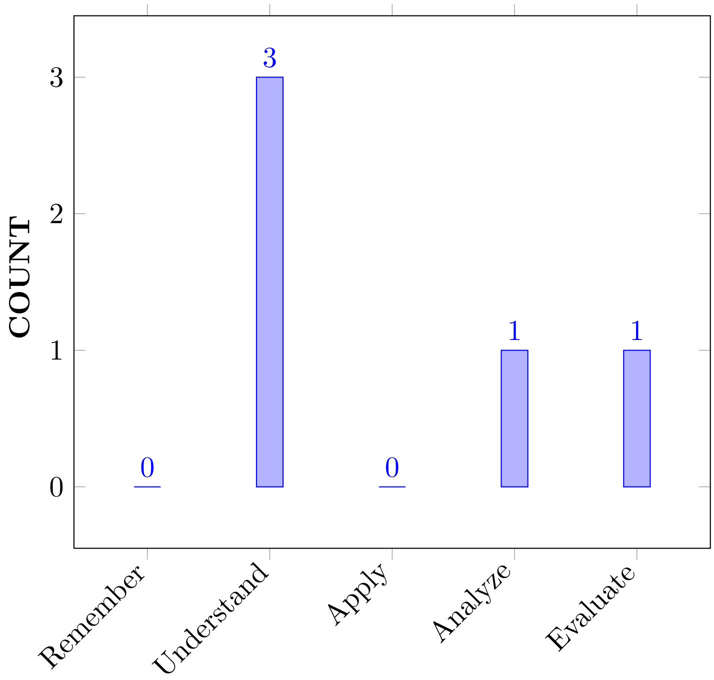
VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Demonstrate** the programming concepts of simulation tools for obtaining parameters of a typical transmission line and modelling	Understand
CO 2	**Illustrate** the formation of bus admittance matrices by adding one element at a time for load flow studies	Understand

CO 3	**Interpret** the symmetrical and unsymmetrical faults for transmission linesusing digital simulation	Understand
CO 4	**Evaluate** the transient response using numerical methods in RLC circuit and infinite bus systems	Evaluate
CO 5	**Analyze** the transformer inrush current for unbalanced three phase parameters	Analyze

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

Program Outcomes	
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	Lab Exercises
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	CIA
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		Strength	Proficiency Assessed by
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.	2	Lab Exercises

3 = High; 2 = Medium; 1 = Low

XI JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Observe the functionality **(knowledge)** of parameters of a typical transmission line and modelling using principles of mathematics and engineering science **principles of Mathematics and Engineering**	3
	PO 2	Understand the given power system components application **problem statement by analyzing complex engineering problems**	3
CO 2	PO 1	Illustrate the formation of bus admittance matrices 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 3	PO 1	Apply **(knowledge)** the symmetrical and unsymmetrical faultsby using the **principles of mathematics, engineering science.**	3
	PO 2	Understand the given the symmetrical and unsymmetrical faultsby **analyzing complex engineering problems**	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	3
CO 4	PO 1	Understand the transient response for RLC circuit using**principles of mathematics and engineering science**	3
	PO 2	Illustrate the transient response for RLC circuit by **analyzing complex engineering problems**	3
CO 5	PO 2	Formulate and Evaluate the unbalanced three phase parameter**Topologies for Energy Conversion**	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
	PSO 3	Formulate and Evaluate the unbalanced three phase parameter **Topologies for Energy Conversion**	3

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 10	PSO 3
CO 1	3	3		
CO 2	3		2	
CO 3	3	3	3	
CO 4	3	3		
CO 5		3	2	3

XIII ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	✓	Student Viva	✓	Certification	-
Assignments	-				

XIV ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XV SYLLABUS:

WEEK I	**FORMATION OF BUS ADMITTANCE AND IMPEDANCE MATRICES**
	Formation of bus admittance matrices by adding one element at a time and also write a program for Zbus building algorithm using MATLAB.
WEEK II	**LOAD FLOW SOLUTION USING GAUSS SEIDEL METHOD**
	Write a MATLAB program for load flow studies without and with generator buses using Gauss Seidel Method.
WEEK III	**LOAD FLOW SOLUTION USING NEWTON RAPHSON AND FDLF METHOD**
	Write a MATLAB program for load flow studies using Newton Raphson and Fast Decoupled Load Flow (FDLF) method.
WEEK IV	**POWER SYSTEM FAULT ANALYSIS**
	Analysis of symmetrical and unsymmetrical faults using symmetrical components using MATLAB.

WEEK V	**POINT BY POINT METHOD**
	Development of MATLAB program for Transient stability analysis of single machine infinite bus and multi machine system by point by point method.
WEEK VI	**TRANSIENT RESPONSE OF RLC CIRCUIT**
	Obtain transient response of RLC circuit using PSCAD.
WEEK VII	**THREE PHASE SHORT CIRCUIT ANALYSIS IN A SYNCHRONOUS MACHINE**
	Analyze symmetrical faults and short circuit studies in a given synchronous machine using PSCAD.
WEEK VIII	**STUDY OF TRANSMISSION SYSTEM AND SHORT CIRCUIT ANALYSIS OF 9 BUS SYSTEM**
	Study of simple transmission system and also Perform short circuit analysis on IEEE 9 bus system using PSCAD.
WEEK IX	**TRANSFORMER INRUSH CURRENT**
	Determination of transformer inrush current under unbalanced three phase parameters using PSCAD.
WEEK X	**SMALL SIGNAL STABILITY ANALYSIS**
	Development of PSCAD Model for stability analysis of single machine-infinite bus with STATCOM.
WEEK XI	**TRANSMISSION LINE PARAMETERS**
	Obtaining parameters of a typical transmission line and modelling it in PSCAD.
WEEK XII	**LOAD FREQUENCY CONTROL**
WEEK XIII	Obtain the frequency response of single and two area power system using PSCAD **POWER QUALITY**
	Familiarization with PSCAD and Understanding of Reactive power and power factor correction in AC circuits. Current harmonics drawn by power electronics interface.
WEEK XIV	**DISTANCE PROTECTION**
	Development of PSCAD model to study the distance protection scheme in long transmission line

TEXTBOOKS

1. M D Singh, K B Kanchandhani, “Power Electronics”, Tata Mc Graw Hill Publishing Company, 2nd Edition, 1998.

2. Dr. P S Bimbhra, “Power Electronics”, Khanna Publishers, 5th Edition, 2012.

3. Ned Mohan, Tore M Undeland, William P Robbins, “Power Electronics: Converters, Applications and Design”, 3rd Edition, John Wiley and sons, 2002.

4. M H Rashid, “Power Electronics, Circuits, Devices and Applications”, Pearson, 3rd Edition, 2001.

REFERENCE BOOKS:

1. Vedam Subramanyam, “Power Electronics”, New Age International Limited, 2nd Edition, 2006.

2. P C Sen, “Power Electronics”, Tata McGraw-Hill Publishing, 1st Edition, 1987.

3. G K Dubey, S R Doradra, A Joshi, R M K Sinha, “Thyristorised Power Controllers”, New Age International Limited, 2nd Edition, 2008.

4. V R Moorthi, “Power Electronics Devices”, Oxford University Press, 4th Edition, 2005.

XVI COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

S.No	Topics to be covered	CO’s	Reference
1	Formation of bus admittance matrices by adding one element at a time and also write a program for Zbus building algorithm using MATLAB.	CO 1	R1: 1.2
2	Write a MATLAB program for load flow studies without and with generator buses using Gauss Seidel Method.	CO 2	R2: 3.5
3	Write a MATLAB program for load flow studies using Newton Raphson and Fast Decoupled Load Flow (FDLF) method.	CO 3	R1: 3.4
4	Analysis of symmetrical and unsymmetrical faults using symmetrical components using MATLAB.	CO 4	R1: 2.2
5	Development of MATLAB program for Transient stability analysis of single machine infinite bus and multi machine system by point by point method	CO 5	R1: 2.4
6	Obtain transient response of RLC circuit using PSCAD.	CO 2	R3: 4.5
7	Analyze symmetrical faults and short circuit studies in a given synchronous machine using PSCAD.	CO 5	R3: 4.6
8	Study of simple transmission system and also Perform short circuit analysis on IEEE 9 bus system using PSCAD.	CO 5	R2: 5.1
9	Determination of transformer inrush current under unbalanced three phase parameters using PSCAD.	CO 5	R2: 5.2
10	Development of PSCAD Model for stability analysis of single machine-infinite bus with STATCOM.	CO 1	R1: 7.1
11	Obtaining parameters of a typical transmission line and modelling it in PSCAD.	CO 2	R1:7.2
12	Obtain the frequency response of single and two area power system using PSCAD	CO 4	R1:7.3
13	Familiarization with PSCAD and Understanding of Reactive power and power factor correction in AC circuits. Current harmonics drawn by power electronics interface.	CO 4	R1:7.2
14	Development of PSCAD model to study the distance protection scheme in long transmission line.	CO 3	R1:7.3

XVII EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	**Numerical relays:** Design numerical relays using MATLAB and PSCAD
2	**Renewable energy conversion:** Design of transmission lines used in renewable energy conversion with simulation software

Signature of Course Coordinator **HOD,EEE**
Mr. G.Viswanath, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**				
Course Title	**ELECTRICAL AND HYBRID VEHICLES**				
Course Code	AEEC54				
Program	B.Tech				
Semester	VIII	EEE			
Course Type	Proffesional Elective				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Ms Shaik Ruksana Begam, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
UG	AEEC11	III	Electrical Machines – I
UG	AEEC15	IV	Electrical Machines – II
UG	AEEC20	V	Power Electronics

II COURSE OVERVIEW:

Electric and Hybrid Vehicles course deals with technical knowledge and practical expertise in commercial automobile technologies. As a part of this course, design, component selection and sizing at both system and vehicle level with a special focus on drives, battery modeling and control has been elaborated. A comprehensive overview of Electric and Hybrid Vehicles is emphasized on configuration, main issues and energy management strategies. This course also concludes with different control schemes used in motor drives and energy management systems.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Electrical and Hybrid Vehicles	70 Marks	30 Marks	100

IV DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	PPT	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	✓	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in below Table.

Percentage of Cognitive Level	Blooms Taxonomy Level
10%	Understand
55%	Apply
25%	Analyze
10%	Evaluate

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in below table

AAT-II	Tech-talk	Complex Problem Solving
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

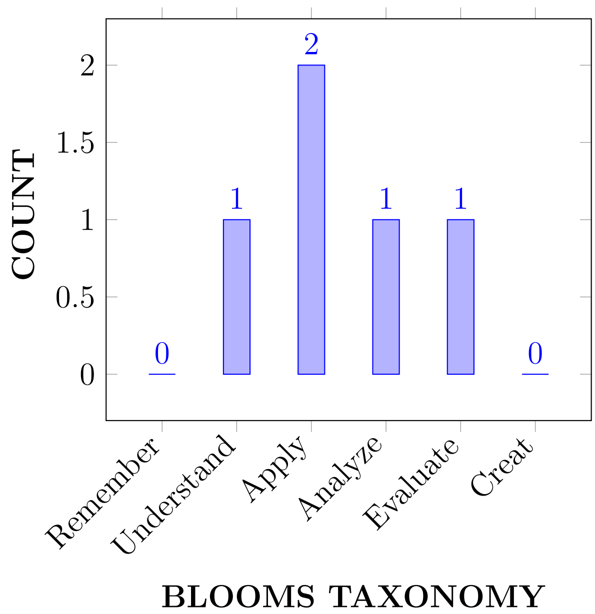
I	The concepts of modeling, design, and development of energy storage systems in hybrid electric vehicles.
II	The importance of hybrid electric vehicles to address the issues associated with environmental pollution and energy crisis.
III	The need of rapid control prototyping techniques to design and validate HEV high level and low level control system.
IV	The Know-how and aptitude towards future trends in Hybrid Electric Vehicles.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Summarize** the various topologies and modeling techniques used in electric and hybrid vehicles for performance analysis.	Understand
CO 2	**Analyze** cost-effectiveness of different types of hybrid drive-trains for transmitting power to driving wheels.	Analyze
CO 3	**Demonstrate** the configuration and control of Electric motor drives for maximizing speed and torque.	Evaluate
CO 4	**Choose** the hybridization of Energy Storage Systems for reducing size.	Apply
CO 5	**Select** suitable Energy Storage Systems and drive train components for optimizing energy management.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/Quiz/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	CIE/Quiz/AAT
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	3	CIE/Quiz/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	CIE/Quiz/AAT
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	3	CIE/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	3	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Design, develop, fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization.	1	CIE / SEE / AAT
PSO 2	Focus on the components of electrical drives with its converter topologies for energy conversion, management and auditing in specific applications of industry and sustainable rural development.	3	CIE / SEE / AAT
PSO 3	Gain the hands-on competency skills in PLC automation, process controllers, HMI and other computing tools necessary for entry level position to meet the requirements of the employer	3	CIE / SEE / AAT

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	✓	✓	-	-	-	-	-	-	-	-	-	✓	-	✓	-

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	**Apply** hybrid electric vehicles concepts in **Engineering knowledge, understanding and applications.**	1
	PO 2	Problem Analysis of hybrid electric vehicle concepts by identification, and system definition.	4
	PO 7	Understand the impact of the social and Environmental impacts of Hybrid and Electric vehicles for Environment and sustainability	2
CO 2	PO 1	Apply the impact of modern drive-trains on Engineering knowledge, understanding and applications	4
	PO 2	Problem Analysis of modern drive-trains by identification, definition, formulation, information and validation for decarburization of energy supply.	1
	PSO 2	Focus on electrical drives with its converter topologies on energy conversion, management and auditing in specific applications.	1
CO 3	PO 1	Apply modeling techniques in hybrid electric vehicles for Engineering knowledge, understanding and applications.	1
	PO 2	Problem Analysis for modeling and performing analysis in hybrid electric vehicles by problem identification, system definition, formulation, data collection, model translation and validation	1
	PO 3	Design Solution for modeling and performance analysis of electric vehicles by defining problem, understand user needs, identify cost drivers, manage design process and evaluate outcomes	1
	PO 5	Use of MATLAB software in modeling and simulation of hybrid electric vehicles.	1
	PSO 1	Simulate and/or fabricate/commission the electrical systems involving utilization of electrical energy.	1
	PSO 3	Gain the hands-on competency skills in use of computing tools necessary for entry level position to meet the requirements.	1

CO 4	PO 1	Develop electric drive-trains in hybrid electric vehicles for Engineering knowledge, understanding and applications.	1
	PO 2	Problem Analysis in identifying electric drive-trains by problem identification, system definition, formulation.	1
	PO 7	Understand the impact of Fuel efficiency for Hybrid storage systems in social and environmental contexts, and need for sustainable development.	2
	PO 12	Analyze vehicle load force for sizing drive system in utilization of electrical energy.	1
	PSO 2	Focus on the components of electrical drives with its converter topologies for energy management and auditing in transmitting power to driving wheels.	2
CO 5	PO 1	Develop electric drive-trains in hybrid electric vehicles for Engineering knowledge, understanding and applications.	1
	PO 2	Problem Analysisin identifying electric drive-trains by problem identification, system definition, formulation.	6
	PO 12	Analyze vehicle load force for sizing drive system in utilization of electrical energy.	1
	PSO 2	Focus on the components of electrical drives with its converter topologies for energy management and auditing for fuel efficiency.	2

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	2	-	-	-	-	3	-	-	-	-		-	-	-
CO 2	1	5	-	-	-	-	-	-	-	-	-	-	-	2	-
CO 3	1	6	4	-	1	-	-	-	-	-	-	-	1	-	1
CO 4	1	3	-	-	-	-	3	-	-	-	-	2	-	2	-
CO 5	1	3	-	-	-	-	-	-	-	-	-	2	-	2	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	33	20	-	-	-	-	30	-	-	-	-		-	-	-
CO 2	33	50	-	-	-	-	-	-	-	-	-	-	-	100	-
CO 3	33	60	40	-	100	-	-	-	-	-	-	-	16	-	-
CO 4	33	30	-	-	100	-	30	-	-	-	-	20	-	100	-
CO 5	33	30	-	-	-	-	-	-	-	-	-	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≤ C≤ 5% – No correlation

2 - 40 % <C < 60% –Moderate

1-5 <C≤ 40% – Low/ Slight

3 - 60% ≤ C < 100% – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	1	-	-	-	-	3	-	-	-	-		-	-	-
CO 2	1	2	-	-	-	-	-	-	-	-	-	-	-	3	-
CO 3	1	3	2	-	3	-	-	-	-	-	-	-	1	-	3
CO 4	1	1	-	-	3	-	3	-	-	-	-	2	-	3	-
CO 5	1	1	-	-	-	-	-	-	-	-	-	2	-	3	-
TOTAL	13	18	4	-	6	-	6	-	-	-	-	4	4	21	6
AVERAGE	1.2	1.6	2	-	3	-	3	-	-	-	-	2	1	3	3

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	
Laboratory Practices		Student Viva		Certification	
Term Paper	✓	5 Minutes Video	✓	Open Ended Experiments	
Assignments					

XVII ASSESSMENT METHODOLOGY INDIRECT:

✓	Early Semester Feedback	✓	End Semester OBE Feedback
X	Assessment of Mini Projects by Experts		

XVIII SYLLABUS

MODULE I	**INTRODUCTION**
	Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies; Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.
MODULE II	**HYBRID ELECTRIC DRIVE TRAINS**
	Hybrid Electric Drive trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive train topologies, fuel efficiency analysis; Electric Drive trains: Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive train topologies, fuel efficiency analysis.

MODULE III	**ELECTRIC MOTORS FOR HYBRID ELECTRIC VEHICLES**
	Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, configuration and control of DC motor drives, configuration and control of Induction Motor drives. Configuration and control of permanent magnet motor drives, configuration and control of switch reluctance motor drives, drive system efficiency.
MODULE IV	**ENERGY STORAGE**
	Energy Storage: Introduction to energy storage requirements in hybrid and electric vehicles, Battery based energy storage and its analysis, fuel cell based energy storage and its analysis, super capacitor based energy storage and its analysis, flywheel based energy storage and its analysis, hybridization of different energy storage devices; sizing the drive system: matching the electric machine and the internal combustion engine (ICE), sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, communications, supporting subsystems.
MODULE V	**ENERGY MANAGEMENT STRATEGIES**
	Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: design of a hybrid electric vehicle (HEV), design of a battery electric vehicle (BEV).

TEXTBOOKS

1. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2ndEdition,2003.
2. James Larminie, John Lowry, "Electric Vehicle Technology", Wiley publications, 1stEdition,2003.
3. Mehrdad Ehsani, YimiGao, Sebastian E Gay, Ali Emadi," Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals Theory and Design", CRC Press, 2ndEdition,2004.

REFERENCE BOOKS:

1. B D McNicol, D A J Rand, "Power Sources for Electric Vehicles", Elsevier publications, 1 stEdition,1998.
2. Seth Leitman, "Build Your Own Electric Vehicle" McGraw-Hill, 1 stEdition,2013.
3. Jeffrey Gonder, Tony Markel, "Energy Management Strategies for Plug-In Hybrid Electric Vehicles", 2007-01- 0290, National Renewable Energy Laboratory

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	Course Objectives, Course Outcomes, CO-PO Mapping, Blooms Taxonomy, CO Articulation Matrix		
CONTENT DELIVERY (THEORY)			
1	Introduction to Hybrid Electric Vehicles	CO1	T1: 1.1, 1.2
2	History of hybrid and electric vehicles	CO1	T1: 1.1, 1.2
3	Social and environmental import hybrid and electric vehicles.	CO1	T1: 1.1, 1.2
4	impact of modern drive-trains on energy supplies	CO2	T1: 1.2
5	Conventional Vehicles: Basics of performance, vehicle power source characterization	CO1	T1: 1.2
6	Transmission characteristics	CO1	T1: 1.3
7	Mathematical models to vehicle performance	CO1	T1: 3.6
8	Hybrid Electric Drive trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies	CO2	T1: 1.1
9	Power flow control in hybrid drive train topologies, fuel efficiency analysis	CO2	T1: 1.1, T1: 3.8
10	Electric Drive trains: Basic concept of electric traction, introduction to various electric drive train topologies	CO2	T1: 4.2,4.3
11	Power flow control in electric drive train topologies	CO3	T1: 4.2,4.3 T2:26.10
12	Fuel efficiency analysis	CO3	T1: 4.4
13	Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles	CO3	R2: 4.7
14	Configuration and control of DC motor drives	CO3	T1: 4.9
15	Configuration and control of Induction Motor drives	CO3	T1: 4.9
16	Configuration and control of permanent magnet motor drives	CO3	T1: 5.1,5.4
15	Configuration and control of switch reluctance motor drives	CO3	T1: 5
17	Drive system efficiency	CO3	T1: 5.1
18	Sizing the drive system: matching the electric machine and the internal combustion engine (ICE)	CO3	T1: 5.1
19	Sizing the propulsion motor, sizing the power electronics	CO3	T1: 5.1
20	Energy Storage: Introduction to energy storage requirements in hybrid vehicles	CO4	T1: 6.1,6.4,6.5
21	Energy Storage: Introduction to energy storage requirements in electric vehicles	CO4	T1: 6.1,6.4,6.5

22	Battery based energy storage and its analysis	CO4	T1: 6.1
23	Fuel cell based energy storage and its analysis	CO4	T1: 6.1
24	Super capacitor based energy storage and its analysis	CO4	T1: 6.1
25	Flywheel based energy storage and its analysis	CO4	T1: 6.1
26	Hybridization of different energy storage devices;,	CO4	T1: 6.13
27	Classification of different storage devices	CO4	R1: 6.14
28	Selecting the energy storage technology	CO4	T1 : 9
29	Communications	CO5	T1: 9.5
30	supporting subsystems	CO5	T1: 9.5
31	Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles	CO5	R2: 9.6 R3: 1.5, 1.9
32	Classification of different energy management strategies	CO5	T1: 9.1 R3: 2.6
33	Comparison of different energy management strategies	CO5	T1: 9.1 R3: 4.3, 4.8
34	Management strategies	CO5	R1: 9.9 R3:5.8, 5.11
35	Introduction to energy management strategies used in hybrid vehicles	CO5	T1 : 9.1
36	Introduction to energy management strategies used in electric vehicles	CO5	T1 : 9.1
37	Classification of different energy management strategies	CO5	T1 : 9.1
38	Implementation issues of energy management strategies	CO5	T1 : 9.1
39	comparison of different energy management strategies	CO5	T1 : 9.1
40	Case Studies: design of a hybrid electric vehicle (HEV)	CO5	T1 : 9.1
41	Design of a battery electric vehicle (BEV).	CO5	T1 : 9.1
PROBLEM SOLVING/ CASE STUDIES			
1	Mathematical models to describe vehicle performance	CO1	R2:7.5
2	Fuel efficiency analysis in hybrid drive trains	CO2	R2:7.5
3	Fuel efficiency analysis in electric drive trains	CO2	T1 : 9
4	Drive system efficiency	CO3	R2:7.5
5	Battery based energy storage system analysis	CO4	T1: 6.1,6.4,6.5
6	Fuel cell based energy storage system analysis	CO4	T1: 6.13
7	Super capacitor based energy storage system analysis	CO4	T1 : 9
8	Flywheel based energy storage system analysis	CO4	T1: 6.1,6.4,6.5
9	Sizing the drive system	CO4	T1: 6.1,6.4,6.5
10	Sizing the power electronics	CO4	T1: 6.1,6.4,6.5
11	Sizing the propulsion motor	CO4	T1: 6.1,6.4,6.5

12	Selecting the energy storage technology	CO4	T1: 6.1,6.4,6.5
13	Implementation issues of energy management strategies	CO5	T1: 9.1,9.1
14	Design of a battery electric vehicle (BEV)	CO5	T1: 9.1,9.1
15	Design of a hybrid electric vehicle (HEV)	CO5	T1: 9.1,9.1
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Introduction to Electric and Hybrid Vehicles	CO1	T1: 9.5
2	Hybrid electric drive trains	CO2	R4:2.1
3	Electric motors for hybrid electric vehicles	CO3	T1: 9.5
4	Energy Stotage Systems	CO4	R4:2.1
5	Energy Mangement Stratergies	CO5	T1 : 9
DISCUSSION OF QUESTION BANK			
1	Mathematical models to vehicle performance	CO1	R4:2.1
2	Hybrid Electric Drive trains	CO2	T4:7.3
3	Induction motor	CO3	R4:5.1
4	Electric Battery	CO4	T1:7.5
5	Energy management	CO5	T1: 4.1

Signature of Course Coordinator **HOD,EEE**
Ms. Shaik Ruksana Begam Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043

COURSE DESCRIPTION

Department	**Electrical and Electronics Engineering**				
Course Title	**Energy Storage Systems**				
Course Code	AEEC48				
Program	B.Tech				
Semester	VIII				
Course Type	Core				
Regulation	UG-20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	0	3	0	0
Course Coordinator	Dr. Sk Abdul Pasha, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
B.Tech	AHSC06	II	Chemistry
B.Tech	AEEC42	V	Power Electronics in Renewable Energy Systems
B.Tech	AEEC43	V	Wind and Solar Energy Systems

II COURSE OVERVIEW:

The objective of this course is to promote basic and advanced research related to energy storage and its application for sustainable developments. Electrochemical energy storages like batteries, supercapacitors, fuel cells have been a leading solution for electrified/green transportation, renewable power grid, consumer electronics, etc. by taking care of the intermittency problem of renewable power sources. Efficient modeling, estimation, optimal control, cyber security, etc. are the primary research concern for efficient utilization of energy storage devices.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Energy Storage Systems	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). CIA is conducted for a total of 30 marks, with 20 marks for Continuous Internal Examination (CIE), and 10 marks for Alternative Assessment Tool (AAT).

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in Table: 1.

Percentage of Cognitive Level	Blooms Taxonomy Level
0 %	Remember
50 %	Understand
50 %	Apply
0 %	Analyze

Table 1: The expected percentage of cognitive level of questions in SEE

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 2), with 20 marks for Continuous Internal Examination (CIE), 10 marks for Alternative Assessment Tool (AAT) (Table 3).

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

Table 2: Assessment pattern for CIA

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8^{th} and 16^{th} week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered.

Alternative Assessment Tool (AAT):
This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table 3.

Concept Video	Tech-talk	Complex Problem Solving
50%	50%	-

Table 3: Assessment pattern for CIA

VI COURSE OBJECTIVES:

The students will try to learn:

I	To introduce generalized storage techniques.
II	To analyze the different features of energy storage systems
III	To know the management and application of energy storage technologies

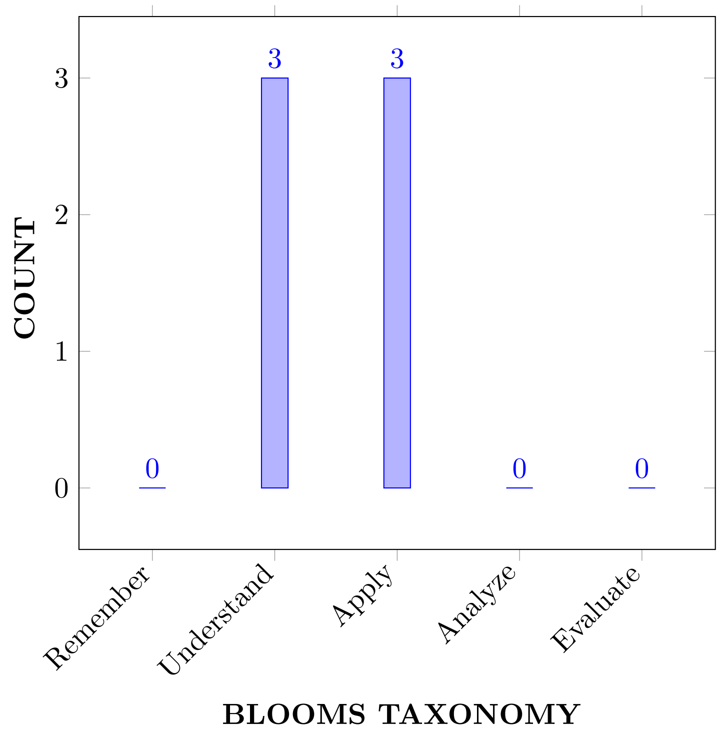
IV	To have an idea about electrical energy storage market potential by different forecasting methods
V	To Enable and identify the optimal solutions to a particular energy storage application or utility.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Identify** the requirement, current status and future prospectus of energy storage systems in view of utility and consumers case.	Apply
CO 2	**Make use of** technical characteristics of various electrochemical energy storage systems for various applications.	Apply
CO 3	**Compare** various mechanical energy storage systems on the basis of power rating and discharge time, storage duration, energy efficiency, energy density based on their generation techniques.	Understand
CO 4	**Describe** the various thermal energy storage technologies on the basis of technical characteristics. in electrical energy storage systems.	Understand
CO 5	**Demonstrate** the types of energy storage systems used for electrical power system networks.	Understand
CO 6	**Utilize** the trends and technologies of various energy storage systems in different domains for suitable applications.	Apply

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of chemistry, physical sciences, engineering fundamentals, and an engineering specialization to the solution of complex engineering networks.

Program Outcomes	
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of chemistry, natural sciences, and electrical engineering concepts.
PO 3	**Design/Development of Solutions:** Design solutions for complex sytems 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 storage systems, 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 sciences, engineering fundamentals and an engineering specialization to the solution of complex engineering systems.	3	CIE/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature and analyze various systems for reaching substantiated conclusions using first principles of natural sciences and engineering sciences.	2	AAT

PROGRAM OUTCOMES		Strength	Proficiency Assessed by
PO 3	**Design/Development of Solutions:** Design models with advanced technologies and design the 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	AAT
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data synthesis of the information to provide valid conclusions.	1	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	AAT
PO 12	**Life-Long Learning:** Recognize the need for having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	1	AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

PROGRAM SPECIFIC OUTCOMES		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the electrical Systems involving Power generation, Transmission, Distribution and Utilization.	2	AAT
PSO 2	Focus on the Components of Electrical systems with its latest technologies and Topologies for energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	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	Emerging needs for EES discussed for vaious applications,roles of EES systems are analysed in **utility and consumer** point of view.	3
	PO 2	Understand the basic characteristics of electricity **features** and **choose** appropriate technologies to achieve **desired output** based on performance characteristics of storage systems.	3
	PO 6	**Understand** the models of energy storage systems for assessment of societal and safety issues **with responsibilities relevant to the professional engineering practice**	1
	PO 12	**Recognize** the need for and having the preparation and ability to engage in independent and life-long learning in the context of optimal selection of storage systems.	2
	PSO 1	Make use of energy storage technologies for **fabricating** the power system networks used in various stages of utilization of electrical energy.	1
CO 2	PO 1	**Identify** the suitable commutation technique, protection and the isolation techniques of thyristors and understand their operation by applying the **principles of mathematics science and engineering fundamentals**. Principles of **energy efficiency** and **heat transfer** are also addressed.	3
	PO 2	Understand problems associated with SCRs during turn on/off and apply this knowledge in design and analysis of protection circuits and commutation circuits by using **first principles of mathematics and engineering sciences**.	3
	PO 12	**Recognize** the need for and having the preparation and ability to engage in independent and life-long learning in the context of energy conversion systems.	2
	PSO 1	Make use of various chemical substances with power conversion devices for smooth operation while **energy conversion**.	1
CO 3	PO 1	Storage systems are designed by various combinational aspects of the materials. The principle of operation,characteristics of are explained by **applying engineering fundamentals,chemistry** and deduce the expressions using **chemical reaction analysis** .	3
	PO 2	Design (formulate) Storage systems are designed to meet given objectives under realistic constraints. Designs are tested (validation) through reaction analysis (experimental design), and modifications are implemented as needed (interpretation of results) using **first principles of chemical sciences**.	5

	PO 12	**Recognize** the need for and having the preparation and ability to engage in independent and life-long learning in the context of optimal selection of storage devices are design new models.	4
	PSO 1	**Design and test** storage technologies for electrical energy in various applications. .	1
	PSO 2	Utilize various energy systems to constant and reliable energy for **applications** includes charging circuits, electric vehicles and **industrial drives**.	1
CO 4	PO 1	Identify (Knowledge) suitable methods are implemented with the **Knowledge of sciences and engineering fundamentals related to electrical engineering**.	3
	PO 2	Design (formulate) hybrid systems with various sources to meet given objectives (problem statement & formulation). Designs are tested (validation) through lab testings and hardware implementation (experimental design), modifications are implemented as needed (interpretation of results) **using first principles of sciences**	6
	PO 4	**Identify the Various problems** to apply the different technologies and understand the corresponding **context of engineering knowledge related** to the performance indicators and measures in the storage systems	6
	PO 12	**Recognize** the need for and having the preparation and ability to engage in independent and life-long learning in the context of designing the regulated power supplies using renewable sources.	4
	PSO 1	**Design** The SMES,TSSS are designed to perform generations of energy there by the results through **testing** and hardware implementations.	1
	PSO 2	Make use of conventional and non conventional sources for **energy conversion** electrical systems in various **applications**.	1
CO 5	PO 1	Analyze power grid systems with **fundamentals of engineering and science** including the application of **materials** in the roles of all electrical storage systems.	3
	PO 2	Identify the problems associated with storage technologies and apply suitable controls to achieve desired output. The developed models and control strategies are validated through numerical experimental setup (interpretation of results) **using first principles chemistry**	5
	PO 12	**Recognize** the need for and having the preparation and ability to engage in independent and life-long learning in the context of designing the storage systems.	4
	PSO 1	**Design** the storage circuits to achieve desired voltage output and interpret the results through **chemical analysis** and hardware implementation.	1
	PSO 2	Make use of chemical substances for **energy conversion** to design various storage systems **industrial applications**.	1

CO 6	PO 1	Explain the concepts and working principle of elctro-chemical energy storage systems with **the knowledge of chemistry and engineering fundamentals related basic electrical and electronics**.	3
	PO 2	Select a suitable models to obtain **desired** output voltage. The techniques and corresponding models are **validated** through experimental setups and results are **interpreted using first principles of chemical sciences and engineering fundamentals**.	5
	PO 3	The **design** of SMES systems includes interfacing with alternate energy sources and improvement of **energy efficiency**, both of which are tied into the **global, economic, environmental and societal context**.	4
	PO 12	**Recognize** the need for and having the preparation and ability to engage in independent and life-long learning in the context of designing the storage circuits.	4
	PSO 1	**Design**Hybrid models are designed to perform storage and usage purposes,interpret the results through **simulation** and hardware implementation.	1
	PSO 2	Make use of Double layer capacitors to drive the **appliances** and other **devices** connected to it by energy conversion.	1

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – PO/ PSO MAPPING:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO(s)		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	-	-	-	1	-	-	-	-	-	2	1	-	-
CO 2	3	3	-	-	-	-	-	-	-	-	-	4	1	-	-
CO 3	3	5	-	-	-	-	-	-	-	-	-	4	1	1	-
CO 4	3	6	-	6	-	-	-	-	-	-	-	4	1	1	-
CO 5	3	5	-	-	-	-	-	-	-	-	-	4	1	1	-
CO 6	3	5	4	-	-	-	-	-	-	-	-	4	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	100	30	-	-	-	20	-	-	-	-	-	25	50	-	-
CO 2	100	30	-	-	-	-	-	-	-	-	-	50	50	-	-
CO 3	100	50	-	-	-	-	-	-	-	-	-	50	50	33.3	-
CO 4	100	60	-	54.5	-	-	-	-	-	-	-	50	50	33.3	-
CO 5	100	50	-	-	-	-	-	-	-	-	-	50	50	33.3	-
CO 6	100	50	40	-	-	-	-	-	-	-	-	50	50	33.3	-

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	1	-	-	-	1	-	-	-	-	-	1	2	-	-
CO 2	3	1	-	-	-	-	-	-	-	-	-	2	2	-	-
CO 3	3	2	-	-	-	-	-	-	-	-	-	2	2	1	-
CO 4	3	3	-	2	-	-	-	-	-	-	-	2	2	1	-
CO 5	3	2	-	-	-	-	-	-	-	-	-	2	2	1	-
CO 6	3	2	1	-	-	-	-	-	-	-	-	2	2	1	-
TOTAL	18	11	1	2	-	1	-	-	-	-	-	11	12	4	-
AVERAGE	3	2	1	1	-	1	-	-	-	-	-	2	2	1	-

XVI ASSESSMENT METHODOLOGY-DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	-
Quiz	-	Tech-Talk	✓	Certification	-
Term Paper	-	Seminars	-	Student Viva	-
Laboratory Practice	-	5 Minutes Video / Concept Video	✓	Open Ended Experiments	-
Micro Projects	-	-	-	-	

XVII ASSESSMENT METHODOLOGY-INDIRECT:

	Assessment of mini projects by experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**NEEDS FOR ELECTRICAL ENERGY STORAGE**
	Emerging needs for EES, more renewable energy, less fossil fuel, Smart Grid uses, The roles of electrical energy storage technologies, The roles from the view point of a utility, The roles from the view point of consumers, The roles from the view point of generators of renewable energy.
MODULE II	**ELECTRICAL ENERGY STORAGE TECHNOLOGIES**
	Characteristics of electricity, Electricity and the roles of EES, High generation cost during peak-demand periods, Need for continuous and flexible supply, long distance between generation and consumption, Congestion in power grids,Transmission by cable.
MODULE III	**FEATURES OF ENERGY STORAGE SYSTEMS**
	Classification of EES systems, Mechanical storage systems,Pumped hydro storage (PHS), Compressed air energy storage (CAES), Fly wheelenergy storage (FES), Electro chemical storage systems.Secondary batteries, Flow batteries,Chemical energystorage,Hydrogen(H2), Synthetic natural gas (SNG).

MODULE IV	ELECTICAL ENERGY STORAGE SYSTEMS
	Electrical storage systems, Double-layer capacitors (DLC), Super conducting magnetic energy storage (SMES), Thermal storage systems, Standards for EES, Technical comparison of EES technologies.
MODULE V	APPLICATIONS
	Present status of applications, Utility use (conventional power generation, grid operation, service) , Consumer use (un uninterruptible power supply for large consumers),New trends in applications ,Renewable energy generation, Smart Grid, Smart Micro grid, Smart House, Electric vehicles, Management and control hierarchy of storage systems, Internal configuration of battery storage systems,External connection of EES systems,Aggregating EES systems and distributed generation (Virtual Power Plant), Battery SCADA–aggregation of many dispersed batteries.

TEXTBOOKS

1. "James M.Eyer, Joseph J.Iannucci and Garth P.Corey, "Energy Storage Benefits and Market Analysis", Sandia National Laboratories, 2004.

REFERENCE BOOKS:

1. Jim Eyer,Garth Corey, "Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide, Report, Sandia National Laboratories, Feb 2010.

WEB REFERENCES:

1. https://www.researchgate.net
2. https://www.electrical4u.com

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	Course Description on Outcome Based Education (OBE)		
CONTENT DELIVERY (THEORY)			
2	Introduction to Electrical energy storage systems	CO1	T1: 1.1 R1: 1.1
3	Necessity of electrical energy storage systems	CO1	T1: 1.1 R1: 1.1
4	Emerging needs for EES	CO1	T1: 1.1 R1: 1.1
5	Renewable energy systems	CO1	T1: 1.1 R1: 1.1
6	Fossil fuels	CO1	T1: 1.1 R1: 1.1
7	Smart grids	CO1	T1: 5.5 R1: 1.7

8	Role of electrical energy storage systems	CO1	T1: 5.5 R1: 1.7 T1: 5.5 R1: 1.7
9	Types of energy storage technologies	CO1	T1: 5.5 R1: 1.7
10	Utility point of energy storage systems	CO1	T1: 5.5 R1: 1.7
11	Consumers point of energy storage systems	CO1	T1: 5.5 R1: 1.7
12	Generators point of energy storage systems	CO1	T1: 5.5 R1: 1.7
13	Numerical analysis related to energy storage systems	CO1	T1: 5.5 R1: 1.7
14	Comparisons of various sources of energy	CO1	T2: 5.5 T1:6.1.1 R1: 1.7
15	Characteristics of electricity	CO2	T1: 6.3.1 T1: 6.3.2 R1: 5.2 R1: 5.4
16	Electricity and the roles of EES	CO2	T1: 6.3.2 R1:5.5
17	High generation costs during peak-demand periods	CO3	T1: 6.7.2 R1: 4.11
18	Need for continuous and flexible supply	CO2	T1: 6.8 T1: 6.9 R1: 6.11 R1: 6.11
19	long distance between generation and consumption	CO2	T1: 9.1 T1: 9.2 R1: 8.5 R1: 8.1
20	Congestion in power grids	CO2	T1: 9.3.2 R1: 8.12
21	Transmission by cable	CO2	T1: 10.1 R1: 9.41
22	Features of energy storage systems	CO3	T1: 10.1 R1: 9.42
23	Classification of EES systems	CO3	T1: 10.2 R1: 9.42
24	Mechanical storage systems	CO3	T1: 7.1 R1: 9.40
25	Pumped hydro storage (PHS)	CO3	T1: 7. R1: 9.40
26	Compressed air energy storage (CAES)	CO3	T1: 7.4, R1: 9.40
27	Flywheel energy storage (FES)	CO3	T1: 7.4 R1: 9.40

28	Electro chemical storage systems	CO3	T1: 7.4 R1: 9.40
29	Secondary batteries	CO3	T1: 7. R1: 9.45
30	Flow batteries	CO3	T1: 8.1, R1: 9.51
31	Chemical energy storage	CO3	T1: 8.9 R1: 9.52
32	Hydrogen(H2)	CO3	T1: 8.10 R1: 9.56
33	Reaction analysis in hydrogen and its components	CO3	T1: 8.4 R1: 9.57
34	Synthetic natural gas (SNG)	CO3	T1: 8.4 R1: 9.62
35	Electrical energy storage systems	CO4	T1: 8.5 R1: 9.66
36	Electrical storage systems	CO4	T1: 8.6 R1: 9.71
37	Double-layer capacitors (DLC),	CO4	T1: 8.8 R1: 9.73
38	Super conducting magnetic energy storage (SMES)	CO4	T1: 8.80 R1: 9.75
39	New trends in applications of EES	CO5	T1: 8.82 R1: 9.77
40	Management and control hierarchy of storage systems	CO5	T1: 8.83 R1: 9.79
41	Internal configuration of battery storagesystems	CO5	T1: 8.85 R1: 9.81
42	External connection of EESsystems	CO5	T1: 8.86 R1: 9.84
43	Aggregating EES systems and distributed generation	CO5	T1: 8.87 R1: 9.86
44	SCADA Systems	CO5	T1: 8.88 R1: 9.88
45	Aggregation of many dispersed batteries.	CO5	T1: 8.89 R1: 9.89
46	Advantages of batteries.	CO5	T1: 8.89 R1: 9.90
PROBLEM SOLVING/ CASE STUDIES			
47	Thermal storage systems	CO1	T1: 4.9 R1: 1.10
48	Standards for EES	CO1	T1: 6.1 R1: 5.1
49	Technical comparison of EES technologies	CO2	T1: 6.9 R1:5.4
50	Applications of storage systems	CO3	T1: 6.9 R1:5.4
51	Present status of applications	CO3	T1: 6.8 T1: 6.9

52	Utility use (conventional power generation)	CO3	T1: 6.6 R1:6.1
53	Consumer use (uninterruptible power supply for large consumers)	CO3	T1: 6.6 R1:6.1
54	New trends in applications	CO4	T1: 6.6 R1:6.2
55	Renewable energy generation	CO4	T1: 6.6 R1:6.2
56	Smart Grid	CO4	T1: 9.3 R1: 8.4
57	Smart Micro grid	CO4	T1: 9.3 R1: 8.4
58	Smart House	CO4	T1: 10.1 R1: 9.42
59	Electric vehicles	CO5	T1: 7.7 R1: 9.40
60	Management and control hierarchy of storage systems	CO5	T1: 7.7 R1: 9.40.
61	Internal configuration of battery storage systems	CO5	T1: 7.5 R1: 10.5
DISCUSSION OF DEFINITION AND TERMINOLOGY			
62	External connection of EES systems	CO1	T1: 1.1 T1: 5.1 R1: 1.7 R1: 1.1
63	Numerical analysis	CO2	T1: 6.1 R1: 5.1
64	Aggregating EES systems and distributed generation (Virtual Power Plant),	CO3	T1: 9.1 T1: 10.1 R1: 9.41 R1: 8.1
65	Battery SCADA systems	CO4	T1: 7.1 T1: 7.6 R1: 10.3 R1: 9.40
66	Aggregation of many dispersed batteries	CO5	T1: 8.8 T1: 8.1 R1: 9.1 R1: 9.38
DISCUSSION OF QUESTION BANK			
67	Necessity for Electrical Energy storage systems	CO1	-
68	Types of Energy storage technologies	CO2	-
69	Features of energy storage technologies	CO3	-
70	Kinds of Energy storage systems	CO4	-
71	Applications to EES systems	CO5	-

Signature of Course Coordinator **HOD,EEE**

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 Chemistry, 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 chemical, natural sciences, and Engineering sciences (**Problem Analysis).** 1. Problem or opportunity identification 2. Problem statement and system definition 3. Problem formulation and abstraction 4. Information and data collection 5. Model translation 6. Validation 7. Experimental design 8. Solution development or experimentation / Implementation 9. Interpretation of results 10. Documentation	**10**
PO 3	Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations (**Design/Development of Solutions).** 1. Investigate and define a problem and identify constraints including environmental and sustainability limitations, health and safety and risk assessment issues 2. Understand customer and user needs and the importance of considerations such as aesthetics 3. Identify and manage cost drivers 4. Use creativity to establish innovative solutions	**10**
	5. Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal 6. Manage the design process and evaluate outcomes. 7. Knowledge and understanding of commercial and economic context of engineering processes 8. Knowledge of management techniques which may be used to achieve engineering objectives within that context 9. Understanding of the requirement for engineering activities to promote sustainable development 10. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues	

PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct Investigations of Complex Problems).** 1. Knowledge of characteristics of particular materials, equipment, processes, or products 2. Workshop and laboratory skills 3. Understanding of contexts in which engineering knowledge can be applied (example, operations and management, technology development, etc.) 4. Understanding use of technical literature and other information sources Awareness of nature of intellectual property and contractual issues 5. Understanding of appropriate codes of practice and industry standards 6. Awareness of quality issues 7. Ability to work with technical uncertainty 8. Understanding of engineering principles and the ability to apply them to analyse key engineering processes 9. Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modeling techniques 10. Ability to apply quantitative methods and computer software relevant to their engineering discipline, in order to solve engineering problems 11. Understanding of and ability to apply a systems approach to engineering problems.	**11**
PO 5	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations **(Modern Tool Usage).** 1. Computer software / simulation packages / diagnostic equipment / technical library resources / literature search tools.	**1**
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The Engineer and Society).** 1. Knowledge and understanding of commercial and economic context of engineering processes 2. Knowledge of management techniques which may be used to achieve engineering objectives within that context 3. Understanding of the requirement for engineering activities to promote sustainable development 4. Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk) issues 5. Understanding of the need for a high level of professional and ethical conduct in engineering.	**5**
PO 7	Understand the impact of the professional Engineering solutions in societal and Environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and Sustainability).** Impact of the professional Engineering solutions (Not technical) 1. Socio economic 2. Political 3. Environmental	**3**

PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice (**Ethics).** 1. Comprises four components: ability to make informed ethical choices, knowledge of professional codes of ethics, evaluates the ethical dimensions of professional practice, and demonstrates ethical behavior. 2. Stood up for what they believed in 3. High degree of trust and integrity	**3**
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and Teamwork).** 1. Independence 2. Maturity – requiring only the achievement of goals to drive their performance 3. Self-direction (take a vaguely defined problem and systematically work to resolution) 4. Teams are used during the classroom periods, in the hands-on labs, and in the design projects. 5. Some teams change for eight-week industry oriented Mini-Project, and for the seventeen -week design project.	**12**
	6. Instruction on effective teamwork and project management is provided along with an appropriate textbook for reference 7. Teamwork is important not only for helping the students know their classmates but also in completing assignments. 8. Students also are responsible for evaluating each other's performance, which is then reflected in the final grade. 9. Subjective evidence from senior students shows that the friendships and teamwork extends into the Junior years, and for some of those students, the friendships continue into the workplace after graduation 10. Ability to work with all levels of people in an organization 11. Ability to get along with others 12. Demonstrated ability to work well with a team	
PO 10	Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication).** "Students should demonstrate the ability to communicate effectively in writing / Orally" 1. Clarity (Writing) 2. Grammar/Punctuation (Writing) 3. References (Writing) 4. Speaking Style (Oral) 5. Subject Matter (Oral)	**5**

PO 11	Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments (**Project Management and Finance).** 1. Scope Statement 2. Critical Success Factors 3. Deliverables 4. Work Breakdown Structure 5. Schedule 6. Budget 7. Quality 8. Human Resources Plan 9. Stakeholder List 10. Communication 11. Risk Register 12. Procurement Plan	**12**
PO 12	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life - Long Learning).** 1. Project management professional certification / MBA 2. Begin work on advanced degree 3. Keeping current in CSE and advanced engineering concepts 4. Personal continuing education efforts 5. Ongoing learning – stays up with industry trends/ new technology 6. Continued personal development 7. Have learned at least 2-3 new significant skills 8. Have taken up to 80 hours (2 weeks) training per year	**8**

ANNEXURE - II

KEY ATTRIBUTES FOR ASSESSING PROGRAM SPECIFIC OUTCOMES

PSO Number	PSO Statement / Key Competencies Features (KCF)	No. of KCF(s)
PSO 1	Design, develop, fabricate and commission the electrical systems involving power generation, transmission, distribution and utilization. 1. Design and develop storage systems. 2. Validate the interconnected power system. 3. Ensure reliable, efficient and compliant operation of electrical systems. 4. Familiarize the safety, legal and health norms in electrical system. 5. Adopt the engineering professional code and conduct.	**5**
PSO 2	Focus on the latest electrical technologies for energy conversion, management and auditing in specific applications of industry and sustainable rural development. 1. Control with the electric drives for renewable and non-renewable energy sources. 2. Fabricate latest devices with various components and control topologies. 3. Synthesis, systematic procedure to examine electrical components/machines using software tools. 4. Inspect, survey and analyze energy flow. 5. Control and manage the power generation and utilization. 6. Familiarize the safety, legal and health norms in electrical system. 7. Adopt the engineering professional code and conduct. 8. Explore autonomous power 9. Evolve into green energy and assess results 10. Realize energy policies and education 11. Potential contribution of clean energy for rural development.	**11**
PSO 3	Gain the hands-on competency skills in PLC automation, process controllers, HMI and other computing tools necessary for entry level position to meet the requirements of the employer. 1. Explicit software and programming tools for electrical systems. 2. Adopt technical library resources and literature search. 3. Model, program for operation and control of electrical systems. 4. Constitute the systems employed for motion control. 5. Interface automation tools. 6. Research, analysis, problem solving and presentation using software aids. 7. Programming and hands-on skills to meet requirements of global environment.	**7**

INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal, Hyderabad - 500 043
COURSE DESCRIPTION

Department	ELECTRICAL AND ELECTRONICS ENGINEERING				
Course Title	DISASTER MANAGEMENT				
Course Code	ACEC31				
Program	B.Tech				
Semester	VIII				
Course Type	Open Elective				
Regulation	IARE-UG20				
Course Structure	Theory			Practical	
	Lecture	Tutorials	Credits	Laboratory	Credits
	3	-	3	-	-
Course Coordinator	Mr. S Selvaprakash, Assistant Professor				

I COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
UG	-	-	-

II COURSE OVERVIEW:

The Disaster management provides a fundamental understanding of different aspects. It deals with the concepts and functions of disaster management to build competencies of professionals and development practitioners. It provides effective supporting environment by the governmental locating substantial resources for effective mitigation of disasters. It helps learners to apply the disaster mitigation strategies, preparedness for reducing damage intensity, loss of life and property.

III MARKS DISTRIBUTION:

Subject	SEE Examination	CIE Examination	Total Marks
Disaster Management	70 Marks	30 Marks	100

IV CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Power Point Presentations	✓	Chalk & Talk	x	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	x	Videos
x	Others						

V EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE modules and each module carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each module. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.
The expected percentage of cognitive level of the questions is broadly based on the criteria given in Table: 1.

Percentage of Cognitive Level	Blooms Taxonomy Level
33.33%	Remember
66.66 %	Understand
0%	Apply
0 %	Analyze
0 %	Evaluate
0 %	Create

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks, with 20 marks for continuous internal examination (CIE) and 10 marks for Alternative Assessment Tool (AAT).

Component		Marks	Total Marks
CIA	Continuous Internal Examination – 1 (Mid-term)	10	30
	Continuous Internal Examination – 2 (Mid-term)	10	
	AAT-1	5	
	AAT-2	5	
SEE	Semester End Examination (SEE)	70	70
Total Marks			100

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively for 10 marks each of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered. **Alternative Assessment Tool (AAT)**

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc. The AAT chosen for this course is given in table

Concept Video	**Tech-talk**	**Complex Problem Solving**
40%	40%	20%

VI COURSE OBJECTIVES:

The students will try to learn:

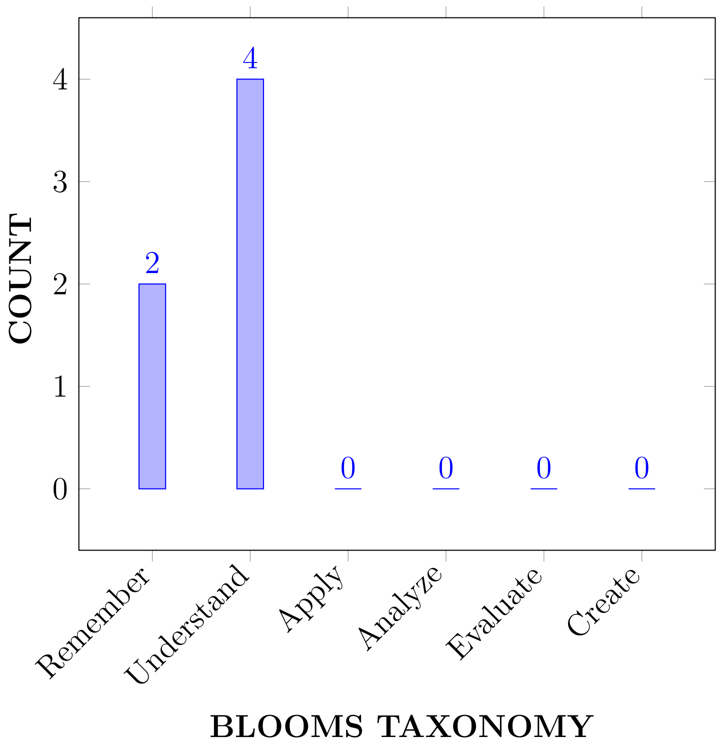
I	The concept of environmental hazards, disasters and various approaches dealing with the mitigation of disasters.
II	The knowledge on various types of environmental disasters and their impacts on human beings and nature.
III	The Different types of endogenous and exogenous hazards and their influence on human life and nature.
IV	The immediate response and damage assessment with information reporting and monitoring tools.

VII COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Classify** Environmental hazards for developing modern disaster management system.	Remember
CO 2	**Illustrate** various approches for reducing the level of risk associated with Disasters.	Understand
CO 3	**Compare** natural and manmade disasters for finding out intensity of damage loss occurred by them.	Understand
CO 4	**List** various hazards and their effects for evaluating their impact on society and Environment.	Remember
CO 5	**Outline** human adjustments and perception towards hazards for mitigation of disasters.	Understand
CO 6	**Summarize** disaster phenomenon and its different contextual aspects for implementing the Disaster Risk Reduction Strategy.	Understand

COURSE KNOWLEDGE COMPETENCY LEVEL



VIII PROGRAM OUTCOMES:

Program Outcomes	
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

IX HOW PROGRAM OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	CIE/SEE/AAT
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	3	CIE/SEE/AAT
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	3	CIE/SEE/AAT
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	1	CIE/SEE/AAT

3 = High; 2 = Medium; 1 = Low

X HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program		Strength	Proficiency Assessed by
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	-	-
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	-	-
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.	-	-

3 = High; 2 = Medium; 1 = Low

XI MAPPING OF EACH CO WITH PO(s),PSO(s):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	✓	-	-	-	-	-	✓	-	-	-	-	-	-	-	-
CO 2	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
CO 4	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
CO 5	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-	-
CO 6	✓	-	-	-	-	✓	-	-	✓	-	-	-	-	-	-

XII JUSTIFICATIONS FOR CO – (PO, PSO) MAPPING -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Apply the knowledge and principals of mathematics to engineering problems in determining an area enclosed by irregular boundary line using the knowledge of **mathematics and science fundamentals**	2
	PO 7	Understand the disaster management by considering Environmental impacts on the livelihood and their effect on Socio economic issues for sustainable development.	2
CO 2	PO 1	Apply the knowledge on various disaster mitigation approaches in **engineering disciplines** and and use their application in geographical researches.	1
	PO 6	Apply the engineering knowledge in disaster management to **promote sustainable development** and build **Awareness on health, safety,** and **risk issues** associated with Disasters.	4
CO 3	PO 6	Identify **engineering activities including personnel, health, safety, and risk and effective disaster management strategies** for implementing, analyzing disaster impacts on human life and environment.	4
	PO 7	Understand intensity of disasters and their impact on **environment** and influence on **socio economic** parameter for assessment of intensity of risk.	2
CO 4	PO 6	Identify **engineering activities including personnel, health, safety, and risk** for analyzing hazard impacts on environment.	4
	PO 7	Identify the impact of various hazards in **socio economic and environmental** aspects for developing modern disaster management system.	2

CO 5	PO 1	Understand the **methodology and scientific principal towards** hazards for human adjustments and perception by sharing technological knowledge from **other engineering branches.**	2
	PO 6	Understanding of the need for a **high level of professional and ethical conduct in engineering** for human adjustments, perception with effective **management strategies**for disaster mitigation.	4
CO 6	PO 1	Understand the **knowledge of scientific principal and methodology** in disaster phenomenon for minimizing impact by implementing the Disaster Risk Reduction Strategy.	2
	PO 6	**Appropriate management strategies** are to be applied to reduce the level of risk in disaster mitigation.	1
	PO 9	Apply disaster risk reduction strategy using vrious organizations and **work effetively as an individual** and **as a member** or **a leader** are to be applied to reduce the level of risk in disaster mitigation.	3

XIII TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING:

COURSE OUTCOMES	Program Outcomes/ No. of Key Competencies Matched												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	1	2	3
CO 1	2	-	-	-	-	-	2	-	-	-	-		-	-	-
CO 2	1	-	-	-	-	4	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	4	2	-	-	-	-		-	-	-
CO 4	-	-	-	-	-	4	2	-	-	-	-	-	-		-
CO 5	2	-	-	-	-	4	-	-	-	-	-	-	-	-	-
CO 6	2	-	-	-	-	1	-	-	3	-	-	-	-	-	-

XIV PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO, PSO):

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	1	2	3
CO 1	66.6	-	-	-	-	-	66.6	-	-	-	-	-	-	-	-
CO 2	33.3	-	-	-	-	80	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	80	66.6	-	-	-	-	-	-		-
CO 4	-	-	-	-	-	80	66.6	-	-	-	-	-	-	-	-
CO 5	66.6	-	-	-	-	80	-	-	-	-	-	-	-	-	-
CO 6	66.6	-	-	-	-	20	-	-	25	-	-	-	-	-	-

XV COURSE ARTICULATION MATRIX (PO – PSO MAPPING):

CO'S and PO'S and CO'S and PSO'S on the scale of 0 to 3, 0 being no correlation, 1 being the low correlation, 2 being medium correlation and 3 being high correlation.
0 - $0 \leq C \leq 5\%$ – No correlation
1 - $5 \leq C \leq 40\%$ – Low/ Slight
2 - $40\ \% < C < 60\%$ –Moderate
3 - $60\% \leq C < 100\%$ – Substantial /High

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	1	2	3
CO 1	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO 2	1	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO 3	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-
CO 4	-	-	-	-	-	3	3	-	-	-	-	-	-		-
CO 5	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO 6	3	-	-	-	-	1	-	-	1	-	-	-	-	-	-
TOTAL	10	-	-	-	-	13	9	-	1	-	-	-	-	-	-
AVERAGE	3	-	-	-	-	3	3	-	1	-	-	-	-	-	-

XVI ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Term Paper	-	Concept Video	✓	Open Ended Experiments	-
Assignments	-	Mini project	-	Tech Talk	✓

XVII ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of mini projects by Experts	✓	End Semester OBE Feedback

XVIII SYLLABUS:

MODULE I	**ENVIRONMENTAL HAZARDS AND DISASTERS**
	Environmental hazards and disasters: meaning of environmental hazards, environmental disasters and environmental stress; concept of environmental hazards, environmental stress and environmental disasters, different approaches and relation with human ecology, landscape approach, ecosystem approach, perception approach, human ecology and its application in geographical researches.
MODULE II	**TYPES OF ENVIRONMENTAL HAZARDS AND DISASTERS**
	Types of environmental hazards and disasters: Natural hazards and disasters, man induced hazards and disasters, natural hazards, planetary hazards/ disasters, extra planetary hazards/ disasters, planetary hazards, endogenous hazards, exogenous hazards.

MODULE III	**ENDOGENOUS HAZARDS**
	Endogenous hazards, volcanic eruption, earthquakes, landslides, volcanic hazards/ disasters, causes and distribution of volcanoes, hazardous effects of volcanic eruptions, environmental impacts of volcanic eruptions. Earthquake hazards/ disasters, causes of earthquakes, distribution of earthquakes, hazardous effects of, earthquakes, earthquake hazards in India,human adjustment, perception and mitigation of earthquake.
MODULE IV	**EXOGENOUS HAZARDS**
	Exogenous hazards/disasters, infrequent events, cumulative atmospheric hazards/disasters; Infrequent events: Cyclones , lightning , hailstorms; Cyclones: Tropical cyclones and local storms, destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation); Cumulative atmospheric hazards/ disasters: Floods, droughts, cold waves, heat waves floods; Causes of floods, flood hazards India, flood control measures (human adjustment, perception and mitigation); Droughts:Impacts of droughts, drought hazards in India, drought control measures,extra planetary hazards/ disasters, man induced hazards /disasters, physical hazards/ disasters, soil erosion, Soil erosion: Mechanics and forms of soil erosion, factors and causes of soil erosion, conservation measures of soil erosion; Chemical hazards/ disasters: Release of toxic chemicals, nuclear explosion, sedimentation processes; Sedimentation processes: Global sedimentation problems regional sedimentation problems, sedimentation and environmental problems, corrective measures of erosion and sedimentation,biological hazards/ disasters, population explosion.
MODULE V	**EMERGING APPROACHES IN DISASTER MANAGEMENT**
	Emerging approaches in Disaster Management, Three Stages 1. Pre, disaster stage(preparedness) 2. Emergency Stage 3. Post Disaster stage, Rehabilitation.

TEXTBOOKS

1. PardeepSahni, “Disaster Mitigation: Experiences and Reflections”, PHI Learning Pvt. Ltd., 1 st Edition, 2001.

2. J.Glynn, GaryW.HeinKe, “Environmental Science and Engineering”,Prentice Hall Publishers, 2 nd Edition, 1996.

REFERENCE BOOKS:

1. R.B.Singh (Ed), “Environmental Geography”, 2nd Edition, 1990.

2. R.B. Singh (Ed), “Disaster Management”, 2nd Edition, 2006.

3. Donald Hyndman “Natural Hazards and Disasters” - 5th edition, 2017.

XIX COURSE PLAN:

The course plan is meant as a guideline. Probably there may be a changes.

S.No	Topics to be covered	CO's	Reference T1: 4.1
OBE DISCUSSION			
1	Course Objectives, Course Outcomes, Program Outcomes, CO-PO Mapping		
CONTENT DELIVERY (THEORY)			
2	Classify Environmental Hazards & Disasters	CO 1	T2:26.3, R2: 3.1
3	Understand the Meaning of Environmental Hazards	CO 1	T2:2.2.2
4	Understand Environmental Stress	CO 1	T2:2.2.2, R3:3.7
5	Understand Environmental stress.	CO 2	T2:2.2.2
6	Obtain knowledge on Concept of Environmental Hazards	CO 2	T1:8.1
7	Capacity to analyze Environmental stress & Environmental Disasters	CO 2	T1:7.1, R2: 1.2
8	Capacity to analyze Ecology concept	CO 2	T2:3.2.3, R2: 1.3
9	Understand Different Approaches	CO 3	T2:4.2.3
10	Understand Landscape Approach -.	CO 3	T2:4.5.2
11	Explain Ecosystem approach -Perception approach.	CO 3	T2:4.7.9
12	Understand Human ecology & its application in geographical researches	CO 4	T2:5.2.1, R2: 6.4
13	Understand Human ecology & its application in geographical researches	CO 4	T2:5.2.1, R2: 6.4
14	Understand Types of Environmental hazards & Disasters	CO 4	T2:5.4
15	Capacity to analyze and evaluate Natural hazards and Disasters	CO 3	T2:5.5.3
16	Capacity to analyze and evaluate Natural hazards and Disasters	CO 3	T2:5.5.3
17	Understand Man induced hazards & Disasters	CO 3	T2:6.2.2
18	Understand Man induced hazards & Disasters	CO 3	T2:6.2.2
19	Obtain knowledge on Natural Hazards- Planetary Hazards/ Disasters	CO 4	R1:2.5, R2: 8.2
20	Obtain knowledge on Natural Hazards- Planetary Hazards/ Disasters	CO 4	R1:2.5, R2: 8.2
21	Analyze the Planetary Hazards-Endogenous Hazards - Exogenous Hazards	CO 4	R2:2.2.5, R2: 9.2
22	Analyze the Planetary Hazards-Endogenous Hazards - Exogenous Hazards	CO 4	R2:2.2.5, R2: 9.2

23	Understand Volcanic Eruption – Earthquakes – Landslides	CO 4	R3:5.4.8, R2: 9.6
24	Understand Volcanic Eruption – Earthquakes – Landslides	CO 4	R3:5.4.8, R2: 9.6
25	Volcanic Hazards/Disasters- Causes and distribution of Volcanoes	CO 4	T2:8.1.2
26	Volcanic Hazards/Disasters- Causes and distribution of Volcanoes	CO 4	T2:8.1.2
27	Explain the Hazardous effects of volcanic eruptions	CO 4	T2:8.3.5, R2: 5.3
28	Explain the Hazardous effects of volcanic eruptions	CO 4	T2:8.3.5, R2: 5.3
29	Understand Environmental impacts of volcanic eruptions - Earthquake Hazards/ disasters - Causes of Earthquakes	CO 4	T2:8.5
30	Understand Environmental impacts of volcanic eruptions - Earthquake Hazards/ disasters - Causes of Earthquakes	CO 4	T2:8.5
31	Distribution of earthquakes - Hazardous effects of - earthquakes - Earthquake Hazards in India	CO 4	T2:8.9.2
32	Explain the Droughts: Impacts of droughts, Drought hazards in India	CO 5	T2:9.2, R3: 4.6
33	Explain the Droughts: Impacts of droughts, Drought hazards in India	CO 5	T2:9.2, R3: 4.6
34	Understand Extra Planetary Hazards/ Disasters- Man induced Hazards /Disasters	CO 5	T2:9.2, R3: 4.7
35	Understand Extra Planetary Hazards/ Disasters- Man induced Hazards /Disasters	CO 5	T2:9.2, R3: 4.7
36	Understand the Infrequent events: Cyclones, Lightning, Hailstorms, Cyclones: Earthquake Hazards in India	CO 5	T2:9.5.3
37	Understand the Infrequent events: Cyclones, Lightning, Hailstorms, Cyclones: Earthquake Hazards in India	CO 5	T2:9.5.3
38	Analyze the Tropical cyclones and Local storms	CO 5	T2:9.6.2, R3: 8.5
39	Understand the Destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation)	CO 5	T2:9.7.5, R3: 8.12
40	Understand the Destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation)	CO 5	T2:9.7.5, R3: 8.12
41	Analyze the Cumulative atmospheric hazards/ disasters : Floods, Droughts, Cold waves, Heat waves Floods	CO 5	T2:9.5.4
42	Analyze the Cumulative atmospheric hazards/ disasters : Floods, Droughts, Cold waves, Heat waves Floods	CO 5	T2:9.5.4
43	Identification of Flood control measures (Human adjustment, perception and mitigation),	CO 6	T2:9.5.4

44	Identification of Flood control measures (Human adjustment, perception and mitigation),	CO 6	T2:9.5.4
45	Analyze the Exogenous hazards/ disasters - Infrequent events- Cumulative atmospheric hazards/ disasters	CO 6	T2:9.5.6
PROBLEM SOLVING/ CASE STUDIES			
1	Case study on modern disaster management system	CO 1	T2:2.2.2
2	Case study on natural disaster	CO 2	T2:2.2.2
3	Case study on manmade disaster	CO 3	T2:2.2.2
2	Case study on Latur earthquake	CO 4	T2:2.2.2
4	Case study on Fukushima Nuclear disaster	CO 4	T2:2.2.2, R3:3.7
5	Case study on tsunami occurred in Japan	CO 5	T2:2.2.2
6	Case study on Hiroshima and Nagasaki	CO 4	T1:8.1
7	Case study on Russian Siberia oil spill	CO 4	T1:7.1, R2: 1.2
8	Case study on Hudhud Cyclone 2014	CO 5	T2:3.2.3, R2: 1.3
9	Case study on South India Floods 2015	CO 5	T2:4.2.3
10	Case study on Bihar Heat Wave 2019	CO 5	T2:4.5.2
11	Case study on Bihar Floods 2019	CO 5	T2:4.7.9
12	Case study on Oil Spillage in Russia 2020	CO 4	T2:5.4
13	Case study on Yellow River Flood in china	CO 4	T2:5.5.3
14	Case study on Bhola Cyclone Bangladesh	CO 5	T2:6.2.2
15	Causes of wildfires and effects	CO 4	T2:9.5.4
16	pre-disaster activities to reduce the impact of cyclones	CO 5	T2:9.5.4
17	Tectonic plate theory	CO 4	T2:9.5.6
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Different approaches and relation with human ecology, landscape approach, ecosystem approach, perception approach	CO 1	T2:2.2.2
2	Natural hazards, planetary hazards/ disasters, extra planetary hazards/ disasters, planetary hazards, endogenous hazards, exogenous hazards	CO 2	T2:2.2.2, R3:3.7
3	Effects of volcanic eruptions, environmental impacts of volcanic eruptions	CO 3, CO 4	T2:2.2.2
4	Lightning , hailstorms; Cyclones: Tropical cyclones and local storms, destruction by tropical cyclones and local storms (causes, distribution human adjustment, perception and mitigation); Cumulative atmospheric hazards/ disasters:	CO 5	T1:8.1
5	Emerging approaches in Disaster Management, Three Stages 1. Pre, disaster stage(preparedness), 2. Emergency Stage ,3. Post Disaster stage, Rehabilitation.	CO 6	T1:7.1, R2: 1.2

DISCUSSION OF QUESTION BANK			
1	Environmental hazards and disasters	CO 1	R1:2.1
2	Types of environmental hazards and disasters	CO 2	T4:7.3
3	Endogenous hazards, volcanic eruption, earthquakes, landslides, volcanic hazards/ disasters, causes and distribution of volcanoes, hazardous effects of volcanic eruptions, and their environmental impacts.	CO 3, CO 4	R2:5.1
4	Global sedimentation problems regional sedimentation problems, sedimentation and environmental problems, corrective measures of erosion and sedimentation,biological hazards/ disasters, population explosion.	CO 5	T1:7.5
5	Emerging approaches in disaster management	CO 6	T1: 4.1

Signature of Course Coordinator **HOD,EEE**
Mr.S.Selvaprakash