INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**				
2	Course Title	**PROFESSIONAL COMMUNICATION**				
3	Course Code	AHSD01				
4	Program	B.Tech				
5	Semester	I Semester				
6	Regulation	BT23				
7	Structure of the course	Theory			Practical	
		Lecture	Tutorials	Credits	Lab	Credits
		3	0	3	-	-
8	Type of course (**Tick type of course**)		Professional Elective	Open Elective	VAC	MOOCs
			-	-	-	-
9	Course Offered	Odd Semester ✓		Even Semester ×		
10	**Total lecture, tutorial and practical hours for this course (16 weeks of teaching per semester)**					
	Lectures: 64		Tutorials: .... Nil		Practical: .... Nil	
11	Course Coordinator	Dr Jan Mohmad Pandit				
12	Date Approved by BOS	24/08/2023				
13	Course Webpage	https://www.iare.ac.in/sites/default/files/BT23/AHSD01.pdf				
14	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**	
		Intermediate	-	-	English Language and Grammar	

15. Course Overview

The principle aim of the course is that the students will get 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.

16. 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	Critical aspect of speaking and reading for interpreting in-depth meaning between the sentences.
IV	Conceptual awareness on writing in terms of unity, content, coherence, and linguistic accuracy.

17. COURSE OUTCOMES:

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

CO 1	**Demonstrate** Demonstrate the prime necessities of listening skills and communication skills for academic and non-academic purposes.	Understand
CO 2	**Comunicate** effectively in spoken English on issues and ideas with a reasonable degree of fluency and accuracy in different social settings.	Understand
CO 3	**Strengthen** acceptable language for developing life skills to overcome the challenges at professional platform.	Understand
CO 4	**Interpret** the grammatical and lexical forms of English and use these forms excellently in specific communicative contexts.	Understand
CO 5	**Articulate** main ideas and important details of literary text at advanced reading levels.	Understand
CO 6	**Extend** writing skills for fulfilling academic and work-place requirements of various written communicative functions.	Understand

18. Topic Learning Outcome (TLOs):

S.No	Topic(s)	TLO No	Topic Learning Outcome's	Course Out-come	Blooms Level
1	Introduction to communication skils	1	**Interpret** fundamental concepts of communication skills through a procedural approach	CO 1	Understand
		2	**Aware** the techniques of perfect communication within and outside the classroom	CO 1	Understand
		3	**Identify** the parameters of the communication within the classroom as well as outside the classroom.	CO 1	Understand

S.No	Topic(s)	TLO No	Topic Learning Outcome's	Course Out-come	Blooms Level
		4	**Practice** ethical communication to embrace a diverse range of individuals, communities, and viewpoints	CO 1	Understand
3	Communication Process	5	**Examine** the process of effective communication at different social situations.	CO 1	Understand
		6	**Articulate** the process of effective communication different social situations	CO 1	Understand
4	Listening Skills	7	**Demonstrate** various kinds of listening setbacks within the classroom.	CO 1	Understand
		8	**Understand** in-depth meaning of audio clips	CO 1	Understand
5	Introduction to phonetics	9	**Familiar** with – and be able to Understand – technical terms for describing and analyzing English pronunciation and be able to read and produce phonemic transcriptions and transcription of intonation patterns.	CO 1	Understand
		10	**Articulate** acceptable language at various academical platforms.	CO 2	Understand
6	Significance of speaking skills	11	**Reinforce** effective oral presentation skillas well as acceptable behavioral traits.	CO 2	Understand
		12	**Maintain** global civic attitude at work place and feel as a responsible citizen.	CO 2	Understand
		13	**Plan** as a professional speaker before going to deliver an academic presentation.	CO 2	Understand
7	Generating talks based on visual prompts	14	**Get** consciousness about the importance of using flash cards, handouts and images to have an effective comprehension.	CO 2	Understand
8	Oral presentation using power point slides	15	**Understand** properly making effective PPTs in order to give a successful presentation.	CO 2	Understand
9	Delivering speech effectively	16	**Anticipate** problems with discussion groups	CO 2	Understand
10	Essentials of speaking skills	17	**Show** acceptable attitude at learning place as well as at work place.	CO 3	Understand
11	Exposure to structured talks	18	**Pay** appropriate attention as a learner of English as a second language.	CO 3	Understand
12	The concept of word formation	19	**Enhance** lexical ability to experience of IELTS, TOEFL, GRE tests.	CO 4	Understand

S.No	Topic(s)	TLO No	Topic Learning Outcome's	Course Outcome	Blooms Level
13	Idioms and phrases	20	**Recognize** and understand the meaning of idioms and phrases.	CO 4	Understand
		21	**Able** to create own idiom story using story jumper	CO 4	Understand
14	Sentence structure	22	**Able** to write syntactical organization of given functions in non-periodic interval	CO 4	Understand
15	Usage of punctuation marks	23	**Understand** well using proper punctuation tools to deliver the topic successfully.	CO 4	Understand
16	Advanced level prepositions	24	**Identify** and define prepositions, prepositional phrases and objects of the preposition.	CO 4	Understand
17	Tenses	25	**Use** tenses syetematically to deliver the message without the ambiguity.	CO 4	Understand
18	Subject verb agreement	26	**Learn** the most common rules for subject/verb agreement and also identify proper and improper subject / verb agreement in the peer writing.	CO 4	Understand
19	Degrees of comparison	27	**Able** to use the positive, comparative, and superlative degrees of the regular and irregular adjectives and adverbs.	CO 4	Understand
20	Direct and indirect speech	28	**Define** direct speech and indirect speech and distinguish between direct and indirect speech and classify the rules for converting direct speech to indirect speech and indirect speech to direct speech.	CO 4	Understand
21	Questions tags.	29	**Use** the correct polarity (positive or negative), depending on the polarity of the statement.	CO 4	Understand
22	Significance of reading skills	30	**Accelerate** the ability of reading comprehension in advanced learning	CO 5	Understand
23	Techniques of reading	31	**Know** Vrious parameters of reading skills	CO 5	Understand
		32	**Use** different literary reading tools to establish his/her argument effectively.	CO 5	Understand
		33	**Extends** consolidates and sustains vocabulary growth	CO 5	Understand
24	Significance of writing skills	34	**Aware** the importance of writing skills particuarly at academic domain	CO 6	Understand
25	Effectiveness of writing	35	**Understand** well using proper writing tools to deliver his/her thesis	CO 6	Understand

S.No	Topic(s)	TLO No	Topic Learning Outcome's	Course Out-come	Blooms Level
26	The role of a topic sentence and supporting sentences in a paragraph	36	**Write** effective topic sentence as well as supporting sentences to convey a message to his/her readers/audience.	CO 6	Understand
27	Organizing principles of paragraphs in a document	37	**Generate** fa paragraph effectively using prime principles	CO 6	Understand
		38	**Describe** the principles of paragraph writing and properities of paragraphs	CO 6	Understand
29	Report writing	39	**Present** an original thesis on a significant topic within a well defined subject area	CO 6	Understand
30	E-mail writing	40	**Use** effectively technical writing tools at workplace	CO 6	Understand
31	Various formats for letter writing	41	**Knows** how to concise a written text without changing the core idea	CO 6	Understand

19. Employability Skills

Example: Communication skills / Programming skills / Project based skills /
Subject: Employment advantage: Effective English language and communication skills are crucial in many aspects of life, including education, business, workplace and social interactions. Proficient English language skills enable individuals to express themselves clearly, understand others, and engage in meaningful conversations. As the primary language of communication across the globe, proficiency in English is a highly sought-after skill in the international workplace and one of the benefits of learning English is therefore that it significantly boosts our job opportunities.

20. Content Delivery / Instructional Methologies:

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

21. Evaluation Methodology:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). CIA is conducted for a total of 40 marks, with 20 marks for Continuous Internal Examination (CIE), and and 05 marks for each Definitions and Terminology / Quiz and remaining 10 marks for Tech Talk / Assignments.

Table 4: Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	CIA - I	CIA - II	SEE	Total Marks
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Definitions and Terminology / Quiz	05 Marks	05 Marks		10 Marks
Tech Talk / Assignment	05 Marks	05 Marks		10 Marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

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 12 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

22. SYLLABUS:

MODULE I	**GENERAL INTRODUCTION AND LISTENING SKILLS | Number of Lectures: 13**
	Introduction to communication skills; communication process; elements of communication; listening skills; significance of listening skills; stages of listening; barriers and effectiveness of listening; Introduction to phonetics; listening comprehension.
MODULE II	**SPEAKING SKILL | Number of Lectures: 13**
	Significance of speaking skills; essentials of speaking skills; verbal and non-verbal communication; generating talks based on visual prompts; public speaking; exposure to structured talks; delivering speech effectively; oral presentation using power point slides; soft skills and hard skills; importance of soft skills for engineers.
MODULE III	**VOCABULARY AND GRAMMAR . |Number of Lectures: 13**
	The concept of word formation; idioms and phrases; one-word substitutes, sentence structure (simple, compound and complex); usage of punctuation marks; advanced level prepositions; tenses; subject verb agreement; degrees of comparison; direct and indirect speech; questions tags.
MODULE IV	**READING SKILL | Number of Lectures: 12**
	Significance of reading skills, techniques of reading, skimming-reading for the gist of a text, scanning–reading for specific information, intensive, extensive reading, reading comprehension, metaphor and figurative language.
MODULE V	**WRITING SKILL | Number of Lectures: 13**
	Significance of writing skills; effectiveness of writing; the role of a topic sentence and supporting sentences in a paragraph; organizing principles of paragraphs in a document; writing introduction and conclusion; techniques for writing precis, various formats for letter writing (block format, full block format, and semi bloc format); e-mail writing, report writing.

TEXTBOOKS

1. Anjana Tiwari, "*Communication Skills in English,* ", Khanna Publishing House: New Delhi, 2022.

REFERENCE BOOKS:

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.

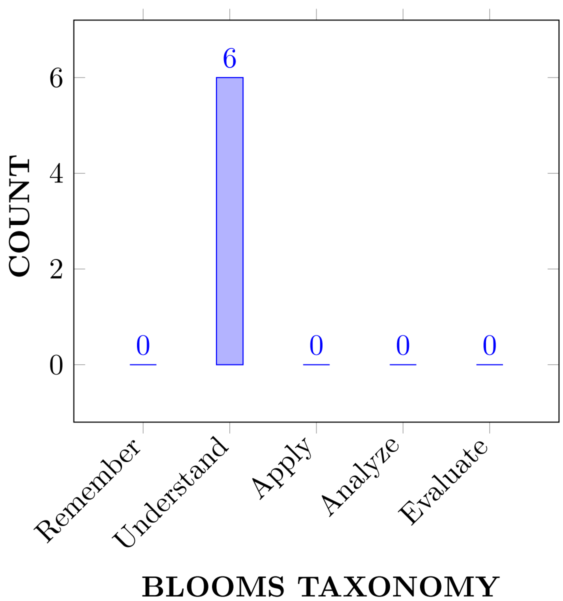
3. Rutherford, Andrea J, "*Basic Communication Skills for Technology,* ", Pearson Education, 2nd Edition, 2010.

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

MATERIALS ONLINE:

1. Lecture notes, ELRV videos and power point presentations
2. Answers / solutions to all questions / problems in the textbook
3. Online exercises
4. Problems and solutions in files

23. COURSE KNOWLEDGE COMPETENCY LEVEL



24. 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 communication skills	CO 1	T1; R1
2	Communication process	CO 1	T1; R1
3	Elements of communication	CO 1	T1; R1
4	Significance of listening skills	CO 1	T1; R1
5	Different stages of listening	CO 1	T1, R1
6	Different stages of listening	CO 1	T1, R1
7	Listening comprehension	CO 1	T1, R1
8	Introduction to phonetics	CO 1	T1, R1
9	Significance of speaking skills	CO 2	T1, R1
10	Essentials of speaking skills	CO 2	T1, R1
11	Verbal and non-verbal communication	CO 2	T1; R1, R2
12	Generating talks based on visual prompts	CO 2	T1; R1, R2
13	Public speaking	CO 1	T1; R1, R2
14	Exposure to structured talks	CO 2	T1; R1, R2
15	Oral presentation using power-point slides	CO 2	T1; R1, R2
16	Soft skills and hard skills	CO 3	T1; R1, R2
17	Importance of soft skills for engineers	CO 3	T1; R1, R2
18	Concept of word formation	CO	T1; R1, R2
19	Idioms and phrases	CO 4	T1; R3, R4
20	One-word substitutes	CO 4	T1; R3, R4
21	Sentence structure	CO 4	T1; R3, R4
22	Usage of punctuation marks	CO 4	T1; R3, R4
23	Advanced level prepositions	CO 4	T1; R3, R4
24	Functions of tenses	CO 4	T1; R3, R4
25	Subject verb agreement	CO 4	T1; R3, R4
26	Degrees of comparison	CO 4	T1; R1, R2
27	Direct and indirect speech	CO 4	T1; R1
28	Question tags	CO 4	T1; R1
29	Significance of reading skills	CO 5	T1; R1
30	Techniques of reading	CO 5	T1; R1
31	Skimming and Scanning	CO 5	T1; R1
32	Intensive and extensive reading	CO 5	T1; R1
33	Significance of writing skills	CO 6	T1; R1

S.No	Topics to be covered	CO's	Reference
34	Effectiveness of writing	CO 6	T1; R1
35	The role of a topic sentence	CO 6	T1; R1
36	Supporting sentences to develop a paragraph	CO 6	T1; R1
37	Organizing principles of paragraphs in a document	CO 6	T1; R4
38	Writing introduction and conclusion	CO 6	T1; R4
39	Metaphor and figurative language	CO 6	T1; R4
40	Technicalities of writing precis, Letter, e-mail, report and Various formats for letter writing	CO 6	T1; R4
PROBLEM SOLVING/ CASE STUDIES			
1	The aspects to improve listening comprehension Discuss in detail.	CO 1	TI:10,11
2	Different types of listeners with examples.	CO 1	TI: 19,21
3	The sounds of English language.	CO 1	TI:23,27
4	verbal communication or written communication.	CO 2	TI: 27,30
5	Various difficulties in public speaking.	CO 2	TI: 32,33
6	Different ways of greeting people in formal and informal situation and discuss how do they matter in communication?	CO 2	TI: 35,37
7	'Oral presentation requires a good planning'.	CO 2	TI:36,38
8	Power point presentation and the ways to make Power point presentation.	CO 3	TI: 37,38
9	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
10	The usage of idioms and phrases in spoken English.	CO 4	TI: 47,50
11	'Structure proposition-evaluation' -Reading technique.	CO 5	TI:56,58
12	Active reading, detailed reading, and speed-reading techniques used in different situations.	CO 5	TI: 79,81
13	The elements of paragraph writing in detail.	CO 6	TI:100,102
14	Logical bridges and Verbal bridges in writing.	CO 6	TI: 102,104
15	The role of topic sentence to develop a paragraph.	CO 6	TI:105, 115
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Soft skills and Interpersonal Communication	CO 3	TI 8,9
2	Language acquisition is a process.	CO 2, CO3	TI: 11,12
3	Communication.	CO 3, CO 4	TI: 20, 25
4	Time management.	CO 5	TI: 36, 42
5	Stress management.	CO 3	T: 55, 68
DISCUSSION OF TUTORIAL QUESTION BANK			
1	Soft Skills for difficult situations in terms of reassurance and reliability.	CO 3	TI
2	Verbal and non-verbal communication.	CO 3	TI
3	Honesty, Respect, Self-Control and Accountability their role in building long lasting interpersonal skills?	CO 3	TI

S.No	Topics to be covered	CO's	Reference
4	Etiquette and manners. Its importance in social, personal and professional communication.	CO 3	TI
5	Problem solving and decision making.	CO 3	TI

25. PROGRAM OUTCOMES & PROGRAM SPECIFIC 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.

Program Outcomes	
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
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.

26. 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. 1. Clarity (Writing); 2. Grammar/Punctuation (Writing); 3. References (Writing); 4. Speaking Style (Oral); 5. Subject Matter (Oral).	5	CIE/Quiz/AAT

27. 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

28. 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	-	-	-	-	-	-	-	-	-	✓	-		-	-	-

29. 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 10	Apply the mathematics, science and Engineering fundamentals to problems involving frictional force additionally in system of forces using the knowledge of mathematics and science fundamentals.	5
CO 3	PO 10	Apply the mathematics, science and Engineering fundamentals for locating centroid and centre of gravity using the knowledge of mathematics and science fundamentals.	5

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 4	PO 10	Interpret the grammatical knowledge and punctuation marks systematically towards providing clarity in speaking and writing.	5
CO 5	PO 10	Demonstrate the role of grammar and punctuation marks to understand the meaning between the sentences as well as paragraphs in speaking or writing for clarity.	5
CO 6	PO 10	Describe the clarity of grammatical usage and the obligation of punctuation marks in speaking and writing.	5

30. 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	-	-	-	-	-

31. 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	-	-	-	-	-

32. 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		
	PO 1	PO 2	PO 3	PO 4	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 1	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO 1	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO 1	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO 1	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO 1	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
TOTAL	-	-	-	-	-		-	-	-	18	-	-	-	-	-
AVERAGE	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-

33. ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	✓				

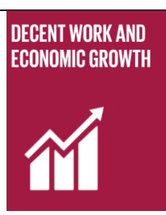
34. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

35. Relevance to Sustainability goals

Write brief description about the course and how its relevance to SDGs.

1		
2		
3		

4		English language has become linguafranca across the globe. For that reason, it is compelsory to learn this language at advanced level. In MNC commpanies, those who have excellent communication skills ,their carrer graph goes to the higher level very quickly. Hence ,the role of English language has become a part of the life.
5		
6		
7		
8		
9		
10		

11	SUSTAINABLE CITIES AND COMMUNITIES	
12	RESPONSIBLE CONSUMPTION AND PRODUCTION	
13	CLIMATE ACTION	
14	LIFE BELOW WATER	
15	LIFE ON LAND	

16		
17		

Approved by: Board of Studies in the meeting conducted on ——————————.

Signature of Course Coordinator **HOD**
Dr Jan Mohmad Pandit, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**				
2	Course Title	**MATRICES AND CALCULUS**				
3	Course Code	AHSD02				
4	Program	B.Tech				
5	Semester	I Semester				
6	Regulation	BT23				
7	Structure of the course	Theory			Practical	
		Lecture	Tutorials	Credits	Lab	Credits
		3	1	4	-	-
8	Type of course (**Tick type of course**)	Core	Professional Elective	Open Elective	VAC	MOOCs
		✓	-	-	-	-
9	Course Offered	Odd Semester ✓		Even Semester ×		
10	**Total lecture, tutorial and practical hours for this course (16 weeks of teaching per semester)**					
	Lectures: 48 hours		Tutorials: 16 hours		Practical: 0 hours	
11	Course Coordinator	Mr. P. Shantan Kumar				
	Course Instructor	Ms L. Indira				
12	Date Approved by BOS	23 August 2023				
13	Course Webpage	https://www.iare.ac.in/sites/default/files/BT23/AHSD02.pdf				
14	Course Prerequistes -	**Level**	**Course Code**	**Semester**	**Prerequisites**	
		10+2	-	-	Basic Principles of Algebra and Calculus	

15. Course Overview

This course is a foundation for all engineering branches. It includes concepts of Matrices, Eigen Values, Eigen Vectors, Functions of Single, Several Variables, Fourier Series and Multiple Integrals. This course is applicable for simulation, colour imaging processing and optimal solutions in all engineering problems.

16. Course Objectives:

The students will try to learn:

I	The Concept of the rank of a matrix, eigen values, eigen vectors and solution of the system of linear equations.
II	The Geometrical approach to the mean value theorems and applications.
III	The Fourier series expansion in periodic and non-periodic intervals.
IV	The Evaluation of multiple integrals and applications.

17. Course Outcomes:

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

CO 1	**Determine** the rank and solutions of linear equations with elementary operations.
CO 2	**Utilize** the Eigen values, Eigen vectors for developing spectral matrices.
CO 3	**Make use of** Cayley-Hamilton theorem for finding powers of the matrix.
CO 4	**Interpret** the maxima and minima of given functions.
CO 5	**Apply** the Fourier series expansion of periodic functions for harmonic series.
CO 6	**Determine** the volume of solid bounded regions by using the integral calculus.

18. Topic Learning Outcome (TLOs):

S.No	**Topic(s)**	**TLO No**	**Topic Learning Outcome's**	**Course Out-come**	Blooms Level
1	Rank of a matrix	1	**Calculate** the rank of a matrix by using determinants	CO 1	Apply
		2	**Calculate** the rank of a matrix by using elementary operations	CO 1	Apply
2	Inverse of a matrix by Gauss-Jordan method	3	**Compute** the inverse of the given matrix by elementary operations	CO 1	Apply
3	System of non-homogeneous equations	4	**Identify** the use of matrix theory to solve the system of linear equations in various engineering problems	CO 1	Apply
		5	**Examine** the system of homogeneous equations by its augmented form	CO 1	Apply
		6	**Examine** the system of non homogeneous equations for its augmented form	CO 1	Apply
4	Characteristic equation	7	**Recall** the concepts of characteristic equations of matrices	CO 2	Remember
5	Eigenvalues and Eigenvectors	8	**Recall** the concepts of eigenvalues for future engineering applications	CO 2	Remember
		9	**Recall** the concepts of eigenvectors for future engineering applications	CO 2	Remember

S.No	Topic(s)	TLO No	Topic Learning Outcome's	Course Out-come	Blooms Level
		10	**Utilize** the characteristic polynomials to compute the eigenvalues and eigenvectors	CO 3	Apply
6	Cayley-Hamilton theorem, Diagonalization of a matrix	11	**Make use of** the Cayley-Hamilton to find inverse of a matrix	CO 3	Apply
		12	**Make use of** the Cayley-Hamilton to find powers of a matrix	CO 3	Apply
		13	**Make use of** the Cayley-Hamilton to find diagonalization of a matrix	CO 3	Apply
7	Continuous functions	14	**Explain** the geometrical interpretation of continuous functions on closed and bounded intervals	CO 4	Understand
8	Mean value theorems	15	**Interpret** the mean value theorems on bounded functions	CO 4	Understand
9	Partial differentiation	16	**Recall** the partial differentiation for the functions of several variables	CO 4	Remember
10	Jacobian transformations	17	**Make use of** Jacobian transformations for the functions are to be dependent or independent	CO 4	Apply
11	Maxima and minima of a function	18	**Identify** the maxima and minima of a function with several variables by using partial derivatives	CO 4	Apply
12	Euler coefficients	19	**State** the Euler coefficients for Fourier expansion of periodic functions in a given interval	CO 5	Remember
13	Fourier series in periodic interval	20	**Extend** the Fourier series of given functions in a given periodic interval $(-\pi, \pi)$	CO 5	Understand
		21	**Extend** the Fourier series of given functions in a given periodic interval $(0,2\pi)$	CO 5	Understand
14	Fourier series in non -periodic intervall	22	**Compute** the Fourier series of given functions in non-periodic interval (0,2l)	CO 5	Apply
15	Half- range Fourier series	23	**Extend** the half- range Fourier series expansions of a function in a given periodic interval $(0,\pi)$	CO 5	Apply
		24	**Extend** the half- range Fourier series expansions of a function in a given arbitrary interval (0, l)	CO 5	Apply

S.No	Topic(s)	TLO No	Topic Learning Outcome's	Course Out-come	Blooms Level
16	Double integrals	25	**Solve** the double integrals of functions in given constant limits	CO 6	Apply
		26	**Solve** the double integrals of functions in cartesian coordinates with given limits	CO 6	Apply
		27	**Solve** the double integrals of functions in polar coordinates with given limits	CO 6	Apply
17	Change order of integration	28	**Identify** the change order of integration of double integrals in cartesian form	CO 6	Remember
18	Triple integrals	29	**Calculate** the triple integrals of function in given constant limits	CO 6	Apply
		30	**Calculate** the triple integrals of function in cartesian coordinates with given limits	CO 6	Apply

19. Employability Skills

1. **Linear Algebra:** Employability/ Skill development: Apply the concepts of Linear Algebra in programming languages
2. **Matrices and Differential Calculus:** Employability/ Skill development: Uses the basic of matrices and Calculus calculation concept in the field of Engineering
3. **Integral Calculus:** Employability/ Skill development: Uses the concept of definite integral in engineering problems
4. **Multivariable calculus:** Employability/ Skill development: Can solve the different Multivariable calculus

20. Content Delivery / Instructional Methologies:

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

21. Evaluation Methodology:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). CIA is conducted for a total of 40 marks, with 20 marks for Continuous Internal Examination (CIE), and 05 marks for each Definitions and Terminology / Quiz and remaining 10 marks for Tech Talk / Assignments.

Semester End Examination (SEE): The SEE is conducted for 60 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. No choice is given from first two modules. Each question carries 12 marks. There could be a maximum of two sub divisions in a question.

Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE :

Activities	CIA - I	CIA - II	SEE	Total Marks
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Definitions and Terminology / Quiz	05 Marks	05 Marks		10 Marks
Tech Talk / Assignment	05 Marks	05 Marks		10 Marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

22. Course content - Number of modules: Five

MODULE I	**MATRICES** | **Number of Lectures: 09**
	Rank of a matrix by echelon form and normal form; inverse of non-singular matrices by Gauss-Jordan method; system of linear equations: solving system of homogeneous and non-homogeneous equations.
MODULE II	**EIGEN VALUES AND EIGEN VECTORS** | **Number of Lectures: 10**
	Eigen values; Eigen vectors and their properties (without proof); Cayley-Hamilton theorem (without proof), verification; finding inverse and power of a matrix by Cayley-Hamilton theorem; diagonalization of a matrix.
MODULE III	**FUNCTIONS OF SINGLE AND SEVERAL VARIABLES .** |**Number of Lectures: 10**
	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 of two variables and three variables; method of Lagrange multipliers.
MODULE IV	**FOURIER SERIES** | **Number of Lectures: 09**
	Fourier expansion of periodic function in a given interval of length 2π; Fourier series of even and odd functions; Fourier series in an arbitrary interval; half-range Fourier sine and cosine expansions.
MODULE V	**MULTIPLE INTEGRALS** | **Number of Lectures: 10**
	Evaluation of double integrals (cartesian and polar coordinates); change of order of integration (only cartesian coordinates); evaluation of triple integrals (cartesian coordinates).

Text Books

1. B. S. Grewal, "*Higher Engineering Mathematics*", Khanna Publishers, 44/e, 2017.
2. Erwin Kreyszig, "*Advanced Engineering Mathematics*", John Wiley & Sons, 10/e, 2011.

ReferenceE Books:

1. R. K. Jain and S. R. K. Iyengar, "*Advanced Engineering Mathematics*", 3/ed Narosa Publications, 5th Edition , 2016.
2. George B. Thomas, Maurice D. Weir and Joel Hass, Thomas,, "*Calculus*", Uma Publications, 13/e Edition,Pearson Publishers, 2013.
3. N.P. Bali and Manish Goyall "*A text book of Engineering Mathematics*", Laxmi Publication, Reprint, 2008.
4. Dean G. Duffy, "*Advanced Engineering Mathematics with MATLAB*", PCRC Press
5. Peter O'Neil, "*Advanced Engineering Mathematics*", Cengage Learning.
6. B.V. Ramana, "*Higher Engineering Mathematics*", McGraw Hill Education

Electronic Resources:

1. https://onlinecourses.nptel.ac.in/noc23_ma88/preview
2. https://onlinecourses.nptel.ac.in/noc23_ma86/preview
3. https://www.efunda.com/math/math_home/math.cfm
4. https://www.ocw.mit.edu/resourcs/#Mathematics
5. https://www.sosmath.com
6. https://www.mathworld.wolfram.com

Materials Online:

1. Course template
2. Tech-talk topics
3. Assignments
4. Definition and terminology
5. Tutorial question bank
6. Model question paper – I
7. Model question paper – II
8. Lecture notes
9. Early lecture readiness videos (ELRV)
10. Power point presentations

23. 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	Theory of Matrices: Types of Real Matrices	CO 1	T1:2.4 R3:3.11
2	Elementary Operations: Elementary Row and Column Transformations	CO 1	T1:2.7.2 R3:3.34
3	Rank of a Matrix by Echelon Form	CO 1	T1:2.7.4 R3:3.38
4	Rank of a Matrix by Normal Form	CO 1	T1:2.7.7 R3:3.38
5	Inverse of a Matrix by Gauss-Jordan Method	CO 1	T1:2.7.6 R3:3.37
6	Solving system of Non-Homogeneous equations	CO 1	T1:2.10.1 R3:3.39
7	Solving system of Homogeneous equations	CO 1	T1:2.10.3 R3:3.39
8	Solving system of Non Homogeneous equations(Unknown Values)	CO 1	T1:2.10.3 R3:3.39
9	Eigen Values of a Matrix	CO 2	T1:2.13.1 R3:3.46
10	Eigen Vectors of a Matrix	CO 2	T1:2.13.2 R3:3.47
11	Properties of Eigen values and Eigen Vectors of a Matrix Problems	CO 2	T1:2.14 R3:3.47
12	Cayley-Hamilton Theorem- Statement, Verification	CO 3	T1:2.15 R3:3.48
13	Applications of Cayley – Hamilton: Finding Inverse and Powers of a Matrix	CO 3	T1:2.15 R3:3.48
14	Diagonalization of Matrix by Linear Transformation	CO 3	T1:2.16.1 R3:3.49
15	Linear Dependence and Independence of Vectors	CO 3	T1:2.3 R3:3.2
16	Mean Value Theorems:1: Rolle's Theorem	CO 4	T1:4.3.1 R6:2.1
17	Mean Value Theorems:2: Lagrange's Theorem	CO 4	T1:4.3.2 R6:2.2
18	Mean Value Theorems:3: Cauchy's Theorem	CO 4	T1:4.3.3 R6:2.3

S.No	Topics to be covered	CO's	Reference
19	Functions of Several Variables: Partial Differentiation	CO 4	T1:5.2 R3:5.1
20	Jacobian Transformations	CO 4	T1:5.7.1 R3:5.10
21	Functional Dependence	CO 4	T1-5.7.4 R3:5.11
22	Maxima and Minima of Functions with Two Variables	CO 4	T1:5.11.1 R3:5.13
23	Maxima and Minima of Functions with Three Variables	CO 4	T1-5.11.1 R3:5.14
24	Method of Lagrange Multipliers	CO 4	T1-5.12 R3:5.15
25	Euler Coefficeients for Fourier Expansion of Periodic Function in a Given Interval of Length (-π,π),(0,2π)	CO 5	T1-10.2 R3:10.3
26	Fourier Series of Even Functions in a Given Interval of Length $(-\pi,\pi)$	CO 5	T1-10.6.1 R3:10.3
27	Fourier Series of Odd Functions in a Given Interval of Length $(-\pi,\pi)$	CO 5	T1-10.6.2 R3:10.3
28	Fourier Series of Neither Functions in a Given Interval of Length $(-\pi,\pi)$	CO 5	T1-10.6.2 R3:10.3
29	Fourier Series in an Arbitrary Interval (0,2l)	CO 5	T1-10.6.1 R3:10.6
30	Fourier Series in an Arbitrary Interval (-l,l)	CO 5	T1-10.6.2 R3:10.6
31	Half- Range Fourier Sine Expansions in a Given Interval of Length (0,π)	CO 5	T1-10.7 R3:10.7
32	Half- Range Fourier Cosine Expansions in a Given Interval of Length (0,π)	CO 5	T1-10.7 R3:10.7
33	Double Integrals in Constant Limits	CO 6	T1-7.1 R3:6.1
34	Double Integrals in Variable Limits	CO 6	T1-7.1 R3:6.2
35	Double Integrals in cartesian coordinates (Area enclosed by plane curves)	CO 6	T1-7.4 R3:6.2
36	Double Integrals in polar coordinates	CO 6	T1-7.3 R3:6.3
37	Change of order of integration (only Cartesian form)	CO 6	T1-7.2 R3:6.4
38	Triple Integrals in Constant Limits	CO 6	T1-7.5 R3:6.5
39	Triple Integrals in Variable Limits	CO 6	T1-7.5 R3:6.5

S.No	Topics to be covered	CO's	Reference
40	Double and Triple Integrals	CO 6	T1-7.1 R3:6.5
PROBLEM SOLVING/ CASE STUDIES			
1	Rank of the Matrix by Echelon and Normal Form	CO 1	T1-2.7 R3:3.38
2	Homogeneous and Non Homogeneous Equations	CO 1	T1-2.10 R3:3.39
3	Eigen Values and Eigen Vectors of the Matrix	CO 2	T1-2.13 R3:3.46
4	Eigen Values and Eigen Vectors of the Matrix	CO 2	T1-2.16 R3:3.49
5	Cayley Hamilton Theorem Problems	CO 3	T1-2.15 R3:3.48
6	Powers of the Matrix by Cayley Hamilton Theorem	CO 3	T1-2.15 R3:3.48
7	Powers of the Matrix by Cayley Hamilton Theorem	CO 4	T1-4.3 R6:2.1
8	Jacobians, Functional Relationship	CO 4	T1-5.7 R3:5.10
9	Maxima and minima problems	CO 4	T1-5.11 R3:5.13
10	Fourier Series expansion of Periodic Function in a Given Interval of Length 2π	CO 5	T1-10.2 R3:10.3
11	Fourier Expansion of Periodic Function in a Given Interval of Length $(-\pi, \pi)$	CO 5	T1-10.6 R3:10.3
12	Fourier Series in an Arbitrary Interval (-l,l), Fourier Sine, Cosine Series in Interval (0,l)	CO 5	T1-10.6 R3:10.6
13	Finding Double Integrals in Cartesian and Polar Coordinates	CO 6	T1:7.1 R3:6.1
14	Change of order of integration	CO 6	T1-7.2 R3:6.4
15	Triple Integrals	CO 6	T1-7.5 R3:6.5
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Rank of a Matrix, Homogeneous and Non-Homogeneous equations	CO 1	T1-2.7 R3:3.39
2	Eigen Values and Eigen Vectors, Diagonalization	CO 2, CO3	T1-2.13 R3:3.46
3	Mean Value Theorems, Jacobian Transformations, Functionally Dependent and Independent	CO 4	T1-4.3 R6:2.1
4	Fourier Series (Even, Odd, Neither Functions)	CO 5	T1-10.2 R3:10.3

S.No	Topics to be covered	CO's	Reference
5	Multiple Integrals (Double and Triple)	CO 6	T1-7.1 R3:3.6.1
DISCUSSION OF TUTORIAL QUESTION BANK			
1	Matrices	CO 1	T1-2.4 R3:3.11
2	Eigen Values and Eigen Vectors	CO 2, CO 3	T1-2.13 R3:3.46
3	Functions of Several Variables	CO 4	T1-5.2 R3:5.1
4	Fourier Series	CO 5	T1-10.2 R3:10.3
5	Multiple Integrals	CO 6	T1-7.1 R3:6.1

24. PROGRAM OUTCOMES & PROGRAM SPECIFIC 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
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

25. 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

26. 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

27. 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	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-

28. 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 modelled by matrices with help of Characteristic 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 modelled by matrices (principles of mathematics).	2

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 4	PO 1	Explain the mean–value theorems for the single variable functions and the extreme values for functions of several variables apply them in the complex engineering problems Partial derivatives of (principles of mathematics).	2
CO 5	PO 1	Build the Fourier series expansion for the complex engineering problems modelled 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
CO 6	PO 1	Determine the solution of complex engineering problems modelled by Double and Triple Integrals by using substitution method and principles of mathematics.	2
	PO 2	Model the problem with the help of ordinary integrations, prepare precise statement of the problem and apply on double and triple integrations by method of ordinary integration and other analytical methods to develop the solution and interpret, validate the results through proper documentation.	6

29. TOTAL COUNT 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	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	6	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	2	6	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	2	6	-	-	-	-	-	-	-	-	-	-	-	-	-

30. 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	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	66.6	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	66.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	66.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	66.6	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	66.6	60	-	-	-	-	-	-	-	-	-	-	-	-	-

31. 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	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	-	-	-	-	-	-	-	-	-	-	-	-	-

32. ASSESSMENT METHODOLOGY DIRECT:

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

33. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

34. Relevance to Sustainability goals:

Brief description about the course and how its relevance to SDGs.

Mathematics plays an important role in the achievement of the Sustainable Development Goals (SDG) and at the same time these allow working with real situations in the subject of mathematics, providing the student with active learning. Sustainability is used to make the student see the usefulness of mathematics while instilling values and attitudes towards it.

×	NO POVERTY	-
×	ZERO HUNGER	-
×	GOOD HEALTH AND WELL-BEING	-
✓	QUALITY EDUCATION	**Quality Education:** Minimizing school dropout: The teaching of mathematics plays an important role in the implementation of sustainable education to achieve future goals: to make learning mathematics more relevant and applicable, as well as to support the development of 21st century skills.
×	GENDER EQUALITY	-
×	CLEAN WATER AND SANITATION	-
×	AFFORDABLE AND CLEAN ENERGY	-
×	DECENT WORK AND ECONOMIC GROWTH	-
×	INDUSTRY, INNOVATION AND INFRASTRUCTURE	-
×	REDUCED INEQUALITIES	-

×	SUSTAINABLE CITIES AND COMMUNITIES	-
×	RESPONSIBLE CONSUMPTION AND PRODUCTION	-
×	CLIMATE ACTION	-
×	LIFE BELOW WATER	-
×	LIFE ON LAND	-
×	PEACE, JUSTICE AND STRONG INSTITUTIONS	-
×	PARTNERSHIPS FOR THE GOALS	-

Approved by: Board of Studies in the meeting conducted on ——————————.

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

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**				
2	Course Title	**ELECTRICAL CIRCUITS**				
3	Course Code	AEEC02				
4	Program	B.Tech				
5	Semester	I Semester				
6	Regulation	BT-23				
7	Structure of the course	Theory			Practical	
		Lecture	Tutorials	Credits	Lab	Credits
		3	0	3	2	1
8	Type of course (**Tick type of course**)	Core	Professional Elective	Open Elective	VAC	MOOCs
		✓	-	-	-	-
9	Course Offered	Odd Semester ✓		Even Semester ×		
10	**Total lecture, tutorial and practical hours for this course (16 weeks of teaching per semester)**					
	Lectures: .... hours		Tutorials: .... hours		Practical: .... hours	
11	Course Coordinator	Dr. L.Rajasekhar Goud				
12	Date Approved by BOS	22/08/2023				
13	Course Webpage	www.iare.ac.in/—-/—-				
14	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**	
		B.Tech	AHS00	I	Engineering Physics	

15. 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.

16. 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 principles of electromagnetic induction and its related electrical systems
IV	The characteristics of two-port networks and network topologies

17. COURSE OUTCOMES:

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

CO 1	**Define** the terminology used to study the characteristics of DC and AC electrical networks.	Remember
CO 2	**Discuss** the laws and indirect quantities associated with electrical circuit for branch currents and nodal voltages.	Understand
CO 3	**Summarize** the network 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 estimate total ampere turns.	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	**Illustrate** the dual networks for compare both mesh and nodal network.	Remember

18. Topic Learning Outcome (TLOs):

S.No	Topic(s)	TLO No	Topic Learning Outcome's	Course Out-come	Blooms Level
1	Introduction to electrical circuits	1	**Interpret** fundamental concepts of circuits through a procedural approach	CO 1	Understand
		2	**Aware** the ohm's law with in the class room	CO 1	Understand
		3	**Identify** the independent and dependent within the classroom as well as outside the classroom.	CO 1	Understand
		4	**Practice** Voltage current relations for paassive elements with in the class room	CO 1	Understand

S.No	Topic(s)	TLO No	Topic Learning Outcome's	Course Out-come	Blooms Level
3	Single phase AC Circuits	5	**Examine** Voltge and current relations of RL Circuit within the classroom and outside world	CO 1	Understand
		6	**Examine** Voltge and current relations of RC Circuit within the classroom and outside world	CO 1	Understand
4	Periodic waveforms	7	**Demonstrate** Triangle waveforms within the classroom.	CO 1	Understand
		8	**Demonstrate** Triangle waveforms within the classroom	CO 1	Understand
5	AC Circuits	9	**Familiar** with Concept of Impedance and be able to calculte impedance o different circuits	CO 1	Understand
		10	**Understand** Concept of Admittaance able to calculte impedance o different circuits	CO 2	Understand
6	Circuit Analysis	11	**Understand** Kirchoff;s lawswithin the classroom and outside world.	CO 2	Understand
		12	**Understand** Source traansformation techniques within the classroom and outside world	CO 2	Understand
		13	**Understand** Passive elements likeRLC within the classroom and outside world	CO 2	Understand
7	Star delta trasformation	14	**Understand** importance of star delta transfformation solving complex problems within the classroom and outside world	CO 2	Understand
8	Mesh and Nodal Analysis	15	**Understand** importance of Mesh and Nodal Analysis solving problems within the classroom and outside world	CO 2	Understand
9	Super Mesh and Super Node	16	**Solve** problems with Super Mesh and Super Node	CO 2	Understand
10	DC Network Theorems	17	**Understand** DC Network Theorems to solve different types of Networks	CO 3	Understand
11	AC Network Theorems	17	**Understand** AC Network Theorems to solve different types of Networks	CO 3	Understand
12	Faradays law of electro magnetic Induction	19	**Understand** Fundamental Principle of Electrical circuits	CO 4	Understand
13	Magnetic Circuits	20	**Understand** Self inductance of Inductive coils	CO 4	Understand

S.No	Topic(s)	TLO No	Topic Learning Outcome's	Course Out-come	Blooms Level
		21	**Able** to Identify Mutual inductance in inductive coils	CO 4	Understand
14	Series magnetic circuits	22	**Able** to Find pplications of Series magnetic circuit	CO 5	Understand
15	Parallel magnetic circuits	23	**Understand** Applications of Parallel magnetic circuits	CO 5	Understand
16	Two port Network	24	**Understand** Applications of Transmission lines	CO 5	Understand
17	Network topology	25	**Understnd** Importance of graph theory in electrical circuits	CO 6	Understand
18	Duality of Networks	26	**Understaand** the Applications of duality in electrical circuits	CO 6	Understand

19. Employability Skills

Example: Communication skills / Programming skills / Project based skills /
From maintaining power infrastructure to developing navigation and communications systems, electrical engineers play crucial roles across nearly every industry. With advanced electrical engineering skills, experts can lead the design, testing and manufacturing of the equipment that keep the world running.

20. Content Delivery / Instructional Methologies:

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

21. Evaluation Methodology:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). CIA is conducted for a total of 40 marks, with 20 marks for Continuous Internal Examination (CIE), and and 05 marks for each Definitions and Terminology / Quiz and remaining 10 marks for Tech Talk / Assignments.

Table 4: Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	CIA - I	CIA - II	SEE	Total Marks
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Definitions and Terminology / Quiz	05 Marks	05 Marks		10 Marks
Tech Talk / Assignment	05 Marks	05 Marks		10 Marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

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 12 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

22. Course content - Number of modules: Five:

MODULE I	**INTRODUCTION TO ELECTRICAL CIRCUITS** . | **Number of Lectures: 09**
	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** | **Number of Lectures: 09**
	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)** . | **Number of Lectures: 10**
	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** | **Number of Lectures: 09**
	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** . | **Number of Lectures: 08**
	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.
3. David A Bell, "*Electric circuits*", Oxford University Press, 7th Edition, 2009.
4. E Hughes, "*Electrical and Electronics Technology*", Pearson Education, 2010.
5. A Chakrabarthy, "*Electric Circuits*", Dhanipat Rai & Sons, 6th Edition, 2010.
6. V D Toro, "*Electrical Engineering Fundamentals*", Prentice Hall India, 1989.

MATERIALS ONLINE:

1. lectronic Resources: https://www.igniteengineers.com
2. https://www.ocw.nthu.edu.tw
3. https://www.uotechnology.edu.iq
4. https://www.iare.ac.in

23. 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 Electrical Circuits	CO 1	T1: 2.1
2	Basic Definitions and Ohm's Law at Constant Temperature	CO 1	T1:2.4

S.No	Topics to be covered	CO's	Reference
3	Classifications of Elements	CO 1	T1:2.4
4	Voltage and current relationships for passive elements	CO 1	T1:2.5
5	Introduction to Single phase AC circuits, Representation of alternating quantities	CO 1	T1: 2.1
6	Properties of different periodic wave forms, Phase and phase difference	CO 1	T1:2.4
7	Concept of Impedance, Admittance and Power in AC Circuits	CO 1	T1:2.4
8	Source transformation	CO 2	T1:1.5- 1.6
9	Kirchhoff's laws	CO 2	T1:1.8- 1.12
10	Introduction to Electrical Circuits	CO 1	T1: 2.1
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

S.No	Topics to be covered	CO's	Reference
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
PROBLEM SOLVING/ CASE STUDIES			
1	Total resistance, inductance and capacitance of circuits	CO 2	T1:10.8
2	Star - delta transformation technique	CO 2	T1:10.9- 10
3	Mesh analysis and Nodal analysis	CO 2	T4:10.10
4	Super mesh and Super node analysis.	CO 2	T1:8.2
5	Tellegen's and reciprocity theorems for DC excitations	CO 3	T1:1.1
6	Thevenin's and Norton's theorems for DC excitations	CO 3	T1:1.5- 1.6
7	maximum power transfer, Milliman's and compensation theorems for DC excitations	CO 3	T1:1.8- 1.12
8	Tellegen's and reciprocity theorems for excitations	CO 3	T1:1.13- 1.18
9	Thevenin's and Norton's theorems for AC excitations	CO 3	T1:1.19.1- 1.19.2
10	maximum power transfer, Milliman's and compensation theorems for AC excitations	CO 3	T1:1.19.1- 1.19.2
11	Dot convention, coefficient of coupling, composite magnetic circuit	CO 4	T1:1.193
12	analysis of series and parallel magnetic circuits	CO 4	T1:1.19.6
13	Two port parameters (Z, Y, T, ABCD)	CO 5	T1:1.19.
14	Incidence matrix, basic tie set and basic cut set matrices for planar networks	CO 5	T1:2.11.1
15	Duality and dual networks	CO 5	T1:2.11.1
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Introduction To Electrical Circuits	CO 1, CO2	R4:2.1

S.No	Topics to be covered	CO's	Reference
2	Analysis Of Electrical Circuits	CO3	T4:7.3
3	Network Theorems (DC And AC)	CO 4	R4:5.1
4	Magnetic Circuits	CO 5	T1:7.5
5	Two Port Network And Graph Theory	CO 6	T1: 4.1
DISCUSSION OF TUTORIAL QUESTION BANK			
1	Introduction To Electrical Circuits	CO 1, CO2	R4:2.1
2	Analysis Of Electrical Circuits	CO3	T4:7.3
3	Network Theorems (DC And AC)	CO 4	R4:5.1
4	Magnetic Circuits	CO 5	T1:7.5
5	Two Port Network And Graph Theory	CO 6	T1: 4.1

24. PROGRAM OUTCOMES & PROGRAM SPECIFIC 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
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 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
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.

25. 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

26. 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

27. 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	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-

28. 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 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 different Theorems with AC and DC excitation from obtained principles using basics fundamentals of mathematics and engineering sciences.	5

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 4	Conduct Investigations of Complex Problems with AC and DC excitation Use research methods including design of experiments.	5
CO 4	PO 1	Apply the knowledge of mathematics, science, engineering fundamentals to the solution of magnetic circuits	3
	PO 2	Describes the fundamental characteristics of electromagnetic induction, self and mutual inductance in the single coil and coupled coils magnetic circuits using basics fundamentals of mathematics and engineering sciences.	5
CO 5	PO 1	Recall the basics of mathematics, engineering sciences and other sciences to understand the concept of two port network and graph theory.	3
	PO 2	Validate the principles of different parameters and network topology from obtained principles using basics fundamentals of mathematics and engineering sciences.	5
	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 1	Recall the basics of mathematics, engineering sciences and other sciences to understand the concept of duality.	3

29. 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	-	-	-	-	-	-	-	-	-	-	-	-	-	-

30. 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	-	-	-	-	-	-	-	-	-	-	-	-	-	-

31. 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	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	2	-	1	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO 6	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	18	10	-	1	-		-	-	-	-	-	-	-	2	-
AVERAGE	3	2	-	1	-		-	-	-	-	-	-	-	2	-

32. ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	✓	Quiz	✓		

33. ASSESSMENT METHODOLOGY INDIRECT:

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

31. Relevance to Sustainability goals

Write brief description about the course and how its relevance to SDGs.

1		
2		
3		
4		**Quality Education:** This subject will improve the quality education in engineers and gives the awareness in electrical usage in day-to-day life.
5		
6		

7	AFFORDABLE AND CLEAN ENERGY	**Affordable and Clean Energy:** Understanding electrical circuits is crucial for developing sustainable energy solutions. Students who learn to design and optimize circuits can contribute to the development of efficient and clean energy systems, such as renewable energy sources and smart grids.
8	DECENT WORK AND ECONOMIC GROWTH	
9	INDUSTRY, INNOVATION AND INFRASTRUCTURE	**Industry, Innovation, and Infrastructure: :** Engineering drawing principles is crucial for developing and maintaining sustainable infrastructure and technological innovations. It contribute to designing safer, more durable, and environmentally friendly infrastructure projects.Electrical circuits are the foundation of modern technology and infrastructure. The skills gained in this course are essential for creating and maintaining advanced infrastructure, including telecommunications, transportation, and manufacturing systems.
10	REDUCED INEQUALITIES	
11	SUSTAINABLE CITIES AND COMMUNITIES	
12	RESPONSIBLE CONSUMPTION AND PRODUCTION	**Responsible Consumption and Production** This subject impacts the demand of electricity and need for saving energy
13	CLIMATE ACTION	
14	LIFE BELOW WATER	

15		
16		
17		

Approved by: Board of Studies in the meeting conducted on ——————————.

Signature of Course Coordinator **HOD,EEE**
Dr. L. Rajasekhar Goud, Associate Professor

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

OBJECT ORIENTED PROGRAMMING
COURSE TEMPLATE

1	Department	ELECTRICAL AND ELECTRONICS ENGINEERING				
2	Course code	ACSD01				
3	Course Title	OBJECT ORIENTED PROGRAMMING				
4	Class / Semester	I / I				
5	Regulation	BT-23				
6	Structure of the course	Theory			Practical	
		Lecture	Tutorials	Credits	Lab	Credits
		3	0	3	-	-
7	Type of course (Tick type of course)	Core	Professional Elective	Open Elective	VAC	MOOCs
		✓	-	-	-	-
8	Course Offered	Odd Semester ✓		Even Semester ×		
9	Total lecture, tutorial and practical hours for this course (16 weeks of teaching per semester)					
	Lectures: 48 hours		Tutorials: 0 hours		Practical: – hours	
10	Course Coordinator	Mr. D. Atchuta Ramacharyulu				
11	Date Approved by BOS	28/08/2023				
12	Course Webpage	https://www.iare.ac.in/?q=pages/btech-course-syllabi-bt23-cse				
13	Course Prerequistes	Level	Course Code	Semester	Prerequisites	
		-	-	-	-	

14. Course Overview
The course provides a solid foundation in object-oriented programming concepts in using them. It includes concepts object-oriented concepts such as information hiding, encapsulation, and polymorphism. It contrasts the use of inheritance and composition as techniques for software reuse. It provides an understanding of object-oriented design using graphical design notations such as Unified Modelling Language (UML) as well as object design patterns.

15. Course Objectives:

The students will try to learn:

I	The fundamental concepts and principles of object-oriented programming in high-level programming languages.
II	Advanced concepts for developing well-structured and efficient programs that involve complex data structures, numerical computations, or domain-specific operations.
III	The design and implementation of features such as inheritance, polymorphism, and encapsulation for tackling complex problems and creating well-organized, modular, and maintainable code.
IV	The usage of input/output interfaces to transmit and receive data to solve real-time computing problems.

16. Course Outcomes:

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

CO 1	**Interpret** the features of object-oriented programming languages, comparison, and evolution of programming languages.
CO 2	**Model** the real-world scenario using class diagrams and exhibit communication between objects.
CO 3	**Estimate** the need for special functions for data initialization.
CO 4	**Outline** the features of object-oriented programming for binding the attributes and behavior of a real-world entity.
CO 5	**Use** the concepts of streams and files that enable data management to enhance programming skills.
CO 6	**Develop** contemporary solutions to software design problems using object-oriented principles.

17. Topic Learning Outcome (TLOs):

S No	Topic(s)	TLO No	Topic Learning Outcome	Course Out-come	Blooms Level
1	Objects and legacy systems	1	**Summarize** fundamental concepts of programming through a procedural approach.	CO 1	Understand
		2	**Differentiate** between OOP and other programming paradigms such as procedural programming.	CO 1	Understand
2	Object-oriented programming	3	**Gain knowledge** to design and implement software solutions using OOP principles.	CO 1	Remember

S No	Topic(s)	TLO No	Topic Learning Outcome	Course Out-come	Blooms Level
		4	**Discuss** applications of OOP in software development, graphical user interface development, and mobile application development.	CO 1	Understand
3	Abstraction: Levels of abstraction	5	**Identify** the data components and behaviors of multiple abstract data types.	CO 1	Remember
		6	**Apply** techniques of decomposition to break a program into smaller pieces.	CO 1	Apply
		7	**Implement** a coherent abstract data type with loose coupling between components and behaviors.	CO 6	Apply
4	Classes and objects: Fields, methods, messages	8	**Interpret** knowledge by defining classes and creating instances to represent and interact with real-world entities or concepts.	CO 2	Understand
		9	**Instantiate** objects from classes to understand the relationship between classes and objects.	CO 2	Remember
5	Access specifiers: public, private, protected	10	**Enumerate** access specifiers' visibility and accessibility of class members (variables and methods) within different parts of a program.	CO 2	Remember
6	Class diagrams	11	**Create and interpret** class diagrams to visually represent classes, relationships, and interactions.	CO 2	Apply
7	Encapsulation	12	**Review** the encapsulation principle by specifying who can access and modify class members.	CO 3	Remember
		13	**Implement** encapsulation by using access modifiers (public, private, protected) to control access to class members.	CO 2	Apply
		14	**Use** static fields to keep a count of the number of objects that have been instantiated or to store a value that must be shared among all instances.	CO 6	Apply

S No	Topic(s)	TLO No	Topic Learning Outcome	Course Out- come	Blooms Level
8	Special member functions: Constructors, destructors	15	**Select** the constructor methods in initializing object attributes when instances are created.	CO 3	Remember
		16	**Illustrate** destructors to manage resources and perform cleanup operations in the classes such as closing files, releasing locks, or cleaning up cached data.	CO 6	Apply
9	Overloading: Functions, operators, constructors	17	**Express** the behavior of operators of a class that enriches programming skills in various ways that are both intuitive and flexible.	CO 3	Understand
		18	**Infer** that data is in a compatible format for specific operations or assignments to avoid unexpected behavior or data loss.	CO 3	Understand
		19	**List** the types of inheritance to facilitate code reuse, organization, and hierarchy for modeling complex systems.	CO 4	Remember
10	Inheritance: Subclasses, and method overriding	20	**Use** subclassing to design class hierarchies that allow code to be reused for distinct subclasses.	CO 4	Apply
		21	**Identify** the type of inheritance to create specialized classes that inherit the properties and behaviors of more general classes.	CO 4	Remember
11	Virtual functions	22	**Demonstrate** code flexibility using virtual functions to work with different types of objects through a common interface.	CO 4	Understand
12	Polymorphism	23	**Review** polymorphism on different derived classes to be treated as objects of their common base class.	CO 4	Remember
		24	**Understand and demonstrate** polymorphic behavior through function overriding and function overloading.	CO 4	Understand

S No	Topic(s)	TLO No	Topic Learning Outcome	Course Out-come	Blooms Level
13	Streams and files	25	**Illustrate** console input and output to create applications that interact with users, and process data.	CO 5	Understand
		26	**Label** objects to store them in files and deserialize them to recreate objects from files.	CO 5	Remember
		27	**Demonstrate** file-handling operations to enrich programming capabilities to create more sophisticated applications that interact with and manipulate external data sources effectively.	CO 5	Understand
		28	**Use** output with manipulators and predefined manipulatorsfor formatting input and output data.	CO 6	Apply
14	Command line arguments	29	**Interpret** software systems and applications to configure and control via command-line arguments.	CO 5	Understand

18. Employability Skills

Example: Communication skills / Programming skills / Project based skills /
1. Programming skills - The tech industry evolves rapidly, and staying up-to-date with the latest programming languages, frameworks, and development practices is crucial. Combining OOP skills with a commitment to continuous learning demonstrates a student's dedication to staying relevant in a dynamic field.
2. Project-based skills - Creating projects that utilize OOP principles allows a student to apply theoretical knowledge to real-world scenarios. This hands-on experience helps solidify their understanding of how OOP concepts work in practice.

19. Content Delivery / Instructional Methologies:

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

20. Evaluation Methodology:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). CIA is conducted for a total of 40 marks, with 20 marks for Continuous Internal Examination (CIE), 05 marks for each Definitions and Terminology / Quiz, and the remaining 10 marks for Tech Talk / Assignments.

Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE:

Activities	CIA - I	CIA - II	SEE	Total Marks
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Definitions and Terminology / Quiz	05 Marks	05 Marks		10 Marks
Tech Talk / Assignment	05 Marks	05 Marks		10 Marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

Semester End Examination (SEE): The SEE is conducted for 60 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. No choice is given in the first two modules. Each question carries 12 marks. There could be a maximum of two sub-divisions in a question.

21. Course content - Number of modules: Five

MODULE I	**Object-oriented concepts** | **Number of Lectures: 09**
	Objects and legacy systems, procedural versus Object-oriented programming, top-down and bottom-up approaches and their differences, benefits of OOP, applications of OOP, and features of OOP. **Abstraction:** Layers of abstraction, forms of abstraction, abstraction mechanisms.
MODULE II	**Classes and objects** | **Number of Lectures: 09**
	Classes and objects: Object data, object behaviors, creating objects, attributes, methods, messages, creating class diagrams. **Access specifiers and initialization of class members:** Accessing members and methods, access specifiers - public, private, protected, memory allocation. Static members, static methods.
MODULE III	**Special member functions and overloading** | **Number of Lectures: 09**
	Constructors and destructors: Need for constructors and destructors, copy constructors, dynamic constructors, parameterized constructors, destructors, constructors and destructors with static members. **Overloading:** Function overloading, constructor overloading, operator overloading - rules for overloading operators, overloading unary and binary operators, friend functions.

MODULE IV	**Inheritance and polymorphism**	**Number of Lectures: 09**
	Inheritance: types of inheritance, base class, derived class, usage of final, ambiguity in multiple and multipath inheritances, virtual base class, overriding member functions, order of execution of constructors and destructors. **Polymorphism and virtual functions:** Virtual functions, pure virtual functions, abstract classes, introduction to polymorphism, static polymorphism, dynamic polymorphism.	
MODULE V	**Console I/O and working with files**	**Number of Lectures: 09**
	Console I/O: Concept of streams, hierarchy of console stream classes, unformatted I/O operations, managing output with manipulators. **Working with files:** Opening, reading, writing, appending, processing, and closing different types of files, and command line arguments.	

TEXTBOOKS

1. Matt Weisfeld, *The Object-Oriented Thought Process*, Addison Wesley Object Technology Series, 4th Edition, 2013.

REFERENCE BOOKS:

1. Timothy Budd, *Introduction to object-oriented programming*, Addison Wesley Object Technology Series, 3rd Edition, 2002.
2. Gaston C. Hillar, *Learning Object-Oriented Programming*, Packt Publishing, 2015.
3. Kingsley Sage *Concise Guide to Object-Oriented Programming*, Springer International Publishing, 1st Edition, 2019.
4. Rudolf Pecinovsky, *OOP - Learn Object Oriented Thinking and Programming*, Tomas Bruckner, 2013.
5. Grady Booch, *Object-oriented analysis and design with applications*, Addison Wesley Object Technology Series, 3rd Edition, 2007.

MATERIALS ONLINE:

1. https://docs.oracle.com/javase/tutorial/java/concepts/
2. https://www.w3schools.com/cpp/
3. https://www.edx.org/learn/object-oriented-programming
4. https://www.geeksforgeeks.org/introduction-of-object-oriented-programming/

22. 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			
Discussion on Outcome Based Education, CO, POs, and PSOs			
CONTENT DELIVERY (THEORY)			
1	Objects and legacy systems	CO 1	T1, Pg: 05
2	Object-oriented programming	CO 1	T1, Pg: 06
3	Procedural versus object-oriented programming	CO 1	T1, Pg: 07, R4: Pg: 13
4	Top-down and bottom-up approaches and their differences	CO 1	R5: 1.5
5	Benefits and applications of OOP	CO 1	R5: 1.6
6	Features of OOP	CO 1	T1, Pg: 12
7	Abstraction and layers of abstraction	CO 1	R1: 2.1
8	Forms of abstraction	CO 1	R1: 2.2
9	Abstraction mechanisms	CO 1	R1: 2.3
10	Object data, object behaviors, creating objects	CO 2	T1, Pg:12, 13
11	Attributes, methods, messages	CO 2	T1, Pg:19, 20
12	Classes	CO 2	T1, Pg: 17
13	Creating class diagrams with examples	CO 2	T1, Pg: 20
14	Accessing members	CO 2	R5: 3.1
15	Accessing methods	CO 2	R5: 3.2
16	Access specifiers - public, private, protected with examples	CO 2	T1, Pg: 188
17	Memory allocation	CO 2	T1, Pg: 90
18	Static members, static methods	CO 2	T1, Pg: 90
19	Constructors need constructors and destructors	CO 3	T1, Pg: 71
20	Copy constructors with examples	CO 3	R1: 15.1
21	Dynamic constructors with examples	CO 3	R1: 15.3
22	Parameterized constructors and destructors	CO 3	R1: 15.3.1
23	Constructors and destructors with static members	CO 3	R1: 15.3.2
24	Function overloading, constructor overloading	CO 3	R1: 15.3.2
25	Operator overloading - rules for overloading operators	CO 3	R1: 15.3.2
26	Overloading unary and binary operators	CO 3	R1: 15.3.2
27	Friend functions	CO 3	R1: 15.3.2
28	Inheritance and types of inheritance	CO 4	T1, Pg: 153
29	Base class, derived class, usage of final	CO 4	T1, Pg: 45
30	Ambiguity in multiple and multipath inheritance	CO 45	T1, Pg: 136

S.No	Topics to be covered	CO's	Reference
31	Virtual base class, overriding member functions	CO 4	T1, Pg: 137
32	Order of execution of constructors and destructors	CO 4	T1, Pg: 28 R1: 14.1
33	Virtual functions, pure virtual functions	CO 4	T1, Pg: 28
34	Abstract classes	CO 4	T1, Pg: 21
35	Introduction to polymorphism	CO 4	T1, Pg: 21
36	Static polymorphism, dynamic polymorphism.	CO 4	T1, Pg: 21
37	Concept of streams, hierarchy of console stream classes.	CO 5	T1, Pg: 225
38	Unformatted I/O operations	CO 5	T1, Pg: 221
39	Managing output with manipulators and predefined manipulators.	CO 5	T1, Pg: 225
40	Data streams, the opening of a file	CO 5	R1: 2.5
41	Reading/writing a character from/into a file	CO 5	T1, Pg: 225
42	Appending into a file	CO 5	T1, Pg: 232
43	Processing and closing files	CO 6	T1, Pg: 227
44	Different types of files and file systems.	CO 5	T1, Pg: 226
45	Command line arguments	CO 5	T1, Pg: 228
46	Question bank discussion	CO 6	T1
47	Question bank discussion	CO 6	T1
48	Question bank discussion	CO 6	T1
PROBLEM SOLVING/ CASE STUDIES			
1	Design a class to represent books with attributes like title, author, and ISBN. Create a class for library patrons with borrowing history and due dates. Implement methods to borrow and return books, tracking availability, and due dates.	CO 1	
2	Design a class for products with properties like name, price, and description. Develop a shopping cart class that allows users to add and remove products. Use objects to create an interactive shopping experience with calculated totals.	CO 1	
3	Create a class for students with attributes like name, age, and enrolment status. Design a class for courses with properties like title, instructor, and schedule. Implement methods to enroll students in courses and track their progress.	CO 1	
4	Design a class representing a geometric shape (e.g., circle, rectangle). Use the const keyword to declare methods that provide information about the shape without modifying its properties.	CO 2	

S.No	Topics to be covered	CO's	Reference
5	Design a university class with nested classes for departments and courses. Utilize nested classes to represent the hierarchical structure of the university's organization.	CO 2	
6	Design a class representing employees with attributes like name, employee ID, and position. Use a constructor to initialize employee information when an object is created. Implement a destructor to handle any cleanup tasks or logging when an employee object is destroyed.	CO 2	
7	Implement a class for complex numbers with overloaded operators for addition, subtraction, multiplication, and division. Allow users to perform arithmetic operations on complex numbers using intuitive syntax.	CO 3	
8	Design a class for representing dates and overload comparison operators. Allow users to compare dates and determine their chronological order.	CO 3	
9	Create a utility to convert measurements between different units (e.g., inches to centimeters, pounds to kilograms). Utilize type conversion to handle unit conversions based on user input.	CO 3	
10	Design a base class Character with virtual functions for movement, attack, and interaction. Implement derived classes PlayerCharacter and EnemyCharacter that override the virtual functions. Use polymorphism to handle interactions between various characters in the game.	CO 4	
11	Create a base class Employee with virtual functions for calculating salary and displaying information. Implement derived classes RegularEmployee and ContractEmployee that override the virtual functions.	CO 4	
12	Design classes representing accounts (e.g., savings, checking) and customers. Use encapsulation to hide sensitive data and provide methods to deposit, withdraw, and check balances. Apply inheritance to create specialized account types, such as VIP accounts with additional features.	CO 4	
13	Develop an application to manage tasks and to-do lists. Use console stream classes to display tasks, prompt users for new tasks, and mark tasks as completed. Enable users to save and load their to-do lists to/from text files using file stream classes.	CO 5	
14	Create a calculator application that performs basic arithmetic operations. Utilize console stream classes to prompt users for operands and operators, and display the calculation results.	CO 5	

S.No	Topics to be covered	CO's	Reference
15	Create a utility that parses and analyzes log files. Read log files, extract relevant information, and present summaries. Use file streams to process large log files efficiently.	CO 5	
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Introduction to programming and object legacy.	CO 1	
2	Constructor and destructor.	CO 2	
3	Operator overloading.	CO 3	
4	Data hiding.	CO 4	
5	Command line arguments.	CO 5	
DISCUSSION OF TUTORIAL QUESTION BANK			
1	Classes and objects.	CO 1	
2	Constructors and destructors.	CO 2	
3	Overloading a unary and binary operator using friend function and member function.	CO 3	
4	Ambiguity in derived classes for multipath inheritance.	CO 4	
5	Console stream classes.	CO 5	

23. Program outcomes and Program specific 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
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.

24. 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:** Identity, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using the 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 public health and safety, and 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 modeling 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.	2	Tech talk/Definitions and terminology
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	CIE/SEE

25. How program-specific outcomes are assessed:

Program Specific Outcomes		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	Tech talk /Definitions and terminology/ Assignments

3 = High; 2 = Medium; 1 = Low

26. 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	✓	✓	✓	-	✓	-	-	-	-	✓	-	✓	-	-	-

27. 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 object-oriented programming while evaluating mathematical expressions in program statements. These concepts provide insight into expression evaluation by applying the principles of mathematics and science.	3
	PO 5	With the help of modern engineering tools, we can easily understand the basic concept of objects and classes while evaluating mathematical expressions in program statements.	1
	PO 10	Extend the knowledge of object-oriented programming to communicate effectively with the engineering community.	1
	PSO 3	Acquire sufficient knowledge of object-oriented concepts and apply it in real-time to build a successful career and do higher studies.	2
CO 2	PO 1	By applying the knowledge of mathematics, science, and engineering fundamentals we can effectively use the properties of OOP.	3
	PO 2	Apply nested classes in problem identification, statement, and validation.	5
	PO 3	Apply constructors and destructors to investigate and understand different complex engineering problems efficiently.	8
	PO 5	Apply static members to model complex engineering activities.	1
	PO 10	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	3
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.	8
	PO 3	Demonstrate the importance of indexing mechanisms in sequences while developing solutions for complex engineering problems and design systems using principles of mathematics, science, and engineering fundamentals. Use creativity to develop more innovative solutions.	6
	PO 5	Demonstrate overloading operators with the usage of modern tools.	1

COURSE OUTCOMES	PO'S PSO'S	**Justification for mapping (Students will be able to)**	No. of Key Competencies
	PSO 3	Infer sufficient knowledge of container data types and apply it in real-time for building a successful career and doing higher studies.	2
CO 4	PO 1	Demonstrate different modules/packages in object-oriented programming while developing solutions using the fundamentals of mathematics, science, and engineering.	3
	PO 3	Understand the usage of modules/packages while developing solutions for complex engineering problems and design systems using principles of mathematics, science, and engineering fundamentals. Use creativity to develop more innovative solutions.	8
	PO 5	Interpret different string functions by using modern tools.	1
	PO 10	Extend the focus to understanding the usage of modules/packages and communicating effectively with the engineering community.	2
	PO 12	Summarize string handling functions that involve manipulating and managing text or character data for tasks like data validation, formatting, and communication.	7
CO 5	PO 1	Make use of parameter passing and different types of arguments in user-defined functions to design efficient modular programs by applying the knowledge of mathematics, science, and Engineering fundamentals.	3
	PO 2	Apply modular programming concepts for problem identification, formulation, and data collection.	8
	PO 3	Select a strong foundation for writing efficient modular programs using parameter-passing mechanisms for career building by understanding the requirements and communicating effectively with the engineering community.	7
	PO 5	Develop different functions by using modern tools.	1
CO 6	PO 1	Apply scientific principles and methodologies, mathematical principles, and other engineering disciplines for procedural and object-oriented programming.	3
	PO 2	Apply object-oriented concepts in problem identification, statement, and validation.	7
	PO 3	Identify the need for object-oriented concepts while developing solutions for complex engineering problems and design systems using principles of mathematics, science, and engineering fundamentals. Use creativity to develop more innovative solutions.	7
	PO 5	Develop object-oriented principles using modern tools.	1
	PO 10	Apply the knowledge of object-oriented programming to communicate effectively with the engineering community.	2

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 12	Identify the need for object-oriented principles for the preparation and the ability to engage in independent and lifelong learning	6

28. 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	-	-	-	-	3
CO 2	3	2	3	-	3	-	-	-	-	3	-	-	-	-	-
CO 3	3	-	3	-	3	-	-	-	-	-	-	-	-	-	3
CO 4	3	-	3	-	3	-	-	-	-	2	-	3	-	-	-
CO 5	3	2	3	-	3	-	-	-	-	-	-	-	-	-	-
CO 6	3	3	3	-	3	-	-	-	-	2	-	3	-	-	-

29. Percentage of key competencies CO – PO / PSO:

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	100	0.0	0.0	0.0	100	0.0	0.0	0.0	0.0	20	0.0	0.0	0.0	0.0	100
CO 2	100	50	80	0.0	100	0.0	0.0	0.0	0.0	60	0.0	0.0	0.0	0.0	0.0
CO 3	100	0.0	60	0.0	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
CO 4	100	0.0	80	0.0	100	0.0	0.0	0.0	0.0	40	0.0	88	0.0	0.0	0.0
CO 5	100	80	70	0.0	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 6	100	80	70	0.0	100	0.0	0.0	0.0	0.0	40	0.0	75	0.0	0.0	0.0

30. 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		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	-	-	-	3	-	-	-	-	1	-	-	-	-	3

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 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	2	3	-	3	-	-	-	-	3	-	-	-	-	-
CO 3	3	-	3	-	3	-	-	-	-	-	-	-	-	-	3
CO 4	3	-	3	-	3	-	-	-	-	2	-	3	-	-	-
CO 5	3	2	3	-	3	-	-	-	-	-	-	-	-	-	-
CO 6	3	3	3	-	3	-	-	-	-	2	-	3	-	-	-
TOTAL	-	7	15	-	-	-	-	-	-	8	-	6	-	-	6
AVERAGE	3	2.3	3	-	3.0		-	-	-	2.0	-	3.0	-	-	3.0

31. Assessment methodology - Direct:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Laboratory Practices	-	Student Viva	-	Certification	-
Definitions and Terminology	✓	Tech talk / 5 Minutes Video	✓	Open Ended Experiments	-
Assignments	✓	Quiz	✓	Tech Talk	✓

32. Assessment methodology - Indirect:

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

33. Relevance to Sustainability goals

Write a brief description of the course and its relevance to SDGs.

1		
2		

3	GOOD HEALTH AND WELL-BEING	
4	QUALITY EDUCATION	**Quality education:** Guarantee an education system that is both inclusive and fair, offering high-quality learning experiences and lifelong opportunities accessible to all.
5	GENDER EQUALITY	
6	CLEAN WATER AND SANITATION	
7	AFFORDABLE AND CLEAN ENERGY	
8	DECENT WORK AND ECONOMIC GROWTH	
9	INDUSTRY, INNOVATION AND INFRASTRUCTURE	**Industry, innovation, and infrastructure:** Strong OOP skills enable to design and development of services like microservice architecture, cloud computing, machine learning, and AI integration in a modular and maintainable way, contributing to a more flexible and scalable infrastructure.

10	REDUCED INEQUALITIES	
11	SUSTAINABLE CITIES AND COMMUNITIES	**Sustainable cities and communities:** OOP skills can develop software solutions that contribute to urban sustainability, improve quality of life, and address challenges like smart city solutions, energy efficiency and monitoring, waste management systems, public transportation optimization, environmental sensor networks, education, and awareness faced by modern cities.
12	RESPONSIBLE CONSUMPTION AND PRODUCTION	
13	CLIMATE ACTION	
14	LIFE BELOW WATER	
15	LIFE ON LAND	
16	PEACE, JUSTICE AND STRONG INSTITUTIONS	

17		

Approved by: Board of Studies in the meeting conducted on 28-08-2023.

Signature of Course Coordinator **HOD EEE**
Mr. D.Atchuta Ramacharyulu, Assistant Professor

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

1	Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**			
2	Course Title	**PROFESSIONAL COMMUNICATION LABORATORY**			
3	Course Code	AHSD04			
4	Program	B.Tech			
5	Semester	I Semester			
6	Regulation	BT23			
7	Structure of the course	Practical			
		Lecture Hours		Practical Hours	
		3		3	
8	Course Offered	Odd Semester ✓		Even Semester ×	
9	Course Coordinator	Dr Jan Mohmad Pandit			
10	Date Approved by BOS	24/08/2023			
11	Course Webpage	https://www.iare.ac.in/?q=pages/btech-course-syllabi-bt23-ae			
12	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**
		B.Tech	AHSD04	I	-

13. Course Overview
This laboratory course is designed to introduce students to create a wide exposure on language learning techniques of the basic elements of listening skills, speaking skills, reading skills and writing skills. In this laboratory, students are trained in communicative English language skills, phonetics, word accent, word stress, rhythm, intonation, oral presentations and extempore speeches. Students are also taught in terms of seminars, group-discussions, presenting techniques of writing, participating in role plays, telephonic etiquettes, asking and giving directions, information transfer, debates, description of persons, places and objects etc. The laboratory encourages 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.

18. COURSE OBJECTIVES:
The students will try to learn:

I	English speech sounds, word accent, intonation and stress patterns for effective pronunciation.
II	Critical aspect of speaking and reading for interpreting in-depth meaning between the sentences.

III	Language techniques for social interactions such as public speaking, group discussions and interviews.
IV	Computer-assisted multi-media instructions and independent language learning.

19. COURSE OUTCOMES:

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

CO 1	**Articulate** the use of draw, modify and dimension commands of AutoCAD for development of 2D and 3D drawings.	Understand
CO 2	**Differentiate**stress shifts, syllabification and make use of past tense and plural markers effectively in connected speech; besides participate in role plays with confidence.	Understnad
CO 3	**Apply** weak forms and strong forms in spoken language and maintain intonation patterns as a native speaker to avoid mother tongue influence; moreover, practice various etiquettes at professional platform.	Understand
CO 4	**Demonstrate** Errors in pronunciation and the decorum of oral presentations; for that reason, take part joining in group discussions and debates with much critical observations	Understand
CO 5	**Strengthen** writing effective messages, notices, summaries and also able to write reviews very critically of art and academical videos.	Understnad
CO 6	**Argue** scholarly, giving the counters to open ended experiments, and also writing slogans for the products talentedly.	Understand

14. Employability Skills

1. **Employment advantage:**Effective English language and communication skills are crucial in many aspects of life, including education, business, workplace and social interactions. Proficient English language skills enable individuals to express themselves clearly, understand others, and engage in meaningful conversations. As the primary language of communication across the globe, proficiency in English is a highly sought-after skill in the international workplace and one of the benefits of learning English is therefore that it significantly boosts our job opportunities

16. Content Delivery / Instructional Methologies:

✓	Day to Day lab evaluation	✓	Demo Video	✓	Viva Voce questions	x	Open Ended Experiments
x	Competitions	x	hackathons	x	Certifications	x	Probing Further Questions

17. Evaluation Methodology:

Each laboratory will be evaluated for a total of 100 marks consisting of 40 marks for internal assessment and 60 marks for semester end lab examination. Out of 40 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance including viva voce, 10 marks for the final internal lab assessment and remaining 10 marks for The remaining 10 marks are for Laboratory Report/Project and Presentation, which consists of the Design (or) Software / Hardware Model Presentation (or) App Development (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 40 marks (Table 1), with 20 marks for continuous lab assessment during day-to-day performance including viva voce, 10 marks for final internal lab assessment and remaining 10 marks for Laboratory Report / Project and Presentation.

Table 3: CIA marks distribution

Component				
Type of Assessment	Day to Day performance and viva voce examination	Final internal lab assessment	Laboratory Report / Project and Presentation	Total Marks
CIA marks	20	10	10	40

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.

Table 4: Experiment based

Objective	Analysis	Design	Conclusion	Viva voce	Total
					20

Table 5: Programming based

Objective	Analysis	Design	Conclusion	Viva voce	Total
					20

Semester End Examination:

The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the other colleges which will be decided by the Head of the institution.

In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

1. 10 marks for write-up
2. 15 for experiment/program
3. 15 for evaluation of results
4. 10 marks for presentation on another experiment/program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course.

20. SYLLABUS:

CO 1	**Recognise English speech sounds in order to execute formal and informal communication**
	1. Introduction to pronunciation 2. Introducing self and introducing others and feedback 3. Introduction to phonetics, listening to English sounds, Vowel and Consonant sounds 4. Describing a person or place or a thing using relevant adjectives – feedback 5. Pronunciation practice
CO 2	**Construct required dialogues in role plays in verbal communication**
	1. Role plays on fixed expressions in various situations 2. Structure of syllables 3. Asking for directions and giving directions 4. Weak forms and strong forms 5. Intonation
CO 3	**ADifferentiate mother tongue influence while speaking English in JAM sessions, debates, group discussions and telephonic conversations.**
	1. Word accent and stress shifts 2. JAM Sessions using public address system 3. Extempore-Picture 4. Etiquette 5. Debates 6. Listening comprehension 7. Group discussion
CO 4	**Pronounce past tense and plural markers and weak forms and strong forms as a native speaker.**
	1. Past tense and plural markers 2. Neutralization of Mother Tongue Influence (MTI) 3. Weak forms and strong forms 4. Common errors in pronunciation practice through tongue twisters 5. Minimal pairs

CO 5	**Demonstrate the techniques of writing leaflets, messages and notices..**
	1. Writing slogan related to the image 2. Providing reviews and remarks 3. Writing slogan related to the image 4. Demonstration on how to write leaflets, messages and notices
CO 6	**Use language appropriately during interviews and oral presentations.**
	1. Oral presentations 2. Techniques and methods to write summaries and reviews of videos 3. Information transfer 4. Open ended experiments-phonetics practice 5. Open ended experiments-text to speech

Note: One Course Outcome may be mapped to multiple number of experiments.

TEXTBOOKS

1. Professional Communication laboratory manual.

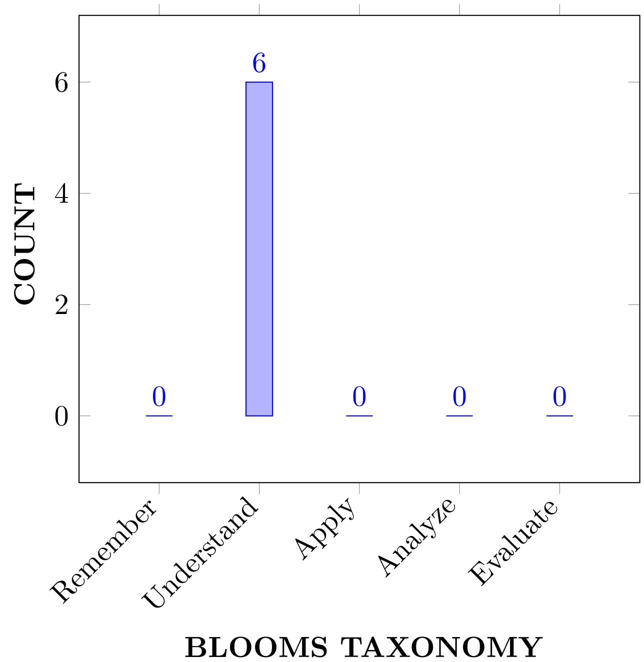
REFERENCE BOOKS:

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..

MATERIALS ONLINE:

1. Cambridge online pronunciation dictionary https://dictionary.cambridge.org/
2. Cambridge online pronunciation dictionary https://dictionary.cambridge.org/
3. Repeat after us https://brycs.org/clearinghouse/3018/
4. Language lab https://brycs.org/clearinghouse/3018/
5. Oxford online videos

22. COURSE KNOWLEDGE COMPETENCY LEVEL



33. 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	CALL LAB: Introduction to pronunciation ICS LAB: Introducing self and introducing others and feedback:	CO 1	Understnad
2	CALL LAB: Introduction to phonetics, listening to English sounds, Vowel and Consonant sounds. ICS LAB: Describing a person or place or a thing using relevant adjectives – feedback	CO 1	Understnad
3	CALL LAB: Structure of syllables. ICS LAB: JAM Sessions using public address system	CO 2	Understnad
4	CALL LAB: Word accent and stress shifts. ICS LAB: Asking for directions and giving directions	CO 2	Understand
5	CALL LAB: Past tense and plural markers ICS LAB: Role plays on fixed expressions in various situations	CO 2	Understand
6	CALL LAB: Weak forms and strong forms ICS LAB: Extempore-Picture	CO 3	Understand
7	CALL LAB: Intonation ICS LAB: Interpretation of Proverbs and Idioms	CO 3	Understand
8	CALL LAB: Neutralization of Mother Tongue Influence (MTI) ICS LAB: Etiquette	CO 3	Understand

S.No	Topics to be covered	CO's	Reference
9	CALL LAB: Common errors in pronunciation practice through tongue twisters ICS LAB: Oral Presentations	CO 4	Understand
10	CALL LAB: Minimal pairs ICS LAB: Debates	CO 4	Understand
11	CALL LAB: Listening comprehension ICS LAB: Group discussion	CO 4	Understand
12	CALL LAB: Demonstration on how to write leaflets, messages and notices. ICS LAB: Techniques and methods to write summaries and reviews of videos	CO 5	Understand
13	CALL LAB: Pronunciation practice ICS LAB: Information transfer	CO 5	Understand
14	CALL LAB; Open Ended Experiments-Phonetics Practice ICS LAB: Providing reviews and remarks	CO 6	Understand
15	CALL LAB: Open Ended experiments-Text to Speech. ICS LAB: Writing slogan related to the image	CO 6	Understand

23. PROGRAM OUTCOMES & PROGRAM SPECIFIC OUTCOMES:

Program Specific 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 Specific 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
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.

24. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		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	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	5	CIE/Quiz/AAT

25. 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

26. 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	-	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-

27. 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 significance of individual learning and the advantages of being a team member and also develop leadership qualities.	5
CO 2	PO 9, PO 10	Demonstrate about roleplays and its impact to enhance fluency levels. Strengthen word accent and stress shifts while doing group discussions.	3, 5
CO 3	PO 9, PO 10	Use intonation in connected speech while participating debates. Identify the number syllables in words and pronounce them as a native speaker.	3, 5
CO 4	PO 10	Pronouns the sentences within the tone boundaries maintaining the melody of the language	3

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 5	PO 10	Interpret writing leaflets, messages and notices like a professional.	5
CO 6	PO 9, PO 10	Explain the procedure of preparing for interviews and academical oral presentations. Besides, recognising English speech sounds in order to maintain speaking efficiency	3, 5

28. 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	-	-	-	-	-	-	-	-	3	5	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	-	3	5	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-
CO 5	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-
CO 6	-	-	-	-	-	-	-	-	3	5	-	-	-	-	-

29. 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	100	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	-	100	100	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	-	-	100	-	-	-	-	-
CO 5	-	-	-	-	-	-	-	-	-	100	-	-	-	-	-
CO 6	-	-	-	-	-	-	-	-	100	100	-	-	-	-	-

30. 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		
	PO 1	PO 2	PO 3	PO 4	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	3	-	-	-	-	-
CO 3	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
CO 4	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO 5	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO 6	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
TOTAL	-	-	-	-	-	-	-	-	9	18	-	-	-	-	-
AVERAGE	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-

31. ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Laboratory Practices	✓
Certification	-	Student Viva	✓	Open Ended Experiments	-

32. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

Experiments for enhanced learning (EEL):

S.No	Design Oriented Experiments

15. Relevance to Sustainability goals

Write brief description about the course and how its relevance to SDGs.

1		
2		

3	GOOD HEALTH AND WELL-BEING	
4	QUALITY EDUCATION	**E**nglish language has become linguafranca across the globe. For that reason, it is compulsory to learn this language at advanced level. In MNC commpanies, those who have excellent communication skills ,their carrer graph is going to high very quickly. Hence ,the role of English language has become a part of the life.
5	GENDER EQUALITY	
6	CLEAN WATER AND SANITATION	
7	AFFORDABLE AND CLEAN ENERGY	
8	DECENT WORK AND ECONOMIC GROWTH	
9	INDUSTRY, INNOVATION AND INFRASTRUCTURE	
10	REDUCED INEQUALITIES	

11		
12		
13		
14		
15		
16		
17		

Approved by: Board of Studies in the meeting conducted on ——————————.

Signature of Course Coordinator **HOD**
Dr Jan Mohmad Pandit, Assistant Professor

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

COURSE TEMPLATE

<table>
<tr><td>1</td><td>Department</td><td colspan="4">ELECTRICAL AND ELECTRONICS ENGINEERING</td></tr>
<tr><td>2</td><td>Course Code</td><td colspan="4">AEED04</td></tr>
<tr><td>3</td><td>Course Title</td><td colspan="4">ELECTRICL CIRCUITS LABORATORY</td></tr>
<tr><td>4</td><td>Semester</td><td colspan="4">I</td></tr>
<tr><td>5</td><td>Regulations</td><td colspan="4">BT-23</td></tr>
<tr><td rowspan="3">6</td><td rowspan="3">Structure of the course</td><td colspan="4">Practical</td></tr>
<tr><td colspan="3">Lecture Hours</td><td>Practical Hours</td></tr>
<tr><td colspan="3">-</td><td>36</td></tr>
<tr><td>7</td><td>Course Offered</td><td colspan="2">Odd Semester ✓</td><td colspan="2">Even Semester ×</td></tr>
<tr><td>8</td><td>Course Coordinator</td><td colspan="4">Mr. P.Shiva Kumar</td></tr>
<tr><td>9</td><td>Date Approved by BOS</td><td colspan="4">24/08/2023</td></tr>
<tr><td>10</td><td>Course Webpage</td><td colspan="4">https://www.iare.ac.in/sites/default/files/BT23/AEED04.pdf</td></tr>
<tr><td rowspan="2">11</td><td rowspan="2">Course Prerequistes</td><td>Level</td><td>Course Code</td><td>Semester</td><td>Prerequisites</td></tr>
<tr><td>Intermediate</td><td>-</td><td>-</td><td>Physics</td></tr>
</table>

12. Course Overview

The course is designed to provide students with hands-on experience and practical skills in the field of electrical engineering. It serves as a complement to the theoretical concepts learned in the concurrent electrical circuits course. This course explores fundamental electrical concepts, such as Ohm's Law, circuit analysis, network theorems, and component characterization. This course is useful for students to gain an in-depth understanding of fundamental electrical circuits, components, measurement techniques, and trouble shooting

13. Course Objectives:

The students will try to learn:

I	The basic laws, network reduction techniques and theorems for different circuits.
II	The circuit design, measurement, testing, and analysis using laboratory equipment such as multimeters, and power supplies.
III	The types of two port network prameters for different circuits.

14. Course Outcomes:

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

CO1	**C**alculate the source resistance, currents, voltage and power in an electrical circuit using various laws associated with electrical circuits	Understand
CO2	**E**valuate the alternating quantities for different periodic waveforms.	Understand
CO3	**D**escribe the superposition principle, reciprocity and maximum power transfer condition for the electrical network with DC excitation.	Understand
CO4	**D**emonstrate Thevenin's and Norton's theorems to reduce complex networks into simple equivalent networks with DC excitation.	Apply
CO5	**A**pply Faraday's laws of electromagnetic induction in the construction of magnetic circuits.	Apply
CO6	**M**ake use of the two port parameters to be measured easily, without solving for all the internal voltages and currents in the different networks.	Apply

15. Employability Skills

1. **Innovative Thinking:** This course helps the students to think innovative through different experiments and tests.
2. **Technological Knowledge:** Here they gain technical knowledge on electrical equipment.
3. **Safety awareness:** Students get holistic safety awareness about electricity which is very important for anyone.

16. Content Delivery / Instructional Methologies:

✓	Day to Day lab evaluation	✓	Demo Video	✓	Viva Voce questions	x	Open Ended Experiments
x	Competitions	x	hackathons	x	Certifications	✓	Probing Further Questions

17. Evaluation Methodology:

Each laboratory will be evaluated for a total of 100 marks consisting of 40 marks for internal assessment and 60 marks for semester end lab examination. Out of 40 marks for internal assessment, continuous lab assessment will be done for 20 marks for the day today's performance including viva voce, 10 marks for the final internal lab assessment, and the remaining 10 marks for Laboratory Report/Project and Presentation, which consists of the Design (or) Software / Hardware Model Presentation (or) AppDevelopment (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 40 marks (Table 1), with 20 marks for continuous lab assessment-during day-to-day performance including viva voce, 10 marks for final internal lab assessment and remaining 10 marks for Laboratory Report/Project and Presentation.

Table 1.0: CIA marks distribution

Component				
Type of Assessment	Day to Day performance and viva voce examination	Final internal lab assessment	Laboratory Report / Project and Presentation	Total Marks
CIA marks	20	10	10	40

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.

Table 2.0: Experiment based

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

Table 3.0: Programming based

Objective	Analysis	Design	Conclusion	Viva voce	Total

Semester End Examination:
The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the other colleges which will be decided by the Head of the institution.
In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

1. 10 marks for write-up
2. 15 for experiment/program
3. 15 for evaluation of results
4. 10 marks for presentation on another experiment/program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course.

18. Course Content:

CO 1	**Solve the source resistance, currents, voltage and power using various laws associated with electrical circuits.**
	1. Introduction to electrical circuits 2. Exercises on Basic Electrical Circuit Law's 3. Exercises on Mesh Analysis 4. Exercises on Nodal Analysis
CO 2	**Analyze the alternating quantities for different periodic waveforms**
	1. Exercises on Characteristics of Periodic Waveforms
CO 3	**Perform the superposition principle, reciprocity and maximum power transfer condition for the electrical network with DC excitationy**
	1. Exercises on Superposition Theorem 2. Exercises on Reciprocity Theorem 3. Exercise on Maximum Power Transfer Theorem
CO 4	**Demonstrate Thevenin's and Norton's theorems to reduce complex networks into simple equivalent networks with DC excitation**
	1. Exercises on Thevenin's Theorem 2. Exercises on Norton's Theorem
CO 5	**Apply Faraday's laws of electromagnetic induction for calculating the various performance parameters in magnetic circuits.**
	1. Exercises on Determination of Circuit Impedance 2. Exercise on Series and Parallel Resonance
CO 6	**Use the connecting wires of good continuity, short circuit of connecting wire leads damage of circuit parameters.**
	1. Exercise on Z and Y Parameters 2. Exercise on H and ABCD Parameters

19. 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	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	
2	Introduction to electrical circuits	CO 1	T1:2.1 R1:1.12.3
3	Exercises on Basic Electrical Circuit Law's	CO 1	T1:1.12-1.18 R1:1.15
4	Exercises on Mesh Analysis	CO 1	T1:5.1-5.2 R1:1.16
5	Exercises on Nodal Analysis	CO 2	T1:5.3 R1:1.13.1
6	Exercises on Characteristics of Periodic Waveforms	CO 3	T1:2.4 R1:1.13.2
7	Exercises on Superposition Theorem	CO 3	T1:2.4 R1:1.13.3
8	Exercises on Reciprocity Theorem	CO 3	T1:5.1-5.2 R1:1.7.1
9	Exercise on Maximum Power Transfer Theorem	CO 3	T1:5.3 R1:1.17.3
10	Exercises on Thevenin's Theorem	CO 4	T1:5.3 R1:2.6.1
11	Exercises on Norton's Theorem	CO 4	T1:5.7 R1:2.6.2
12	Exercises on Determination of Circuit Impedance	CO 5	T1:1.3-1.8 R1:2.10
13	Exercise on Series and Parallel Resonance	CO 5	T1:8.12-8.14
14	Exercise on Z and Y Parameters	CO 6	T1:8.12-8.14
15	Exercise on H and ABCD Parameters	CO 6	T1:8.12-8.14

20 Experiments for Enhanced Learning (EEL):

S.No	Design Oriented Experiments
1	Design series and parallel networks using resistors,inductors and capacitors
2	Using MATLAB Verify phase relations of RLC circuits

21. Program Outcomes & Program Specific 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
Program Specific Outcomes	
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization

Program Outcomes	
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.

22. 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 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	CIE/Quiz/AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations,and give and receive clear instructions.	2	CIE/Quiz/AAT

23. How program specific outcomes are assessed:

Program Specific Outcomes		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	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

24. 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	✓	✓	-	-	✓	-	-	-	-	✓	-	-	-	-	✓

25. 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 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.	3
	PO 5	Validate the principles of different laws associated with electrical circuits using digital simulation	1
	PO 10	Improve the documentation skills for their problem-solving approaches, calculations, and findings, resulting in well-structured and informative reports	1
	PSO 3	Verify the various electrical circuit laws using computing tools like Simulink	1
CO 2	PO 1	Recall the basics of mathematics, engineering sciences and other sciences to understand the concept of Kirch- hom's laws	3
	PO 2	Analyze mesh analysis and nodal analysis technique using principles of mathematics, science and engineering fundamentals	5
	PO 5	Analyze mesh analysis and nodal analysis technique using digital simulation	1
	PO 10	Improve the documentation skills for their problem-solving approaches, calculations, and findings, resulting in well-structured and informative reports	1

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PSO 3	Verify mesh and nodal analysis using computing tools like Simulink	1
CO 3	PO 1	Apply the basics of mathematics, engineering sciences and other sciences to understand the network theorems	3
	PO 2	Describes the different Theorems with AC andDC excitation from obtained principles using basics fundamentals of mathematics and engineering sciences.	5
	PO 5	Construct various electrical circuits to validate Theorems with DC excitation using digital simulation	1
	PO 10	Improve the documentation skills for their problem-solving approaches, calculations, and findings, resulting in well-structured and informative reports	1
	PSO 3	Verify the superposition principle, reciprocity and maximum power transfer condition for the electrical network with DC excitation using computing tools like Simulink	1
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
	PO 5	Construct various electrical circuits to validate Thevenin's and Norton's theorems using digital simulation	1
	PO 10	Improve the documentation skills for their problem-solving approaches, calculations, and findings, resulting in well-structured and informative reports	1
	PSO 3	Verify Thevenin's and Norton's theorems for the electrical network with DC excitation using computing tools like Simulink	1
CO 5	PO 1	Recall the basics of mathematics, engineering sciences and other sciences to understand the concept of two port network and graph theory.	3
	PO 2	Validate the principles of different parameters and network topology from obtained principles using basics fundamentals of mathematics and engineering sciences.	5
	PO 5	Validate the principles of different parameters and network topology using digital simulation.	1

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 10	Improve the documentation skills for their problem-solving approaches, calculations, and findings, resulting in well-structured and informative reports	1
	PSO 3	Study the frequency response characteristics of series resonance circuit and plot the waveforms using computing tools like Simulink	1
CO 6	PO 1	Identify complex engineering problems on two port network and graph theory using first principles of mathematics, natural sciences, and engineering sciences.	3
	PO 2	Recall the basics of mathematics, engineering sciences and other sciences to understand the concept of duality.	5
	PO 5	Determine the H and ABCD parameters for Circuit using digital simulation.	1
	PO 10	Improve the documentation skills for their problem-solving approaches, calculations, and findings, resulting in well-structured and informative reports	1
	PSO 3	Evalute the two port network parameters in various electrical circuits using computing tools like Simulink	1

26. 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	-	-	1	-	-	-	-	3	-	-	-	-	2
CO 2	3	5	-	-	1	-	-	-	-	3	-	-	-	-	2
CO 3	3	5	-	-	1	-	-	-	-	3	-	-	-	-	2
CO 4	3	5	-	-	1	-	-	-	-	3	-	-	-	-	2
CO 5	3	5	-	-	1	-	-	-	-	3	-	-	-	-	2
CO 6	3	5	-	-	1	-	-	-	-	3	-	-	-	-	2

27. 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	-	-	100	-	-	-	-	60	-	-	-	-	28.5
CO 2	100	50	-	-	100	-	-	-	-	60	-	-	-	-	28.5
CO 3	100	50	-	-	100	-	-	-	-	60	-	-	-	-	28.5
CO 4	100	50	-	-	100	-	-	-	-	60	-	-	-	-	28.5

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 5	100	50	-	-	100	-	-	-	-	60	-	-	-	-	28.5
CO 6	100	50	-	-	100	-	-	-	-	60	-	-	-	-	28.5

28. 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		
	PO 1	PO 2	PO 3	PO 4	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	-	-	-	-	3	-	-	-	-	1
CO 2	3	2	-	-	3	-	-	-	-	3	-	-	-	-	1
CO 3	3	2	-	-	3	-	-	-	-	3	-	-	-	-	1
CO 4	3	2	-	-	3	-	-	-	-	3	-	-	-	-	1
CO 5	3	2	-	-	3	-	-	-	-	3	-	-	-	-	1
CO 6	3	2	-	-	3	-	-	-	-	3	-	-	-	-	1
TOTAL	18	12	-	-	18		-	-	-	-	-	-	-	-	-
AVERAGE	3	2	-	-	3	-	2	-	-	-	-	-	-	-	-

29. Assessment methodology direct:

CIE Exams	✓	SEE Exams	✓	Laboratory Practices	✓
Certification	-	Student Viva	✓	Open Ended Experiments	-

30. Assessment methodology indirect:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

31. Relevance to Sustainability goals

Write brief description about the course and how its relevance to SDGs.

1	NO POVERTY	
2	ZERO HUNGER	
3	GOOD HEALTH AND WELL-BEING	
4	QUALITY EDUCATION	**Quality Education:** This subject will improve the quality education in engineers and gives the awareness in electrical usage in day-to-day life.
5	GENDER EQUALITY	
6	CLEAN WATER AND SANITATION	
7	AFFORDABLE AND CLEAN ENERGY	**Affordable and Clean Energy:** Understanding electrical circuits is crucial for developing sustainable energy solutions. Students who learn to design and optimize circuits can contribute to the development of efficient and clean energy systems, such as renewable energy sources and smart grids.
8	DECENT WORK AND ECONOMIC GROWTH	

9		**Industry, Innovation, and Infrastructure: :** Engineering drawing principles is crucial for developing and maintaining sustainable infrastructure and technological innovations. It contribute to designing safer, more durable, and environmentally friendly infrastructure projects.Electrical circuits are the foundation of modern technology and infrastructure. The skills gained in this course are essential for creating and maintaining advanced infrastructure, including telecommunications, transportation, and manufacturing systems.
10		
11		
12		**Responsible Consumption and Production** This subject impacts the demand of electricity and need for saving energy
13		
14		
15		

16		
17		

Approved by: Board of Studies in the meeting conducted on ——————————.

Signature of Course Coordinator **HOD,EEE**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**			
2	Course Title	**OBJECT ORIENTED PROGRAMMING WITH JAVA**			
3	Course Code	ACSD02			
4	Program	B.Tech			
5	Semester	I Semester			
6	Regulation	BT-23			
7	Structure of the course	Practical			
		Tutorial Hours		Practical Hours	
		1		2	
8	Course Offered	Odd Semester ✓		Even Semester ×	
9	Course Coordinator	Mr. D. Atchuta Ramacharyulu			
10	Date Approved by BOS	25/08/2023			
11	Course Webpage	www.iare.ac.in/—-/—-			
12	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**
		-	-	-	-
		-	-	-	-

13. COURSE OVERVIEW

This course provides a solid foundation in object-oriented programming concepts and hands-on experience in using them. It introduces the concepts of abstraction and reusable code design via the object-oriented paradigm. Through a series of examples and exercises students gain coding skills and develop an understanding of professional programming practices. Mastering Java facilitate the learning of other technologies.

14. COURSE OBJECTIVES

The students will try to learn:

I	The strong foundation with the Java Virtual Machine, its concepts and features.
II	The systematic understanding of key aspects of the Java Class Library
III	The usage of a modern IDE with an object oriented programming language to develop programs.

15. COURSE OUTCOMES

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

CO 1	Develop non-trivial programs in an modern programming language.
CO 2	Apply the principles of selection and iteration.
CO 3	Appreciate uses of modular programming concepts for handling complex problems.
CO 4	Recognise and apply principle features of object-oriented design such as abstraction and encapsulation.
CO 5	Design classes with a view of flexibility and reusability.
CO 6	Code, test and evaluate small usecases to conform to a specification.

16. EMPLOYABILITY SKILLS

1. **Problem-Solving and Critical Thinking:** Students learn to analyze complex problems, design solutions using Java's object-oriented principles, and translate real-world scenarios into code.
2. **Debugging and Troubleshooting:** Debugging challenges in the lab help students master error identification, interpretation, and use of debugging tools, essential for real-world software development.

17. CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES

✓	Day to Day lab evaluation	✓	Demo Video	✓	Expected Viva Voce questions	✓	Open Ended Experiments
X	Competitions	X	hackathons	✓	Certifications	✓	Probing Further Questions

18. EVALUATION METHODOLOGY

Each laboratory will be evaluated for a total of 100 marks consisting of 40 marks for internal assessment and 60 marks for semester end lab examination. Out of 40 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance including viva voce, 10 marks for the final internal lab assessment and remaining 10 marks for The remaining 10 marks are for Laboratory Report/Project and Presentation, which consists of the Design (or) Software / Hardware Model Presentation (or) App Development (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 40 marks (Table 1), with 20 marks for continuous lab assessment during day-to-day performance including viva voce, 10 marks for final internal lab assessment and remaining 10 marks for Laboratory Report / Project and Presentation.

Table 3: CIA marks distribution

Component				
Type of Assessment	Day to Day performance and viva voce examination	Final internal lab assessment	Laboratory Report / Project and Presentation	Total Marks
CIA marks	20	10	10	40

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.

Table 4: Experiment based

Objective	Analysis	Design	Conclusion	Viva voce	Total
					20

Table 5: Programming based

Objective	Analysis	Program	Results	Viva voce	Total
4	4	6	4	2	20

Semester End Examination:
The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the other colleges which will be decided by the Head of the institution.
In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

1. 10 marks for write-up
2. 15 for experiment/program
3. 15 for evaluation of results
4. 10 marks for presentation on another experiment/program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course.

19. COURSE CONTENT

CO 1	**Develop non-trivial programs in an modern programming language.**
	1. Getting Started Exercises 2. Exercises on Number Systems (for Science/Engineering Students)
CO 2	**Apply the principles of selection and iteration.**
	1. Exercises on Decision and Loop 2. Exercises on Input, Decision and Loop 3. Exercises on Nested-Loops (Patterns) 4. Magic(Special) Numbers 5. Exercises on String and char Operations 6. Exercises on Arrays
CO 3	**Appreciate uses of modular programming concepts for handling complex problems.**
	1. Exercises on Methods 2. Exercises on Command-line Arguments and Recursion 3. More (Difficult) Exercises
CO 4	**Recognise and apply principle features of object-oriented design such as abstraction and encapsulation.**
	1. Exercises on Classes and Objects
CO 5	**Design classes with a view of flexibility and reusability.**
	1. Exercises on Inheritance
CO 6	**Code, test and evaluate small usecases to conform to a specification.**
	1. Exercises on Polymorphism, Abstract Classes and Interfaces

Note: One Course Outcome may be mapped to multiple number of experiments.

Text Books

1. Farrell, Joyce.“*Java Programming*”, Cengage Learning B S Publishers, 8th Edition, 2020

2. Schildt, Herbert. ”*Java: The Complete Reference*” 11th Edition, McGraw-Hill Education, 2018.

Reference Books

1. Deitel, Paul and Deitel, Harvey. "*Java: How to Program*", Pearson, 11th Edition,2018.
2. Evans, Benjamin J. and Flanagan, David. "*Java in a Nutshell*", O'Reilly Media, 7th Edition, 2018.
3. Bloch, Joshua. "*Effective Java*", Addison-Wesley Professional, 3rd Edition, 2017.
4. Sierra, Kathy and Bates, Bert. "*Head First Java*", O'Reilly Media, 2nd Edition, 2005.

Materials Online

1. https://docs.oracle.com/en/java/
2. https://www.geeksforgeeks.org/java
3. https://www.tutorialspoint.com/java/index.htm
4. https://www.coursera.org/courses?query=java

20. COURSE PLAN

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

S.No	Topics to be covered	CO's
1	Getting Started Exercises	CO 1
2	Exercises on Number Systems (for Science/Engineering Students)	CO 1
3	Exercises on Decision and Loop	CO 2
4	Exercises on Input, Decision and Loop	CO 2
5	Exercises on Nested-Loops (Patterns)	CO 2
6	Magic(Special) Numbers	CO 2
7	Exercises on String and char Operations	CO 2
8	Exercises on Arrays	CO 2
9	Exercises on Methods	CO 3
10	Exercises on Command-line Arguments, Recursion	CO 3
11	More (Difficult) Exercises	CO 3
12	Exercises on Classes	CO 4
13	Exercises on Inheritance	CO 5
14	Exercises on Polymorphism, Abstract Classes and Interfaces	CO 6

Experiments for enhanced learning (EEL):

S.No	Design Oriented Experiments
1.	Given an array of integers nums and an integer target, return indices of the two numbers such that they add up to target.
2.	Given a sorted array of distinct integers and a target value, return the index if the target is found. If not, return the index where it would be if it were inserted in order.
3.	Given a roman numeral, convert it to an integer.

4.	Implement the myAtoi(string s) function, which converts a string to a 32-bit signed integer
5.	Given a string s, find the length of the longest substring without repeating characters.

21. PROGRAM OUTCOMES & PROGRAM SPECIFIC 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

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.

22. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1	LAB PROGRAMS/CIE/SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	LAB PROGRAMS/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 PROGRAMS/CIE/SEE
PO 5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	3	LAB PROGRAMS/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 PROGRAMS/CIE/SEE
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	3	LAB PROGRAMS/CIE/SEE

23. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		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 PROGRAMS/CIE/SEE

3 = High; 2 = Medium; 1 = Low

24. 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	-	✓	-	-	-	✓	-	✓	-	-	-	-	-	-	-

25. JUSTIFICATIONS FOR CO – PO / PSO MAPPING - DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1
	PO 5	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
	PSO 3	Make use of programming skills to pursue Higher Studies and develop employabilty skills.	1

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 2	PO 1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	1
	PO 2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	7
CO 3	PO 1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2
	PO 2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	7
	PSO 3	Make use of programming skills to pursue Higher Studies and develop employabilty skills	4
CO 4	PO 2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	7
	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.	6
CO 5	PO 2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	7
	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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 6	PO 2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	7
	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
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	4

26. 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	-	-	-	1	-	-	-	-	-	-	-	-	-	1
CO 2	1	7	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	1	7	-	-	-	-	-	-	-	-	-	-	-	-	1
CO 4	-	7	6	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	-	7	-	-	-	1	-	-	-	-	-	-	-	-	-
CO 6	-	7	-	-	-	3	-	2	-	-	-	-	-	-	-

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	33.3	-	-	-	100	-	-	-	-	-	-	-	-	-	33.33
CO 2	33.3	70	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	33.3	70	-	-	-	-	-	-	-	-	-	-	-	-	33.33
CO 4	-	70	60	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	-	70	-	-	-	20	-	-	-	-	-	-	-	-	-
CO 6	-	70	-	-	-	60	-	66.6	-	-	-	-	-	-	

28. 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		
	PO 1	PO 2	PO 3	PO 4	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	-	-	-	-	-	-	-	-	-	1
CO 2	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	1	3	-	-	-	-	-	-	-	-	-	-	-	-	1
CO 4	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	-	3	-	-	-	1	-	-	-	-	-	-	-	-	-
CO 6	-	3	-	-	-	3	-	3	-	-	-	-	-	-	-
TOTAL	3	15	3	-	3	4	-	3	-	-	-	-	-	-	2
AVERAGE	1	3	3	-	3	2	-	3	-	-	-	-	-	-	1

29. ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Laboratory Practices	✓
Certification	-	Student Viva	✓	Open Ended Experiments	-

30. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

31.RELEVANCE TO SUSTAINABILITY GOALS

Write brief description about the course and how its relevance to SDGs.

X		
X		
X		

✓	QUALITY EDUCATION	**Quality Education:** The students can gain a deeper understanding of how technology can be harnessed to address global challenges. This promotes quality education by fostering critical thinking and problem-solving skills in the context of sustainable development.
X	GENDER EQUALITY	
X	CLEAN WATER AND SANITATION	
X	AFFORDABLE AND CLEAN ENERGY	
X	DECENT WORK AND ECONOMIC GROWTH	
✓	INDUSTRY, INNOVATION AND INFRASTRUCTURE	**Industry, Innovation, and Infrastructure:** Java programming skills are essential for developing innovative software solutions. Students working on projects related to sustainable development can contribute to building resilient infrastructure and promoting inclusive and sustainable industrialization.
X	REDUCED INEQUALITIES	
✓	SUSTAINABLE CITIES AND COMMUNITIES	**Sustainable Cities and Communities:** Java programming plays a crucial role in developing applications for smart cities, efficient transportation, and waste management systems. Through projects in the lab, students can explore ways to create more sustainable urban environments.

X	RESPONSIBLE CONSUMPTION AND PRODUCTION	
✓	CLIMATE ACTION	**Climate Action:** Students can create climate-related applications, such as carbon footprint calculators or climate data analysis tools, using Java programming. This directly contributes to SDG 13 by raising awareness and facilitating climate action.
X	LIFE BELOW WATER	
X	LIFE ON LAND	
X	PEACE, JUSTICE AND STRONG INSTITUTIONS	
✓	PARTNERSHIPS FOR THE GOALS	**Partnerships for the Goals:** Collaborative projects can foster partnerships among students, educators, and local communities. These partnerships enhance knowledge sharing and the development of innovative solutions that align with multiple SDGs.

Approved by: Board of Studies in the meeting conducted on ——————————.

Signature of Course Coordinator **HOD,EEE**
Mr. D. Atchuta Ramacharyulu, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MANUFACTURING PRACTICE
COURSE TEMPLATE

1	Department	ELECTRICAL AND ELCTRONICS ENGINEERING			
2	Course Code	AMED02			
3	Course Title	MANUFACTURING PRACTICE			
4	Semester	I Semester			
5	Regulation	BT-23			
6	Structure of the course	Practical			
		Lecture Hours		Practical Hours	
		–		2	
7	Course Offered	Odd Semester ✓		Even Semester ✓	
8	Course Coordinator	Dr. Ch. Sandeep			
9	Date Approved by BOS	24/08/2023			
10	Course Webpage	https://www.iare.ac.in/?q=pages/btech-course-syllabi-bt23-cseaiml			
11	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**
		–	–	–	No prerequisites

12. Course Overview:

This course provides the opportunity to become confident with new tools, equipment, and techniques for creating physical objects and mechanisms with a variety of materials. The students will learn the concepts of 3D printing, laser cutting, circuit board soldering, wood carving and CNC machining. Skills learned in the course enable the students about the design process in digital manufacturing used in various industrial applications.

13. Course objectives:

The students will try to learn:

I	The digital and additive manufacturing techniques used in various industrial applications in the current era to develop prototype models.
II	The unconventional machining processes and their selective applications as an alternative to traditional manufacturing methods.
III	The standard electrical wiring practices for domestic and industrial appliances.
IV	The soldering and de-soldering components on a circuit board safely and correctly.

14. Course outcomes:

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

CO 1	Practice the various types of manufacturing methods for preparing the given material to desired shape by using traditional and unconventional manufacturing practices.
CO 2	Execute the additive manufacturing technology for learning about the 3D printing processes and techniques.
CO 3	Select computer numerical control laser techniques for preparing the required geometrical profiles
CO 4	Demonstrate with the moulding techniques for producing cast components in complex shapes using different patterns
CO 5	Make use of computer numerical technologies to create products using wood carving techniques.
CO 6	Apply the plumbing skills to work with fittings and pipes made of PVC and galvanized steel.

15. Employability Skills:

1. **Employment advantage:** This can give competitive advantage when seeking employment to apply knowledge about engineering tools used in manufacturing of products.
2. **Programming skills:**Understanding basics of CNC programming for application in laying, shaping and cutting process for product development.
3. **Project based skills:** This can give hands on experience for design, analysis and fabrication of prototype model for real time applications.
4. **Safety Awareness:** Understanding the different machines, instruments and tools to handle in real-time environment and can apply this awareness to workplaces where safety is a priority.

16. Content delivery / Instructional methologies:

✓	Day to Day lab evaluation	✓	23.png Demo Video	✓	Viva Voce questions	✓	Open Ended Experiments
x	Competitions	x	hackathons	x	Certifications	✓	Probing Further Questions

17. Evaluation methodology:

Each laboratory will be evaluated for a total of 100 marks consisting of 40 marks for internal assessment and 60 marks for semester end lab examination. Out of 40 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance including viva voce, 10 marks for the final internal lab assessment and remaining 10 marks for The remaining 10 marks are for Laboratory Report/Project and Presentation, which consists of the Design (or) Software / Hardware Model Presentation (or) App Development (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 40 marks (Table 1), with 20 marks for continuous lab assessment during day-to-day performance including viva voce, 10 marks for final internal lab assessment and remaining 10 marks for Laboratory Report / Project and Presentation.

Table 3: CIA marks distribution

Component				
Type of Assessment	Day to Day performance and viva voce examination	Final internal lab assessment	Laboratory Report / Project and Presentation	Total Marks
CIA marks	20	10	10	40

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.

Table 4: Experiment based

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

Table 5: Programming based

Objective	Analysis	Design	Conclusion	Viva voce	Total
–	–	–	–	–	20

Semester End Examination:
The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the other colleges which will be decided by the Head of the institution.
In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

1. 10 marks for write-up
2. 15 for experiment/program
3. 15 for evaluation of results
4. 10 marks for presentation on another experiment/program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course.

18. Course content:

CO 1	**Practice the various types of manufacturing methods for preparing the given material to desired shape by using traditional and unconventional manufacturing practices.**
	1. Preparation of mild steel (MS) material for step turning with grooving operation. **Try** 1.1 Preparation of Mild Steel (MS) material for step turning with tapper operation. 2. Preparation of mild steel (MS) material for thread cutting and knurling operation. **Try** 2.1 Preparation of aluminium material for step turning with tapper operation. 3. Preparation of slotting operation. **Try** 3.1 Perform the boring and reaming operation on a rectangular work piece to obtain the required dimensions using vertical milling machine. 4. Preparation of V-groove operation. **Try** 4.1 Perform the key ways on a cylindrical work piece to obtain the required dimensions using shaping machine. 5. Demonstration on industry standard grinding. **Try** 5.1 Demonstration grinding methods and machines.
CO 2	**Execute the additive manufacturing technology for learning about the 3D printing processes and techniques.**
	1. Preparation of stepped pulley with PLA material. **Try** 1.1 Preparation of spur gear with ABS material.

CO 3	**Select computer numerical control laser techniques for preparing the required geometrical profiles on non-metallic materials.**
	1. Preparation of acrylic gears using CNC laser engraving / cutting machine. **Try** 1.1 Preparation of artistic components IARE logo using CNC laser engraving. 2. Demonstration of articulated robot for lifting load. **Try** 2.1 Demonstration the pick and place operation for the articulated robot 3. Demonstration of milling and lathe system switchable on one simulator. **Try** 3.1 Demonstration the combination of CNC Simulator with CNC machining simulation.
CO 4	**Demonstrate the assembly and disassembly of electrical equipment's and controls for safe domestic applications.**
	1. Preparation of wiring for a stair case arrangement using a two-way switch. **Try** 1.1 Prepare wiring for a tube light with switch control. 2. Preparation of soldering from a circuit board. **Try** 2.1 Perform desoldering operation from a circuit board. 3. Perform the maintenance of ceiling fan and ending the trouble shoot. problems. **Try** 3.1 Perform the maintenance for mixer grinder from a circuit board.
CO 5	**Make use of computer numerical technologies to create products using wood carving techniques.**
	1. Preparation of wooden wheel using computerized wood carving machine. **Try** 1.1 Preparation of IARE lettering using CNC wood carving.

CO 6	**Apply the plumbing skills to work with fittings and pipes made of PVC and galvanized steel.**
	1. Preparation of PVC material for pipe threading and fitting. **Try** 1.1 Preparation of galvanized steel I joint.

TEXTBOOKS

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Media promoters and publishers private limited, Mumbai, 2020.
2. Kalpakjian S, Steven S. Schmid, "Manufacturing Engineering and Technology", Pearson Education India Edition, 7 th Edition, 2019.

REFERENCE BOOKS:

1. Rupinder Singh, J. Paulo Davim, "Additive Manufacturing: Applications and Innovations", CRC Press, 2 nd Edition, August, 2021.
2. Jeyaprakash Natarajan , Muralimohan Cheepu , Che-Hua Yang , "Advances in Additive Manufacturing Processes", Bentham Books, 4 th Edition, September, 2021.

MATERIALS ONLINE:

1. Lab manual
2. Question bank

19. Course plan:

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

S.No	Topics to be covered	CO's
1	Preparation of stepped pulley with PLA material using the principles of 3D printing and additive manufacturing techniques.	CO 1
2	Preparation of acrylic gears using CNC laser engraving / cutting machine.	CO 1
3	Preparation of wooden wheel using computerized wood carving machine.	CO 1
4	Preparation of PVC material for pipe threading and fitting using die sets.	CO 2
5	Preparation of mild steel (MS) material for step turning with grooving operation using computer numerical control (CNC) lathe machines.	CO 2

S.No	Topics to be covered	CO's
6	Preparation of mild steel (MS) material for thread cutting and knurling operation using conventional lathe machines.	CO 3
7	Preparation of slotting operation using milling machine.	CO 4
8	Preparation of V-groove operation using shaping machine.	CO 4
9	Preparation of wiring for a stair case arrangement using a two-way switch.	CO 5
10	Preparation of soldering and desoldering from a circuit board.	CO 6
11	Perform the maintenance of ceiling fan and ending the trouble shoot problems.	CO 6
12	Demonstration of articulated robot for lifting load.	CO 6
13	Demonstration of milling and lathe system switchable on one FANUC simulator.	CO 6
14	Demonstration on industry standard grinding.	CO 6

20. Experiments for enhanced learning (EEL):

S.No	Product Oriented Experiments
1	**Divided Tenon Joint:** It is the simplest form of Mortise and tenon joint and this joint is made by fitting a short tenon into a continuous groove. This joint has the advantage of being easy to cut and is often used to make cabinet doors and other light duty frame and panel assemblies.
2	**Cross Fitting:** It is the fundamental of type of fitting which are used fitting trade and it is formed by joining the two inclined shaped cut specimens together and is often used to join the universal bearings.
3	**hard soldering:** Metals and alloys of dissimilar compositions can be hard-soldered (brazed or silver-soldered) together, for example: copper to brass; copper to steel; brass to steel; cast iron to mild steel; and mild steel to stainless steel.
4	**T-Pipe Joint:** T-pipe is a type of fitting which is T-shaped having two outlets at 90 degrees to the main line. It is short piece of pipe with a lateral outlet. It is widely used as pipe fittings.
5	**Concrete cube:** Plastic or Steel Concrete Cube Moulds are used to form specimens for concrete compressive strength testing. They can also be used as sample containers in the determination of mortar set times as indicated in ASTM C403 and AASHTO T 197.

21. Program Outcomes and Program Specific 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
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..

22. 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.	1	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.	1	CIA
PO 5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	3	Lab Exercises
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	1	SEE

23. 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	Lab Exercises

3 = High; 2 = Medium; 1 = Low

24. 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	✓	-	-	-	✓	-	-	-	-	-	✓	-	-	-	-

25. Justifications for CO – PO/ PSO mapping -DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Apply the knowledge of engineering fundamentals to join given wooden pieces according to given sketch to develop required joint.	1
	PO 3	Conversion of given design into a practical output using designsolution 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.	1
	PO 11	Demonstrate knowledge and understanding of the engineeringand 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 2	PO 1	Apply the knowledge of engineering fundamentals to join given metal pieces according to given sketch to develop required joint.	1
	PO 5	Develop the given resources and engineering tools into proper fitment as given in the diagrammatical representation.	1
	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 3	PO 1	Apply the knowledge of engineering fundamentals to make metal rod into given required shape according to given sketch to develop required joint.	1
	PO 5	Develop the given resources and engineering tools into required shape as given in the diagrammatical representation.	1
CO 4	PO 1	Apply the knowledge of engineering fundamentals to make the casting product from given materials according to given sketch to develop required shape.	1
	PO 3	Conversion of given design into a practical output using design solution for complex engineering problems and design system components	2
	PO 11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	2

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	3
CO 5	PO 5	Develop the given resources and engineering tools into required shape as given in the diagrammatical representation	1
	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.	1
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.	1
	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

26. 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	-	1	-	-	-	-	-	2	-	-	-	-
CO 2	1	-	-	-	1	-	-	-	-	-	2	-	-	-	-
CO 3	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO 4	1	-	2	-	-	-	-	-	-	-	2	-	-	-	3
CO 5	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-
CO 6	1	-	-	-	1	-	-	-	-	-	2	-	-	-	-

27. Percentage of key competencies CO – PO/ PSO:

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

28. 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		
	PO 1	PO 2	PO 3	PO 4	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	-	-	-	-
CO 2	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-
CO 3	1	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO 4	1	-	1	-	-	-	3	-	-	-	-	-	-	-	3
CO 5	-	-	-	-	3	-	-	-	-	-	1	-	-	-	-
CO 6	1	-	-	-	3	-	3	-	-	-	1	-	-	-	-
Total	5	-	2	-	12	-	-	-	-	-	4	-		-	3
Average	3	-	1	-	3	-	-	-	-	-	1	-	-	-	3

29. Assessment methodology -Direct:

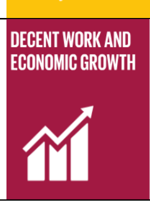
CIE Exams	✓	SEE Exams	✓	Laboratory Practices	✓
Certification	-	Student Viva	✓	Open Ended Experiments	✓

30. Assessment methodology -Indirect:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

31. Relevance to Sustainability goals (SDGs):

Write brief description about the course and how its relevance to SDGs.

1		
2		
3		
4		**Quality Education:** Manufacturing Practice course provides students with a strong foundation in CNC programming for application in laying, shaping and cutting process for product development, enhancing their learning experience and empowering them to address real- world challenges.
5		
6		
7		
8		

9	INDUSTRY, INNOVATION AND INFRASTRUCTURE	
10	REDUCED INEQUALITIES	
11	SUSTAINABLE CITIES AND COMMUNITIES	
12	RESPONSIBLE CONSUMPTION AND PRODUCTION	**Responsible Consumption and Production:** By focusing on efficient material use, waste reduction, and product durability, manufacturing practice can aid in designing products and systems that align with responsible consumption and production practices.
13	CLIMATE ACTION	
14	LIFE BELOW WATER	
15	LIFE ON LAND	

16		
17		

Approved by: Board of Studies in the meeting conducted on 24.08.2023.

Signature of Course Coordinator **HOD, IT**
Mr.V.Suryaprakash Reddy, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

<table>
<tr><td>1</td><td>Department</td><td colspan="5">ELECTRICAL AND ELECTRONICS ENGINEERING</td></tr>
<tr><td>2</td><td>Course Title</td><td colspan="5">ENGINEERING CHEMISTRY</td></tr>
<tr><td>3</td><td>Course Code</td><td colspan="5">AHSD03</td></tr>
<tr><td>4</td><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>5</td><td>Semester</td><td colspan="5">II Semester</td></tr>
<tr><td>6</td><td>Regulation</td><td colspan="5">BT-23</td></tr>
<tr><td rowspan="2">7</td><td rowspan="2">Structure of the course</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture
3</td><td>Tutorials
0</td><td>Credits
3</td><td>Lab
-</td><td>Credits
-</td></tr>
<tr><td>8</td><td>Type of course
(Tick type of course)</td><td>Core
✓</td><td>Professional
Elective
-</td><td>Open
Elective
-</td><td>VAC
-</td><td>MOOCs
-</td></tr>
<tr><td>9</td><td>Course Offered</td><td colspan="2">Odd Semester ✓</td><td colspan="3">Even Semester ×</td></tr>
<tr><td rowspan="2">10</td><td colspan="6">Total lecture, tutorial and practical hours for this course
(16 weeks of teaching per semester)</td></tr>
<tr><td colspan="2">Lectures: 64 hours</td><td colspan="2">Tutorials: .... hours</td><td colspan="2">Practical: .... hours</td></tr>
<tr><td>11</td><td>Course Coordinator</td><td colspan="5">Dr.V Anitha Rani</td></tr>
<tr><td>12</td><td>Date Approved by BOS</td><td colspan="5">24/08/2023</td></tr>
<tr><td>13</td><td>Course Webpage</td><td colspan="5">https://www.iare.ac.in/sites/default/files/BT23/AHSD03.pdf</td></tr>
<tr><td rowspan="3">14</td><td rowspan="3">Course Prerequistes</td><td>Level</td><td>Course Code</td><td>Semester</td><td colspan="2">Prerequisites</td></tr>
<tr><td>Intermediate</td><td>-</td><td>-</td><td colspan="2">-</td></tr>
<tr><td>B.Tech</td><td>-</td><td>-</td><td colspan="2">-</td></tr>
</table>

15. Course Overview

The course focuses on the fundamental concepts of chemistry to impart knowledge on applications of chemical sciences in engineering and technology. It deals with topics such as electrochemical principles in batteries, techniques to control corrosion, alternative sources of energy and water purification process. The significance of advanced materials and their usage in industrial, commercial and social sectors for sustainable development.

16. COURSE OBJECTIVES:

The students will try to learn:

I	The concepts of electrochemical principles and causes of corrosion in the new developments and breakthroughs efficiently in engineering and technology.
II	The different parameters to remove causes of hardness of water and their reactions towards complexometric method.
III	The properties, separation techniques of natural gas and crude oil along with potential applications in major chemical reactions..
IV	The different types of materials with respect to mechanisms and its significance in industrial applications.

17. COURSE OUTCOMES:

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

CO 1	**Implement** the principles of electrochemical systems to control the corrosion in metals.
CO 2	**Analyze** the basic properties of water for its usage in domestic and industrial purposes.
CO 3	**Use** complexometry for calculation of hardness of water to avoid industrial problems.
CO 4	**Extend** the applications of polymers based on their degradability and properties..
CO 5	**Choose** the appropriate fuel based on their calorific value for energy efficient processes.
CO 6	**Predict** the knowledge on viability of advanced materials for technological improvements in various sectors.

18. Topic Learning Outcome (TLOs):

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Outcome:	Blooms Level
1	Galvanic cell	TLO 1	Recall the oxidation and reduction reactions by observing the chemical changes in a cell.	CO 1	Remember
		TLO 2	Explain the operation of electrochemical cell to produce electrical energy from spontaneous redox reactions..	CO 1	Understand
		TLO 3	Use electrochemical principles in batteries.	CO 1	Apply

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Out-come:	Blooms Level
2	Electrolytic cell	TLO 4	Illustrate the process of electrolysis by using electrical energy for non-spontaneous chemical reactions..	CO 1	Understand
		TLO 5	Use electrolysis process in separating or obtaining pure elements from ores.	CO 1	Apply
3	Electrochemical series	TLO 6	Interpret the degree of reactivity of electrodes based on activity series table with standard hydrogen electrode.	CO 1	Understand
		TLO 7	Use standard reduction potential data to determine the relative strength of oxidizing and reducing agents.	CO 1	Apply
4	Zinc-air battery	TLO 8	Discuss the chemical reactions in Zinc and oxygen to produce electrical energy.	CO 1	Understand
5	Lead-Acid battery and Li-ion battery	TLO 9	Relate the relationship between charge produced and the amount of product formed for both electrochemical cell and electrolytic cells.	CO1	Understand
6	Causes of corrosion	TLO 10	Recall the corrosion process in metals in presence of environment.	CO 1	Understand
7	Chemical Corrosion	TLO 11	Interpret the oxidation and reduction reactions on the surface of metal in presence of oxygen to form metal oxide in presence of oxygen.	CO 1	Understand
8	Electrochemical corrosion	TLO 12	Illustrate the electrochemical corrosion of metals in acidic and alkaline environment.	CO1	Understand
9	Cathodic protection	TLO 13	Use sacrificial anodes to control corrosion inmetal structures.	CO1	Apply
10	Galvanizing, Tinning	TLO 14	Make use of metallic coatings and coating deposition technologies to prevent corrosion in metals	CO1	Apply
11	Electroplating	TLO 15	Use the process of electrolysis in industries to prevent corrosion in metals.	CO1	Apply

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Out-come:	Blooms Level
12	Treatment methods of potable water, Ion-exchange process and Reverse osmosis	TLO 16	Estimate the different water treatment methods to use in industries and domestic purpose.	CO2	Understand
13	Expression of hardness	TLO 17	Select the CaCO3 equivalents to express the total, temporary and permanent hardness of water.	CO3	Apply
14	Complexometry method	TLO 18	Make use of complexometry method to calculate the hardness of water	CO3	Apply
15	Types of polymerization	TLO 19	Relate the addition and condensation polymerization process to synthesize the polymers	CO4	Understand
16	Synthetic polymers	TLO 20	Explain the properties of polymers from organiccompounds.	CO4	Understand
17	Applications of polymers	TLO 21	Use polymers in various sectors based on their properties.	CO4	Apply
18	Classification of fuels	TLO 22	Classify the different types of fuels based their physical state of aggregation.	CO5	Understand
19	Analysis of coal	TLO 23	Demonstrate the qualitative and quantitative analysis of coal to prevent problems inindustries.	CO 5	Understand
20	Refining of petroleuml	TLO 24	Illustrate the fractions of crude oil by fractional distillation process.	CO 5	Understand
21	Demonstrate the qualitative and quantitative analysis of coal to prevent problems inindustries.	TLO 25	Develop the work energy relations and apply to connected systems.	CO5	Understand
22	Gaseous fuels	TLO 26	Use Liquefied petroleum gas and Compressed natural gas in various sectors.	CO 5	Apply
23	Calorific value of fuels	TLO 26	Use the Dulong's formula to find the highercalorific value and lower calorific value of fuels	CO 5	Apply
24	Combustion of fuels	TLO 27	Use theoretical calculation of amount of air required for combustion of fuels.	CO 5	Apply

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Out-come:	Blooms Level
25	Synthesis of Nanomaterials	TLO 28	Enhance the understanding of nano-structural materials	CO 6	Apply
26	Nanomaterials	TLO 29	Enhance the use of nanomaterials as a complex materials and structures in buildings.	CO 6	Apply
27	Smart materials	TLO 30	Recognize the importance and applications of smart materials.	CO 6	understand
28	Thermoresponse materials	TLO 31	Identify the importance and benefits of thermoresponse materials	CO 6	understand
29	Setting and hardening of cement	TLO 32	Relate the chemical reactions in setting and hardening of cement	CO 6	understand
30	Mechanism of lubrication	TLO 33	Discuss the mechanism of lubrication processapplied under different load, pressure andtemperatureconditions	CO6	understand

19. Employability Skills

Example: Communication skills / Programming skills / Project based skills /
Project based skills Engineering chemistry for students based on qualitative and quantitative analysis of experimental skills.

20. Content Delivery / Instructional Methologies:

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

21. Evaluation Methodology:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). CIA is conducted for a total of 40 marks, with 20 marks for Continuous Internal Examination (CIE), and and 05 marks for each Definitions and Terminology / Quiz and remaining 10 marks for Tech Talk / Assignments.

22. COURSE CONTENT-Number of Modules:Five

MODULE I	**BATTERIES CHEMISTRY AND CORROSION** | Number of Lectures: 13
	Introduction to electrochemical cells: electrolytic cell, Galvanic cell; electrochemical series and its applications; Batteries: classification of batteries, construction, working and applications of Zinc-air battery, Lead-acid battery, Li-ion battery, applications of Li-ion battery to electric vehicles; 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 methods; Metallic coatings: Galvanization and tinning; electroplating of Copper.
MODULE II	**WATER AND ITS TREATMENT** | **Number of Lectures: 13**
	Hardness 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	**POLYMER TECHNOLOGY** . |**Number of Lectures: 13**
	Polymers: classification of polymers; types of polymerization-addition, condensation polymerization withexamples. Plastics: thermoplastic and thermosetting plastics; preparation, properties and engineering applications of PVC, Nylon6,6 and Bakelite; Biodegradable polymers: polylactic acid and polyvinyl alcohol and theirapplications. Elastomers: Introduction to natural rubber, vulcanization of natural rubber, preparation, properties and engineering applications of Buna-S and Thiokol rubber.
MODULE IV	**ENERGY SOURCES** | **Number of Lectures: 13**
	Introduction to fuels; classification of fuels; Solid fuels: coal; analysis of coal, proximate and ultimate analysis and their significance; Liquid fuels: petroleum and its refining; Gaseous fuels: composition, characteristics and applications of natural gas, LPG and CNG; Alternative and non-conventional sources of energy: solar, wind and hydropower advantages and disadvantages. Calorific value of fuel: HCV and LCV, Dulongs formula, calculation of air quantity required for complete combustion of fuel, numerical problems

MODULE V	**ENGINEERING MATERIALS** | **Number of Lectures: 12**
	Nanomaterials: introduction, preparation of nanoparticles by sol-gel method, chemical reduction method, applications of nanomaterials. Smart materials and their engineering applications: shape memory materials, poly L-lactic acid. Thermoresponse materials: Polyacryl amides, Poly vinyl amides. Cement: composition of Portland cement, setting and hardening of cement. Lubricants: characteristics of a good lubricant, mechanism of lubrication, thick film, thin film and extreme pressure lubrication; properties of lubricants: viscosity, Redwood viscometer, flash and fire point, cloud and pour point.

TEXTBOOKS

1. Jain and jain, Monika jain , "*Engineering Chemistry* ", Dhanpat Rai Publishers, 17th Edition, 2022.

REFERENCE BOOKS:

1. Shashi chawla& *Engineering Chemistry*", 1th Edition, 2017.
2. jaya sree Reddy, "*Engineering Chemistry*", wiley Publications, 2023.
3. S.S Dara "*Engineering Chemistrys. chand*"12th Edition, 2018.
4. Nitin K Puri "*Nanomaterials Synthesis Properties And Applications*", I K international publishing house pvt Ltd, 1st edition 2021.
5. S. Bhavikatti, "*Engineering Chemistry*", New Age International, 5th Edition, 2020.
6. R. C. Hibbler, "*Engineering Chemistry*", Pearson Press, 2021.

MATERIALS ONLINE:

1. Lecture notes, ELRV videos and power point presentations
2. Answers / solutions to all questions / problems in the textbook
3. Online exercises
4. Problems and solutions in files

23. 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	Electrochemical cells (Galvanic cell), electrolytic cell	CO 1	T1:6.1, R1:7.4,8
2	Electrochemical series and its applications	CO 1	T1: 6.7, R1:10
3	Batteries, classification of batteries	CO 1	T2:5.10 R1:1.15
4	Construction, working and applications of Zinc-air battery	CO 1	T1:3.13, R1:23.1
5	Construction, working and applications of Lead-acid storage battery	CO 1	T1:3.13,R1:23.2
6	Construction, working and applications of Li-ion battery, applications of Li-ion battery to electric vehicles	CO 1	T1:3.14 , R1:24
7	Corrosion, causes and effects of corrosion, chemical corrosion	CO 1	T1:3.20, R1:1.2
8	Electrochemical corrosion, mechanism of electrochemical corrosion	CO 1	T1:3.21, R1:2.1
9	Cathodic protection, sacrificial anode and impressed current methods	CO 1	T1:3.22, R1:6.4
10	Metallic coatings, Galvanization and tinning, electroplating of Copper.	CO 1	T1:3.23, R1:6.3,6.6
11	Hardness of water, causes of hardness, disadvantages of hard water	CO 2	T1:2.1, R1:4
12	Types of hardness, temporary and permanent, expression and units of hardness	CO 2	T1:2.1, R1:5.3
13	Estimation of hardness of water by complexometric method	CO 3	T1:2.6, R1:6.1
14	potable water and its specifications, steps involved in the treatment of water, disinfection of water by chlorination and ozonization	CO 2	T1:2.6.5, R1:14
15	External treatment of water, ion-exchange process	CO 3	T1:2.8, R1:12.3
16	Desalination of water, reverse osmosis	CO 3	T1:2.10.2, R1:17.4
17	Classification of polymers; types of polymerization-addition, condensation polymerization with examples.	CO 4	T1: 3.5, R1: 3

S.No	Topics to be covered	CO's	Reference
18	Plastics, thermoplastic and thermosetting plastics	CO 4	T1:1.4, R1: 2.10
19	Preparation, properties and engineering applications of PVC	CO 3	T1:3.5, R1: 7.2
20	Preparation, properties and engineering applications of Nylon 6,6 s	CO 4	T1: 3.12, R1:7.7 5.1.2
21	Preparation, properties and engineering applications of Bakelite	CO 4	T1:3.14, R1: 3.2.3
22	Biodegradable polymers, polylactic acid and polyvinyl alcohol and their applications.	CO 4	T1:3.14, R1: 3.2.3
23	Elastomers, vulcanization of natural rubber	CO 4	T1: 3.15, R1:6.1
24	Preparation, properties and applications of Buna-s and Thiokol rubber.	CO 4	T1: 3.22, R1: 6.7
25	Classification of fuels, analysis of coal, proximate analysis of coal and their significance	CO 5	T1:4.2, R1: 2.1, 7.1,7.2
26	Ultimate analysis of coal and their significance	CO 4	T1:4.4.1, R1:7.1,7.2
27	Liquid fuels, petroleum and its refining	CO 5	T1:4.5.2, R1:15.2
28	Composition, characteristics and applications of natural gas, LPG and CNG	CO 5	T1:4.6, R1:9.1,9.2
29	Alternative and non-conventional sources of energy: solar, wind and hydropower advantages and disadvantages.	CO 4	T1:4.6, R1:9.8
30	Calorific value of fuel: HCV and LCV, Dulongs formula,	CO 5	T1:4.8, R1: 4.1
31	Calculation of air quantity required for complete combustion of fuel, numerical problems.	CO 5	T2:16.9 R1:8.11.2
32	Nanomaterials, preparation of nanoparticles by sol-gel method	CO 6	T1: 6.0, R1: 1
33	Preparation of nanoparticles by chemical reduction method and applications of nanomaterials.	CO 6	T1: 6.1, R1:11
34	Smart materials and their engineering applications, shape memory materials, Poly L-Lactic acid.	CO 6	T1: 6.1 R2:12.24
35	Thermoresponse materials, Polyacryl amides, Poly vinyl amides.	CO 6	T1: 6.1
36	Cement, composition of Portland cement	CO 6	T1: 5.1.2, R1: 3.2
37	Setting and hardening of cement.	CO 6	T1: 5.1.3, R1: 3.3
38	Lubricants, characteristics of a good lubricant	CO 6	T1: 3.24, R1: 3,5

S.No	Topics to be covered	CO's	Reference
39	Mechanism of lubrication, thick film, thin film and extreme pressure lubrication	CO 6	T1: 3.24, R1: 3,5
40	properties of lubricants, viscosity, flash and fire point, cloud and pour point	CO 6	T1: 3.25, R1: 7 R1: 7
PROBLEM SOLVING/ CASE STUDIES			
1	Problems on temporary and permanent hardness in Degree French and ppm	CO 3	T1:2.1, R1:5.4
2	Problems on temporary, permanent and total hardness in ppm and Degree Clark	CO 3	T1:2.1, R1:5.4
3	Problems on the temporary, permanent and total hardness of water in Degree French and Degree Clark.	CO 3	T1:2.1, R1:5.5
4	Problems on the temporary, permanent and total hardness of water in Degree Clark and Mg/L.	CO 3	T1:2.1, R1:5.5
5	Problems on the total hardness in terms of calcium carbonate equivalents by using EDTA method.	CO 3	T1:2.6, R1:6.2
6	Problems on the temporary hardness and permanent hardness in terms of calcium carbonate equivalents by using EDTA method.	CO 3	T1:2.6, R1:6.2
7	Problems on the temporary hardness in terms of calcium carbonate equivalents by using EDTA method.	CO 3	T1:2.6, R1:6.2
8	Problems on the permanent hardness in terms of calcium carbonate equivalents by using EDTA method.	CO 3	T1:2.6, R1:6.2
9	Problems on the higher and lower calorific values of the fuel.	CO5	T1:4.8, R1:4.3
10	Problems on the gross and net calorific values of the fuel.	CO 5	T1:4.8, R1:4.3
11	Problems on HCV and LCV (polar coordinates).	CO 5	T1:4.8, R1:4.3
12	Problems on GCV and NCV	CO 5	T1:4.8, R1:4.3
13	Problems on calculation of air quantity required for complete combustion of coal	CO 5	T1:4.9, R1:10.2
14	Problems on complete combustion of fuel in air	CO 5	T1:4.9, R1:10.2
15	Problems on calculation of air quantity required for complete combustion of fuel	CO 5	T1:4.9, R1:10.2
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Definitions & terminology discussion onbatteries chemistry and corrosion	CO 1	T1:6.1, R1: 7.4,1.2
2	Definitions & terminology discussion on water and its treatment	CO 2, CO3	T1:2.1, R1:5.3
3	Definitions &terminology discussion on polymer technology	CO 3, CO 4	T1: 3.5, R1: 7.2

S.No	Topics to be covered	CO's	Reference
4	Definitions &terminology discussion on energy sources	CO 5	T1:4.2, R1:2.1
5	Definitions & terminology discussion on engineering materials	CO 6	T1: 6.0, R1: 11,3,3.2
DISCUSSION OF TUTORIAL QUESTION BANK			
1	Question bank discussion on batteries chemistry and corrosion	CO 1	T1:6.1, R1: 7.4,1.2
2	Question bank discussion on water and its treatment	CO 2, CO 3	T1:2.1, R1:5.3
3	Question bank discussion on polymer technology	CO 4	T1: 3.5, R1: 7.2
4	Question bank discussion on energy sources	CO 5	T1:4.2, R1:2.1
5	Question bank discussion on engineering materials	CO 6	T1: 6.0, R1: 11,3,3.2

24. PROGRAM OUTCOMES & PROGRAM SPECIFIC 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
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.

25. 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.	1	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	Seminar / Conferences / Research papers

26. 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

27. 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	✓	-	-	-	-	-	✓	-	-	-	-	-	-	-	-

28. 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 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
	PO 7	Use metallic coatings to control the corrosion in metals and know the impact in socio economic and environmental contexts for sustainable development..	2
CO 2	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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 3	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.	3
	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	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
	PO 7	Use biodegradable polymers to reduce the soil pollution and know the impact in socio economic and environmental contexts for sustainable development..	2
CO 5	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.	3
	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
	PO 7	Use biodegradable polymers to reduce the soil pollution and know the impact in socio economic and environmental contexts for sustainable development.	2
CO 6	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
	PO 7	Use biodegradable polymers to reduce the soil pollution and know the impact in socio economic and environmental contexts for sustainable development.	2

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

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

30. 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	-	-	-	-	-	66.6	-	-	-	-	-	-	-	-
CO 2	66.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	100	20	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	66.6	-	-	-	-	-	66.6	-	-	-	-	-	-	-	-
CO 5	100	20	-	-	-	-	66.6	-	-	-	-	-	-	-	-
CO 6	66.6	-	-	-	-	-	66.6	-	-	-	-	-	-	-	-

31. 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	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO 2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO 5	3	1	-	-	-	-	3	-	-	-	-	-	-	-	-
CO 6	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
TOTAL	18	2	-	-	-	-	12	-	-	-	-	-	-	-	-
Average	3	1	-	-	-		3	-	-	-	-	-	-	-	-

32. ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	✓				

33. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

34. Relevance to Sustainability goals

Write brief description about the course and how its relevance to SDGs.

1		
2		
3		Water purification can help to decrease dangerous bacteria and other chemicals that can weaken the immune system by removing pollutants and impurities. This may assist stay in good health and lowers chance of illness.
4		The fundamental principles of water treatment and its applications in industry, apply electrochemical principle in batteries
5		

6	CLEAN WATER AND SANITATION	Safe and readily available water is important for public health, domestic use, food production or recreational purpose.countries' economic growth and can contribute greatly to poverty reduction.
7	AFFORDABLE AND CLEAN ENERGY	Affordable electricity is provided by clean energy sources such as solar, wind and hydropower.
8	DECENT WORK AND ECONOMIC GROWTH	
9	INDUSTRY, INNOVATION AND INFRASTRUCTURE	
10	REDUCED INEQUALITIES	
11	SUSTAINABLE CITIES AND COMMUNITIES	Renewable energy systems for sustainable cities
12	RESPONSIBLE CONSUMPTION AND PRODUCTION	Renewable energy systems for sustainable cities

13	CLIMATE ACTION	Non-renewable energy resources release harmful greenhouse gases into the atmosphere, creating the greenhouse effect which causes global warming.
14	LIFE BELOW WATER	
15	LIFE ON LAND	The biodegradable plastics material focuses on creating a more sustainable and greener world with a smaller environmental imprint.
16	PEACE, JUSTICE AND STRONG INSTITUTIONS	
17	PARTNERSHIPS FOR THE GOALS	

Approved by: Board of Studies in the meeting conducted on21-August-2023 .

Signature of Course Coordinator **HOD,EEE**

COURSE TEMPLATE

1	Department	**Electrical and Electronics Engineering**				
2	Course Title	**Applied Physics**				
3	Course Code	AHSD07				
4	Class / Semester	II				
5	Regulation	BT-23				
6	Structure of the course	Theory			Practical	
		Lecture	Tutorials	Credits	Lab	Credits
		3	-	3	-	-
7	Type of course (**Tick type of course**)	Core	Professional Elective	Open Elective	VAC	MOOCs
		-	-	-	-	-
8	Course Offered	Odd Semester ×		Even Semester ✓		
9	**Total lecture, tutorial and practical hours for this course (16 weeks of teaching per semester)**					
	Lectures: 64		Tutorials: Nil		Practical: Nil	
10	Course Coordinator	Dr. Rizwana				
11	Date Approved by BOS	24 August 2023				
12	Course Webpage	https://www.iare.ac.in/sites/default/files/BT23/AHSD07.pdf				
13	Course Prerequistes	**Level UG/PG**	**Course Code**	**Course Title**	**Semester**	
		Intermediate	-	-	-	

14. Course Overview

The aim of this course is to promote understanding of fundamental knowledge in physics needed for the future technological advances. The concepts covered are in the fields of solid state physics, modern physics, superconductors and nanoscience. This knowledge helps to develop the ability to apply the principles in many advanced technological sectors such as nanotechnology, optical fiber communication, quantum technology etc.

15. Course Objectives:

The students will try to learn:

I	Fundamental concepts needed to explain a crystal structure in terms of atom positions, unit cells, and crystal symmetry.
II	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.
III	The metrics of optoelectronic components, lasers, optical fiber communication and be able to incorporate them into systems for optimal performance.
IV	The appropriate magnetic, superconducting and nanomaterials required for various engineering applications.

16. Course Outcomes:

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

S.No	Course outcome description
CO 1	Use the general rules of indexing of directions and planes in lattices to identify the crystal systems and the Bravais lattices.
CO 2	Extend the principles of dual nature of matter and Schrodinger wave equation to a particle enclosed in simple systems.
CO 3	Analyze the concepts of laser with normal light in terms of mechanism for applications in different fields and scientific practices.
CO 4	Comprehend the knowledge on functionality of components in optical fiber communication system by using the basics of signal propagation, attenuation and dispersion.
CO 5	Gain knowledge on properties of magnetic and superconducting materials suitable for engineering applications.
CO 6	Formulate the principle factors, fabrication, characterization techniques and the applications of nanomaterials.

17. Mapping of topic learning outcomes (TLO) to course outcomes

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Out-come:	Blooms Level
1	Space lattice, Basis, unit cell, lattice parameters	TLO 1	Recollect the basic properties of crystallography and crystal structures.	CO 1	Remember
2	Crystal systems	TLO 2	Classify various crystal systems in terms of unit cell dimensions and crystallographic axes.	CO1	Understand
3	Bravais lattices	TLO 3	Draw the Bravais lattice structures formed in seven crystal systems.	CO1	Understand

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Out-come:	Blooms Level
4	Simple cubic, Body centered cubic, Face centered cubic structures	TLO 4	Explain different crystal structures and determine their packing fractions.	CO1	Understand
5	Planes in a crystal	TLO 5	Identify different planes that can be formed in the crystal structure.	CO1	Apply
6	Interplanar distance	TLO 6	Determine the expression for interplanar spacing in orthogonal crystal system.	CO1	Apply
7	Waves and particles	TLO 7	Explainthe concept of dual nature of matter and light radiation.	CO2	Understand
8	de broglie hypothesis, Matter waves	TLO 8	Extend the debroglie hypothesis to the concept of matter waves.	CO2	Understand
9	Davisson and Germers experiment	TLO 9	Describe how Davisson and Germer experiment explained the existence of matter waves.	CO2	Understand
10	Schrodinger time independent wave equation	TLO 10	Discuss the Schrodinger time independent wave equation associated with matter waves.	CO2	Understand
11	Physical significance of wave function	TLO 11	Analyze the physical significance of wave function associated with matter waves.	CO2	Apply
12	Infinite square well potential	TLO 12	Apply Schrödinger's wave equation for energy values of a free particle confined in one dimensional potential square well.	CO2	Apply
13	Characteristics of lasers	TLO 14	Discuss the basic concepts of laser light sources.	CO3	Understand
14	Spontaneousand stimulated emission of radiation	TLO 15	Obtain the relation between Einstein coefficients associated with absorption, spontaneous emission and stimulated emission.	CO3	Apply
15	Lasing action	TLO 16	Explain the concepts involvedin producing lasing action.	CO3	Understand
16	Ruby and He-Ne lasers	TLO 17	Describe in detail the principle and working of Ruby and He-Ne lasers.	CO3	Understand
17	Applications of lasers	TLO 18	Identify the engineering applications of lasers in different fields.	CO3	Apply

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Out-come:	Blooms Level
18	Principle and construction of an optical fiber	TLO 19	Illustrate the principle and construction of optical fibersused in communication system.	CO 4	Understand
19	Acceptance angle, Numerical Aperture	TLO 20	Derive the expressions for the acceptance angle and numerical aperture of an optical fiber.	CO 4	Understand
20	Types of optical fibers, Single mode, multimode, step index, graded index	TLO 21	Discuss different types of optical fibers based on refractive index profile and modes of propagation.	CO 4	Understand
21	Optical fiber communication system	TLO 22	Elucidate the block diagram of fiber optic communication system.	CO 4	Apply
22	Applications of optical fibers	TLO 23	Enlist the applications of optical fibers.	CO4	Remember
23	Permeability, field intensity, magnetic field induction, magnetization, magnetic susceptibility,	TLO 24	Acquire knowledge of basic terms related to magnetic materials.	CO 5	Understand
24	Origin of magnetic moment, Bohr magneton	TLO 25	Describe magnetic moment in an atom in termsof Bohr magneton.	CO 5	Understand
25	Classification of dia, para and ferro magnetic materials on the basis of magnetic moment	TLO 26	Classify different magnetic materials based on electron theory.	CO 5	Understand
26	Hysteresis curve	TLO 27	Examine the spontaneous magnetization in ferromagnets based on orientation of domains.	CO 5	Understand
27	Superconductivity, general properties	TLO 28	Recall he definition of superconductivity based on resistance.	CO 5	Remember
28	Meissner effect	TLO 30	Explain the Meissner effect related to superconductors.	CO 5	Understand

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Out-come:	Blooms Level
29	Effect of magnetic field	TLO 31	Analyze the effect of magnetic field on superconductors.	CO 5	Apply
31	BCS theory	TLO 33	Elucidate the concept of flux quantization and BCS theory.	CO 5	Apply
32	Applications of superconductors	TLO 34	Discuss the applications of superconductors.	CO 5	Understand
33	Nanoscale	TLO 35	Recall the definition of nano scale and nanotechnology.	CO 6	Remember
34	Quantum confinement	TLO 36	Explain the quantum confinement factor of nanomaterials.	CO 6	Understand
35	Surface to volume ratio	TLO 37	How the surface to volume ratio changes when particle size is reduced to nano scale.	CO 6	Understand
36	Bottom-up fabrication: sol-gel, precipitation, combustion methods, top-down fabrication: ball milling, physical vapor deposition, chemical vapor deposition	TLO 38	Discuss different methods of preparation of nanomaterialssuch as sol-gel, precipitation, and combustion, ball milling, physical vapor deposition and chemical vapor deposition.	CO 6	Understand
37	Characterization techniques: x-ray diffraction, transmission electron microscopy	TLO 39	Acquire the knowledge of different characterization techniques such as X-ray diffraction, Scanning Electron Microscopy and Transmission Electron Microscopy.	CO 6	Understand
38	Applications of nanomaterials	TLO 40	Discuss the applications of nanomaterialsin different engineering fields.	CO 6	Understand

18. Employability Skills

Project based skills: Applied physics for engineering students develop experimental skills, mathematical and problem solving abilities, required to carry out research and development in a large number of specialties.

19. Content Delivery / Instructional Methologies:

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

20. Evaluation Methodology:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). CIA is conducted for a total of 40 marks, with 20 marks for Continuous Internal Examination (CIE), and 05 marks for each Definitions and Terminology / Quiz and remaining 10 marks for Tech Talk / Assignments.

Semester End Examination (SEE): The SEE is conducted for 60 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. No choice is given from first two modules. Each question carries 12 marks. There could be a maximum of two sub divisions in a question.

Table 4: Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	**CIA - I**	**CIA - II**	**SEE**	**Total Marks**
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Definitions and Terminology / Quiz	05 Marks	05 Marks		10 Marks
Tech Talk / Assignment	05 Marks	05 Marks		10 Marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

21. Course content - Number of modules: Five

MODULE I	CRYSTAL STRUCTURES	Number of Lectures: 12
	Introduction, space lattice, basis, unit cell, lattice parameter, Bravais lattices, crystal systems, structure and packing fractions of simple cubic, body centered cubic, face centered cubic crystals, directions and planes in crystals, Miller indices, separation between successive [h k l] planes.	
MODULE II	QUANTUM PHYSICS	Number of Lectures: 12
	Waves and particles, de Broglie hypothesis, matter Waves, Davisson and Germer's experiment, Heisenberg's uncertainty principle, Schrödinger's time independent wave equation, physical significance of the wave function, infinite square well potential.	

MODULE III	**LASERS AND FIBER OPTICS**	**|Number of Lectures: 15**
	Characteristics of lasers, spontaneous and stimulated emission of radiation, population inversion, lasing action, Ruby laser, He-Ne laser and applications of lasers. **P**rinciple 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	MAGNETIC AND SUPERCONDUCTING PROPERTIES	| Number of Lectures: 12
	Permeability, field intensity, magnetic field induction, magnetization, magnetic susceptibility, origin of magnetic moment, Bohr magneton, classification of dia, para and ferro magnetic materials on the basis of magnetic moment. Superconductivity, general properties, Meissner effect, effect of magnetic field, type-I & type-II superconductors, BCS theory, applications of superconductors.	
MODULE V	NANOTECHNOLOGY	| Number of Lectures: 13
	Nanoscale, quantum confinement, surface to volume ratio, bottom-up fabrication: sol-gel, precipitation, combustion methods, top-down fabrication: ball milling, physical vapor deposition, chemical vapor deposition, characterization techniques: x-ray diffraction, transmission emission microscopy, applications of nanomaterials.	

TEXTBOOKS

1. Arthur Beiser, Shobhit Mahajan and Rai Choudhary, *Concepts of Modern Physics,* , Tata McGraw Hill, 7th Edition, 2017.

REFERENCE BOOKS:

1. H J Callister, *A Textbook of Materials Science and Engineering,* , Wiley Eastern Edition, 8th Edition, 2013.
2. Halliday, Resnick and Walker, *Fundamentals of Physics,* , John Wiley Sons,11th Edition, 2018.
3. Charles Kittel, *Introduction to Solid State Physics,* , Wiley Eastern, 2019.
4. S.L. Gupta and V. Kumar, *Elementary Solid State Physics,* ,Pragathi Prakashan, 2019.
5. K K Chattopadhyay and A N Banerjee, *Introduction to Nanoscience and Nanotechnology,* , Prentice Hall India, 2nd Edition, 2011.

Electronic Resources:

1. NPTEL :: Physics - NOC:Quantum Mechanics I
2. NPTEL :: Physics - NOC:Introduction to Solid State Physics
3. NPTEL :: Physics - NOC:Solid State Physics
4. https://nptel.ac.in/courses/104104085
5. NPTEL :: Metallurgy and Material Science - NOC:Nanotechnology, Science and Applications

Material Online:

1. Course template
2. Tutorial question bank
3. Definition and terminology
4. Tech-talk topics
5. Assignments
6. Model question paper - I
7. Model question paper - II
8. Lecture notes
9. Early learning readiness videos (ELRV)
10. Power point presentations

22. COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
Discussion on OBE			
1	Discussion on Outcome Based Education, CO, POs and PSOs		
Content Delivery (Theory)			
1	Introduction, space lattice	CO 1	T1; R1
2	Basis, unit cell, lattice parameter	CO 1	T1; R1
3	Crystal systems	CO 1	T1; R1
4	Bravais lattices	CO 1	T1; R1
5	Simple cubic structure	CO 1	T1; R1
6	Body centered cubic structure	CO 1	T1; R1
7	Face centered cubic structure	CO 1	T1; R1
8	Directions and planes in crystals	CO 1	T1; R1
9	Miller indices	CO 1	T1; R1
10	Separation between successive [h k l] planes	CO 1	T1; R1
11	Introduction to Quantum Physics	CO 2	T1; R1, R2
12	Wave-particle duality of radiation	CO 2	T1; R1, R2
13	de broglie hypothesis and de broglie wavelength	CO 2	T1; R1, R2
14	Properties of Matter waves	CO 2	T1; R1, R2
15	Davisson and Germer's experiment	CO 2	T1; R1, R2
16	Schr¨odinger time independent wave equation	CO 2	T1; R1, R2
17	Physical significance of wavefunction	CO 2	T1; R1, R2
18	Particle in a one-dimensional potential box	CO 2	T1; R1, R2
19	Characteristics of laser, Spontaneous and Stimulated emis sion	CO 3	T1; R3, R4
20	Metastable state, Population inversion, Lasing action	CO 3	T1; R3, R4
21	Ruby laser	CO 3	T1; R3, R4

S.No	Topics to be covered	CO's	Reference
22	He-Ne laser, Applications of LASER	CO 3	T1; R3, R4
23	Principle and construction of optical fibers	CO 4	T1; R3, R4
24	Acceptance angle, Acceptance cone, Numerical Aperture	CO 4	T1; R3, R4
25	Types of optical fibers	CO 4	T1; R3, R4
26	Optical fiber communication system, Applications of optical fibers	CO 4	T1; R1, R2
27	Permeability, field intensity, magnetic field induction, magnetization, magnetic susceptibility	CO 5	T1; R1
28	origin of magnetic moment, Bohr magneton	CO 5	T1; R1
29	Diamagnetic and Paramagnetic materials	CO 5	T1; R1
30	Ferromagnetic materials	CO 5	T1; R1
31	Hysteresis curve	CO 5	T1; R1
32	Superconductivity, general properties	CO 5	T1; R1
33	Meissner effect, effect of magnetic field	CO 5	T1; R1
34	type-I & type-II superconductors	CO 5	T1; R1
35	BCS theory	CO 5	T1; R1
36	applications of superconductors	CO 5	T1; R1
37	Nanoscale, quantum confinement, surface to volume ratio	CO 6	T1; R4
38	bottom-up fabrication: sol-gel, precipitation, combustion methods	CO 6	T1; R4
39	top-down fabrication: ball milling, physical vapor deposition, chemical vapor deposition	CO 6	T1; R4
40	characterization techniques: x-ray diffraction, transmission electron microscopy, applications of nanomaterials	CO 6	T1; R4
Problem Solving/Case Studies			
1	Packing fraction	CO 1	T1; R1
2	Miller indices	CO 2	T1; R1
3	Interplanar spacing	CO 2	T1; R1
4	de broglie wavelength	CO 2	T1; R1, R2
5	Energies associated with one dimensional potential box	CO 2	T1; R1, R2
6	Wavelength and Energy bandgap, Divergence	CO 3	T1; R3, R4
7	Relative population of two states, Number of photons emitted	CO 3	T1; R3, R4
8	Acceptance angle and Numerical Aperture	CO 4	T1; R1
9	Magnetic moment, Magnetic induction, Permeability	CO 5	T1; R1
10	Intensity of magnetization, Magnetic susceptibility	CO 5	T1; R1
11	Critical temperature	CO 5	T1; R4
12	Critical field	CO 5	T1; R4
13	Surface to volume ration	CO 6	T1; R4
14	Particle size	CO 6	T1; R4
15	Debye Scherrer method	CO 6	T1; R4

S.No	Topics to be covered	CO's	Reference
Definition and Terminology			
1	Crystal structures	CO 1	T1; R1
2	Quantum physics	CO 2	T1; R1, R2
3	Lasers and fiber Optics	CO 3	T1; R3, R4
4	Magnetic and superconducting properties	CO 4	T1; R1
5	Nanotechnology	CO 5	T1; R4
Tutorial Question Bank			
1	Crystal structures	CO 1	T1; R1
2	Quantum physics	CO 2	T1; R1, R2
3	Lasers and fiber Optics	CO 3	T1; R3, R4
4	Magnetic and superconducting Properties	CO 4	T1; R1
5	Nanotechnology	CO 5	T1; R4

23. PROGRAM OUTCOMES & PROGRAM SPECIFIC 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
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.

24. 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	AAT

3 = High; 2 = Medium; 1 = Low

25. 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

26. 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	✓	✓	-	-		-	-	-	-	-	-	-	-	-	-

27. 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** the different crystal structures based on arrangement of atoms in a unit cell, calculate their packing fraction and use those expressions to integrate with other engineering disciplines.	3
	PO 2	**Explain** the given **problem statement** and formulate lattice parameters and miller indices of a crystal from the provided **information** and **data** in reaching substantial conclusions by the **interpretation of packing fraction.**	4

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 2	PO 1	**Outline** drawbacks of classical mechanics, basic principles **dual nature** of matter wave, **derive** mathematical wave 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 result**s.	4
	PO 4	**Identify** the use of these semiconductors under study and their conduction mechanism for the **research based knowledge** and **technological development**.	2
CO 3	PO 1	**Compare** the concepts of laser and normal light in terms of mechanism and **working principle** for applications in different fields and scientific practices.	3
	PO 2	**Explain** different components involved in **laser system** by using the **basics** of absorption, emission and amplification of light radiation.	4
CO 4	PO 1	**Gather** the knowledge on functionality of components in optical fiber communication system by using the basics of signal propagation, attenuation and dispersion.	3
	PO 2	**Explain** functionality of components in optical fiber communication **system** by using the **basics** of signal propagation, attenuation and dispersion.	4
	PO 4	**Identify the given problem** and **formulate** expressions for acceptance angle and numerical aperture with the given **information** and **data** by applying principles of information of propagation through optical waveguides.	2
CO 5	PO 1	**Utilize** spin and orbital motion of electrons in determining **magnetic moment** of materials in terms of Bohr magneton materials having specific **engineering applications**.	3
CO 6	PO 1	**Illustrate** the different principal factors affecting particle size, calculate their surface to volume ratio and use those expressions to integrate with other engineering disciplines.	3
	PO 2	**Explain** the given **problem statement** and formulate fabrication, characterization of nanomaterials provided **information** and **data** in reaching substantial conclusions by the **interpretation of application in different fields.**	4

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

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

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

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

30. 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		
	PO 1	PO 2	PO 3	PO 4	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	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	2	-	1	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	18	10	-	2	-		-	-	-	-	-	-	-	-	-
AVERAGE	3	2	-	1	-		-	-	-	-	-	-	-	-	-

31. ASSESSMENT METHODOLOGY DIRECT:

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

32. ASSESSMENT METHODOLOGY INDIRECT:

-	Assessment of mini Projects by Experts	✓	End Semester OBE Feedback

33. Relevance to Sustainability goals

Write brief description about the course and how its relevance to SDGs.

1	NO POVERTY	
2	ZERO HUNGER	
3	GOOD HEALTH AND WELL-BEING	
4	QUALITY EDUCATION	Graduates who have specialized in physics provide a unique component of the technical workforce. They are able to attack a wide variety of problems with their problem-solving skills and grasp of the principles of physics,. A well-trained physicist is capable of moving quickly among different technical areas, particularly into areas so new that they have not yet evolved into an engineering discipline.
5	GENDER EQUALITY	

6	CLEAN WATER AND SANITATION	
7	AFFORDABLE AND CLEAN ENERGY	
8	DECENT WORK AND ECONOMIC GROWTH	
9	INDUSTRY, INNOVATION AND INFRASTRUCTURE	
10	REDUCED INEQUALITIES	
11	SUSTAINABLE CITIES AND COMMUNITIES	
12	RESPONSIBLE CONSUMPTION AND PRODUCTION	
13	CLIMATE ACTION	

14	LIFE BELOW WATER	
15	LIFE ON LAND	
16	PEACE, JUSTICE AND STRONG INSTITUTIONS	
17	PARTNERSHIPS FOR THE GOALS	

Approved by: Board of Studies in the meeting conducted on 24 August 2023 .

Signature of Course Coordinator **HOD, EEE**
Dr. Rizwana, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

<table>
<tr><td>1</td><td>Department</td><td colspan="5">ELECTRICAL AND ELECTRONICS ENGINEERING</td></tr>
<tr><td>2</td><td>Course Title</td><td colspan="5">DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS</td></tr>
<tr><td>3</td><td>Course Code</td><td colspan="5">AHSD08</td></tr>
<tr><td>4</td><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>5</td><td>Class/Semester</td><td colspan="5">II</td></tr>
<tr><td>6</td><td>Regulation</td><td colspan="5">BT-23</td></tr>
<tr><td rowspan="2">7</td><td rowspan="2">Structure of the course</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture
3</td><td>Tutorials
1</td><td>Credits
4</td><td>Lab
-</td><td>Credits
-</td></tr>
<tr><td>8</td><td>Type of course
(Tick type of course)</td><td>Core
✓</td><td>Professional Elective
×</td><td>Open Elective
×</td><td>VAC
×</td><td>MOOCs
×</td></tr>
<tr><td>9</td><td>Course Offered</td><td colspan="2">Odd Semester ×</td><td colspan="3">Even Semester ✓</td></tr>
<tr><td rowspan="2">10</td><td colspan="6">Total lecture, tutorial and practical hours for this course (16 weeks of teaching per semester)</td></tr>
<tr><td colspan="2">Lectures: 48 hours</td><td colspan="2">Tutorials: 16 hours</td><td colspan="2">Practical: 0 hours</td></tr>
<tr><td>11</td><td>Course Instructor</td><td colspan="5">Dr. JISHU JANA</td></tr>
<tr><td>12</td><td>Date Approved by BOS</td><td colspan="5">23/08/2023</td></tr>
<tr><td>13</td><td>Course Webpage</td><td colspan="5">www.iare.ac.in/—-/—-</td></tr>
<tr><td rowspan="2">14</td><td rowspan="2">Course Prerequistes</td><td>Level</td><td>Course Code</td><td>Semester</td><td colspan="2">Prerequisites</td></tr>
<tr><td>B.Tech</td><td>AHSD02</td><td>I</td><td colspan="2">Matrices and Calculus</td></tr>
</table>

15. Course Overview

This course serves as a foundation course on differential equations and vector calculus. It includes techniques for solving ordinary differential equations, partial differential equations, vector differentiation and vector integration. It is designed to extract the mathematical developments, skills, from basic concepts to advance level of engineering problems to meet the technological challenges.

16. COURSE OBJECTIVES:

The students will try to learn:

I	The analytical methods for solving first and higher order differential equations with constant coefficients.
II	The analytical methods for formation and solving partial differential equations.
III	The physical quantities of vector valued functions involved in engineering field. .
IV	The logic of vector theorems for finding line, surface and volume integrals. .

17. COURSE OUTCOMES:

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

CO 1	Utilize the methods of differential equations for solving the orthogonal trajectories and Newton's law of cooling
CO 2	Solve the higher order linear differential equations with constant coefficients by using method of variation of parameters.
CO 3	Make use of analytical methods for PDE formation to solve boundary value problems.
CO 4	Identify various techniques of Lagrange's method for solving linear partial differential equations which occur in Science and engineering.
CO 5	Interpret the vector differential operators and their relationships for solving engineering problems.
CO 6	Apply the integral transformations to surface, volume and line of different geometrical models .

18. Topic Learning Outcome (TLOs):

S No	TOPIC NAME	TLO No	Topic Learning Outcome's	Course Outcome	Blooms Level
1	Fundamentals of ordinary differential equation	TLO 1	**Summarize** basic fundamentals of ordinary differential equations through a procedural approach.	CO 1	Understand
2	Differential equations of first order	TLO 2	**Identify** the method of variables separable to obtain the solution for ordinary differential equations.	CO 1	Apply
		TLO 3	**Use** the standard methods to solve homogeneous equations.	CO 1	Apply
		TLO 4	**Solve** the ordinary differential equations by converting the non-homogenous equations to homogenous form which is used to get the solution.	CO 1	Apply

S No	TOPIC NAME	TLO No	Topic Learning Outcome's	Course Outcome	Blooms Level
3	Exact and non-Exact differential equations	TLO 5	**Distinguish** in between non-exact and exact equations with suitable examples	CO 1	Apply
		TLO 6	**Determine** the solution for non-exact equations based on set of ordinary differential equations.	CO 1	Understand
4	Applications of ODE	TLO 7	**Apply** standard methods for finding Orthogonal Trajectories of a family of curves.	CO 1	Apply
		TLO 8	**Determine** temperature of body at any time using Newton's law of cooling.	CO 1	Apply
5	Higher order linear differential equations	TLO 9	**Solve** higher order linear differential equations with constant coefficients to obtain the solution	CO 2	Apply
		TLO 10	**Utilize** the method of variation parameters to obtain the solution of higher order differential equations .	CO 2	Apply
6	Formation of partial differential equation	TLO 11	**Interpret** the partial differential equations by eliminating arbitrary constants.	CO 3	Understand
		TLO 12	**Formulate** the partial differential equations by eliminating arbitrary functions.	CO 3	Understand
7	Method of grouping and multipliers	TLO 13	**Utilize** the method of grouping to solve the Lagrange's linear equations.	CO 4	Apply
		TLO 14	**Use** the method of multipliers to obtain the solution of Lagrange's linear equations.	CO4	Apply
		TLO 15	**Solve** linear partial differential equation by using analytical methods.	CO 4	Apply
8	Fundamentals of vector functions	TLO 16	**Review** the vector properties on vector and scalar point functions which are used to find gradient ,divergence and curl	CO 5	Understand
		TLO 17	**Determine** directional derivative of vector point function to find its rate of change in given direction	CO 5	Understand

S No	TOPIC NAME	TLO No	Topic Learning Outcome's	Course Outcome	Blooms Level
9	Solenoidal and irrotational vectors	TLO 18	**Interpret** the vector properties to test whether the vector functions are solenoidal or irrotational	CO 5	Understand
10	Line, surface and volume integrals	TLO 19	**Determine** areas and volumes of functions by using line, surface and volume integrals.	CO 6	Understand
11	Integral theorems	TLO 20	**Determine** the areas of functions by using Green's theorem with suitable examples.	CO 6	Apply
		TLO 21	**Identify** the relation between surface integral and volume integral to find the volumes by using Stoke's theorem and Gauss-divergence theorem.	CO 6	Apply

19. Employability Skills

Example: Communication skills / Programming skills / Project based skills /
Differential Equations: Employability/ Skill development: Uses the basic of differential equation calculation concept in the field of engineering.
Vector Calculus: Employability/ Skill development: Uses the concept of definite integral in engineering problems

20. Content Delivery / Instructional Methologies:

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

21. Evaluation Methodology:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). CIA is conducted for a total of 40 marks, with 20 marks for Continuous Internal Examination (CIE), and and 05 marks for each Definitions and Terminology / Quiz and remaining 10 marks for Tech Talk / Assignments.

Semester End Examination (SEE): The SEE is conducted for 60 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. No choice is given from first two modules. Each question carries 12 marks. There could be a maximum of two sub divisions in a question

Table 4: Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	**CIA - I**	**CIA - II**	**SEE**	**Total Marks**
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Definitions and Terminology / Quiz	05 Marks	05 Marks		10 Marks
Tech Talk / Assignment	05 Marks	05 Marks		10 Marks
Semester End Examination (SEE)	-	-	60 Marks	40 Marks
Total	-	-	**100 Marks**	

22. Course content - Number of modules: Five:

MODULE I	**First order and first degree ordinary differential equations | Number of Lectures: 10**
	Exact differential equations, Equations reducible to exact differential equations, linear and Bernoulli's equations,. Applications: Orthogonal Trajectories (Cartesian Coordinates) Newton's law of cooling.
MODULE II	**Ordinary differential equations of higher order | Number of Lectures: 10**
	Second order linear differential equations with constant coefficients: non-homogeneous terms of the type e^{ax},sin ax,cosax, polynomials in x,$e^{ax}V(x)$ and method of variation of parameters.
MODULE III	**Partial differntiatial equations |Number of Lectures: 09**
	Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions, solutions of first order linear equations.
MODULE IV	**Vector differentiation | Number of Lectures: 09**
	Scalar and vector point functions; definitions of gradient, divergent and curl with examples; solenoidal and irrotational vector point functions; scalar potential function.
MODULE V	**Vector integration | Number of Lectures: 10**
	Line integral, surface integral and volume integral, Green's theorem in a plane, Stoke's theorem and Gauss divergence theorem without proofs.

TEXTBOOKS

1. B.S. Grewal "*Higher Engineering Mathematics*", Khanna Publishers, 44th Edition, 2017.
2. Erwin Kreyszig "*Advanced Engineering Mathematics*",10/e, John Wiley& Sons, 2011.

REFERENCE BOOKS:

1. R. K. Jain and S. R. K. Iyengar , "*, Advanced Engineering Mathematics*", 5th Edition, TMH, 2017.
2. George B. Thomas, Maurice D. Weir and Joel Hass, Thomas, "*Calculus*", 13/e, Pearson Publishers, 2013.
3. N.P.Bali and Manish Goyal"*A textbook of Engineering Mathematics*",Laxmi Publications, Reprint,2008

4. Dean G. Duffy, “*Advanced Engineering Mathematics with MATLAB*”,CRC Press
5. Peter O’Neil, “*Advanced Engineering Mathematics*”, Cengage Learning.
6. B.V. Ramana, “*Higher Engineering Mathematics*”, McGraw Hill Education.

ELECTRONIC RESOURCES:

1. Engineering Mathematics - I, By Prof. Jitendra Kumar — IIT Kharagpur https://onlinecourses.nptel.ac.in/noc23_ma88/preview
2. Advanced Calculus for Engineers, By Prof. Jitendra Kumar, Prof. Somesh Kumar — IIT Kharagpur https://onlinecourses.nptel.ac.in/noc23_ma86/preview
3. http://www.efunda.com/math/math_home/math.cfm
4. http://www.ocw.mit.edu/resourcs/Mathematics
5. http://www.sosmath.com
6. http://www.mathworld.wolfram.com

23. COURSE PLAN:

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

S.No	Topics to be covered	CO’s	Reference
	Discussion on OBE		
1	**Discussion on Outcome Based Education, CO, POs and PSOs**		
	CONTENT DELIVERY (THEORY)		
1	Introduction to ordinary Differential equations	CO 1	T1:11.1,11.2 R3:11.1,11.2
2	Variable Separable,homogeneous differential equations and non-homogeneous differential equations .	CO 1	T1:11.4,11.5 R3:11.4,11.5
3	Exact differential equations	CO 1	T1:11.7,11.8 R3:11.6,11.7
4	Non-exact differential equations using integrating factors	CO 1	T1:11.9 R3:11.8
5	Linear differential equations of first order	CO 1	T1:11.10 R3:11.9
6	Bernoulli’s Equation	CO 1	T1:11.11 R3:11.10
7	Reducible to linear equation by substitution	CO 1	T1:11.12 R3:11.12
8	Applications of ODE, Orthogonal trajectories	CO 1	T1:12.3 R3:12.3,12.4
9	Applications of ODE, Newton’s law of cooling	CO 1	T1:12.6 R3:12.9

S.No	Topics to be covered	CO's	Reference
10	Linear Differential Equations of Second and Higher Order with Constant Coefficients	CO 2	T2:2.8 R6:2.5
11	Non-Homogeneous term of the type f (X) = e^{ax}	CO 2	T2:2.8 R6:2.5
12	Non-Homogeneous term of the type f (X) = Sinax	CO 2	T2:7.4 R3:7.1
13	Non-Homogeneous term of the type f (X) = Cosax	CO 2	T2:7.4 R3:7.1
14	Non-Homogeneous term of the type f (X) = X^n.	CO 2	T2:7.4 R3:7.1
15	Determine particular non-homogeneous term of the type f (X) = e^{ax} V(x)	CO 2	T2:7.4 R3:7.1
16	Solving second order linear differential equations using method of variation of parameters.	CO 2	T2:2.1 R6:2.9
17	Introduction to Partial differential equations	CO 3	T1:17.1 R3:16.1
18	Elimination of arbitrary constants (Formation of PDE)	CO 3	T1:17.1,17.2 R3:16.1,16.2
19	Elimination of arbitrary functions (Formation of PDE)	CO 3	T1:17.2 R3:16.2
20	Lagrange's Linear equation- Method of grouping	CO 4	T1:17.5,17.6 R3:16.3.1
21	Lagrange's Linear Equation -Method of Multipliers	CO 4	T1:17.5,17.6 R3:16.4- 16.5
22	Linear Partial differential equation of first order	CO 4	T1:17.5- 17.6 R3:16.5- 16.6
23	Solution of linear partial differential equation	CO 4	T1:17.5- 17.6 R3:16.5- 16.6
24	In Scalar and Vector Point Function(Definitions of Gradient, divergent, curl	CO 5	T1: 8.4 R6:8.1
25	Problems on directional derivative	CO5	T1:8.5 R6:11.3
26	Problems on Gradient of vector point functions	CO 5	T1:8.5 R6:11.3
27	Problems on divergence of vector point functions.	CO 5	T1:8.6 R6:11.4
28	Problems on curl of vector point function	CO 5	T1:8.6 R6:11.4
29	Properties of divergence and curl	CO 5	T1: 8.6 R6:11.7
30	Solenoidal and irrotational vectors	CO 5	T1: 8.6 R6:11.7
31	Introduction to Line integral	CO 6	T1: 8.11 R6:12.2

S.No	Topics to be covered	CO's	Reference
32	Problems on line integral	CO 6	T1: 8.28 R6:12.9
33	Introduction to surface integral	CO 6	T1: 8.12 R6:12.3
34	Problems on surface integral	CO 6	T1: 8.31 R6:12.26
35	Calculating areas by using Green's theorem	CO 6	T1: 8.13.4 R6:12.40
36	Stoke's theorem	CO 6	T1: 8.14 R6:12.6
37	Problems on Stoke's theorem	CO 6	T1: 8.36 R6:12.53
38	Volume integral	CO6	T1:8.15 R6:12.4
39	Gauss divergence theorem	CO 6	T1: 8.16 R6:12.7
40	Calculate the volumes by using Gauss divergence theorem	CO 6	T1: 8.42 R6:12.68
PROBLEM SOLVING/ CASE STUDIES			
1	Solving first order differential equations by using standard methods	CO 1	T1:21.1,21.4 R1:5.1
2	Applications of ODE: Orthogonal trajectories and Newton's law of cooling	CO 1	T1:21.13 R1:5.1,5.3
3	Solving Second order and higher order differential equations with constant coefficients	CO 2	T1:21.14 R1:5.5
4	Solving Second order and higher order differential equations by method of variation of parameters	CO 2	T1:22.3 R1:10.8
5	Solving problems on formation of partial differential equations by elimination of arbitrary constants	CO 3	T1:22.4 R1:10.9
6	Solving problems on formation of partial differential equations by elimination of arbitrary functions	CO 3	T2:10.1 R1:16.1
7	Solving linear Lagrange's equation by using grouping method	CO 4	T2:10.1 R1:16.2
8	Solving linear Lagrange's equation by using multipliers method	CO 4	T2:10.1 R1:16.2
9	Solving problems on Gradient and divergence	CO 5	T2:11.3 R1:16.5
10	Solving problems on Divergence and curl of a vector point functions	CO 5	T2: 11.3 R1:16.11
11	Solving problems on scalar potential function.	CO 5	T2: 11.3 R1:16.11

S.No	Topics to be covered	CO's	Reference
12	Solving problems on vector point functions: Solenoidal and irrotational.	CO 5	T2: 11.3 R1:16.9
13	Solving problems on Green's theorem	CO 6	T2: 11.4 R1:16.18
14	Solving problems on Stokes theorem	CO 6	T1:17.1- 17.2 R1:16.1- 16.2
15	Solving problems on Gauss divergence theorem	CO 6	T1:17.1- 17.2 R1:16.1- 16.2
DEFINITION AND TERMINOLOGY			
1	Definitions and terminology on ordinary differential equations	CO 1	T1:21.1,21.4 R1:5.1
2	Definitions and terminology on higher order differential equations	CO 2	T1:22.1-22.2 R1:10.8
3	Definitions and terminology on partial differential equations	CO 3 CO 4	T2:15.5 R1:7.5
4	Definitions and terminology on vector differentiation	CO 5	T2:10.3 R1:16.4
5	Definitions and terminology on vector integration	CO 6	T1:17.1- 17.2 R1:16.1-16.2
QUESTION BANK			
1	Discussion of first order differential equations	CO 1	T1:21.1,21.4 R1:5.1
2	Discussion of second and higher order differential equations	CO 2	T1:22.1- 22.2 R1:10.8
3	Discussion of partial differential equations	CO 3 CO 4	T2:15.5 R1:7.5
4	Discussion of vector differentiation	CO 5	T2:10.3 R1:16.4
5	Discussion of vector integration	CO 6	T1:17.1- 17.2 R1:16.1- 16.2

24. PROGRAM OUTCOMES & PROGRAM SPECIFIC 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
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.

25. 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

26. 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

27. 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	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-

28. 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	Determine the solution of complex engineering problems modelled by first order linear differential equations by using standard methods of Principles of Mathematics	2
	PO 2	Model the problems with help of ordinary differential equations, formulation of statement Newton's law of cooling apply the basic principle of mathematics and solve complex engineering problems by interpretation of results	6
CO 2	PO 1	Determine the solution of complex engineering problems modelled by Second and higher order linear differential equations with constant coefficients by using Principle of mathematics, substitution method and method of variation of parameter	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 3	PO 2	Make use of the different methods in the 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
CO 4	PO 1	Solve Lagrange's linear equation related to complex engineering problems such as grouping and multiplier method using principle of mathematics for solving linear partial differential equations which occur in Science and engineering .	2

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 5	PO 2	Interpret the statement and formulation by differential calculus of complex engineering problems which transforms vector functions, gradients. Divergence, curl, using principle of mathematics to different bounded regions in calculating areas. by interpretation of results.	6
CO 6	PO 1	Apply the mathematics, science and Engineering fundamentals to dynamic equilibrium the problems for analysis of forces using the knowledge of mathematics and science fundamentals.	2

29. 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	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	6	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-

30. 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	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	66.7	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	-	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	66.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	-	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	66.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-

31. 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		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	12	12	-	-	-		-	-	-	-	-	-	-	-	-
AVERAGE	3	3	-	-	-		-	-	-	-	-	-	-	-	-

32. ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	✓				

33. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

34. Relevance to Sustainability goals

Write brief description about the course and how its relevance to SDGs. Mathematics plays an important role in the achievement of the Sustainable Development Goals (SDG) and at the same time these allow working with real situations in the subject of mathematics, providing the student with active learning. Sustainability is used to make the student see the usefulness of mathematics while instilling values and attitudes towards it.

x	1		
x	2		

x	3	GOOD HEALTH AND WELL-BEING	
✓	4	QUALITY EDUCATION	**Quality Education:**This subject will improve the quality education in engineering and provides the knowledge in mathematical modelling which is used for real time applications
x	5	GENDER EQUALITY	
x	6	CLEAN WATER AND SANITATION	
x	7	AFFORDABLE AND CLEAN ENERGY	
x	8	DECENT WORK AND ECONOMIC GROWTH	
x	9	INDUSTRY, INNOVATION AND INFRASTRUCTURE	

x	10	REDUCED INEQUALITIES	
x	11	SUSTAINABLE CITIES AND COMMUNITIES	
x	12	RESPONSIBLE CONSUMPTION AND PRODUCTION	
x	13	CLIMATE ACTION	
x	14	LIFE BELOW WATER	
x	15	LIFE ON LAND	
x	16	PEACE, JUSTICE AND STRONG INSTITUTIONS	

x	17	PARTNERSHIPS FOR THE GOALS	

Approved by: Board of Studies in the meeting conducted on 23/08/2023

Signature of Course Coordinator **HOD**
Dr. Jishu Jana, Assistant Professor

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

COURSE TEMPLATE

1	Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**			
2	Course Title	**ENGINEERING GRAPHICS**			
3	Course Code	AMED03			
4	Program	B.Tech			
5	Semester	II Semester			
6	Regulation	BT-23			
7	Structure of the course	Practical			
		Lecture Hours		Practical Hours	
		15		30	
8	Course Offered	Odd Semester ✗		Even Semester ✓	
9	Course Faculty	Mr. M Sunil Kumar			
10	Date Approved by BOS	30/08/2023			
11	Course Webpage	www.iare.ac.in/—-/—-			
12	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**

13. Course Overview

Introduction to graphical representation using free hand drawing and computer-aided drafting. Engineering graphics covers basic engineering drawing techniques such as lines & lettering, geometrical constructions, principles of tangency, orthographic projections, sectional views, and dimensioning. This course assists to draw 2D drawings for industrial applications.

14. COURSE OBJECTIVES:

The students will try to learn:

I	The basic engineering drawing formats.
II	Projections of points, lines, planes and solids at inclinations of horizontal plane and vertical plane.
III	Use of computer-aided design (CAD) to communicate concepts and ideas in the design of three-dimensional engineering products.

15. COURSE OUTCOMES:

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

CO 1	**Demonstrate** an ability to dimension and annotate two-dimensional engineering graphics..	Understand
CO 2	**Demonstrate**the freehand sketching to aid in the visualization process and to efficiently communicate ideas graphically.	Understand
CO 3	**Make use of** CAD software for the creation of 3D models and 2D engineering graphics.	Apply
CO 4	**Comprehend** the principles and techniques for creating sectional views of three-dimensional solids in engineering graphics.	Understand
CO 5	**Explain** the application of industry standards and best practices applied in engineering graphics.	Understand
CO 6	**Apply** the general projection theory with emphasis on orthographic projection to represent three-dimensional objects in two-dimensional views.	Apply

16. Employability Skills

1. **Employment advantage:** This can give competitive advantage when seeking employment as Design Engineer.
2. **Problem-Solving and Analytical Thinking:** Engineering Drawing involves CFD analysis and structural analysis of structures before inspection of prototype. This cultivates the ability to think critically and find innovative solutions, which is a fundamental skill sought by employers before finalization of product design in industries.
3. **Safety Awareness:** The analysis, decides the safety factor for the machine member when subjected to static and dynamic forces which enhances safety consciousness. Graduates should consider this awareness in every engineering industry where safety is a priority.

17. Content Delivery / Instructional Methologies:

✓	Day to Day lab evaluation	✓	Demo Video	✓	Viva Voce questions	x	Open Ended Experiments
x	Competitions	x	hackathons	x	Certifications	✓	Probing Further Questions

18. Evaluation Methodology:

Each laboratory will be evaluated for a total of 100 marks consisting of 40 marks for internal assessment and 60 marks for semester end lab examination. Out of 40 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance including viva voce, 10 marks for the final internal lab assessment and remaining 10 marks for The remaining 10 marks are for Laboratory Report/Project and Presentation, which consists of the Design (or) Software / Hardware Model Presentation (or) App Development (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 40 marks (Table 1), with 20 marks for continuous lab assessment during day-to-day performance including viva voce, 10 marks for final internal lab assessment and remaining 10 marks for Laboratory Report / Project and Presentation.

Table 3: CIA marks distribution

Component				
Type of Assessment	Day to Day performance and viva voce examination	Final internal lab assessment	Laboratory Report / Project and Presentation	Total Marks
CIA marks	20	10	10	40

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.

Table 4: Experiment based

Objective	Analysis	Design	Conclusion	Viva voce	Total
	5	5	5	5	20

Table 5: Programming based

Objective	Analysis	Design	Conclusion	Viva voce	Total
					20

Semester End Examination:
The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the other colleges which will be decided by the Head of the institution.
In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

1. 10 marks for write-up
2. 15 for experiment/program
3. 15 for evaluation of results
4. 10 marks for presentation on another experiment/program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course.

19. COURSE CONTENT SYLLABUS:

CO 1	**Demonstrate an ability to dimension and annotate two-dimensional engineering graphics.**
	1. Introduction to CAD 2. Introduction to Engineering Drawing 3. Exercises on Dimensioning 4. Exercises on Geometrical Constructions
CO 2	**Demonstrate the freehand sketching to aid in the visualization process and to efficiently communicate ideas graphically.**
	1. Exercises on Conic Sections
CO 3	**Make use of CAD software for the creation of 3D models and 2D engineering graphics.**
	1. Exercises on Technical Sketching and Shape Description
CO 4	**Comprehend the principles and techniques for creating sectional views of three-dimensional solids in engineering graphics.**
	1. Exercises on Sectional views
CO 5	**Explain the application of industry standards and best practices applied in engineering graphics.**
	1. Exercise on Development of surfaces-1 (Prisms) 2. Exercise on Development of surfaces-2 (Cylinder, Cone and Pyramid)
CO 6	**Apply the general projection theory with emphasis on orthographic projection to represent three-dimensional objects in two-dimensional views.**
	1. Exercise on orthographic views 2. Exercise on Isometric projection of planes 3. Exercise on isometric projections of solids 4. Demonstration of SOLID WORKS Software 5. Demonstration of CREO Software

Note: One Course Outcome may be mapped to multiple number of experiments.

TEXTBOOKS

1. Frederick E Giesecke, Alva Mitchell, Henry C Spencer, Ivan L Hill, John T Dygdon, James E. Novak, R. O. Loving, Shawna Lockhart, Cindy Johnson" *Technical Drawing with Engineering Graphics*", Pearson Education, 16th Edition, 2016.

2. Donald Hearn "*Computer Graphics*", Pearson Education, 12th Edition, 2021.

REFERENCE BOOKS:

1. Basant Agrawal and C M Agrawal "*Engineering Drwing*", 3 rd Edition, Mc GraHill, 2018.
2. James M. Leake, Molly Hathaway Goldstein, Jacob L. Borgerson, "*Engineering Design Graphics, Modelling and Visualization* ", Wiley Publications, 3 rd Edition, 2020.

MATERIALS ONLINE:

1. Lecture notes, ELRV videos and power point presentations
2. Answers / solutions to all questions / problems in the textbook
3. Online exercises
4. Problems and solutions in files

20. COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
1	Introduction to AUTOCAD	CO 1	
2	Introduction to Engineering Drawing	CO 1	T1:5.6 R1:1.12.3
3	Exercises on Dimensioning	CO 1	T2:5.10 R1:1.15
4	Exercises on Geometrical Constructions	CO 1	T2:5.15 R1:1.16
5	Exercises on Conic Sections	CO 2	T2:5.17 R1:1.13.1
6	Exercises on Technical Sketching and Shape Description	CO 3	T2:5.18 R1:1.13.2
7	Exercises on Sectional views	CO 4	T2:5.19 R1:1.13.3
8	Exercise on Development of surfaces-1(Prisms)	CO 5	T2:5.20 R1:1.7.1
9	Exercise on Development of surfaces-2 (Cylinder, Cone, Pyramid)	CO 5	T2:5.24 R1:1.17.3
10	Exercise on orthographic views	CO 6	T2:6.3 R1:2.6.1
11	Exercise on Isometric projection of Planes	CO 6	T2:6.5 R1:2.6.2
12	Exercise on Isometric projection of Solids	CO 6	T2:7.7 R1:2.10

S.No	Topics to be covered	CO's	Reference
13	Demonstration of SOLID WORKS Software	CO 6	T2:7.11
14	Demonstration of CREO Software	CO 6	T2:7.11

21. EXPERIMENS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Develop the procedure to draw knuckle joint by using AUTO CAD.
2	Develop the standard procedure to draw 2D drawing of any machine component by using AUTO CAD.

22. PROGRAM OUTCOMES & PROGRAM SPECIFIC 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.
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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.

Program Outcomes	
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
Program Specific Outcomes	
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23. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Strength	Proficiency Assessed by
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 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	2	CIE/Quiz/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	Seminar / Conferences / Research papers
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society 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	Seminar / Conferences / Research papers
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 / Conferences / Research papers

24. 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

25. 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	-	-	-	-	-	-	✓	✓	✓	✓	-	✓	-	-	-

26. 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 7	Understand the impact of the engineering graphics in societal and environmental contexts for sustainable development.	1
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering graphics..	1
	PO 9	Function effectively as an individual, and as a member or leader in a design team.	5
	PO 10	Communicate effectively on complex engineering drawing to write effective reports and design documentation.	2
	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 designing.	2

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 2	PO 7	Understand the impact of the engineering graphics in societal and environmental contexts for sustainable development.	1
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering graphics..	1
	PO 9	Function effectively as an individual, and as a member or leader in a design team.	5
	PO 10	Communicate effectively on complex engineering drawing to write effective reports and design documentation.	2
	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 designing.	2
CO 3	PO 7	Understand the impact of the engineering graphics in societal and environmental contexts for sustainable development.	1
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering graphics..	1
	PO 9	Function effectively as an individual, and as a member or leader in a design team.	5
	PO 10	Communicate effectively on complex engineering drawing to write effective reports and design documentation.	2
	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 designing.	2
CO 4	PO 7	Understand the impact of the engineering graphics in societal and environmental contexts for sustainable development.	1
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering graphics..	1
	PO 9	Function effectively as an individual, and as a member or leader in a design team.	5
	PO 10	Communicate effectively on complex engineering drawing to write effective reports and design documentation.	2
	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 designing.	2
CO 5	PO 7	Understand the impact of the engineering graphics in societal and environmental contexts for sustainable development.	1
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering graphics..	1
	PO 9	Function effectively as an individual, and as a member or leader in a design team.	5

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 10	Communicate effectively on complex engineering drawing to write effective reports and design documentation.	2
	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 designing.	2
CO 6	PO 7	Understand the impact of the engineering graphics in societal and environmental contexts for sustainable development.	1
	PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering graphics..	1
	PO 9	Function effectively as an individual, and as a member or leader in a design team.	5
	PO 10	Communicate effectively on complex engineering drawing to write effective reports and design documentation.	2
	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 designing.	2

27. 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	1	5	2	-	2		-	-
CO 2	-	-	-	-	-	-	1	1	5	2	-	2		-	-
CO 3	-	-	-	-	-	-	1	1	5	2	-	2		-	-
CO 4	-	-	-	-	-	-	1	1	5	2	-	2		-	-
CO 5	-	-	-	-	-	-	1	1	5	2	-	2		-	-
CO 6	-	-	-	-	-	-	1	1	5	2	-	2		-	-

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	-	-	-	-	-	33.3	33.3	42	40	-	25		-	-
CO 2	-	-	-	-	-	-	33.3	33.3	42	40	-	25		-	-
CO 3	-	-	-	-	-	-	33.3	33.3	42	40	-	25		-	-
CO 4	-	-	-	-	-	-	33.3	33.3	42	40	-	25		-	-
CO 5	-	-	-	-	-	-	33.3	33.3	42	40	-	25		-	-
CO 6	-	-	-	-	-	-	33.3	33.3	42	40	-	25		-	-

29. 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	2	1	1	-	1	-	-	-
CO 2	-	-	-	-	-	-	1	2	1	1	-	1	-	-	-
CO 3	-	-	-	-	-	-	1	2	1	1	-	1	-	-	-
CO 4	-	-	-	-	-	-	1	2	1	1	-	1	-	-	-
CO 5	-	-	-	-	-	-	1	2	1	1	-	1	-	-	-
CO 6	-	-	-	-	-	-	1	2	1	1	-	1	-	-	-
TOTAL	-	-	-	-	-	-	6	12	6	6	-	6	-	-	-
AVERAGE	-	-	-	-	-	-	1	2	1	1	-	1	-	-	-

30. ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Laboratory Practices	✓
Certification	-	Student Viva	✓	Open Ended Experiments	-

31. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

32. Relevance to Sustainability goals

1		
2		
3		

4	QUALITY EDUCATION	**Quality Education:** An engineering drawing course provides students with a strong foundation in design-analysis skills, enhancing their overall educational experience and empowering them to address real-world challenges.
5	GENDER EQUALITY	
6	CLEAN WATER AND SANITATION	**Clean Water and Sanitation:** Proper infrastructure design, can contribute to the effective delivery of clean water and sanitation services, benefiting communities' health and well-being.
7	AFFORDABLE AND CLEAN ENERGY	**Affordable and Clean Energy:** Engineering drawing plays a role in the design and analysis of equipments, contributing the sustainable energy solutions. Students learn to optimize energy use, design renewable energy systems, and enhance energy efficiency in various applications.
8	DECENT WORK AND ECONOMIC GROWTH	**Decent Work and Economic Growth:** Engineering drawing equips students with skills that contribute the job creation and economic growth while also promoting ethical and responsible engineering practices.
9	INDUSTRY, INNOVATION AND INFRASTRUCTURE	**Industry, Innovation, and Infrastructure:** Engineering drawing principles is crucial for developing and maintaining sustainable infrastructure and technological innovations. It contribute to designing safer, more durable, and environmentally friendly infrastructure projects.
10	REDUCED INEQUALITIES	
11	SUSTAINABLE CITIES AND COMMUNITIES	**Sustainable Cities and Communities:**Engineering drawing underpins the construction and maintenance of urban infrastructure, which can withstand environmental challenges and contribute to the safety and sustainability of urban spaces.
12	RESPONSIBLE CONSUMPTION AND PRODUCTION	
13	CLIMATE ACTION	

14		
15		
16		
17		

Approved by: Board of Studies in the meeting conducted on 30/08/2023

Signature of Course Faculty **HOD, EEE**
Mr. M Sunil Kumar, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**			
2	Course Code	AHSD05			
3	Course Title	**ENGINEERING CHEMISTRY LABORATORY**			
4	Semester	II			
5	Regulations	BT-23			
6	Structure of the course	Practical			
		Lecture Hours		Practical Hours	
		-		36	
7	Course Offered	Odd Semester ✗		Even Semester ✓	
8	Course Coordinator	Dr. B Divya			
9	Date Approved by BOS				
10	Course Webpage	https://www.iare.ac.in/sites/default/files/BT23/AHSD05.pdf			
11	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**
		-	-	-	-

12. Course Overview

The course promotes the use of analytical tools from an engineering standpoint. It provides the overview of analytical techniques, and outline the importance of volumetric analysis, comprehensive instrumental analysis for properties of polymers, colorimetric analysis, and spectroscopic analysis. This practical approach gives the awareness to chemical methods and perform testing of materials in various industries.

13. Course Objectives:

The students will try to learn:

I	The quantitative analysis to know the strength of unknown solutions by instrumental methods.
II	The troubles of hard water and its estimation by analytical techniques
III	The applications of appropriate lubricant for finely tuned machinery
IV	The basic knowledge on synthesis of nanomaterials and its properties

14. Course Outcomes:

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

CO1	Use conductivity meter and potentiometer for measurement of conductance and electromotive force of solutions
CO2	Use PH meter for measurement of Strength of Acidic Solutions.

CO3	Make use of the principles of water analysis for domestic and industrial applications.
CO4	Predict the Properties of polymeric materials by synthesizing the monomers
CO5	Use different types of lubricants to know its properties for the proper lubrication of machinery in industries.
CO6	Interpret the absorption tendency of solids or liquids by using Colorimetry and spectroscopy techniques.

15. Employability Skills

1. **Project based skills:** Awareness on instrumental methods of analysis and real-time applications through properties of materials.

16. Content Delivery / Instructional Methologies:

✓	Day to Day lab evaluation	✓	Demo Video	✓	Viva Voce questions	x	Open Ended Experiments
x	Competitions	x	hackathons	x	Certifications	✓	Probing Further Questions

17. Evaluation Methodology:

Each laboratory will be evaluated for a total of 100 marks consisting of 40 marks for internal assessment and 60 marks for semester end lab examination. Out of 40 marks for internal assessment, continuous lab assessment will be done for 20 marks for the day today's performance including viva voce, 10 marks for the final internal lab assessment, and the remaining 10 marks for Laboratory Report/Project and Presentation, which consists of the Design (or) Software / Hardware Model Presentation (or) AppDevelopment (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 40 marks (Table 1), with 20 marks for continuous lab assessment during day-to-day performance including viva voce, 10 marks for final internal lab assessment and remaining 10 marks for Laboratory Report/Project and Presentation.

Table 1.0: CIA marks distribution

Component				
Type of Assessment	Day to Day performance and viva voce examination	Final internal lab assessment	Laboratory Report / Project and Presentation	Total Marks
CIA marks	20	10	10	40

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.

Table 2.0: Experiment based

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

Table 3.0: Programming based

Objective	Analysis	Design	Conclusion	Viva voce	Total

Semester End Examination:
The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the other colleges which will be decided by the Head of the institution.
In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

1. 10 marks for write-up
2. 15 for experiment/program
3. 15 for evaluation of results
4. 10 marks for presentation on another experiment/program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course.

18. Course Content:

CO 1	**Use conductivity meter and potentiometer for measurement of conductance and electromotive force of solutions**
	1. Determine the Neutralization Point between Strong Acid against Strong Base 2. Estimate the Amount of Iron by Potentiometry 3. Determine the pH of the unknown solution by pH metry
CO 2	**Use PH meter for measurement of strength of acidic solutions.**
	1. Determine the pH of the unknown solution by pH metry
CO 3	**Make use of the principles of water analysis to control the hardness of water used in domestic and industrial purposes**
	1. Determination of chloride content of water by argentometry 2. Measurement of Total Dissolved Solids (TDS) in different water samples 3. Estimate the Total Hardness of water using EDTA

CO 4	**Predict the properties of polymeric materials by synthesizing the monomers.**
	1. Synthesize Thiokol rubber using sodium polysulphide with 1, 2-Dichloroethane.
CO 5	**Use the appropriate lubricant oil for the industrial machinery based on their properties.**
	1. Determine the Viscosity of the Lubricants using Red Wood Viscometer / Ostwald's Viscometer 2. Determine the Flash and Fire Points of Lubricants 3. Determine Cloud and Pour Points of Lubricants
CO 6	**Interpret the absorption tendency of solids or liquids using colorimetry and spectroscopic techniques.**
	1. Estimate the Metal Ion Concentration using Colorimeter 2. Characterization of Nanomaterials by UV-Visible Spectrophotometer

Note: One Course Outcome may be mapped to multiple number of experiments.

19. 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	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping ; Introduction to chemistry laboratory Safety guidelines to chemistry laboratory	CO 1	T2:10.31
2	Determine the neutralization point by titration of strong acid against strong base by conductometrically.	CO 1	T1:10.12 T2:10.31 R1:1.12.3
3	Studying the electrode potential measurements and estimate the amount of Fe^{2+} by using potentiometer.	CO 1	T2:10.31 R1:1.15
4	Determination of the pH of a given solution by pH metry	CO 1	T1:10.12 R1:1.16
5	Determination of chloride content of water by argentometry.	CO 2	T1:16.8 R1:1.13.1
6	Studying the water hardness and determine the Total Dissolved Solids (TDS) in each test liquid.	CO 3	T5:17.5 R1:1.13.2

S.No	Topics to be covered	CO's	Reference
7	Studying the specifications of water and estimate the total hardness of water by complexometric method	CO 3	T5:17.5 R1:1.13.3
8	Synthesize Thiokol rubber using sodium polysulphide with 1, 2-Dichloroethane.	CO 4	T3:2.6 R1:1.7.1
9	Studying the viscosity of lubricants and determine the viscosity of lubricants at various temperature using Red wood viscometer	CO 5	T1:19.10 R1:1.17.3
10	Determination of flash and fire points of lubricants by using Pensky Martens apparatus	CO 5	T1:19.10 R1:2.6.1
11	Determination of cloud and pour points of lubricants.	CO 5	T1:19.10 R1:2.6.2
12	Estimation of metals ion concentration by colorimetry	CO 6	T2:16.9 R1:2.10
13	Characterization of nanomaterials by using UV-visible spectrophotometer	CO 6	T2:16.9

20 Experiments for Enhanced Learning (EEL):

S.No	Design Oriented Experiments
1	To study the Beer Lambert's Law and utilize for the determination metal concentration in effluents by colorimetry
2	To study the absorption edges of metal complex using spectrophotometry
3	To study the iron content by potentiometry using different oxidizing agents

21. Program Outcomes & Program Specific 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

Program Outcomes	
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
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.

22. 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	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 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..	2	Laboratory experiments, internal and external lab examinations.

23. 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

24. 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	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-

25. 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 basic principle of conductance and EMF to make use of titrimetry to obtain graphical plots to determine the strength of acid by using principles of science and mathematical expression for solving engineering problems	3
	PO 2	Use basic principles of conductance and EMF to find the neutralization point that helps in interpretation of results..	2
CO 2	PO 1	Interpret the basic principles of pH metry to find the pH of unknown solutions and obtain graphical plots to determine the strength of acid by using principles of science and mathematical expressions or solving engineering problems.	3
	PO 2	Make use of pH metry and find the neutralization point that helps in interpretation of results.	2
CO 3	PO 1	Make use of coloured indicators to complex the metal ions, Investigate the concentration of hardness causing salts using Complexometry and argentometry methods by using principles of science and mathematical expression for solving engineering problems	3
	PO 2	Identify the problems of hard water and examine the total dissolved salts that provides information and data for its usage in industry.	2
	PO 7	Recognize the problems in industries by using hard water and its impact in socio economic and environmental contexts for sustainable development.	2
CO 4	PO 1	IExplain the polymerization process to synthesize the polymers from monomers by using principles of science and for solving engineering problems	2
CO 5	PO 1	Describe the physical properties of a lubricant and its determination using instrumental methods by using principles of science and mathematical expression for solving engineering problems	3
	PO 2	Extend the properties of lubricants with experimental collection of information and data in reaching conclusions by the interpretation of results.	2
CO 6	PO 1	Explain the principle of molecular transitions and make use of mathematical expression of Beer Lambert's Law colorimetry and UV-VIS spectroscopy by using principles of science and mathematical expression for solving engineering problems	3

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 2	Utilize graphical analysis of concentration versus absorbance for a given solution, and interpret the data, to provide valid conclusions regarding the quantitative analysis.	2

26. Total count of key competencies for CO – (PO, PSO) MAPPING:

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

27. Percentage of key competencies for CO – (PO, PSO):

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

28. 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		
	PO 1	PO 2	PO 3	PO 4	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	-	-	-	-	-	-	-	-	-	-	-	-	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 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	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	2	-	-	-	-	2	-	-	-	-	-	-	-	-
CO 4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	17	10	-	-	-		-	-	-	-	-	-	-	-	-
AVERAGE	2.8	2	-	-	-	-	2	-	-	-	-	-	-	-	-

29. Assessment methodology direct:

CIE Exams	✓	SEE Exams	✓	Laboratory Practices	✓
Certification	-	Student Viva	✓	Open Ended Experiments	-

30. Assessment methodology indirect:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

31. Relevance to Sustainability goals

Write brief description about the course and how its relevance to SDGs.

1		
2		
3		

4		**Quality Education:** Enhancement in the additional skills for the students with analytical tools.
5		
6		**Clean Water and Sanitation:** Ensures the availability to clean water through hard water analysis and its removal with chemical methodology
7		
8		
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12		

13		
14		**Life Below Water:** Knowledge gained on the colorimetry provides awareness to students on the effect of metals from industrial effluents on living organisms in water bodies
15		
16		
17		

Approved by: Board of Studies in the meeting conducted on ——————————.

Signature of Course Coordinator **HOD,EEE**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**Electrical and Electronics Engineering**			
2	Course Title	**Applied Physics Laboratory**			
3	Course Code	AHSD09			
4	Program	B.Tech			
5	Semester	II Semester			
6	Regulation	BT-23			
7	Structure of the course	Practical			
		Practical Hours			Credits
		48			1
8	Course Offered	Odd Semester ×		Even Semester ✓	
9	Course Coordinator	Dr. N V Surya Sharma			
10	Date Approved by BOS	24/08/2023			
11	Course Webpage	www.iare.ac.in/B.Tech. Course Syllabus BT23 -EEE/—-			
12	Course Prerequistes	**Level UG/PG**	**Course Code**	**Course Tittle**	**Semester**
		Intermediate	-	-	-

13. Course Overview

The aim of the course is to provide hands on experience for experiments in different areas of physics. This laboratory includes experiments involving electromagnetism and optoelectronics. This also develops student's expertise in applying physical concepts to practical problem and apply it for different applications.

14. COURSE OBJECTIVES:

The students will try to learn:

I	Familiarize with the lab facilities, equipment, standard operating procedures..
II	About the different kinds of functional magnetic materials which paves away 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 application characteristics of lasers and its propagation in optical fibre communication.

15. 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 and resistivity of a semiconductor diode using four probe method.
CO 2	**Illustrate** principle, working and application of wave propagation and compare the results of frequency with theoretical harmonics and overtones.
CO 3	**Investigate** the energy losses, curie temperature and properties associated with a given Ferro magnetic material
CO 4	**Examine** launching of light through optical fiber from the concept of light gathering capacity of numerical aperture and determine the divergence of Laser beam
CO 5	**Graph** V-I /L-I characteristics of various optoelectronic devices like Light Emitting diode, Solar cell at different intensities to understand their basic principle of functioning as well as to infer the value of Planck's constant
CO 6	**Analyse** the variation of magnetic field induction produced at various points along the axis of current carrying coil.

16. Employability Skills

1. **Project based:** Project based skills: Would be able to familiarize themselves with basic experiments and calculations that would inculcate the concept of learning by doing.

17. Content Delivery / Instructional Methologies:

✓	Day to Day lab evaluation	✓	Demo Video	✓	Viva Voce questions	✓	Open Ended Experiments
x	Competitions	x	hackathons	x	Certifications		Probing Further Questions

18. Evaluation Methodology:

Each laboratory will be evaluated for a total of 100 marks consisting of 40 marks for internal assessment and 60 marks for semester end lab examination. Out of 40 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance including viva voce, 10 marks for the final internal lab assessment and remaining 10 marks for The remaining 10 marks are for Laboratory Report/Project and Presentation, which consists of the Design (or) Software / Hardware Model Presentation (or) App Development (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 40 marks (Table 1), with 20 marks for continuous lab assessment during day-to-day performance including viva voce, 10 marks for final internal lab assessment and remaining 10 marks for Laboratory Report / Project and Presentation.

Table 3: CIA marks distribution

Component				
Type of Assessment	Day to Day performance and viva voce examination	Final internal lab assessment	Laboratory Report / Project and Presentation	Total Marks
CIA marks	20	10	10	40

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.

Table 4: Experiment based

Objective	Analysis	Design	Conclusion	Viva voce	Total
	5	5	5	5	20

Table 5: Programming based

Objective	Analysis	Design	Conclusion	Viva voce	Total
					20

Semester End Examination:
The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the other colleges which will be decided by the Head of the institution.
In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

1. 10 marks for write-up
2. 15 for experiment/program
3. 15 for evaluation of results
4. 10 marks for presentation on another experiment/program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course.

19. COURSE CONTENT SYLLABUS:

CO 1	**Identify the type of semiconductor using the principle of Hall effect and also determine the energy gap and resistivity of a semiconductor diode using four probe method.**
	1. Errors and Measurement 2. Hall Effect (Loreentz Force) 3. Energy gap of a Semiconductor diode 4. Resistivity -Four probe Method

CO 2	**Illustrate principle, working and application of wave propagation and compare the results of frequency with theoretical harmonics and overtones.**
	1. Melde's Experiment
CO 3	**Investigate the energy losses, curie temperature and properties associated with a given Ferro magnetic material.**
	1. B-H Curve With CRO 2. Magnetic Materials
CO 4	**Examine launching of light through optical fiber from the concept of light gathering capacity of numerical aperture and determine the divergence of Laser beam**
	1. 1 Optical Fiber 2. 2 Laser Divergence
CO 5	**Graph V-I /L-I characteristics of various optoelectronic devices like Light Emitting diode, Solar cell at different intensities to understand their basic principle of functioning as well as to infer the value of Planck's constant.**
	1. Solar Cell 2. Light Emitting Diode 3. Planck's Constant 4. Biassing Diode
CO 6	**Analyse the variation of magnetic field induction produced at various points along the axis of current carrying coil**
	1. Stewart's and Gee's Appratus

Note: One Course Outcome may be mapped to multiple number of experiments.

TEXTBOOKS

1. C. L. Arora, "Practical Physics", S. Chand Co., New Delhi, 3rd Edition, 2012.
2. Vijay Kumar, Dr. T. Radha krishna, "Practical Physics for Engineering Students", S M Enterprises, 2nd Edition, 2014.
3. Dr. Rizwana, "Engineering Physics Manual", Spectrum Techno Press, 2018

REFERENCE BOOKS:

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

20. COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
1	To estimate the error and uncertainty in measurement	CO 1	T1 :10.2
2	Study the phenomenon of Hall effect and determine the charge carrier density and Hall coefficient of a given sample	CO 1	T1:13.5
3	Determination of energy gap of a given semiconductor diode by measuring the variation of current as a function of temperature	CO 1	T1:16.8
4	Determination of the resistivity by forcing current through two outer probes and reading the voltage across the two inner probes of semiconductor by four probe method.	CO 1	T2:5.15 R1:1.16
5	Determination of frequency of a given tuning fork in longitudinal wave propagation and transverse mode of wave propagation	CO 2	T1:15.5 R1:1.13.1
6	Evaluate the energy loss per unit volume of a given magnetic material per cycle by tracing the hysteresis loop (B-H curve)	CO 3	T1:15.7
7	Determine the curie temperature (Tc) and relative permeability of a ferromagnetic materials.	CO 4	T1:15.8
8	Evaluation of numerical aperture and acceptance angle of a given optical fiber.	CO 4	T1:17.9
9	Determination of the beam divergence of the given laser beam	CO 4	T1:17.5
10	Studying the characteristics of solar cell at different intensities and determination of maximum workable power.	CO 5	T1:17.5
11	Studying V-I characteristics of LED in forward bias for different LEDs and measure the threshold voltage and forward resistance	CO 5	T1:19.10
12	Determination of Planck's constant by measuring threshold voltage of given LED.	CO 5	T1:19.10
13	Study the forward bias of LED and reverse bias of Photodiode	CO 5	T1:19.10
14	Study the magnetic field along the axis of current carrying coil – Stewart and Gee's method	CO 6	T1:14.7

21. Experiments for enhanced learning (EEL):

S.No	Design Oriented Experiments
1	To study the bending losses and transmission losses of an optical Fiber
2	To determine the mobility and conductivity of given semiconductor using Hall Effect
3	To Determine the resistivity of given ferromagnetic material using Two Probe method.

22. PROGRAM OUTCOMES & PROGRAM SPECIFIC 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.

Program Outcomes	
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
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.

23. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Strength	Proficiency Assessed by
PO 1	**Engineering Knowledge** 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

24. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Strength	Proficiency Assessed by
PSO1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization	-	-
PSO2	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.	-	-

PSO3	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

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

COURSE OUTCOME	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	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	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-

26. 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	PO1	Identify basic principle of Hall effect and make use of mathematical expression for Hall coefficient to deduce the type of semiconductor	3
	PO 2	Understand the given problem statement of variation of resistance with temperature in a semiconductor diode and formulate Resistivity from experimental collection of information and data in reaching substantial conclusions by the interpretation of results.	4
	PO 4	Make use of graphical analysis of current versus temperature curve for a given semiconductor, and interpret the data, to provide valid conclusions regarding the energy gap in a given semiconductor	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.	1
	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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 3	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 effect of temperature on a given ferromagnetic material and formulate Curie temperature and relative permittivity from experimental collection of information and data in reaching substantial conclusions by the interpretation of results.	4
	PSO 3	Apply the CRO for visualizing and analysing the Hysteresis of Ferromagnetic materials.	1
CO 4	PO 1	Interpret launching of light through optical fibre and make use of mathematical expression for analysing light gathering capacity through numerical aperture	2
	PO 2	Understand the given problem statement on directionality of laser light in comparison with ordinary light and formulate the divergence of a given laser source from experimental collection of information and data in reaching substantial conclusions by the interpretation of results.	3
CO 5	PO 1	Understand the phenomenon of recombination of electron-hole pair and determine the value of threshold voltage of a given LED	1
	PO 2	Understand the given problem statement of conversion light energy to electrical energy and formulate V-I characteristics of solar cell from experimental collection of information and data in reaching substantial conclusions by the interpretation of results.	2
	PO 4	Analyse and interpret the data obtained by using different LED's and synthesise the information to infer the value of Planck's constant	2
CO 6	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

27. 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	-	-	-	-	-	-	-	-	-	-	-
CO 2	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	4	-	-	-	-	-	-	-	-	-	-		-	-
CO 4	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	1	2	-	2	-	-	-	-	-	-	-	-	-	-	-
CO 6	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-

28. 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	40	-	18	-	-	-	-	-	-	-	-	-	-	-
CO 2	66	40	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	66	40	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	66	40	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	66	40	-	18	-	-	-	-	-	-	-	-	-	-	-
CO 6	66	40	-	-	-	-	-	-	-	-	-	-	-	-	-

29. 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		
	PO 1	PO 2	PO 3	PO 4	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	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 6	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	11	6	-	2	-	-	-	-	-	-	-	-	-	-	-
AVERAGE	1.8	1	-	1	-	-	-	-	-	-	-	-	-	-	-

30. ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Laboratory Practices	✓
Certification	-	Student Viva	✓	Open Ended Experiments	✓

31. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

32. Relevance to Sustainability goals

Write brief description about the course and how its relevance to SDGs.

1		-
2		-
3		-
4		**Quality Education:In order to ensure inclusive and equitable quality education and promote life long learning oppurtunities for all, foundation is very much important. Physics laboratory comes under basic science course falicitating students to gain and ascertain basic knowledge which will help them to envisage to their higher education**
5		-

6	CLEAN WATER AND SANITATION	-
7	AFFORDABLE AND CLEAN ENERGY	-
8	DECENT WORK AND ECONOMIC GROWTH	-
9	INDUSTRY, INNOVATION AND INFRASTRUCTURE	-.
10	REDUCED INEQUALITIES	-
11	SUSTAINABLE CITIES AND COMMUNITIES	-
12	RESPONSIBLE CONSUMPTION AND PRODUCTION	-
13	CLIMATE ACTION	-
14	LIFE BELOW WATER	-
15	LIFE ON LAND	-

16		-
17		-

Approved by: Board of Studies in the meeting conducted on24/08/2023

Signature of Course Coordinator **HOD**
Dr. N V Surya Sharma, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**				
2	Course Title	**ESSENTIALS OF PROBLEM SOLVING**				
3	Course Code	ACSD05				
4	Class / Semester	B.Tech II Semester				
5	Regulation	BT-23				
6	Structure of the course	Theory			Practical	
		Lecture	Tutorials	Credits	Lab	Credits
		3	0	3	-	-
7	Type of course (**Tick type of course**)	Core	Professional Elective	Open Elective	VAC	MOOCs
		✓	-	-	-	-
8	Course Offered	Odd Semester ×		Even Semester ✓		
9	**Total lecture, tutorial and practical hours for this course (16 weeks of teaching per semester)**					
	Lectures: 48 hours		Tutorials: 0 hours		Practical: – hours	
10	Course Coordinator	Dr.V.Kishen Ajay Kumar				
11	Date Approved by BOS	22/08/2023				
12	Course Webpage	https://www.iare.ac.in/?q=pages/btech-course-syllabi-bt23-cse				
13	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**	
		-	-	-	-	

14. Course Overview

This course aims to provide exposure to problem solving through programming. Useful graph theory concepts, numerical techniques, and their applications to real world problems are discussed. Graph theoretical notions and the use of algorithms, both in the mathematical theory of graphs and its applications are discussed. Student will also learn how to implement and interpret numerical solutions by writing a well-designed computer programs in regard to their efficiency and suitability for real-life applications.

15.Course Objectives:

The students will try to learn:

I	The fundamental concepts of graph theory and its properties.
II	The basics related to paths and cycles using Eulerian and Hamiltonian cycles.
III	The applications of graph colouring and traversal algorithms for solving real-time problems.
IV	The numerical methods to solve algebraic equations.
V	The skill to solve numerical integration and ordinary differential equations of first and second order.

16. Course Outcomes:

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

CO 1	**Outline** the graph terminologies, graph representation techniques, and relate them to practical examples. the static structures dealing with systems of forces using laws of mechanics	Understand
CO 2	**Build** efficient algorithms for various optimization problems on graphs..	Apply
CO 3	**Use** effective techniques from graph theory to solve problems in networking and telecommunication.	Apply
CO 4	**Interpret** the fundamental concepts of polynomials, roots of equations and solve corresponding problems using computer programs.	Apply
CO 5	**Apply** the knowledge of numerical methods to solve algebraic and transcendental equations arising in real-life situations.	Apply
CO 6	**Solve** numerical integrals and ordinary differential equations to simulate discrete time algorithms.	Apply

17. Mapping of topic learning outcomes (TLO) to course outcomes

S. No	Topic(s)	TLO No	Topic Learning Outcome's	Course Outcome	Blooms Level
1	Introduction to graph terminology	1	Understand the graph terminologies to solve real-time problems.	CO 1	Understand
2	Diagraphs, weighted graphs, complete graphs	2	Understand the basics of graph theory and their various properties in various cutting-edge applications such as traffic networks, navigable networks and optimal routing.	CO 1	Understand
3	Graph complements	3	Apply graph complements and graph combinations to solve real world applications like routing, TSP/traffic control.	CO 1	Apply
4	Bipartite graphs				
5	Graph combinations				
6	Isomorphisms				

S. No	Topic(s)	TLC No	Topic Learning Outcome's	Course Outcome	Blooms Level
7	Matrix representations of graphs	4	Show the matrix representations of graphs to know whether pairs of vertices are adjacent or not in the graph.	CO 1	Understand
8	Degree sequence				
9	Eulerian circuits – Konigsberg bridge problem	5	Solve the Konigsberg bridge problem using Eulerian circuits to solve problems for shortening any path.	CO 2	Apply
10	Touring a graph				
11	Eulerian graphs				
12	Hamiltonian cycles	6	Apply Hamiltonian cycles to solve the traveling salesman problem.	CO 2	Apply
13	The traveling salesman problem				
14	Shortest paths – Dijkstra's algorithm	7	Use Dijkstra's algorithm to calculate shortest path from source to destination node.	CO 2	Apply
15	Walks using matrices				
16	Four color theorem	8	Relate the concept of vertex coloring to assign colors to the vertices of a graph using four color theorem.	CO 3	Understand
17	Vertex coloring				
18	Edge coloring	9	Understand proper edge coloring of a graph to apply in scheduling problems.	CO 3	Understand
19	Coloring variations				
20	First-fit coloring algorithm				
21	Depth-first search	10	Apply breadth first or depth first search technique in finding shortest paths and all possible paths.	CO 3	Apply
22	Bread-first search				
23	Minimum spanning trees: Kruskal's algorithms	11	Use minimum spanning tree concept in network design and optimization.	CO 3	Apply
24	Prim's algorithm				
25	Union-find structure				
26	Algebraic equations	12	Solve algebraic and transcendental equations to solve single variable function over the interval.	CO 5	Apply
27	Bisection method				
28	Method of false position				
29	Iteration method				
30	Newton-Raphson method	13	Solve polynomials, logarithmic and exponential functions to solve real time applications.	CO 4	Apply
31	Ramanujan's method				
32	Secant method				
33	Muller's method				

S. No	Topic(s)	TLC No	Topic Learning Outcome's	Course Outcome	Blooms Level
34	Numerical integration	14	Solve problems using numerical integration to compute numerical approximations to the integral of the function.	CO 6	Apply
35	Trapezoidal rule				
36	Simpson's 1/3 rule				
37	Simpson's 3/8 rule				
38	Solution by Taylor's series				
39	Euler's method	15	Use Euler's method for approximating solutions to differential equations and curve with line segments.	CO 6	Apply
40	Runge-Kutta's method	16	Apply Runge-Kutta method for solving initial-value problems of differential equations.	CO 6	Apply

18. Employability Skills

Example: Communication skills / Programming skills / Project based skills /
1. Programming skills - The tech industry evolves rapidly, and staying up-to-date with the latest programming languages, frameworks, and development practices is crucial. Combining essentials of problem solving skills with a commitment to continuous learning demonstrates a student's dedication to staying relevant in a dynamic field.
2. Project-based skills - Creating projects that utilize graph theory principles to allow a student to apply theoretical knowledge to real-world scenarios. This hands-on experience helps solidify their understanding of how problem solving concepts work in practice.

19. Content Delivery / Instructional Methologies:

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

20. Evaluation Methodology:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). CIA is conducted for a total of 40 marks, with 20 marks for Continuous Internal Examination (CIE), and and 05 marks for each Definitions and Terminology / Quiz and remaining 10 marks for Tech Talk / Assignments.

Table 4: Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	**CIA - I**	**CIA - II**	**SEE**	**Total Marks**
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Definitions and Terminology / Quiz	05 Marks	05 Marks		10 Marks
Tech Talk / Assignment	05 Marks	05 Marks		10 Marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

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

Percentage of Cognitive Level	**Blooms Taxonomy Level**
17%	Understand
83%	Apply

21. Course content - Number of modules: Five

MODULE I	**GRAPH THEORY** | **Number of Lectures: 8**
	Graph Terminology: Digraphs, weighted graphs, complete graphs, graph complements, bipartite graphs, graph combinations, isomorphisms, matrix representations of graphs – incidence and adjacency matrices, degree sequence.
MODULE II	**GRAPH ROUTES** | **Number of Lectures: 10**
	Eulerian Circuits: Konigsberg bridge problem, touring a graph, Eulerian graphs, Hamiltonian cycles, the traveling salesman problem, shortest paths – Dijkstra's algorithm, walks using matrices.
MODULE III	**GRAPH COLORING AND GRAPH ALGORITHMS** . |**Number of Lectures: 10**
	Graph Colouring: Four color theorem, vertex coloring, edge coloring, coloring variations – first-fit coloring algorithm. **Graph Traversal:** Depth-first search, bread-first search, applications, and minimum spanning trees: Kruskal's and Prim's algorithm, union-find structure.
MODULE IV	**ALGEBRAIC AND TRANSCENDENTAL EQUATIONS** | **Number of Lectures: 10**
	Algebraic Equations: Algebraic equations, method of false position, bisection method, iteration method, Newton-Raphson method, Secant method, Ramanujan's Method, Muller's method (Approximation up to 2 decimals only).

MODULE V	**NUMERICAL INTEGRATION AND ORDINARY DIFFERENTIATIAL EQUATIONS** | **Number of Lectures: 10**
	Numerical Integration: Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, Solution by Taylor's series, Euler's method of solving an ordinary differential equation numerically, Runge-Kutta's second order method of solving ordinary differential equations (Approximation up to 2 decimals only).

TEXTBOOKS

1. Karin R Saoub, *Graph Theory: An Introduction to Proofs, Algorithms, and Applications*, Chapman and Hall, 1st Edition, 2021.
2. S S Sastry, *Introductory Methods of Numerical Analysis*, PHI Learning Private Ltd., 5th Edition, 2012.

REFERENCE BOOKS:

1. Mahinder Kumar Jain & J. V. Rao, *Numerical Methods: For Scientific and Scientific Computation*, 7th Edition, New Age International Pvt. Ltd., 2019.
2. P Kandasamy, K Thilagavathy, K Gunavathi, *Numerical Methods*, S Chand and Company, 2006.
3. R Balakrishnan, K Ranganathan *A Textbook of Graph Theory*, Springer Exclusive, 2nd Edition, 2019.
4. Jann Kiusalaas, *Numerical Methods in Engineering with Python*,Cambridge University Press, 2nd Edition, 2010.
5. Gary Chartrand, Ping Zhang, *A First Course in Graph Theory*, Dover Publications Inc., 2012.
6. James F. Epperson, *An Introduction to Numerical Methods and Analysis*,Wiley, 2nd Edition, 2021.

Electronic Resources:

1. https://www.geeksforgeeks.org/numerical-methods-and-calculus-gq/
2. https://www.geeksforgeeks.org/program-for-bisection-method/
3. https://ocw.mit.edu/courses/2-993j-introduction-to-numerical-analysis-for-engineering-13-002j-spring-2005/pages/lecture-notes/
4. https://www.tutorialspoint.com/graphs-and-its-traversal-algorithms
5. https://web.mit.edu/urban-or-book/www/book/chapter6/6.4.4.html
6. https://www.hackerearth.com/practice/algorithms/graphs/minimum-spanning-tree/tutorial/
7. https://www.codingninjas.com/studio/library/euler-and-hamilton-paths

Materials Online:

1. Course template
2. Tutorial question bank

3. Tech-talk topics
4. Open-ended experiments
5. Definition and terminology
6. Assignments
7. Model question paper - 1
8. Model question paper - 2
9. Lecture notes
10. Power point presentation
11. E-learning readiness videos (ELRV)

22. COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
Discussion on OBE			
1	Discussion on Outcome Based Education, CO, POs and PSOs		
Content Delivery (Theory)			
1	Introduction to graph terminology	CO 1	T1:1.2
2	Diagraphs, weighted graphs, complete graphs	CO 1	T1:1.2.1
3	Graph complements	CO 1	T1:1.2.4
4	Bipartite graphs	CO 1	T1:1.2.5
5	Graph combinations	CO 1	T1:1.2.6
6	Isomorphisms	CO 1	T1:1.2.6
7	Matrix representations of graphs	CO 1	T1:1.4
8	Degree sequence	CO 1	T1:1.6
9	Eulerian circuits – Konigsberg bridge problem	CO 2	T1:2.1.1
10	Touring a graph	CO 2	T1:2.1.2
11	Eulerian graphs	CO 2	T1:2.1.3
12	Hamiltonian cycles	CO 2	T1:2.2
13	The traveling salesman problem	CO 2	T1:2.2.1
14	Shortest paths – Dijkstra's algorithm	CO 2	T1:2.31
15	Walks using matrices	CO 2	T1:2.3.2
16	Four color theorem	CO 3	T1:6.1
17	Vertex coloring	CO 3	T1:6.2
18	Edge coloring	CO 3	T1:6.3
19	Coloring variations	CO 3	T1:6.4
20	First-fit coloring algorithm	CO 3	T1:6.4.1
21	Depth-first search	CO 3	T1:3.3.1

S.No	Topics to be covered	CO's	Reference
22	Bread-first search	CO 3	T1:3.3.2
23	Minimum spanning trees: Kruskal's algorithms	CO 3	T1:3.1.1
24	Prim's algorithm	CO 3	T1:3.1.1
25	Union-find structure	CO 3	T1:3.1.1
26	Algebraic equations	CO 4	T2: 2.1
27	Bisection method	CO 4	T2: 2.2
28	Method of false position	CO 4	T2: 2.3
29	Iteration method	CO 4	T2: 2.4
30	Newton-Raphson method	CO 4	T2: 2.5
31	Ramanujan's method	CO 4	T2: 2.6
32	Secant method	CO 4	T2: 2.7
33	Muller's method	CO 5	T2: 2.8
34	Numerical integration	CO 5	T2: 6.4
35	Trapezoidal rule	CO 5	T2: 6.4.1
36	Simpson's 1/3 rule	CO 5	T2: 6.4.2
37	Simpson's 3/8 rule	CO 5	T2: 6.4.3
38	Solution by Taylor's series	CO 6	T2: 8.2
39	Euler's method	CO 6	T2: 8.4
40	Runge-Kutta's method	CO 6	T2: 8.5
Problem Solving/Case Studies			
1	Matrix representation of graph	CO 1	T1:1.4
2	Euler circuit in a directed graph	CO 2	T1:2.1.1
3	Eulerian path in an undirected graph	CO 2	T1:2.1.1
4	Hamiltonian graph	CO 2	T1:2.2
5	Dijkstra's algorithm	CO 2	T1:2.3.1
6	Breadth first search or traversal for a graph	CO 3	T1:3.3.1
7	Prim's algorithm for minimum spanning tree (MST)	CO 3	T1:3.1.1
8	Bisection method to find a real root of an equation	CO 4	T2:2.2
9	False position method to find a real root of an equation	CO 4	T2:2.3
10	Newton Raphson method to find a real root of an equation	CO 4	T2:2.5
11	Simpsons 1/3 Rule	CO 5	T2:6.4.2
12	Trapezoidal Rule	CO 6	T2:6.4.1
13	Simpsons 3/8 Rule	CO 6	T2:6.4.3
14	Numerical differential equation using Runge-Kutta 2 method (1st order derivative)	CO 6	T2:8.5
15	Numerical differential equation using Taylor Series method (1st order derivative)	CO 6	T2:8.2
Definition and Terminology			
1	Graph basic terminologies, types of graphs and matrix representation	CO 1	T1:1.2-1.4
2	Graph routing algorithms	CO 2	T1:2.1-2.3

S.No	Topics to be covered	CO's	Reference
3	Graph coloring and graph traversal algorithms	CO 3	T1:3.1,3.3, 6.1-6.4
4	Algebraic and transcendental equations	CO 4	T2:2.1-2.8
5	Numerical integration and ordinary differential equations	CO 5, CO 6	T2:6.4.1-6.4.3,8.2, 8.4,8.5
Tutorial Question Bank			
1	Graph basic terminologies, types of graphs and matrix representation	CO 1	T1:1.2-1.4
2	Graph routing algorithms	CO 2	T1:2.1-2.3
3	Graph coloring and graph traversal algorithms	CO 3	T1:3.1,3.3, 6.1-6.4
4	Algebraic and transcendental equations	CO 4	T2:2.1-2.8
5	Numerical integration and ordinary differential equations	CO 5, CO 6	T2:6.4.1-6.4.3,8.2, 8.4,8.5

23. PROGRAM OUTCOMES & PROGRAM SPECIFIC 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
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.

24. 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/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/SEE/Quiz/ AAT
PO 3	**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	CIE/SEE/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	2	CIE/SEE/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	2	Seminar / Conferences / Research papers

25. 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	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

26. 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	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	✓	-	✓

27. JUSTIFICATIONS FOR CO – PO / PSO MAPPING - DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Understand the basic graph terminologies, graph complements and representation of graphs.	3
	PO 5	Explain the various types of graphs and formulate problems related to matrix representation of graphs.	1

COURSE OUTCOMES	PO'S PSO'S	**Justification for mapping (Students will be able to)**	No. of Key Competencies
	PSO 1	Understand the object-oriented programming while writing and analyzing computer programs in the areas related to Machine Learning, Big data, and Artificial Intelligence.	4
CO 2	PO 1	Apply the knowledge of graph routing algorithms for solving Eulerian circuits, Hamiltonian cycles.	3
	PO 2	Solve the problems related to shortest path algorithms using Dijkstra's algorithm and walks using matrics.	5
	PO 3	Design efficient algorithms for various optimization problems using graph concepts.	8
	PO 5	Demonstrate the solutions of Konigsberg bridge, Chinese postman, traveling salesman problems by touring a graph.	1
	PSO 1	Understand, design and analyse computer programs in the areas related to networking and telecommunication.	5
	PSO 3	Make use of modern computer tools to determine the multiple shortest paths in a graph using various algorithms.	2
CO 3	PO 1	Use the concepts of graph coloring to solve problems in various domains such as register allocation, map colouring, mobile radio frequency assignment etc.	3
	PO 3	Develop solutions in many research areas of computer science such as data mining, image segmentation, image capturing, networking etc.	6
	PO 5	Apply appropriate graph traversal techniques in the field of city planning, traffic control, transport and navigation etc.	1
	PSO 1	Design and analyse computer programs in the areas related to many applications such as social networks, epidemiology, neural networks etc.	6
	PSO 3	Make use of modern computer tools and appropriate programming languages to write programs for various applications of graphs.	2
CO 4	PO 1	Apply the knowledge of numerical methods to solve complex problems handling large systems of equations nonlinearities and complicated grometrics.	3
	PO 3	Design solutions for complex Engineering problems using bisection, Newton-Raphson, Secant method and so on.	8
	PO 5	Apply appropriate algebraic techniques, and transcendental equations in solving complex problems in engineering.	1
	PO 12	Summarize various numerical methods related to numerical integration and differentiation.	7
	PSO 1	Analyse computer programs in optimizing the solutions of various applications.	5

COURSE OUTCOMES	PO'S PSO'S	**Justification for mapping (Students will be able to)**	No. of Key Competencies
	PSO 3	Illustrate modern computer tools in implementing a wide range of problems in science, engineering, business, finance and operations research.	2
CO 5	PO 1	Apply the knowledge of numerical integration and differentiation to solve many types of real-time problems.	3
	PO 2	Solve various open problems using the concepts of ordinary differential equation (ODE) programming.	8
	PO 3	Develop solutions for complex Engineering problems by solving algebraic equations.	7
	PO 5	Use effective and widely used method for solving differential-equations by using modern tools.	1
	PSO 1	Develop, design and analyse problems for solving initial-value problems of differential equations.	5
CO 6	PO 1	Apply numerical integrals and ordinary differential equations for engineering disciplines.	3
	PO 2	Analyse and solve real life applications such as weather prediction, car safety, machine learning and many other domains.	7
	PO 3	Identify the need for numerical analysis for solving problems throughout the natural sciences, social sciences, engineering, medicine and business.	7
	PO 5	Develop algorithms for obtaining numerical solutions to problems involving continuous variables.	1
	PO 12	Summarize the various numerical methods and apply it in multiple real-time domains for problem solving.	6
	PSO 1	Write programs using appropriate programming languages solving problems in multiple applications such as computational geometry, machine learning, big data, and AI.	6
	PSO 3	Write programs using appropriate programming languages solving problems in multiple applications such as computational geometry, machine learning, big data, and AI.	2

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

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

29. 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	-	-	-	-	-	-	-	-	-	-
CO 2	100	50	80	-	100	-	-	-	-	-	-	-	83.3	-	100
CO 3	100	-	60	-	100	-	-	-	-	-	-	-	100	-	100
CO 4	100	-	80	-	100	-	-	-	-	-	-	88	83.3	-	100
CO 5	100	80	70	-	100	-	-	-	-	-	-	-	100	-	-
CO 6	100	80	70	-	100	-	-	-	-	-	-	75	100	-	100

30. 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		
	PO 1	PO 2	PO 3	PO 4	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	-	-
CO 2	3	2	3	-	3	-	-	-	-	-	-	-	3	-	3
CO 3	3	-	3	-	3	-	-	-	-	-	-	-	3	-	3
CO 4	3	-	3	-	3	-	-	-	-	-	-	3	3	-	3
CO 5	3	2	3	-	3	-	-	-	-	-	-	-	3	-	-
CO 6	3	3	3	-	3	-	-	-	-	-	-	3	3	-	3
TOTAL	**18**	**7**	**15**	**0**	**18**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**18**	**0**	**12**

31. ASSESSMENT METHODOLOGY DIRECT:

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

32. ASSESSMENT METHODOLOGY INDIRECT:

-	Assessment of mini Projects by Experts	✓	End Semester OBE Feedback

33. Relevance to Sustainability goals

Write brief description about the course and how its relevance to SDGs.

1		**No Poverty:** Python programming aims to end poverty in all its forms everywhere. Its objectives include ensuring that the entire population and especially the poorest and most vulnerable have equal rights to economic resources, access to basic services, property and land control, natural resources and new technologies.
2		
3		
4		**Quality Education:** The students can gain a deeper understanding of how technology can be harnessed to address global challenges. This promotes quality education by fostering critical thinking and problem-solving skills in the context of sustainable development.

5	GENDER EQUALITY	
6	CLEAN WATER AND SANITATION	
7	AFFORDABLE AND CLEAN ENERGY	
8	DECENT WORK AND ECONOMIC GROWTH	**Decent work and economic growth:** The students can gain a deeper understanding of how technology can be harnessed to address global challenges. This promotes quality education by fostering critical thinking and problem-solving skills in the context of sustainable development.
9	INDUSTRY, INNOVATION AND INFRASTRUCTURE	**Industry, Innovation, and Infrastructure:** Python programming skills are essential for developing innovative software solutions. Students working on projects related to sustainable development can contribute to building resilient infrastructure and promoting inclusive and sustainable industrialization.
10	REDUCED INEQUALITIES	
11	SUSTAINABLE CITIES AND COMMUNITIES	

12		
13		
14		
15		
16		
17		**Partnerships for the Goals:** Collaborative projects can foster partnerships among students, educators, and local communities. These partnerships enhance knowledge sharing and the development of innovative solutions that align with multiple SDGs.

Approved by: Board of Studies in the meeting conducted on 22-08-2023.

Signature of Course Coordinator **HOD, EEE**
Dr.V.Kishen Ajay Kumar, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

<table>
<tr><td>1</td><td>Department</td><td colspan="4">Electrical and Electronics Engineering</td></tr>
<tr><td>2</td><td>Course Title</td><td colspan="4">Programming for problem solving laboratory</td></tr>
<tr><td>3</td><td>Course Code</td><td colspan="4">ACSD06</td></tr>
<tr><td>4</td><td>Program</td><td colspan="4">B.Tech</td></tr>
<tr><td>5</td><td>Semester</td><td colspan="4">II Semester</td></tr>
<tr><td>6</td><td>Regulation</td><td colspan="4">BT-23</td></tr>
<tr><td rowspan="2">7</td><td rowspan="2">Structure of the course</td><td colspan="4">Practical</td></tr>
<tr><td colspan="3">Tutorial Hours
1</td><td>Practical Hours
2</td></tr>
<tr><td>8</td><td>Course Offered</td><td colspan="2">Odd Semester ×</td><td colspan="2">Even Semester ✓</td></tr>
<tr><td>9</td><td>Course Coordinator</td><td colspan="4">Dr.V.Kishen Ajay Kumar</td></tr>
<tr><td>10</td><td>Date Approved by BOS</td><td colspan="4">22/08/2023</td></tr>
<tr><td>11</td><td>Course Webpage</td><td colspan="4">https://www.iare.ac.in/?q=pages/btech-course-syllabi-bt23-eee</td></tr>
<tr><td rowspan="2">12</td><td rowspan="2">Course Prerequistes</td><td>Level</td><td>Course Code</td><td>Semester</td><td>Prerequisites</td></tr>
<tr><td>UG</td><td>ACSD01</td><td>I</td><td>Object oriented programming</td></tr>
</table>

13. COURSE OVERVIEW

The course is designed with the fundamental programming skills and problem-solving strategies necessary to tackle a wide range of computational challenges. Through hands-on programming exercises, students will learn how to write code, analyze problems and develop solutions using various tools. This course empowers individuals to automate tasks and create innovative solutions to complex challenges.

14. COURSE OBJECTIVES

The students will try to learn:

I	The fundamental programming constructs and use of collection data types in python.
II	The ability to develop programs using object-oriented features
III	Basic data structures and algorithms for efficient problem-solving
IV	Principles of graph theory and be able to apply their knowledge to a wide range of practical problems across various disciplines

15. COURSE OUTCOMES

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

CO1	Adapt programming concepts, syntax, and data structures through hands on coding exercises
CO2	Develop the ability to solve a variety of programming problems and algorithms using python
CO3	Implement complex and custom data structures to solve real-world problems
CO4	Demonstrate proficiency in implementing graph algorithms to solve variety of problems and scenarios
CO5	Develop critical thinking skills to solve the various real-world applications using graph theory
CO6	Learn the importance of numerical methods and apply them to tackle a wide range of computational problems.

16. EMPLOYABILITY SKILLS

1. **Problem-Solving and Critical Thinking:** Students learn to analyze complex problems, design solutions using object-oriented principles, and translate real-world scenarios into code.
2. **Debugging and Troubleshooting:** Debugging challenges in the lab help students master error identification, interpretation, and use of debugging tools, essential for real-world software development.

17. CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES

✓	Day to Day lab evaluation	✓	Demo Video	✓	Expected Viva Voce questions	✓	Open Ended Experiments
X	Competitions	X	hackathons	✓	Certifications	✓	Probing Further Questions

18. EVALUATION METHODOLOGY

Each laboratory will be evaluated for a total of 100 marks consisting of 40 marks for internal assessment and 60 marks for semester end lab examination. Out of 40 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance including viva voce, 10 marks for the final internal lab assessment and remaining 10 marks for The remaining 10 marks are for Laboratory Report/Project and Presentation, which consists of the Design (or) Software / Hardware Model Presentation (or) App Development (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 40 marks (Table 1), with 20 marks for continuous lab assessment during day-to-day performance including viva voce, 10 marks for final internal lab assessment and remaining 10 marks for Laboratory Report / Project and Presentation.

Table 3: CIA marks distribution

Component				
Type of Assessment	Day to Day performance and viva voce examination	Final internal lab assessment	Laboratory Report / Project and Presentation	Total Marks
CIA marks	20	10	10	40

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 2 hours duration.

Table 4: Experiment based

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

Table 5: Programming based

Objective	Analysis	Program	Results	Viva voce	Total
4	4	6	4	2	20

Semester End Examination:
The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the other colleges which will be decided by the Head of the institution.
In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

1. 10 marks for write-up
2. 15 for experiment/program
3. 15 for evaluation of results
4. 10 marks for presentation on another experiment/program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course.

19. COURSE CONTENT

CO 1	**Summarize programming concepts and skills needed for a solid foundation in python programming through hands on coding exercises.**
	1. Getting Started Exercises
CO 2	**Develop the ability to solve a variety of programming problems and algorithms using python.**
	1. Exercises on simple problems using lists, tuples, sets and dictionaries.
CO 3	**Understand complex and custom data structures to solve real-world problems.**
	1. Exercises on implementation of stacks 2. Exercises on implementation of queues
CO 4	**Demostrate proficiency implementing graph algorithms to solve variety of problems and scenarios.**
	1. Exercises on graph representaion 2. Exercises on implementation of graph routing algorithms 3. Exercises on shortest path algorithms
CO 5	**Build critical thinking skills to solve the various real-world applications to using graph theory**
	1. Exercises on graph colouring 2. Exercises on graph traversals 3. Exercises on minimum spanning trees
CO 6	**Learn the importance of numerical methods and apply those thinking skills to tackle a wide range of computational problems..**
	1. Exercises on roots of quadratic equations 2. Exercises on numerical integration 3. Exercises on ordinary differential equations

Note: One Course Outcome may be mapped to multiple number of experiments.

Text Books

1. Eric Matthes."*Python Crash Course: A Hands-On, Project-based Introduction to Programming*", No Starch Press, 3rd Edition, 2023.

2. John M Zelle "*Python Programming: An Introduction to Computer Science*" Ingram short title, 3rd Edition, 2016.

Reference Books

1. Martin C. Brown. "*Python: The Complete Referencel*", Mc. Graw Hill, Indian Edition, 2018.
2. Paul Barry "*Head First Python: A Brain-Friendly Guide*", O'Reilly, 2nd Edition, 2016
3. Taneja Sheetal, Kumar Naveen "*Python Programming – A Modular Approach*", Pearson, 1st Edition, 2017.
4. R Nageswar Rao "*Core Python Programming*", Dreamtech Press, 2018.

Materials Online

1. https://realPython.com/python3-object-oriented-programming/
2. https://python.swaroopch.com/oop.html
3. https://python-textbok.readthedocs.io/en/1.0/object oriented programming.html
4. https://www.programiz.com/python-programming/
5. https://www.geeksforgeeks.org/python-programming-language/

20. COURSE PLAN

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

S.No	Topics to be covered	CO's
1	Getting Started Exercises	CO 1
2	Exercises on Matrix Operations (for Science/Engineering Students)	CO 1
3	Exercises on Stack implementation using List	CO 2
4	Exercises on Linear Queue using List	CO 2
5	Exercises on Graph Representation	CO 2
6	Exercises on Graph Routing Algorithms	CO 2
7	Exercises on Shortest Path Algorithms	CO 2
8	Exercises on Graph Coloring	CO 2
9	Exercises on Graph Traversal	CO 3
10	Exercises on Minimum Spanning Tree (MST)	CO 3
11	Exercises on roots of Equations	CO 3
12	Exercises on Numerical Integration	CO 4
13	Exercises on Ordinary Differential Equations	CO 5
14	Exercises and program on challenging problems	CO 6

Experiments for enhanced learning (EEL):

S.No	Design Oriented Experiments
1.	Implement error handling to catch file-related exceptions.
2.	Call a custom function that takes parameters and returns a value.
3.	Read data from a text file, perform some operation, and write the result back to a new file.
4.	Implement a program to add, remove, and manipulate elements in a list.
5.	Use list comprehensions to generate new lists.

21. PROGRAM OUTCOMES & PROGRAM SPECIFIC 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
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 Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.
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

24. 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/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/SEE/Quiz/ AAT
PO 3	**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	CIE/SEE/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	2	CIE/SEE/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	2	Seminar / Conferences / Research papers

23. 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	LAB PROGRAMS/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.	2	LAB PROGRAMS/CIE/SEE

3 = High; 2 = Medium; 1 = Low

26. 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	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	✓	-	✓

27. JUSTIFICATIONS FOR CO – PO / PSO MAPPING - DIRECT:

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 1	PO 1	Understand the basic graph terminologies, graph complements and representation of graphs.	3
	PO 5	Explain the various types of graphs and formulate problems related to matrix representation of graphs.	1
	PSO 1	Understand the object-oriented programming while writing and analyzing computer programs in the areas related to Machine Learning, Big data, and Artificial Intelligence.	4
CO 2	PO 1	Apply the knowledge of graph routing algorithms for solving Eulerian circuits, Hamiltonian cycles.	3
	PO 2	Solve the problems related to shortest path algorithms using Dijkstra's algorithm and walks using matrics.	5
	PO 3	Design efficient algorithms for various optimization problems using graph concepts.	8
	PO 5	Demonstrate the solutions of Konigsberg bridge, Chinese postman, traveling salesman problems by touring a graph.	1

COURSE OUTCOMES	PO'S PSO'S	**Justification for mapping (Students will be able to)**	No. of Key Competencies
	PSO 1	Understand, design and analyse computer programs in the areas related to networking and telecommunication.	5
	PSO 3	Make use of modern computer tools to determine the multiple shortest paths in a graph using various algorithms.	2
CO 3	PO 1	Use the concepts of graph coloring to solve problems in various domains such as register allocation, map colouring, mobile radio frequency assignment etc.	3
	PO 3	Develop solutions in many research areas of computer science such as data mining, image segmentation, image capturing, networking etc.	6
	PO 5	Apply appropriate graph traversal techniques in the field of city planning, traffic control, transport and navigation etc.	1
	PSO 1	Design and analyse computer programs in the areas related to many applications such as social networks, epidemiology, neural networks etc.	6
	PSO 3	Make use of modern computer tools and appropriate programming languages to write programs for various applications of graphs.	2
CO 4	PO 1	Apply the knowledge of numerical methods to solve complex problems handling large systems of equations nonlinearities and complicated grometrics.	3
	PO 3	Design solutions for complex Engineering problems using bisection, Newton-Raphson, Secant method and so on.	8
	PO 5	Apply appropriate algebraic techniques, and transcendental equations in solving complex problems in engineering.	1
	PO 12	Summarize various numerical methods related to numerical integration and differentiation.	7
	PSO 1	Analyse computer programs in optimizing the solutions of various applications.	5
	PSO 3	Illustrate modern computer tools in implementing a wide range of problems in science, engineering, business, finance and operations research.	2
CO 5	PO 1	Apply the knowledge of numerical integration and differentiation to solve many types of real-time problems.	3
	PO 2	Solve various open problems using the concepts of ordinary differential equation (ODE) programming.	8
	PO 3	Develop solutions for complex Engineering problems by solving algebraic equations.	7
	PO 5	Use effective and widely used method for solving differential-equations by using modern tools.	1

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PSO 1	Develop, design and analyse problems for solving initial-value problems of differential equations.	5
CO 6	PO 1	Apply numerical integrals and ordinary differential equations for engineering disciplines.	3
	PO 2	Analyse and solve real life applications such as weather prediction, car safety, machine learning and many other domains.	7
	PO 3	Identify the need for numerical analysis for solving problems throughout the natural sciences, social sciences, engineering, medicine and business.	7
	PO 5	Develop algorithms for obtaining numerical solutions to problems involving continuous variables.	1
	PO 12	Summarize the various numerical methods and apply it in multiple real-time domains for problem solving.	6
	PSO 1	Write programs using appropriate programming languages solving problems in multiple applications such as computational geometry, machine learning, big data, and AI.	6
	PSO 3	Write programs using appropriate programming languages solving problems in multiple applications such as computational geometry, machine learning, big data, and AI.	2

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

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

29. 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	-	-	-	-	-	-	-	-	-	-
CO 2	100	50	80	-	100	-	-	-	-	-	-	-	83.3	-	100
CO 3	100	-	60	-	100	-	-	-	-	-	-	-	100	-	100
CO 4	100	-	80	-	100	-	-	-	-	-	-	88	83.3	-	100
CO 5	100	80	70	-	100	-	-	-	-	-	-	-	100	-	-
CO 6	100	80	70	-	100	-	-	-	-	-	-	75	100	-	100

30. 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		
	PO 1	PO 2	PO 3	PO 4	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	-	-
CO 2	3	2	3	-	3	-	-	-	-	-	-	-	3	-	3
CO 3	3	-	3	-	3	-	-	-	-	-	-	-	3	-	3
CO 4	3	-	3	-	3	-	-	-	-	-	-	3	3	-	3
CO 5	3	2	3	-	3	-	-	-	-	-	-	-	3	-	-
CO 6	3	3	3	-	3	-	-	-	-	-	-	3	3	-	3
TOTAL	**18**	**7**	**15**	**0**	**18**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**18**	**0**	**12**

29. ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Laboratory Practices	✓
Certification	-	Student Viva	✓	Open Ended Experiments	-

30. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

31.RELEVANCE TO SUSTAINABILITY GOALS

Write brief description about the course and how its relevance to SDGs.

1	NO POVERTY	**No Poverty:** Python programming aims to end poverty in all its forms everywhere. Its objectives include ensuring that the entire population and especially the poorest and most vulnerable have equal rights to economic resources, access to basic services, property and land control, natural resources and new technologies.
2	ZERO HUNGER	
3	GOOD HEALTH AND WELL-BEING	
4	QUALITY EDUCATION	**Quality Education:** The students can gain a deeper understanding of how technology can be harnessed to address global challenges. This promotes quality education by fostering critical thinking and problem-solving skills in the context of sustainable development.
5	GENDER EQUALITY	
6	CLEAN WATER AND SANITATION	
7	AFFORDABLE AND CLEAN ENERGY	
8	DECENT WORK AND ECONOMIC GROWTH	**Quality Education:** The students can gain a deeper understanding of how technology can be harnessed to address global challenges. This promotes quality education by fostering critical thinking and problem-solving skills in the context of sustainable development.

9		**Industry, Innovation, and Infrastructure:** Python programming skills are essential for developing innovative software solutions. Students working on projects related to sustainable development can contribute to building resilient infrastructure and promoting inclusive and sustainable industrialization.
10		
11		
12		
13		
14		
15		
16		

17		**Partnerships for the Goals:** Collaborative projects can foster partnerships among students, educators, and local communities. These partnerships enhance knowledge sharing and the development of innovative solutions that align with multiple SDGs.

Approved by: Board of Studies in the meeting conducted on 22.8.2023.

Signature of Course Coordinator **HOD,EEE**
Dr.V.Kishen Ajay Kumar, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**			
2	Course Title	**MOBILE AND WEB APPLICATIONS DEVELOPMENT**			
3	Course Code	ACSD07			
4	Program	B.Tech			
5	Semester	II Semester			
6	Regulation	BT-23			
7	Structure of the course	Practical			
		Tutorial Hours		Practical Hours	
		0		3	
8	Course Offered	Odd Semester ✗		Even Semester ✓	
9	Course Coordinator	Dr. D.Durga Bhavani			
10	Date Approved by BOS	25/08/2023			
11	Course Webpage	www.iare.ac.in/—-/—-			
12	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**
		-	-	-	-
		-	-	-	-

13. COURSE OVERVIEW

This course offers fundamental for understanding mobile application design and web development. It covers the concepts of HTML, CSS, JavaScript, Android framework and builds upon the Android development platform. Students will gain the knowledge to develop and deploy their own web and mobile applications.

14. COURSE OBJECTIVES:

The students will try to learn:

I	The characteristics, systematic methods, model for developing web applications
II	The fundamentals of HTML and CSS to design static and dynamic web pages.
III	The concepts of client side programming with Bootstrap, JavaScript, Ajax , Design user interfaces that follow best practices for usability and user experience
IV	The mobile application development for different platforms using appropriate tools and frameworks.
V	The user interface design with best practices for usability and user experience

15. COURSE OUTCOMES:

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

CO I	Create a web page with different layouts including links by applying different styles and colors to produce specified outputs
CO 2	Design and implement web and mobile applications to meet client requirements.
CO 3	Use coherent knowledge of web and mobile app development to evaluate contemporary and emerging web and mobile technologies.
CO 4	Apply layout management and multi layout techniques to create adaptable user interface.
CO 5	Design and manage databases in support of web and mobile applications
CO 6	Identify ethical, legal, and security issues related to web and mobile development.

16. EMPLOYABILITY SKILLS

1. **Problem-Solving and Analytical Thinking:** Web design is an incredibly popular and lucrative profession. As businesses are moving online, the demand for web design professionals is going up quickly. Organizations depend on their online storefronts to boost the bottom line, and customer expectations are high when it comes to interacting with professional websites.

17. CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES

✓	Day to Day lab evaluation	✓	Demo Video	✓	Expected Viva Voce questions	✓	Open Ended Experiments
X	Competitions	X	hackathons	✓	Certifications	✓	Probing Further Questions

18. EVALUATION METHODOLOGY

Each laboratory will be evaluated for a total of 100 marks consisting of 40 marks for internal assessment and 60 marks for semester end lab examination. Out of 40 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance including viva voce, 10 marks for the final internal lab assessment and remaining 10 marks for The remaining 10 marks are for Laboratory Report/Project and Presentation, which consists of the Design (or) Software / Hardware Model Presentation (or) App Development (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 40 marks (Table 1), with 20 marks for continuous lab assessment during day-to-day performance including viva voce, 10 marks for final internal lab assessment and remaining 10 marks for Laboratory Report / Project and Presentation.

Table 3: CIA marks distribution

Component				
Type of Assessment	Day to Day performance and viva voce examination	Final internal lab assessment	Laboratory Report / Project and Presentation	Total Marks
CIA marks	20	10	10	40

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.

Table 4: Experiment based

Objective	Analysis	Design	Conclusion	Viva voce	Total
					20

Table 5: Programming based

Objective	Analysis	Program	Results	Viva voce	Total
4	4	6	4	2	20

Semester End Examination:

The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the other colleges which will be decided by the Head of the institution.

In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

1. 10 marks for write-up
2. 15 for experiment/program

3. 15 for evaluation of results
4. 10 marks for presentation on another experiment/program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course.

19. COURSE CONTENT

CO 1	**Create a web page with different layouts including links by applying different styles and colors to produce specified outputs.**
	1. Getting Started Exercises 2. Exercises on java script
CO 2	**Design and implement web and mobile applications to meet client requirements.**
	1. Online Recruitment System 2. Student Counseling Management System 3. Data Mart Management System
CO 3	**Use coherent knowledge of web and mobile app development to evaluate contemporary and emerging web and mobile technologies.**
	1. Restaurant Reservation and Table Management Solutions 2. Secure Stock Exchange System using Web Services 3. Country Cargo and Express Couriers
CO 4	**Apply layout management and multi layout techniques to create adaptable user interface**
	1. Food ordering application 2. Music player application
CO 5	**Design and manage databases in support of web and mobile applications.**
	1. Smart Health Prediction 2. Hostel Management Application
CO 6	**Identify ethical, legal, and security issues related to web and mobile development.**

	1. Stay safe women security application 2. Controlling Anti Ragging Application 3. Extracurricular Event Tracking Application 4. Student management system 5. Pharm easy application 6. News Application

Note: One Course Outcome may be mapped to multiple number of experiments.

TEXTBOOKS

1. Thomas A. Powell."*The Complete Reference*", HTML and CSS, 5th Edition, 2017
2. Elisabeth Robson , Eric Freeman. "*Head First HTML and CSS: A Learner's Guide to Creating Standards-Based Web Pages*" 2nd Edition, 2012.
3. Adam Boduchand Roy Derks. "*React and React Native: A Complete Hands-on Guide to Modern Web and Mobile Development with React.js*" 3rd Edition, 2020.
4. RetoMeier. "*ProfessionalAndroid 4 Application Development*" 1st Edition, Wile Publication.

REFERENCE BOOKS:

1. W Hans Bergsten. "*Java Server Pages*", O'Reilly, 3rdEdition, 2003
2. D. Flanagan. "*Java Script*", O'Reilly, 6th Edition, 2011
3. Jon Duckett. "*Beginning Web Programming*", WROX, 2ndEdition, 2008.
4. Bill Phillips and Chris Stewart. "*Android Programming*", The Big Nerd Ranch Guide, 3rd Edition, 2017.
5. Dawn Griffiths, David Griffiths. "*Head First Android Development: A Brain-Friendly Guide*", 2017
6. Antonio Leiva. "*Kotlin for Android Developers: Learn Kotlin while developing an Android App*", CreateSpace Independent Publishing, 2016

MATERIALS ONLINE:

1. https://www.codecademy.com/learn/paths/web-development/
2. https://nptel.ac.in/courses/106/105/106105084/
3. https://www.javatpoint.com/android-tutorial
4. https://www.tutorialspoint.com/android/index.htm

20. COURSE PLAN:

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

S.No	Topics to be covered	CO's
1	Getting Started Exercises	CO 1
2	Exercises on java script	CO 1
3	Online Recruitment System	CO1 to CO6
4	Student Counseling Management System	CO1 to CO6
5	Data Mart Management System	CO1 to CO6
6	Restaurant Reservation and Table Management Solutions	CO1 to CO6
7	Secure Stock Exchange System using Web Services	CO1 to CO6
8	Country Cargo and Express Couriers	CO1 to CO6
9	Food ordering application	CO1 to CO6
10	Music player application	CO1 to CO6 3
11	Smart Health Prediction	CO1 to CO6
12	Hostel Management Application	CO1 to CO6
13	Stay safe women security	CO1 to CO6
14	Controlling Anti Ragging Application	CO1 to CO6
15	Extracurricular Event Tracking Application	CO1 to CO6
16	Student management system	CO1 to CO6
17	Extracurricular Event Tracking Application	CO1 to CO6
18	News Application	CO1 to CO6

Experiments for enhanced learning (EEL):

S.No	Design Oriented Experiments
1.	Develop the code using JavaScript for student information system. Student registration number should not be negative, if that is the case it should display a message using popup window.

2.	Write down the program to create a state component and subscribe button , when clicked the button to display thank you message.
3.	Build an HTML page to form a table to show the values in a tabular form with heading as Roll No., Student name, Subject Name, and values as Ram, Physics Shyam, Math Murli, Chemistry.
4.	Build a basic bootstrap table that has a light padding and only horizontal dividers.
5.	Build a script that inputs three integers from the user and displays sum, average, product, smallest and largest of these numbers in an alert dialog.

21. PROGRAM OUTCOMES & PROGRAM SPECIFIC 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.

Program Outcomes	
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
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.

22. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	LAB PROGRAMS/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 PROGRAMS/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 PROGRAMS/CIE/SEE
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	LAB PROGRAMS/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 PROGRAMS/CIE/SEE
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	3	LAB PROGRAMS/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 (Communication). "Students should demonstrate the ability to communicate effectively in writing / Orally."	3	LAB PROGRAMS/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	1	LAB PROGRAMS/CIE/SEE

23. 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	LAB PROGRAMS/CIE/SEE

3 = High; 2 = Medium; 1 = Low

24. 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	✓	✓	✓	-	✓	-	-	✓	-	✓	-	✓	-	-	-

25. 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 science, engineering fundamentals, and an engineering specialization to create a web page to produce specified outputs to the solutions of complex engineering problems.	3
	PO 2	Identify and analyze complex engineering problems reaching substantiated conclusions using first principles of natural sciences, and engineering sciences to create a web page to produce specified outputs.	3
	PO 3	Design solutions using web pages for complex engineering problems and design system components that meet the specified needs with appropriate consideration for the societal, and environmental considerations.	2
	PO 5	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
CO 2	PO 1	Apply the knowledge of science, engineering fundamentals, and an engineering specialization to create a web page to produce specified outputs to the solutions of complex engineering problems.	3
	PO 2	Identify and analyze complex engineering problems reaching substantiated conclusions using first principles of natural sciences, and engineering sciences to create a web page to produce specified outputs.	2
	PO 3	Develop and design solutions with interactive forms in different styles using javascript for complex engineering problems.	2
	PO 4	IUse research-based knowledge and research methods for analysis and interpretation of data, and synthesis of the information to provide valid conclusions using interactive forms with different styles using javascript, CSS and bind data using AJAX.	2
	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
	PSO 1	Design and implement web and mobile applications to meet client requirements.	2

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 3	PO 3	Develop and design solutions with interactive forms in different styles using javascript for complex engineering problems.	2
	PO 4	Use research-based knowledge and research methods for analysis and interpretation of data, and synthesis of the information to provide valid conclusions using interactive forms with different styles using javascript, CSS and bind data using AJAX.	1
	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
CO 4	PO 2	Identify and analyze complex engineering problems reaching substantiated conclusions using first principles of natural sciences, and engineering sciences to create a web page to produce specified outputs.	2
	PO 3	Design solutions using web pages for complex engineering problems and design system components that meet the specified needs with appropriate consideration for the societal, and environmental considerations.	1
	PO 4	Use research-based knowledge and research methods for analysis and interpretation of data, and synthesis of the information to provide valid conclusions using interactive forms with different styles using javascript, CSS and bind data using AJAX.	2
	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
	PO 12	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to produce specified outputs using web pages as per the requirements of the clients for different applications.	1
CO 5	PO 1	Apply the knowledge of science, engineering fundamentals, and an engineering specialization to create a web page to produce specified outputs to the solutions of complex engineering problems.	3

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 2	Identify and analyze complex engineering problems reaching substantiated conclusions using first principles of natural sciences, and engineering sciences to create a web page to produce specified outputs.	2
	PO 3	Design solutions using web pages for complex engineering problems and design system components that meet the specified needs with appropriate consideration for the societal, and environmental considerations.	2
	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
	PO 10	Communication, Communicate effectively on complex engineering activities with the help of write effective reports and design documentation.	3
	PO 12	Recognize the need for life-long learning in the broadest context of technological change to extend the features and deployment of applications for solving problems that require interaction with a web server.	1
	PSO 1	Design and manage databases in support of web and mobile applications	2
CO 6	PO 1	Apply the knowledge of science, engineering fundamentals, and an engineering specialization to create a web page to produce specified outputs to the solutions of complex engineering problems.	3
	PO 2	Identify and analyze complex engineering problems reaching substantiated conclusions using first principles of natural sciences, and engineering sciences to create a web page to produce specified outputs.	2
	PO 3	Design solutions using web pages for complex engineering problems and design system components that meet the specified needs with appropriate consideration for the societal, and environmental considerations.	2
	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
	PO 8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	3

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 10	Communication, Communicate effectively on complex engineering activities with the help of write effective reports and design documentation.	3
	PO 12	Recognize the need for life-long learning in the broadest context of technological change to extend the features and deployment of applications for solving problems that require interaction with a web server.	1

26. 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	2	-	1	-	-	-	-	-	-	-	-	-	-
CO 2	3	3	2	2	1	-	-	-	-	-	-	-	2	-	-
CO 3	-	-	1	2	1	-	-	-	-	-	-	-	-	-	-
CO 4	-	2	1	1	1	-	-	-	-	-	-	1	-	-	-
CO 5	3	2	2	-	1	-	-	-	-	3	-	1	2	-	-
CO 6	3	2	2	-	1	-	-	3	-	3	-	1	-	-	-

27. 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	-	100	-	-	-	-	-	-	-	-	-	-
CO 2	100	66.6	40	55	100	-	-	-	-	-	-	-	100	-	-
CO 3	-	-	30	55	100	-	-	-	-	-	-	-	-	-	-
CO 4	-	66.6	30	55	100	-	-	-	-	-	-	33	-	-	-
CO 5	100	66.6	40	-	100	-	-	-	-	60	-	33	100	-	-
CO 6	100	66.6	40	-	100	-	-	100	-	60	-	33	-	-	-

28 . 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	3	3	2	-	3	-	-	-	-	-	-	-	-	-	-
CO 2	3	2	2	2	3	-	-	-	-	-	-	-	3	-	-
CO 3	-	-	1	2	3	-	-	-	-	-	-	-	-	-	-
CO 4	-	2	1	2	3	-	-	-	-	-	-	1	-	-	-
CO 5	3	2	2	-	3	-	-	-	-	2	-	1	3	-	-
CO 6	3	2	2	-	3	-	-	3	-	2	-	1	-	-	-
TOTAL	12	11	10	6	18	-	-	3	-	4	-	3	6	-	-
AVERAGE	3	2	2	2	3	-	-	3	-	1	-	1	3	-	-

29. ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Laboratory Practices	✓
Certification	-	Student Viva	✓	Open Ended Experiments	-

30. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

31. RELEVANCE TO SUSTAINABILITY GOALS

Write brief description about the course and how its relevance to SDGs.

X		
X		
X		

✓	QUALITY EDUCATION	**Quality Education:** Apps with good quality content can bring about significant cognitive development and motivate students to become more diligent in the process.
X	GENDER EQUALITY	
X	CLEAN WATER AND SANITATION	
X	AFFORDABLE AND CLEAN ENERGY	
X	DECENT WORK AND ECONOMIC GROWTH	
✓	INDUSTRY, INNOVATION AND INFRASTRUCTURE	**Industry, Innovation, and Infrastructure:** Web and Mobile application development fundamentals are crucial for developing and maintaining Web application and technological innovations. It contribute to designing safer, more durable, and user friendly projects.
X	REDUCED INEQUALITIES	
X	SUSTAINABLE CITIES AND COMMUNITIES	
X	RESPONSIBLE CONSUMPTION AND PRODUCTION	

✓		**Climate Action:** Students can create climate-related applications, such as carbon footprint calculators or climate data analysis tools, using Java script. This directly contributes to SDG 13 by raising awareness and facilitating climate action.
X		
X		
✓		**Peace, Justice, and Strong Institutions:** Web and Mobile application skills can be applied to create tools for transparency, accountability, and data security. By focusing on ethical coding practices, the lab can contribute to strong and just institutions.
✓		**Partnerships for the Goals:** Collaborative projects can foster partnerships among students, educators, and local communities. These partnerships enhance knowledge sharing and the development of innovative solutions that align with multiple SDGs.

Approved by: Board of Studies in the meeting conducted on ——————————.

Signature of Course Coordinator **HOD,EEE**
Dr.D.Durga Bhavani, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

<table>
<tr><td>1</td><td>Department</td><td colspan="5">Electrical and Electronics Engineering</td></tr>
<tr><td>2</td><td>Course Title</td><td colspan="5">Analysis of Electrical Networks</td></tr>
<tr><td>3</td><td>Course Code</td><td colspan="5">AEED05</td></tr>
<tr><td>4</td><td>Class/ Semester</td><td colspan="5">II/ III</td></tr>
<tr><td>5</td><td>Regulation</td><td colspan="5">BT-23</td></tr>
<tr><td rowspan="2">6</td><td rowspan="2">Structure of the course</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture
3</td><td>Tutorials
-</td><td>Credits
3</td><td>Lab
-</td><td>Credits
-</td></tr>
<tr><td>7</td><td>Type of course
(Tick type of course)</td><td>Core
✓</td><td>Professional Elective
-</td><td>Open Elective
-</td><td>VAC
-</td><td>MOOCs
-</td></tr>
<tr><td>8</td><td>Course Offered</td><td colspan="2">Odd Semester ✓</td><td colspan="3">Even Semester ×</td></tr>
<tr><td rowspan="2">9</td><td colspan="6">Total lecture, tutorial and practical hours for this course (16 weeks of teaching per semester)</td></tr>
<tr><td colspan="2">Lectures: 48 hours</td><td colspan="2">Tutorials: Nil hours</td><td colspan="2">Practical: Nil hours</td></tr>
<tr><td>10</td><td>Course Coordinator</td><td colspan="5">Mr.P.Mallikarjun</td></tr>
<tr><td>11</td><td>Date Approved by BOS</td><td colspan="5">24/08/2023</td></tr>
<tr><td>12</td><td>Course Webpage</td><td colspan="5">www.iare.ac.in/—-/—-</td></tr>
<tr><td rowspan="2">13</td><td rowspan="2">Course Prerequistes</td><td>Level</td><td>Course Code</td><td>Course title</td><td colspan="2">Semester</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td colspan="2">-</td></tr>
</table>

14. 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.

15. 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. .

16. 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

18. Topic Learning Outcome (TLOs):

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Out-come:	Blooms Level
1	Analysis of Electrical Circuits	1	Analysis of AC circuits (Definition and terminology)	CO1	Understand
		2	Analysis of R,L,C with AC supply	CO 1	Understand
		3	Analysis of L,C with AC supply.	CO 1	Understand
2	Analysis of Electrical Circuits	4	Analysis of RL,RC with AC supply	CO 1	Understand
		5	Analysis of Series RLC with AC supply	CO 1	Understand
3	Resonance	6	Series Resonance.	CO 1	Apply
		7	Parallel Resonance	CO 1	Apply
4	DC Response	8	DC Response of series RL Circuit	CO 1	Understand

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Out-come:	Blooms Level
5	DC Response	9	DC Response of series RC Circuit	CO2	Understand
6	DC Response	10	DC Response of series RLC Circuit	CO2	Understand
7	AC Response	11	AC transient analysis series RL circuit	CO2	Understand
8	AC Response	12	AC transient analysis series RC circuit	CO2	Understand
9	AC Response	13	AC transient analysis series RLC circuit	CO2	Understand
10	Transient Response	14	Transient response of series RL circuit using Laplace transform	CO2	Understand
11	Transient Response	15	Transient response of series RC circuit using Laplace transform	CO2	Apply
12	Transient Response	16	Transient response of series RLC circuit using Laplace transform	CO2	Understand
‘13	Problems on Transient Response	17	Problems on RLC circuits	CO3	Understand
14	Locus diagrams	18	Locus diagrams of series RL,RC circuit.	CO3	Understand
15	Locus diagrams	19	Locus diagrams of series RLC circuit.	CO3	Understand
16	Locus diagrams	20	Locus diagrams of parallel RLC circuit.	CO3	Understand
17	Network functions	21	Network function-one port and two port network, Driving point functions	CO3	Apply
18	Network functions	22	Significance of poles, zeros and stability of function	CO4	Understand
19	Time response	23	Time response from pole zero plot	CO4	Understand
20	Time response	24	Necessary conditions for transfer function and driving point functions	CO4	Apply
21	Three Phase Systems	25	Generation of three phase voltages , types of connections (star and delta)	CO4	Understand
22	Three Phase Systems	26	Relationship between currents and voltages and three phase power in star and delta connections	CO4	Understand
23	Wattmeter Methods	27	Measurement of active and reactive power by using wattmeter methods.	CO4	Apply

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Out-come:	Blooms Level
24	Wattmeter Methods	28	Measurement of three phase power by using two wattmeter method	CO5	Understand
25	Wattmeter Methods	29	Measurement of Reactive power with single wattmeter method	CO5	Understand
26	Network filters	30	Introduction to network filters: Classification of filters	CO5	Understand
27	Network filters	31	Filter network equations: characteristic impedence, image impedence	CO5	Understand
28	Network filters	32	Constant K low pass filter	CO5	Understand
29	Network filters	33	Constant K High pass filter	CO5	Understand
30	Network filters	34	M-derive low pass filter	CO5	Understand
31	Network filters	35	M-derive high pass filter	CO5	Understand
32	Network filters	36	Design of Constant K Band pass filter .	CO6	Understand
33	Network filters	37	Design of Constant K Band stop filter .	CO6	Understand
34	Problems on Network filters	38	problems	CO6	Understand
35	Problems on Network filters	39	problems	CO6	Understand
36	Problems on Network filters	40	problems	CO6	Understand

18. Employability Skills

Example: Communication skills / Programming skills / Project based skills /
Project based skills Elements of electrical and electronics engineering for students based on qualitative and quantitative analysis of experimental skills

19. Content Delivery / Instructional Methologies:

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

20. Evaluation Methodology:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). CIA is conducted for a total of 40 marks, with 20 marks for Continuous Internal Examination (CIE), and and 05 marks for each Definitions and Terminology / Quiz and remaining 10 marks for Tech Talk / Assignments.

Table 4: Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	**CIA - I**	**CIA - II**	**SEE**	**Total Marks**
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Definitions and Terminology / Quiz	05 Marks	05 Marks		10 Marks
Tech Talk / Assignment	05 Marks	05 Marks		10 Marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

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 12 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.

21. Course Content-Number of Modules: Five

MODULE I	**ANALYSIS OF AC CIRCUITS** . | **Number of Lectures: 09**
	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** . | **Number of Lectures: 10**
	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** . |**Number of Lectures: 10**
	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** . | **Number of Lectures: 10**
	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** . | **Number of Lectures: 09**
	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. DavidA Bell, "*Electric circuits*", Oxford University Press,7th edition,2009.
3. C L Wadhwa "*Electrical Circuit Analysis including Passive Network Synthesis*", New Age International, 2nd Edition, 2009.
4. M E Van Valkenberg, " *Network Analysis*", Prentice Hall India, 3rd Edition, 2014.

MATERIALS ONLINE:

1. https://nptel.ac.in/courses/112105171/1
2. https://www.geosci.uchicago.edu/ moyer/GEOS24705/Readings/Klempner_Ch1.pdf
3. https://www.users.ece.cmu.edu/ dwg/personal/sample.pdf.
4. https://www.iare.ac.in

22. COURSE PLAN:

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

S.No	Topics to be covered	Course Outcome's	Reference
Discussion on OBE			
1	Discussion on Outcome Based Education, CO, POs and PSOs		
CONTENT DELIVERY (THEORY)			
1	Analysis of AC circuits (Definition and terminology)	CO 1	T1:1.1-1.3
2	Analysis of R,L,C with AC supply	CO 1	T1:1.4-1.8
3	Analysis of L,C with AC supply	CO 1	T1:2.6
4	Analysis of RL,RC with AC supply	CO 1	T1:2.7
5	Analysis of Series RLC with AC supply	CO 1	T1:2.9
6	Concept of impedance and admittance triangles, power factor in series circuits	CO 1	T1:2.8
7	Series Resonance	CO 1	T1:4.1-4.5
8	Concept of band width and Q factor.	CO 1	T1:4.7-4.8
9	Parallel Resonance	CO 2	T1:2.11
10	Concept of band width and Q factor.	CO 2	T1:2.11.1
11	Transient response: Initial conditions of R,L,C	CO 2	T1:2.11.2
12	DC Response of series RL Circuit	CO 2	T1:2.11.3
13	DC Response of series RC Circuit	CO 2	T1:2.11.4
14	DC Response of series RLC Circuit	CO 2	T1:2.11.5
15	Problems on RL,RC Circuit	CO 2	T1:2.11.6
16	AC transient analysis series RL circuit	CO 2	T1: 5.2
17	AC transient analysis series RC,RLC circuit	CO 3	T1: 9.2
18	Transient response of series RL circuit using Laplace transform	CO 3	T1: 9.6
19	Transient response of series RC circuit using Laplace transform	CO 3	T1: 9.7
20	Transient response of series RLC circuit using Laplace transform	CO 4	T2: 1.1
21	Problems on RLC circuits	CO 4	T2: 1.2
22	Locus diagrams of series RL circuit.	CO 4	T2: 1.9
23	Locus diagrams of series RC circuit.	CO 4	T2: 1.10
24	Locus diagrams of series RLC circuit.	CO 4	T2: 1.11
25	Locus diagrams of parallel RLC circuit.	CO 4	T2: 1.12
26	Problems on RLC circuits	CO 4	T2: 1.10
27	Network function-one port and two port network, Driving point functions	CO 5	T2: 3.1

S.No	Topics to be covered	Course Out-come's	Reference
28	Relationship between currents and voltages and three phase power in star and delta connections	CO 5	T2: 3.1.2
29	Significance of poles, zeros and stability of function	CO 5	T2: 3.1.3
30	Time response from pole zero plot	CO 5	T2: 3.6
31	Necessary conditions for transfer function and driving point functions	CO 5	T2: 3.7
32	Generation of three phase voltages , types of connections (star and delta)	CO 5	T2: 3.8
33	Balances three phase systems (Star) and (Delta)	CO 5	T2: 4.1
34	Measurement of three phase power by using two wattmeter method	CO 6	T2: 3.9
35	Measurement of Reactive power with single wattmeter method	CO 6	T2: 5.2
36	Introduction to network filters: Classification of filters	CO 6	T2: 5.2.7
37	Filter network equations: characteristic impedence, image impedence	CO 6	T2: 5.3.1
38	Constant K low pass filter and High pass filter	CO 6	T2: 5.3.2
39	M-derive low pass and high pass filter	CO 6	T2: 5.3.3
40	Design of Constant K Band pass and Band stop filter .	CO 6	T2: 5.5
PROBLEM SOLVING/ CASE STUDIES			
1	Problems on steady state analysis of series circuits	CO 1	T1: 2.6
2	Problems on steady state analysis of parallel circuits	CO 1	T1: 2.7
3	Problems on series and parallel Resonance	CO 1	T1: 2.8-2.9
4	Problems on transient analysis of series circuits	CO 2	T1: 2.11
5	Problems on transient analysis of parallel circuits	CO 2	T1: 2.11.1
6	Problems on Laplace tranform of series and parallel circuits	CO 2	T1: 2.11.2
7	Problems on Locus diagrams of RL circuit	CO 3	T1: 9.2
8	Problems on tmre domain response from polezero plot	CO 3	T1: 9.3
9	Problems on Locus diagrams of RC circuit	CO 3	T1: 9.4
10	Problems on Locus diagrams of RLC circuit	CO 3	T1: 9.5
11	Problems on voltages and currents in star connection	CO 4	T1: 7.4
12	Problems on voltages and currents in delta connection	CO 4	T1: 7.5
13	Problems on measurement of active and reactive power	CO 4	T2: 1.10
14	Problems on constant k filters	CO 5	T2: 3.6
15	Problems on m derived T section filters	CO 6	T2: 3.7-3.8
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Introduction to Electrical circuits (AC)	CO 1	T1: 1.1-1.12
2	Definition and terminology from transient systems.	CO 2	T1: 2.1-2.12
3	Definition and terminology from Locus diagrams	CO 3, CO 4	T1: 7,8,9 T2: 1.1-1.12

S.No	Topics to be covered	Course Out-come's	Reference
4	Definition and terminology from three phase AC circuits	CO 5	T2: 3.1-3.10
5	Definition and terminology from filters	CO 6	T2: 9.1-9.6
DISCUSSION OF TUTORIAL QUESTION BANK			
1	Question bank from electrical circuits (AC)	CO 1	T1: 1.1-1.12
2	Question bank from transient analysis	CO 2	T1: 1.1-1.12
3	Question bank from Locus diagrams	CO 3,CO 4	T1: 7,8,9 T2: 1.1-1.12
4	Question bank from three phase AC circuits	CO 5	T2: 3.1-3.10
5	Question bank from filters	CO 6	T2:9.1-9.6

23. PROGRAM OUTCOMES & PROGRAM SPECIFIC 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
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..

24. 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/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/SEE/AAT

25. 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	CIE/SEE/AAT

3 = High; 2 = Medium; 1 = Low

26. 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	✓	✓	-	-	-	-	-	-	-	-	-	-	-	✓	-

27. 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 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	PO1	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
	PSO2	Understand three-phase active and reactive power in three phase systems	1
CO 5	PO 1	Recall the engineering sciences to understand two wattmeter method for three phase star and delta connected systems	3
	PSO2	Understand two wattmeter method in three phase systems	1

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 6	PO1	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
	PSO2	Understand the active filters characteristics, execute digital simulation using MATLAB	1

28. 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	-

29. 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	-

30. 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		
	PO 1	PO 2	PO 3	PO 4	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	-

31. ASSESSMENT METHODOLOGY DIRECT:

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

32. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

33. Relevance to Sustainability goals

Write brief description about the course and how its relevance to SDGs.

1		
2		

3	GOOD HEALTH AND WELL-BEING	
4	QUALITY EDUCATION	This subject improves the quality of education in engineers and gives the awareness of electrical usage in day to day life.
5	GENDER EQUALITY	
6	CLEAN WATER AND SANITATION	
7	AFFORDABLE AND CLEAN ENERGY	
8	DECENT WORK AND ECONOMIC GROWTH	
9	INDUSTRY, INNOVATION AND INFRASTRUCTURE	

10	REDUCED INEQUALITIES	
11	SUSTAINABLE CITIES AND COMMUNITIES	
12	RESPONSIBLE CONSUMPTION AND PRODUCTION	Responsible Consumption and Production: This subject gives the importance of electricity, by learning how to optimize electrical energy for different applications, students can contribute to reducing energy consumption and minimizing electronic waste and the need for saving energy.
13	CLIMATE ACTION	
14	LIFE BELOW WATER	
15	LIFE ON LAND	
16	PEACE, JUSTICE AND STRONG INSTITUTIONS	

17	PARTNERSHIPS FOR THE GOALS	

Approved by: Board of Studies in the meeting conducted on - 24/08/2023

Signature of Course Coordinator **HOD**
Mr.Poola Mallikarjun, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**				
2	Course Title	**DC MACHINES AND TRANSFORMERS**				
3	Course Code	AEED06				
4	Class/ Semester	II/ III				
5	Regulation	BT23				
6	Structure of the course	Theory			Practical	
		Lecture	Tutorials	Credits	Lab	Credits
		3	-	3	-	-
7	Type of course (**Tick type of course**)	Core	Professional Elective	Open Elective	VAC	MOOCs
		✓	-	-	-	-
8	Course Offered	Even Semester ×		Odd Semester ✓		
9	**Total lecture, tutorial and practical hours for this course (16 weeks of teaching per semester)**					
	Lectures: 48 hours		Tutorials: *Nil* hours		Practical: *Nil* hours	
10	Course Coordinator	Dr.G Seshadri				
11	Date Approved by BOS	18/08/2024				
12	Course Webpage	www.iare.ac.in/—-/—-				
13	Course Prerequistes	**Level**	**Course Code**	**Course title**	**Semester**	
		UG	AEED02	Electrical Circuits	I	

14. Course Overview

The course provides basic foundation in electrical and electronics. It includes the concepts related to electrical circuits, the fundamental operating principles of electrical machines and the characteristics of semiconductor devices. It also empowers students to understand electronics and electrical systems in their daily lives, from household appliances to personal devices.

15. 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.

16. 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	Identify various control strategies for calculating the performance parameters and voltage regulation of electrical machines .	Understand
CO 5	Describe the load sharing capabilities and reliability of electrical machines using parallel operation under various loading conditions.	Uderstand
CO 6	Illustrate the amplifier circuits using transistors for computing hybrid parameters.	Apply

18. Topic Learning Outcome (TLOs):

SNo	**TOPIC(S)**	**TLO No**	**Topic Learning Outcome's**	**Course Out-come:**	Blooms Level
1	Electrical Circuits	TLO 1	Introduction to electrical circuits	CO1	Understand
		TLO 2	Basic Definitions of Electrical Circuits	CO 1	Understand
		TLO 3	Equivalent resistance of electrical circuits and source transformation of electrical circuits.	CO 1	Understand
2	Electrical laws	TLO 4	Basic Electric laws	CO 1	Understand
		TLO 5	Star to delta and delta bto star transformation	CO 1	Understand
3	Electrical analysis	TLO 6	Calculate voltages and currents with mesh analysis.	CO 1	Apply
		TLO 7	Calculate voltages and currents with nodal analysis	CO 1	Apply
4	AC Circuits	TLO 8	Demonstrate the basics of single-phase AC circuits	CO 1	Understand

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Out-come:	Blooms Level
5	Electrical Theorem	TLO9	Procedure for Superposition theorem	CO2	Understand
6	Electrical Theorem	TLO10	Procedure for Reciprocity theorem	CO2	Understand
7	Electrical Theorem	TLO11	Procedure for Thevenin's theorem	CO2	Understand
8	Electrical Theorem	TLO12	Procedure for Norton's theorem	CO2	Understand
9	Electrical Theorem	TLO13	Procedure for Maximum Power Transfer theorem	CO2	Understand
10	3 phase voltages	TLO14	Voltage and current relationships in star and delta connections	CO2	Understand
11	DC Circuits	TLO 15	Apply the basic theorems to solve the problems on DC circuits.	CO2	Apply
12	3Phase cirrcuits	TLO 16	Basics of three-phase AC circuits	CO2	Understand
‘13	DCmachines and AC machines	TLO 17	Illustrate the construction and operation of DC and AC motors and generators	CO3	Understand
14	DC machines	TLO 18	EMF equation of DC motors and generators	CO3	Understand
15	DC machines	TLO 19	Types of DC motors and generators	CO3	Understand
16	DC machines	TLO 20	Applications and losses of DC motors and generators	CO3	Understand
17	DC machines	TLO 21	Problems based on losses and Efficiency of DC motors and generators	CO3	Apply
18	semiconductor diode	TLO 22	Understand the basics of semiconductor elements	CO4	Understand
19	semiconductor diode characterictics	TLO 23	Illustrate the characteristics of the PN junction diode	CO4	Understand
20	rectifiers	TLO 24	Develop the rectifiers using diodes and their characteristics	CO4	Apply
21	Operation of semiconductor diode	TLO25	Operation of a diode as a switch	CO4	Understand
22	Zener diode	TLO26	Operation of Zener diode as the voltage regulator	CO4	Understand
23	Rectifier parameters	TLO27	Calculation of Rectifier parameters	CO4	Apply

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Out-come:	Blooms Level
24	Transistors	TLO28	Introduction to bipolar junction transistors	CO5	Understand
25	Transistor configurations	TLO29	Illustrate the characteristics of bipolar junction transistors with various configurations	CO5	Understand
26	Transistor principle	TLO30	Working principle of NPN Transistor	CO5	Understand
27	Transistor principle	TLO31	Working principle of PNP Transistor	CO5	Understand
28	Transistor configuration	TLO32	Transistor characteristics under CE configuration	CO5	Understand
29	transistor configuration	TLO33	Transistor characteristics under CB configuration	CO5	Understand
30	transistor configuration	TLO34	Transistor characteristics under CC configuration	CO5	Understand
31	BJT characteristics	TLO35	Input and output characteristics of bipolar junction transistor	CO5	Understand
32	Amplifiers	TLO36	Understand the operation of a transistor as an amplifier	CO6	Understand
33	Amplifier circuits	TLO37	Understand the two port devices and networks of Amplifier circuits	CO6	Understand
34	Models of transistors	TLO38	Small signal operation and models for transistors	CO6	Understand
35	CE Amplifier	TLO39	Method of amplification in CE amplifier	CO6	Understand
36	H parameters	TLO40	Describe the h parameters of bipolar junction transistors with the concept of small signal operation	CO6	Understand

18. Employability Skills

Example: Communication skills / Programming skills / Project based skills /
Project based skills Elements of electrical and electronics engineering for students based on qualitative and quantitative analysis of experimental skills

19. Content Delivery / Instructional Methologies:

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

20. Evaluation Methodology:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). CIA is conducted for a total of 40 marks, with 20 marks for Continuous Internal Examination (CIE), and and 05 marks for each Definitions and Terminology / Quiz and remaining 10 marks for Tech Talk / Assignments.

Table 4: Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	**CIA - I**	**CIA - II**	**SEE**	**Total Marks**
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Definitions and Terminology / Quiz	05 Marks	05 Marks		10 Marks
Tech Talk / Assignment	05 Marks	05 Marks		10 Marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

Semester End Examination (SEE): The SEE is conducted for 60 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 12 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.

21. Course Content-Number of Modules: Five

MODULE I	**DC GENERATORS** | **Number of Lectures: 09**
	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** . | **Number of Lectures: 10**
	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** . |**Number of Lectures: 10**
	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** . | **Number of Lectures: 10**
	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** . | **Number of Lectures: 09**
	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, " *Electric Machinery*" ,Khanna Publishers, 2011.
3. P S Bimbhra, " *Electric Machine*" ,Khanna Publishers, 2011.

REFERENCE BOOKS:

1. C.L. Wadhwa & "*Electrical Circuit Analysis including Passive Network Synthesis*", International,2nd edition,2009.
2. DavidA Bell, "*Electric circuits*", Oxford University Press,7th edition,2009.
3. P.S Bimbra "*Electrical Machines*", KhannaPublishers,2nd edition,2008.
4. D.P. Kothari and I. J. Nagrath, " *Basic Electrical Engineering*", Tata McGraw Hill, 4th Edition, 2021.

MATERIALS ONLINE:

1. https://www.kuet.ac.bd/webportal/ppmv2/uploads/1364120248DC%20Machines
2. https://www.eleccompengineering.files.wordpress.com/2014/08/a-textbook-of-electrical-technologyvolume-ii-ac-and-dc-machines-b-l-thferaja.pdf
3. https://www.geosci.uchicago.edu/ moyer/GEOS24705/Readings/Klempner_Ch1.pdf
4. https://www.ibiblio.org/kuphaldt/electricCircuits/DC/DC.pdf
5. https://www.users.ece.cmu.edu/ dwg/personal/sample.pdf.
6. https://www.iare.ac.in

22. COURSE PLAN:

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

S.No	Topics to be covered	Course Outcome's	Reference
Discussion on OBE			
1	Discussion on Outcome Based Education, CO, POs and PSOs		
CONTENT DELIVERY (THEORY)			
1	Understand principle of operation of DC generator.	CO 1	T1:4.1- 4.2
2	Know the different parts in a DC machine and understand the functioning of each component..	CO 1	T1:4.3
3	Know the different types of windings used in DC generators.	CO 1	T1:4.4- 4.9
4	Understand why the core of a DC machine is laminated and functioning of commutator	CO 1	T1:4.3
5	Derive the equation of EMF induced in a DC generator and solve the simple problems	CO 1	T1:4.10
6	Distinguish the different types of DC generators and know how the voltage is buildup in DC generators	CO 2	T1:6.1- 6.2
7	Distinguish the different types of DC generators and know how the voltage is buildup in DC generators.	CO 2	T1:6.1- 6.2
8	Problems on the different types of DC generators.	CO 2	T1:6.1- 6.2
9	Problems on the different types of DC generators.	CO 2	T1:6.1- 6.2
10	Understand the concept of critical field resistance and critical speed.	CO 2	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 2	T1:6.13- 6.14
12	Understand the concept of armature reaction in DC generator	CO 2	T1:5.1- 5.2

S.No	Topics to be covered	Course Out-come's	Reference
13	Understand the concept of cross magnetization and demagnetization in DC generator	CO 2	T1:5.3
14	Solve the problems on armature reaction	CO 2	T1:5.7
15	Understand the concept of commutation, and know different methods used for improving the commutation	CO 2	T1:5.4- 5.6
16	Draw the different types of characteristics for DC generators	CO 2	T1:6.5- 6.11
17	Understand the basic principle of operating the generators in parallel	CO 3	T1:7.1-7.4
18	Understand the function of equalizer bar and its usage	CO 3	T1:7.2
19	Solve the different types of numerical problems related to DC generators.	CO 3	T1:4.1- 7.4
20	Understand the basic principle of dc motor and its function	CO 3	T1:8.2
21	Understand how the back EMF is induced in DC motor and derive the torque equation	CO 3	T1:8.4- 8.6
22	Know different types of motors and solve simple problems.	CO 3	T1:8.7.1- 8.7.5
23	Understand the occurrence of armature reaction and study the commutation techniques	CO 3	T1:8.16
24	Draw the performance characteristics of DC motors	CO 3	T1:8.18- 8.23
25	Understand the methods of speed control	CO 3	T1:9.1- 9.3
26	Know why starters are used and different types of starters	CO 4	T1:9.4-97
27	Understand the differ types of losses that are occurred in a DC motor.	CO 4	T1:10.1- 10.4
28	Solve different numerical problems related to efficiency of DC motor	CO 4	T1:10.1- 10.4
29	Conduct the Swinburne's test and Brake test on DC motor and compare the two methods	CO 4	T1:10.7
30	Conduct the regenerative test, Hopkinson's test and determine the efficiency of DC motor	CO 4	T1:10.8
31	Conduct the field's test on DC series motor, and retardation test on DC shunt motor	CO 4	T1:10.9- 10.10
32	Summarize the different types of losses and separate the each loss from total losses	CO 4	T4:10.10
33	Solve the different types of numerical problems related to DC motors testing	CO4	T1:8.2- 10.10
34	Explain the operation, construction and types of single phase transformer	CO 5	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 5	T1:1.5- 1.6
36	Discuss the operation of transformer under no load and on load with the phasor diagrams	CO 5	T1:1.8- 1.12

S.No	Topics to be covered	Course Out-come's	Reference
37	Draw the equivalent circuit of single phase transformer and study the concept of regulation and all day efficiency	CO 6	T1:1.13- 1.18
38	Solve the Numerical problems on EMF equation and draw the phasor diagrams	CO 6	T1:1.1- 1.18
39	Understand the objectives of testing, and kwon how to conduct polarity test and how to measure resistance	CO 6	T1:1.19.1- 1.19.2
40	Conduct OC and SC tests on transformer and determine the efficiency and regulation at different loads	CO6	T1:1.193- 1.195
PROBLEM SOLVING/ CASE STUDIES			
1	Problems on equivalent resistance	CO 1	T1: 2.6
2	Problems on star to delta and delta to star transformation	CO 1	T1: 2.7
3	Problems on mesh and nodal analysis	CO 1	T1: 2.8-2.9
4	Problems on superposition theorem	CO 2	T1: 2.11
5	Problems on reciprocity theorem	CO 2	T1: 2.11.1
6	Problems on Maximum power transfer theorem	CO 2	T1: 2.11.2
7	Problems on emf equation of DC generators	CO 3	T1: 9.2
8	Problems on efficiency of DC generators	CO 3	T1: 9.3
9	Problems on DC motors	CO 3	T1: 9.4
10	Problems on efficiency of DC motors	CO 3	T1: 9.5
11	Problems on alternator emf equation	CO 4	T1: 7.4
12	Problems on alternators	CO 4	T1: 7.5
13	Problems on rectifiers using diodes	CO 4	T2: 1.10
14	Problems on transistors CB configuration	CO 5	T2: 3.6
15	Problems on transistors CE and CC configuration	CO 6	T2: 3.7-3.8
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Introduction to Engineering Mechanics	CO 1	T1: 1.1-1.12
2	Definition and terminology from network theorems and three phase AC circuits	CO 2	T1: 2.1-2.12
3	Definition and terminology from electrical machines and diodes	CO 3, CO 4	T1: 7,8,9 T2: 1.1-1.12
4	Definition and terminology from transistors	CO 5	T2: 3.1-3.10
5	Definition and terminology from transistor amplifier circuits	CO 6	T2: 9.1-9.6
DISCUSSION OF TUTORIAL QUESTION BANK			
1	Question bank from electrical circuits	CO 1	T1: 1.1-1.12
2	Question bank from network theorems and three phase AC circuits	CO 2	T1: 1.1-1.12
3	Question bank from electrical machines and diodes	CO 3,CO 4	T1: 7,8,9 T2: 1.1-1.12
4	Question bank from electrical machines and diodes	CO 5	T2: 3.1-3.10
5	Question bank from transistor amplifier circuits	CO 6	T2:9.1-9.6

23. PROGRAM OUTCOMES & PROGRAM SPECIFIC 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
Program Specific Outcomes	
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.

Program Outcomes	
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.

24. 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/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/SEE/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/SEE/AAT

25. 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	CIE/SEE/AAT

3 = High; 2 = Medium; 1 = Low

26. 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	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-

27. 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	Recollect the concept of electricity is described through scientific principles, importance Kirchhoff laws in relation with law of conservation of energy and charge circuits are explained using mathematics, engineering fundamentals and various source transformation techniques are adopted for solving complex circuits.	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	PO1	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.	2
	PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	2

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
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.s	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 sciencess	5
CO 6	PO 1	Understand the mathematical principles for design the biasing techniques for BJT amplifier circuits for stable operation by applying the methodology	2
	PO 2	Demonstrate the calculation of h parameters with small signal operation using the principles of mathematics and natural sciences.	4

28. 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	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	5	-	-	-	-	-	-	-	-	-	-	-	-	-

29. 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	-	-	-	-	-	-	-	-	-	-	33.3	-	-
CO 5	66.6	50	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	66.6	50	-	-	-	-	-	-	-	-	-	-	-	-	-

30. 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	3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 5	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL	15	11	2	-	-	-	-	-	-	-	-	-	2	-	-
AVERAGE	3	2.2	0.4	-	-	-	-	-	-	-	-	-	0.3	-	-

31. ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Assignments	-
Quiz	✓	Student Viva	✓	Certificates	-
Laboratory Practices	-	5 Minutes Video	–	Open Ended Experiments	-
Micro Projects	-				

32. ASSESSMENT METHODOLOGY INDIRECT:

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

33. Relevance to Sustainability goals

Write brief description about the course and how its relevance to SDGs.

1		

2	ZERO HUNGER	
3	GOOD HEALTH AND WELL-BEING	
4	QUALITY EDUCATION	This subject improves the quality of education in engineers and gives the awareness of electrical usage in day to day life.
5	GENDER EQUALITY	
6	CLEAN WATER AND SANITATION	
7	AFFORDABLE AND CLEAN ENERGY	
8	DECENT WORK AND ECONOMIC GROWTH	

9		
10		
11		
12		Responsible Consumption and Production: This subject gives the importance of electricity, by learning how to optimize electrical energy for different applications, students can contribute to reducing energy consumption and minimizing electronic waste and the need for saving energy.
13		
14		
15		

16	PEACE, JUSTICE AND STRONG INSTITUTIONS	
17	PARTNERSHIPS FOR THE GOALS	

Approved by: Board of Studies in the meeting conducted on - 18/08/2024

Signature of Course Coordinator **HOD EEE**
Dr.G.Seshadri, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**Electrical and Electronics Engineering**				
2	Course Title	**Electromagnetic Fields**				
3	Course Code	AEED07				
4	Class/ Semester	II/ III				
5	Regulation	BT-23				
6	Structure of the course	Theory			Practical	
		Lecture	Tutorials	Credits	Lab	Credits
		3	-	3	-	-
7	Type of course (**Tick type of course**)	Core	Professional Elective	Open Elective	VAC	MOOCs
		✓	-	-	-	-
8	Course Offered	Odd Semester ✓		Even Semester ×		
9	**Total lecture, tutorial and practical hours for this course (16 weeks of teaching per semester)**					
	Lectures: 48 hours		Tutorials: *Nil* hours		Practical: *Nil* hours	
10	Course Coordinator	Mrs.T.Saritha Kumari				
11	Date Approved by BOS	24/08/2023				
12	Course Webpage	www.iare.ac.in/—-/—-				
13	Course Prerequistes -	**Level**	**Course Code**	**Course title**	**Semester**	
		B.Tech	AHSD02	Matrices and Calculus	I	-

14. 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.

15. 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

16. 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	**Develop** Maxwell's Equations and investigate their applications within the realm oftime-varying fields and boundary conditions.	Apply
CO 6	**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

17. TOPIC LEARNING OUTCOME (TLOs):

SNo	**TOPIC(S)**	**TLO No**	**Topic Learning Outcome's**	**Course Out-come:**	Blooms Level
1	Vector Algebra	TLO 1	Introduction to vector algebra	CO1	Understand
		TLO 2	Problems on vector algebra	CO 1	Apply
2	Different types of co-ordinates	TLO 3	Analysis of different types of co-ordinates	CO 1	Understand
		TLO 4	Conversion of different types of co-ordinates	CO 1	Apply
3	Capacitance	TLO 5	Calculation of capacitance	CO 2	Apply
		TLO 6	Problems on Calculation of capacitance	CO 2	Apply

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Outcome:	Blooms Level
4	Electrostatic fields and Coulomb's law	TLO 7	Introduction to electrostatic fields	CO 1	Understand
		TLO 8	Introduction to coulomb's law	CO 1	Understand
5	Gauss's law	TLO 9	State Gauss's law	CO1	Understand
		TLO 7	Applications of Gaiss's Law	CO 1	Apply
6	Electrostatics	TLO 10	Problem discussion I on electrostatics	CO 1	Apply
		TLO 11	Problem discussion II on electrostatics II	CO 1	Apply
7	Maxwell's first law	TLO 12	Application of Maxwell's first law	CO 1	Apply
8	Magneto statics	TLO 13	Introduction to magneto statics	CO 3	Understand
9	Self and mutual inductance	TLO 14	Self and mutual inductance	CO 3	Understand
10	Time varying fields and finite element method definitions	TLO 15	Time varying fields definitions	CO 5	Understand
		TLO 16	Finite element method definitions	CO 1	Apply
11	Faraday's law and time varying field	TLO 17	Applicaton of Faraday's law	CO 5	Apply
		TLO 18	Time varying fields	CO 5	Apply
12	Force on electromagnetic field	TLO 19	Force on electromagnetic field	CO 4	Understand
		TLO 20	Force on electromagnetic field definitions	CO 4	Understand
'13	Electrostatic fields definitions	TLO 21	Electrostatic fields definitions	CO 1	Understand
14	Dipole, current density and capacitance	TLO 22	Dipole, current density and capacitance definitions	CO 2	Understand
15	Conductors and dielectrics	TLO 23	Conductors and dielectrics	CO 2	Understand
16	Magneto statics	TLO 24	Magneto statics definitions	CO 3	Understand
17	Conductors and dielectrics	TLO 25	Problems on conductors and dielectrics	CO 2	Apply
18	Electric field and polarization	TLO 26	Electric field and polarization	CO 2	Understand

SNo	TOPIC(S)	TLO No	Topic Learning Outcome's	Course Outcome:	Blooms Level
19	Electrostatic fields and different charge density	TLO 27	Electrostatic fields and different charge density	CO 2	Understand
20	Field in electrical and electronics	TLO 28	Field in electrical and electronics	CO4	Apply
21	Potential and potential difference	TLO 29	Potential and potential difference	CO4	Understand
22	Time varying filed	TLO 30	Application of time varying filed	CO4	Understand
23	Electromagnetic field	TLO 31	Electromagnetic field basic concepts	CO4	Apply
24	Lorentz force	TLO 32	Application of Lorentz force	CO5	Understand
25	Polarization	TLO 33	Polarization	CO5	Understand
26	Magnetic polarization	TLO 34	Magnetic polarization	CO 4	Understand
27	Ampere circuital law	TLO 35	Ampere circuital law	CO5	Understand
28	Maxwell's equation	TLO 36	Maxwell's equation	CO5	Understand
29	Electromagnetic wave propagation	TLO 37	Electromagnetic wave propagation	CO5	Understand
30	Problems on time varying field	TLO 38	Problems on time varying field	CO5	Understand
31	Problems on time varying field - II	TLO 39	Problems on time varying field - II	CO5	Understand
32	Poynting theorem	TLO 40	Poynting theorem	CO6	Understand
33	Problems on electrostatics – I	TLO 41	Problems on electrostatics – I	CO6	Apply
34	Problems on electrostatics – II	TLO 42	Problems on electrostatics – II	CO6	Apply
35	Laws of electromagnetics	TLO 43	Laws of electromagnetics	CO6	Understand
36	Laws of electromagnetics – II	TLO 44	Laws of electromagnetics – II	CO6	Understand
37	Problem on Magneto statics	TLO 45	Problem on Magneto statics	CO6	Apply

18. EMPLOYABILITY SKILLS

Example: Communication skills / Programming skills / Project based skills /
Project based skills: Electromagnetic Fields for students based on qualitative and quantitative analysis of experimental skills

19. CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES:

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

20. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). CIA is conducted for a total of 40 marks, with 20 marks for Continuous Internal Examination (CIE), and and 05 marks for each Definitions and Terminology / Quiz and remaining 10 marks for Tech Talk / Assignments.

Table 4: Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	**CIA - I**	**CIA - II**	**SEE**	**Total Marks**
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Definitions and Terminology / Quiz	05 Marks	05 Marks		10 Marks
Tech Talk / Assignment	05 Marks	05 Marks		10 Marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

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 12 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.

21. COURSE CONTENT-NUMBER OF MODULES: FIVE

MODULE I	**ELECTROSTATICS** ‘ . | **Number of Lectures: 10**
	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	**CONCENTRATORS AND DIELECTRICS** . | **Number of Lectures: 08**
	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** . |**Number of Lectures: 10**
	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** . | **Number of Lectures: 10**
	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 FINITE ELEMENT METHOD** . | **Number of Lectures: 09**
	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.
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2. https://www.eleccompengineering.files.wordpress.com/2014/08/a-textbook-of-electrical-technologyvolume-ii-ac-and-dc-machines-b-l-thferaja.pdf
3. https://www.geosci.uchicago.edu/ moyer/GEOS24705/Readings/Klempner_Ch1.pdf
4. https://www.ibiblio.org/kuphaldt/electricCircuits/DC/DC.pdf
5. https://www.users.ece.cmu.edu/ dwg/personal/sample.pdf.
6. https://www.iare.ac.in

22. COURSE PLAN:

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

S.No	Topics to be covered	Course Out-come's	Reference
Discussion on OBE			
1	Discussion on Outcome Based Education, CO, POs and PSOs	-	-

S.No	Topics to be covered	Course Out-come's	Reference
CONTENT DELIVERY (THEORY)			
1	Introduction to vector algebra	CO1	T1: 1.12, R4:1.1- 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

S.No	Topics to be covered	Course Out-come's	Reference
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

S.No	Topics to be covered	Course Out-come's	Reference
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

S.No	Topics to be covered	Course Out-come's	Reference
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 TUTORIAL QUESTION BANK			
1	Field intensity, permittivity of Medium, charge distribution	CO 1	R4:2.1
2	Electric dipole moment, potential and toque due to electric dipole.	CO 2	T4:7.3
3	Magnetic field, magnetic field intensity permeability of core intensity of magnetization.	CO 3	R4:5.1
4	Magnetic dipole moment. torque due to magnetic dipole	CO 4	T1:7.5
5	Time varying field, total current density, displacement and conduction current density. types of emf induced in coil.	CO 5	T1: 4.1

23. PROGRAM OUTCOMES & PROGRAM SPECIFIC 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
Program Specific Outcomes	
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.

24. 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/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/SEE/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/SEE/AAT
PO 4	**Conduct Investigations of Complex Problems:** se 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/SEE/AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	CIE/SEE/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	CIE/SEE/AAT

25. 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

26. 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	✓	✓	✓	✓	-	-	-	-	-	✓	-	✓	✓	-	-

27. 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	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
	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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	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
	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

COURSE OUTCOMES	PO'S PSO'S	**Justification for mapping (Students will be able to)**	No. of Key Competencies
	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
	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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	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
CO 6	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**	5
	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
	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

28. 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	-	-

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

29. 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	-	-
CO 6	100	70	50	80	-	-	-	-	-	20	-	25	50	-	-

30. 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		
	PO 1	PO 2	PO 3	PO 4	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	-	-
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	-	-
CO 6	3	3	2	3	-	-	-	-	-	1	-	1	2	-	-
TOTAL	18	18	14	14	-	-	-	-	-	6	-	9	12	-	-
AVERAGE	3	3	2.3	2.3	-	-	-	-	-	1	-	1.5	2	-	-

31. ASSESSMENT METHODOLOGY DIRECT:

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

32. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

33. RELEVANCE TO SUATAINABILITY GOALS

Write brief description about the course and how its relevance to SDGs.

1		
2		
3		
4		This subject improves the quality of education in engineers and gives the awareness of electrical usage in day to day life.
5		

6	CLEAN WATER AND SANITATION	
7	AFFORDABLE AND CLEAN ENERGY	
8	DECENT WORK AND ECONOMIC GROWTH	
9	INDUSTRY, INNOVATION AND INFRASTRUCTURE	
10	REDUCED INEQUALITIES	
11	SUSTAINABLE CITIES AND COMMUNITIES	
12	RESPONSIBLE CONSUMPTION AND PRODUCTION	Responsible Consumption and Production: This subject gives the importance of electricity, by learning how to optimize electrical energy for different applications, students can contribute to reducing energy consumption and minimizing electronic waste and the need for saving energy.

13		
14		
15		
16		
17		

Approved by: Board of Studies in the meeting conducted on - 24/08/2023

Signature of Course Coordinator **HOD**
Mrs.T.Saritha Kumari, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**				
2	Course Title	**DATA STRUCTURES**				
3	Course Code	ACSD08				
4	Class / Semester	B.Tech III Semester				
5	Regulation	BT-23				
6	Structure of the course	Theory			Practical	
		Lecture	Tutorials	Credits	Lab	Credits
		3	0	3	-	-
7	Type of course (**Tick type of course**)	Core ✓	Professional Elective -	Open Elective -	VAC -	MOOCs -
8	Course Offered	Odd Semester ✓		Even Semester ×		
9	**Total lecture, tutorial and practical hours for this course (16 weeks of teaching per semester)**					
	Lectures: 48 hours		Tutorials: 0 hours		Practical: – hours	
10	Course Coordinator	Mr. S. Srikanth				
11	Date Approved by BOS	22/08/2023				
12	Course Webpage	https://www.iare.ac.in/?q=pages/btech-course-syllabi-bt23-cse				
13	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**	
		B.Tech	ACSD05	II	Essentials of Problem Solving	

14. 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.

15. Course Objectives:

The students will try to learn:

I	The skills needed to understand and analyze performance trade-offs of different algorithms / implementations and asymptotic analysis of their running time and memory usage.
II	The 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	The implementing these data structures and algorithms in Java.
V	The essential for future programming and software engineering courses.

16. 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

17. Mapping of topic learning outcomes (TLO) to course outcomes

S. No	Topic(s)	TLO No	Topic Learning Outcome's	Course Outcome	Blooms Level
1	Introduction to data structures	1	Understand various data structures to solve real-time problems.	CO 1	Understand
2	Classification of data structures, Operations on data structures	2	Understand the classification and operations of various data structures.	CO 1	Understand
3	Recursive algorithms and performance analysis	3	Understand the specifications of writing algorithms, developing recursive procedures.	CO 1	Understand
4	Searching Techniques: Linear Search, Binary Search	4	Apply knowledge of searching techniques to solve real word applications.	CO 2	Apply
5	Uniform Binary Search, Interpolation Search				
6	Fibonacci Search and comparison				

S. No	Topic(s)	TLC No	Topic Learning Outcome's	Course Outcome	Blooms Level
7	Sorting techniques: Bubble, Selection sort	5	Apply knowledge of sorting techniques to solve real word applications.	CO 2	Apply
8	Insertion, Quick sort				
9	Merge, Radix sort, Shell sort and comparison				
10	Stack ADT, definition and operations, Implementations of stacks using array	6	Understand stack data structure and apply the knowledge to perform infix to postfix conversion and postfix evaluation.	CO 3,CO 4, CO 6	Apply
11	Applications of stacks, Arithmetic expression conversion and evaluation				
12	Queues: Primitive operations; Implementation of queues using Arrays	7	Understand stack data structure and apply the knowledge to solve real world applications.	CO 3,CO 4, CO 6	Apply
13	Applications of linear queue, circular queue				
14	double ended queue (deque)				
15	Linked lists: Introduction, singly linked list, representation of a linked list in memory	8	Apply linked list data structure to perform polynomial representation and sparse matrix manipulation	CO 3,CO 4, CO 6	Apply
16	operations on a single linked list, Applications of linked lists Polynomial representation				
17	Sparse matrix manipulation				
18	Types of linked lists: Circular linked lists	9	Understand types of linked lists and implement stack and queue mechanisms using linked list.	CO 3,CO 4, CO 6	Apply
19	doubly linked lists				
20	Linked list representation and operations of Stack				
21	Linked list representation and operations of queue				

S. No	Topic(s)	TLO No	Topic Learning Outcome's	Course Outcome	Blooms Level
22	Trees: Basic concept, binary tree	10	Understand the concept of trees and various methods of its representation.	CO 3	Apply
23	binary tree array representation				
24	binary tree linked list representation				
25	binary tree traversal	11	Understand inorder, preorder and post order traversals of trees.	CO 3	Apply
26	Binary tree variants	12	Understand various variants of binary trees in real world applications.	CO 3	Apply
27	Threaded binary tree				
28	Application of trees	13	Apply the knowledge of variants of binary trees and its operations to solve real world problems.	CO 4	Apply
29	Graphs: Basic concept, graph terminology	14	Understand the basics of graphs, its representation and implementation.	CO 3	Apply
30	Graph Representations-Adjacency matrix, Adjacency lists				
31	Graph implementation				
32	Graph traversals – BFS	15	Apply the basics of graphs, its representation to implement graph traversals.	CO 3,CO 4, CO 6	Apply
33	Graph traversals – DFS				
34	Application of graphs				
35	Minimum spanning trees – Prims and Kruskal algorithms	16	Understand the concept of spanning tress and two algorithms for finding minimum spanning trees	CO 3,CO 4, CO 6	Apply
36	Binary search trees: Binary search trees, properties and operations	17	Understand the concept of binary search tree with its variants.	CO 3	Understand
37	Balanced search trees: AVL trees				
38	Introduction to M-Way search trees	18	Understand various generalized versions of binary tress.	CO 3,CO 4, CO 6	Understand
39	B trees				
40	Hashing and collision	19	Apply the concept of hashing in real world applications for data fast retreival.	CO 5	Apply

18. Employability Skills

Example: Communication skills / Programming skills / Project based skills /
1. Programming skills - The tech industry evolves rapidly, and staying up-to-date with the latest programming languages, frameworks, and development practices is crucial. Combining essentials of problem solving skills with a commitment to continuous learning demonstrates a student's dedication to staying relevant in a dynamic field.
2. Project-based skills - Creating projects that utilize graph theory principles to allow a student to apply theoretical knowledge to real-world scenarios. This hands-on experience helps solidify their understanding of how problem solving concepts work in practice.

19. Content Delivery / Instructional Methologies:

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

20. Evaluation Methodology:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). CIA is conducted for a total of 40 marks, with 20 marks for Continuous Internal Examination (CIE), 05 marks for each Definition and Terminology / Quiz, and the remaining 10 marks for Tech Talk / Assignments.

Table 4: Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	**CIA - I**	**CIA - II**	**SEE**	**Total Marks**
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Definitions and Terminology / Quiz	05 Marks	05 Marks		10 Marks
Tech Talk / Assignment	05 Marks	05 Marks		10 Marks
Semester End Examination (SEE)	-	-	60 Marks	40 Marks
Total	-	-	**100 Marks**	

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 12 marks. There could be a maximum of two sub divisions in a question.

21. Course content - Number of modules: Five

MODULE I	INTRODUCTION TO DATA STRUCTURES, SEARCHING AND SORTING | Number of Lectures: 9
	Basic concepts: Introduction to data structures, classification of data structures, operations on data structures, Algorithm Specification, Recursive algorithms, Data Abstraction, Performance analysis- time complexity and space complexity, Introduction to Linear and Non Linear data structures **Searching techniques:** Linear and Binary search, Uniform Binary Search, Interpolation Search, Fibonacci Search; **Sorting techniques:** Bubble, Selection, Insertion, and Quick, Merge, Radix and Shell Sort and comparison of sorting algorithms.
MODULE II	LINEAR DATA STRUCTURES | Number of Lectures: 9
	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 |Number of Lectures: 9
	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 | Number of Lectures: 9
	Trees: Basic concept, binary tree, binary tree representation, array and linked representations, binary tree traversal, binary tree variants, threaded binary trees, 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 | Number of Lectures: 9
	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:** ntroduction, hash tables, hash functions, collisions, applications of hashing.

TEXTBOOKS

1. Narasimha Karumanchi, —Data Structures and Algorithms Made Easy in Java, CareerMonk, 5th Edition, 2020.

2. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser —Data Structures and Algorithms in Java, John Wiley & Sons, Inc., 6th Edition, 2014.

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.

Electronic Resources:

1. https://www.tutorialspoint.com/data_structures_algorithms/algorithms_basics.htm
2. https://www.codechef.com/certification/data-structures-and-algorithms/prepare
3. https://www.cs.auckland.ac.nz/software/AlgAnim/dsToC.html
4. https://online-learning.harvard.edu/course/data-structures-and-algorithms

22. COURSE PLAN:

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

S.No	Topics to be covered	CO's	Reference
Discussion on OBE			
1	Discussion on Outcome Based Education, CO, POs and PSOs		
Content Delivery (Theory)			
1	Introduction to data structures	CO 1	T1:1.3 R1:1.3 R2 : 1.4
2	Classification of data structures, Operations on data Structures	CO 1	R1:1.3
3	Recursive algorithm, Performance Analysis	CO 1	T1:1.6,2.1 R1:2.3
4	Searching techniques: Linear search, binary search	CO 2	T1:11 R1:4.8
5	Searching techniques: Uniform binary search and interpolation search	CO 2	T1:11 R1:4.9
6	Searching techniques: Fibonacci search	CO 2	T1:11 R1:4.9
7	Sorting techniques: Bubble sort, selection sort	CO 2	T1:10.5,10.6 R1:4.7
8	Sorting techniques: Insertion sort, Quick sort	CO 2	T1:10.7,10.11
9	Sorting techniques: Merge sort and Radix sort, Shell sort and comparison of sorting algorithms	CO 2	T1:10.9,10.17, 10.8
10	Stacks ADT, definition and operations, implementation of stacks using Arrays	CO 3, CO 6	T1:4.3,4.6 R1:6.1
11	Applications of stacks, arithmetic expression conversion and evaluation	CO 4, CO 6	T1:4.5 R1:6.7
12	Queues: Primitive operations; Implementation of queues using Array	CO 3	T1:5 R1:6.11
13	Applications of linear queue, circular queue	CO 4	T1:5.5 R1:6.12
14	Double ended queue (deque)	CO 3	T1:5.5 R1:6.15
15	Linked lists: Introduction, singly linked list, representation of a linked list in memory	CO 3	T1:3 R1:5.1

S.No	Topics to be covered	CO's	Reference
16	Operations on a single linked list, Applications of linked lists - Polyomial representation	CO 3	T1:3.12 R1:5.7
17	Sparse matrix manipulation	CO 4, CO 6	T1:3.12 R1:4.17
18	Types of linked lists:Circular linked lists	CO 3	T1:3.8 R1:5.10
19	double linked lists	CO 3	T1:3.9 R1:5.11
20	Linked list representation and operations of Stack	CO 3	R1:6.4
21	Linked list representation and operations of queue	CO 3	R1:6.12
22	Trees: Basic concept, Binary Tree	CO 3	T1:6.3 R1:7.1
23	Binary tree representation using array	CO 3	T1:6.3 R1:7.3
24	Binary tree representation using linked list	CO 3	T1:6.3 R1:7.5
25	Binary tree traversal	CO 3	T1:6.4 R1:7.4
26	Binary tree variants	CO 3	T2:13.2 R1:7.4
27	Threaded binary tree	CO 3	T1:6.6 R1:7.7
28	Application of trees	CO 4	R1:7.24
29	Graphs: Basic concept, graph terminology	CO 3	T1:9.1 R1 : 8.1
30	Graph representation- Adjacency matrix, adjacency list	CO 3	T1:9.4 R1:8.5
31	Graph implementation	CO 3	R1 : 8.5
32	Graph traversals BFS	CO 3, CO 4, CO 6	T1:9.5 R1:8.7
33	Graph traversals :DFS	CO 3, CO 4, CO 6	T1:9.5 R1:8.7
34	Application of graphs	CO 3, CO 4, CO 6	T1:9.7
35	Minimum Spanning Trees-Prims and Kruskal algorithms	CO 3, CO 4, CO 6	T1:6.1 T1:9.8 R1:8.9
36	Binary search trees, properties and operations	CO 3	T1:6.9 R1:7.8
37	AVL trees	CO 3	T1:6.11 R1:7.12
38	M- Way search trees	CO 3, CO 4, CO 6	T1:6.12 R1:7.15,7.17

S.No	Topics to be covered	CO's	Reference
39	B trees	CO 3	T1:6.12 R1:7.17
40	Hashing, Collision	CO 5	T1:14.1,14.9 R1:9.10
Problem Solving/Case Studies			
1	Problems on linear search, binary search and Fibonacci search.	CO 2	T1:11 R1:4.8
2	Problems on bubble sort, selection and insertion sort	CO 2	10.5,10.6 R1:4.7
3	Problems on quick and merge sort	CO 2	T1:10.7,10.11
4	Problems on Arithmetic expression conversion and evaluation	CO 4 CO 4	T1:4.5 R1:6.7
5	Problems on single linked list to add, delete element	CO 3, CO 4	T1:3 R1:5.1
6	Problems on double linked list to add, delete element	CO 3, CO 4	T1:3.9 R1:5.11
7	Problems on circular linked list to add, delete element	CO 3, CO 4	T1:3.9 R1:5.11
8	Problems on double ended queues to add, delete element	CO 3, CO 4	T1:5.5 R1:6.15
9	Problems on stack using linked list	CO 3, CO 4	T1:4.5 R1:6.7
10	Problems on queue using linked list	CO 3, CO 4	T1:5.5 R1:6.12
11	Problems on Binary tree: creation ,insertion and deletion of a node	CO 3	T1:6.4 R1:7.4
12	Problems on Graph Traversal: DFS and BFS	CO 3, CO 4	T1:9.5 R1:8.7
13	Problems on MST: Prim's and Kruskal's	CO 3, CO 4	T1:9.8 R1:8.9
14	Problems on Binary search tree	CO 4	T1:6.9 R1:7.8
15	Problems oh hashing	CO 5	T1:14.1,14.9 R1:9.10
Discussion of Definition and Terminology			
1	Data Structures, Searching and Sorting	CO 1,CO2,CO 3	T1:1.3 R1:1.3 R1:14
2	Linear Data Structures - Stack, Queue	CO 3	T1:4.3,4.6 R1:6.1
3	Linked Lists - Single Linked List, Double Linked List, Circular Linked Lists	CO 3	T1:3 R1:5.1
4	Non Linear data Structures - Trees, Graphs	CO 3	T1:6.3 R1:7.1

S.No	Topics to be covered	CO's	Reference
5	Binary Trees, Binary Search Tree, Hashing and Collision	CO 3 CO 5	T1:14.1,14.9 R1:9.10
Discussion of Tutorial Question Bank			
1	Introduction to Data Structures, Searching and Sorting	CO 1, CO2,CO6	T1:1 R1:14
2	Linear Data Structures	CO 3,CO 4,CO 6	T1:4.3,4.6 R1:6.1
3	Linked Lists	CO 3,CO 4,CO 6	T1:4.3,4.6 R1:6.1
4	Non Linear Data Structures	CO 3,CO 4,CO 6	T1:6.3 R1:7.1
5	Binary Trees and Hashing	CO 3,CO 5,CO 6	T1:14.1,14.9 R1:9.10

23. PROGRAM OUTCOMES & PROGRAM SPECIFIC 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
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.

24. 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/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	1	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.	1	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/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/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/Open ended Experiments

25. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		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	CIE/ SEE/ Tech Talk/ Open ended experiments

3 = High; 2 = Medium; 1 = Low

26. 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	✓	✓	✓	✓	✓	-	-	-	-	✓	-	✓	-	-	✓

27. 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
CO1	PO 1	**Understand** (knowledge) the concept of algorithm analysisvand types of notations used to represent time and space complexities (understand) by applying principles of **mathematics** 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
	PSO3	**Understand** the different computer tools for finding space and time complexities of a complex progarms	3
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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	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
	PSO3	**Develop** various searching and sorting techniques to extend the knowledge for advance computer tools and platforms which are necessary for engineering practices and employment.	3
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
	PSO3	**Describe** various linear or nonlinear data structures to extend the knowledge of computer tools and platforms which are necessary for engineering practices and employment	3
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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	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
	PSO3	**Make use of** various linear or nonlinear data structures to solve real time applications	4
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
	PSO3	**Demonstrate** the knowledge on hashing techniques and collision resolution methods so that new product can be developed which improves employability skills.	4
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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	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 3	**Develop** various types of data structures so that new product can be developed, which leads to become successful entrepreneur in the present market.	3

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

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

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	33.3	40	20	-	-	-	-	-	-	40	-	-	-	-	43
CO 2	33.3	50	20	-	100	-	-	-	-	40	-	-	-	-	43
CO 3	66.6	70	50	36.3	100	-	-	-	-	40	-	-	-	-	43
CO 4	100	70	20	36.3	100	-	-	-	-	40	-	-	-	-	57
CO 5	33.3	-	20	-	100	-	-	-	-	40	-	-	-	-	57
CO 6	100	70	50	36.3	100	-	-	-	-	40	-	25	-	-	43

30. 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		
	PO 1	PO 2	PO 3	PO 4	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
CO 2	1	2	1	-	3	-	-	-	-	1	-	-	-	-	2
CO 3	3	3	2	1	3	-	-	-	-	1	-	-	-	-	2
CO 4	3	3	1	1	3	-	-	-	-	1	-	-	-	-	2
CO 5	1	-	1	-	3	-	-	-	-	1	-	-	-	-	2
CO 6	3	3	2	1	3	-	-	-	-	1	-	1	-	-	2
TOTAL	12	12	8	3	15	-	-	-	-	6	-	1	-	-	12
AVERAGE	2.0	2.4	1.3	1.0	3.0	-	-	-	-	1	-	1	-	-	2.0

31. ASSESSMENT METHODOLOGY DIRECT:

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

32. ASSESSMENT METHODOLOGY INDIRECT:

-	Assessment of mini Projects by Experts	✓	End Semester OBE Feedback

33. Relevance to Sustainability goals

Write brief description about the course and how its relevance to SDGs.

1		

2	ZERO HUNGER	
3	GOOD HEALTH AND WELL-BEING	
4	QUALITY EDUCATION	Quality education: Guarantee an education system that is both inclusive and fair, offering high-quality learning experiences and lifelong opportunities accessible to all.
5	GENDER EQUALITY	
6	CLEAN WATER AND SANITATION	
7	AFFORDABLE AND CLEAN ENERGY	
8	DECENT WORK AND ECONOMIC GROWTH	

9	INDUSTRY, INNOVATION AND INFRASTRUCTURE	Industry, innovation, and infrastructure: Strong problem solving skills with appropriate data structures enable to design and development of services like microservice architecture, cloud computing, machine learning, and AI integration in a modular and maintainable way, contributing to a more flexible and scalable infrastructure.
10	REDUCED INEQUALITIES	
11	SUSTAINABLE CITIES AND COMMUNITIES	Sustainable cities and communities: Programming skills with appropriate use of data structures can develop software solutions that contribute to urban sustainability, improve quality of life, and address challenges like smart city solutions, energy efficiency and monitoring, waste management systems, public transportation optimization, environmental sensor networks, education, and awareness faced by modern cities.
12	RESPONSIBLE CONSUMPTION AND PRODUCTION	
13	CLIMATE ACTION	
14	LIFE BELOW WATER	

15		
16		
17		

Approved by: Board of Studies in the meeting conducted on 22-08-2023.

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

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

<table>
<tr><td>1</td><td>Department</td><td colspan="5">ELECTRICAL AND ELECTRONICS ENGINEERING</td></tr>
<tr><td>2</td><td>Course Title</td><td colspan="5">ANALOG CIRCUITS</td></tr>
<tr><td>3</td><td>Course Code</td><td colspan="5">AECD05</td></tr>
<tr><td>4</td><td>Program</td><td colspan="5">B.Tech</td></tr>
<tr><td>5</td><td>Semester</td><td colspan="5">III Semester</td></tr>
<tr><td>6</td><td>Regulation</td><td colspan="5">BT-23</td></tr>
<tr><td rowspan="3">7</td><td rowspan="3">Structure of the course</td><td colspan="3">Theory</td><td colspan="2">Practical</td></tr>
<tr><td>Lecture</td><td>Tutorials</td><td>Credits</td><td>Lab</td><td>Credits</td></tr>
<tr><td>3</td><td>0</td><td>3</td><td>0</td><td>0</td></tr>
<tr><td rowspan="2">8</td><td rowspan="2">Type of course
(Tick type of course)</td><td>Core</td><td>Professional Elective</td><td>Open Elective</td><td>VAC</td><td>MOOCs</td></tr>
<tr><td>✓</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>9</td><td>Course Offered</td><td colspan="2">Odd Semester ✓</td><td colspan="3">Even Semester ×</td></tr>
<tr><td rowspan="2">10</td><td colspan="6">Total lecture, tutorial and practical hours for this course
(16 weeks of teaching per semester)</td></tr>
<tr><td colspan="2">Lectures: .... hours</td><td colspan="2">Tutorials: .... hours</td><td colspan="2">Practical: .... hours</td></tr>
<tr><td>11</td><td>Course Coordinator</td><td colspan="5">V.Bindusree</td></tr>
<tr><td>12</td><td>Date Approved by BOS</td><td colspan="5">23 /08/2023</td></tr>
<tr><td>13</td><td>Course Webpage</td><td colspan="5">www.iare.ac.in/—-/—-</td></tr>
<tr><td rowspan="2">14</td><td rowspan="2">Course Prerequistes</td><td>Level</td><td>Course Code</td><td>Semester</td><td colspan="2">Prerequisites</td></tr>
<tr><td>B.Tech</td><td>AHS00</td><td>I</td><td colspan="2">Engineering Physics</td></tr>
</table>

15. 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 wave shaping. It focuses on applications in the area of power electronics, digital electronics and VLSI design.

16. COURSE OBJECTIVES:

The students will try to learn:

I	The operational principles, characteristics of semiconductor devices and circuits for rectification, amplification, conditioning and voltage regularization of signals.
II	The operational principles of analog electronic circuits such as feedback amplifiers and operational amplifiers
III	The generation of non-linear oscillations by using regenerative feedback circuit for multivibrators.
IV	The basic building blocks, characteristics and applications of operational amplifier.

17. COURSE OUTCOMES:

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

CO 1	**Extend** the biasing techniques for bipolar and uni-polar transistor amplifier circuits considering stability condition for establishing a proper operating point.	Understand
CO 2	**Apply** the pn junction characteristics for the diode applications such as switch, rectifiers, Clippers and Clampers.	Apply
CO 3	**Summarize** the concept of feedback in amplifiers for the distinction between negative and positive feedback. .	Understand
CO 4	**Obtain** the expression to find frequency of oscillations for RC and LC type oscillator circuits.	Understand
CO 5	**Describe** the principles and characteristics of op-amp circuits to perform arithmetic operations	Understand
CO 6	**Build** bistable, monostable and astable multivibrator circuits using transistors for real time applications.	Apply

18. Topic Learning Outcome (TLOs):

S.No	**Topic(s)**	**TLO No**	**Topic Learning Outcome's**	**Course Out-come**	Blooms Level
1	P-N junction diode,	1	**Interpret** fundamental concepts of P-type and N-type material within the classroom	CO 1	Understand
		2	**Aware** drift and diffusion materials with in the class room	CO 1	Understand
2	Bipolar Junction Transistor	3	**Identify** the input and output characteristics of BJT construction	CO 1	Understand

S.No	Topic(s)	TLO No	Topic Learning Outcome's	Course Out-come	Blooms Level
		4	**Examine** Input output characteristics Common Base, Common Emitter, Common Collector configurations within the class room	CO 1	Understand
3	Field Effect Transistor	5	**Understand** the transfer characteristics of FET within the classroom	CO 1	Understand
		6	**Examine** the input and transfer characteristics of MOSFET within the class room	CO 1	Understand
4	Rectifiers	7	**Demonstrate** Half wave rectifier within the classroom.	CO 1	Understand
		8	**Demonstrate** Full wave rectifier within the classroom	CO 2	Understand
5	Linear and Nonlinear wave shaping circuits	9	**Examine** the clippers and clampers circuits and be able to calculate graphs	CO 2	Understand
		10	**Understand** Concept of BJT load line analysis	CO 2	Understand
6	Amplifiers	12	**Understand** the common emitter amplifier within the classroom	CO 2	Understand
		13	**Understand** the common base and common collector amplifier within the classroom	CO 2	Understand
7	Small signal equivalent circuit	14	**Understand** input and output impedance's of small signal model of FET within the classroom and outside world	CO 2	Understand
		15	**Examine** the common gate,source and common drain amplifier within the classroom	CO 2	Understand
8	Feedback Amplifier	16	**Understand** the feedback amplifier and classifications of feedback amplifier within the classroom and outside world	CO 3	Understand
		17	**Examine** the characteristics of feedback amplifier within the classroom	CO 3	Understand
		18	**Understand** to solve different types of circuitswithin the classroom	CO 3	Understand
9	Oscillators	19	**Understand** the Fundamental Principle and characteristics of oscillators	CO 3	Understand
		20	**Understand** the different types of oscillators for regenerative feedback	CO 4	Understand

S.No	Topic(s)	TLO No	Topic Learning Outcome's	Course Out-come	Blooms Level
10	Operational Amplifiers	21	**Understand** the concepts of operational amplifier within the classroom	CO 5	Understand
		22	**Understand** the characteristics of dual input balanced and unbalanced output configuration	CO 5	Understand
		23	**Understand** the characteristics and specifications of operational amplifier	CO 5	Understand
		24	**Understand** the integrator and differentiaor of High pass and Low pass RC circuits	CO 6	Understand
		25	**Understand** the different types of multi-vibrator of the circuit	CO 6	Understand

19. Employability Skills

Example: Communication skills / Programming skills / Project based skills /
From maintaining power infrastructure to developing navigation and communications systems, electrical engineers play crucial roles across nearly every industry. With advanced electrical engineering skills, experts can lead the design, testing and manufacturing of the equipment that keep the world running.

20. Content Delivery / Instructional Methologies:

✓	Power Point Pressentation	✓	Chalk & Talk	✓	Assignments	x	MOOC
x	Open Ended Experiments	x	Seminars	x	Mini Project	✓	23.png Videos

21. Evaluation Methodology:

The course will be evaluated for a total of 100 marks, with 40 marks for Continuous Internal Assessment (CIA) and 60 marks for Semester End Examination (SEE). CIA is conducted for a total of 40 marks, with 20 marks for Continuous Internal Examination (CIE), and and 05 marks for each Definitions and Terminology / Quiz and remaining 10 marks for Tech Talk / Assignments.

Table 4: Outline for Continuous Internal Assessments (CIA - I and CIA - II) and SEE

Activities	**CIA - I**	**CIA - II**	**SEE**	**Total Marks**
Continuous Internal Examination (CIE)	10 Marks	10 Marks		20 Marks
Definitions and Terminology / Quiz	05 Marks	05 Marks		10 Marks
Tech Talk / Assignment	05 Marks	05 Marks		10 Marks
Semester End Examination (SEE)	-	-	60 Marks	60 Marks
Total	-	-	**100 Marks**	

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 12 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

22. Course content - Number of modules: Five:

MODULE I	**SEMICONDUCTOR DEVICES** . | **Number of Lectures: 10**
	P-N junction diode, V-I characteristics of a diode, BJT construction, Input output characteristics Common Base, Common Emitter, Common Collector configurations, FET, MOSFET construction, drain and transfer characteristics.
MODULE II	**SEMICONDUCTOR DEVICE APPLICATIONS.** . | **Number of Lectures: 9**
	P-N diode applications:half-wave and full-wave rectifiers, clippers and clampers, BJT Load line analysis, common emitter, common base and common collector amplifiers; Small signal equivalent circuits. small signal model of FET, gain, input and output impedances, common-source, common-gate and common-drain amplifiers.
MODULE III	**FEEDBACK AMPLIFIERS AND OSCILLATORS** . | Number of Lectures: 10
	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 IV	**OPERATIONAL AMPLIFIERS** . | Number of Lectures: 10
	Operational Amplifier: Differential Amplifier, DC and AC analysis of dual input balanced output configuration, dual input unbalanced output. Characteristics of Op-amps, Op-amp block diagram, ideal and practical Op-amp specifications. DC characteristics: Input, output offset voltages and currents, drift. AC characteristics: Frequency response, slew rate, CMRR

MODULE V	**OPERATIONAL AMPLIFIER APPLICATIONS** . | Number of Lectures: 09
	Linear applications of Op-amps: Inverting and non-inverting amplifier, integrator, differentiator, instrumentation amplifier. Non-linear applications of Op-Amps: Comparators, monostable and astable multi vibrators, triangular, saw tooth, square wave generators, log and anti-log amplifiers.

TEXTBOOKS

1. Jacob Millman, Christos C Halkias,, " *"Integrated Electronics"*, McGraw Hill Education, 2 nd Edition 2010.
2. Ramakanth A, Gayakwad, " *"Op-Amps "*, PHI, 2003.

REFERENCE BOOKS:

1. Thomas L. Floyd, "Electronic Devices Conventional and Current Version", Pearson, 2013.
2. J. Millman and A. Grabel, "Microelectronics", McGraw Hill Education, 1988.
3. David A Bell "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

MATERIALS ONLINE:

1. electronic Resources: https://www.igniteengineers.com
2. https://www.ocw.nthu.edu.tw
3. https://www.uotechnology.edu.iq
4. https://www.iare.ac.in

23. 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 Analog Circuits.	CO 1	T1: 2.1
2	P-N junction diode	CO 1	T1:2.4
3	CV-I characteristics of a diode	CO 1	T1:2.4
4	BJT construction	CO 1	T1:2.5
5	Input output characteristics Common Base cofiguration	CO 1	T1: 2.1

S.No	Topics to be covered	CO's	Reference
6	Input output characteristics Common Emitter configuration	CO 1	T1:2.4
7	Input output characteristics Common collector configuration	CO 1	T1:2.4
8	Introduction to FET construction	CO 2	T1:1.5- 1.6
9	Introduction to MOSFET construction	CO 2	T1:1.8- 1.12
10	construction of drain and transfer characteristics.	CO 1	T1: 2.1
11	Introduction to P-N diode applications,	CO 2	T1:1.13- 1.18
12	Half-wave Rectifier	CO 2	T1:1.1- 1.18
13	full-wave rectifiers	CO 2	T1:5.1- 5.2
14	postivie and negative clippers	CO 2	T1:5.3
15	positive and negative clamper,	CO 2	T1:5.7
16	BJT Load line analysis	CO 2	T1:5.4- 5.6
17	common collector Amplifier	CO 2	T1:6.5- 6.11
18	Common base Amplifier	CO 2	T1:7.1-7.4
19	Small signal equivalent circuits.	CO 2	T1:5.3
20	small signal model of FET	CO 2	T1:5.7
21	small signal model of FET charcateristics of gain	CO 2	T1:5.1- 5.2
22	and common-drain amplifiers.	CO 2	T1:5.3
23	Concepts of feedback Amplifier	CO 3	T1:5.7
24	Classification of feedback amplifiers	CO 3	T1:5.4- 5.6
25	General characteristics of negative feedback amplifiers,	CO 3	T1:6.5- 6.11
26	Effect of feedback on amplifier characteristics	CO 3	T1:7.1-7.4
27	voltage series, voltage shunt	CO 3	T1:8.4- 8.6
28	current series, current shunt feedback configurations	CO 3	T1: 8.12-8.15
29		CO 3	T1:8.4- 8.6
30	Introduction to Oscillators	CO 3	T1: 8.12-8.15
31	Condition for Oscillations	CO 3	T1:8.4- 8.6
32	RC type Oscillators	CO 3	T1: 8.12-8.15
33	RC phase shift oscillators	CO 3	T1:8.4- 8.6
34	Wien-bridge Oscillators	CO 3	T1: 8.12-8.15
35	LC type Oscillators	CO 3	T1:8.4- 8.6
36	Hartley and Colpitts oscillators	CO 3	T1: 8.12-8.15
37	Introduction to Operational Amplifier	CO 4	T1:8.4- 8.6
38	Differential Amplifier	CO 4	T1: 8.12-8.15
39	Dual input unbalanced output	CO 4	T1:8.4- 8.6
40	Characteristics of Op-amps, Op-amp block diagram,	CO 4	T1:8.12-8.15

S.No	Topics to be covered	CO's	Reference
41	Ideal and practical Op-amp specifications.	CO 4	T1: 8.12-8.15
PROBLEM SOLVING/ CASE STUDIES			
1	Input output characteristics Common Base Common Emitter	CO 1	T1:10.8
2	Input output characteristics Common Base, Common Emitter,	CO 1	T1:10.9- 10
3	small signal model of FET, gain, input and output impedances,	CO 2	T4:10.10
4	Half-wave and full-wave rectifiers	CO 2	T1:8.2
5	voltage series, voltage shunt,	CO 3	T1:1.1
6	current series and current shunt feedback configurations, simple problems.	CO 3	T1:1.5- 1.6
7	Hartley and Colpitts oscillators	CO 3	T1:1.8- 1.12
8	Input, output offset voltages and currents	CO 4	T1:1.13- 1.18
9	slew rate, CMRR.	CO 5	T1:1.19.1- 1.19.2
10	mmonostable and astable multi vibrators,	CO 5	T1:1.19.1- 1.19.2
11	triangular, saw tooth, square wave generators	CO 6	T1:1.193
12	Dual input unbalanced output	CO 4	T1:8.4- 8.6
13	Non-linear applications of Op-Amps:	CO 6	T1:8.12-8.15
45	Comparators	CO 5	T1:8.12-8.15
46	monostable and astable multi vibrators	CO 6	T1: 8.12-8.15
14	triangular, saw tooth, square wave generators, .	CO 6	T1:8.4- 8.6
15	log and anti-log amplifiers	CO 6	T1:8.12-8.15
DISCUSSION OF DEFINITION AND TERMINOLOGY			
1	Introduction To Analog Circuits	CO 1, CO2	R4:2.1
2	Analysis Of FET,MOSFET Circuits	CO3	T4:7.3
3	Feedback Amplifiers	CO 4	R4:5.1
4	Oscillators	CO 5	T1:7.5
5	Operational Amplifier	CO 6	T1: 4.1
DISCUSSION OF TUTORIAL QUESTION BANK			
1	Introduction To Analog Circuits	CO 1, CO2	R4:2.1
2	Analysis Of BJT,FET,MOSFET Circuits	CO3	T4:7.3
3	Feedback Amplifiers	CO 4	R4:5.1
4	Oscillators	CO 5	T1:7.5
5	Operational Amplifiers and Applications	CO 6	T1: 4.1

24. PROGRAM OUTCOMES & PROGRAM SPECIFIC 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
Program Specific Outcomes	
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.

Program Outcomes	
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.

25. HOW PROGRAM OUTCOMES ARE ASSESSED:

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

26. 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	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

27. 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	✓	✓	-	-	-	-	-	-	-	✓	-	-	-	-	-

28. 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 **mathematical principles** for design the biasing techniques for BJT, JFET and MOSFETs amplifier circuits for stable operation by applying the **methodology**	2
	PO 2	Understand the **problem statement** of biasing techniques for BJT, JFET and MOSFETs amplifier and **formulation** of proper operating point for **validating** the amplifiers and **interpret** the results.	4
	PO 3	Define a **problem and identify constraints** of amplifier circuits to satisfy the **user needs** to develop the **sustainable** development in amplifiers.	3
	PO 10	**Communicate orally** on biasing methids for BJT and FETS and **write** effective reports on stability factors with biasing approaches for transistors	2
	PSO 1	Formulate the amplifier circuits using BJT and FET for **developing real time** problems and **digital circuits**	2
CO 2	PO 1	Apply the pn junction characteristics for the diode applications of diode as switch, clippers, Clampers and rectifiers by analyzing complex engineering problems using the principles of **mathematics, scintific principles and methodology**	2
	PO 2	Understand the given the diode application **problem statement** and finding the **implementation** of rectifier,clipper and clamper circuits by using diode	2
	PO 3	Undertsnad the **user needs**, then define a problem and identify the constraints then **manage the design process** using diode as rectifiers for **awareness of the framework of relevant engineering activities, safety issues**	4

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 10	**Communicate orally** on appliactions of semiconductor diode and **write** effective reports on electronic circuits using diode	2
	PSO 1	Formulate and Evaluate the rectifier circuit applications in the field of **Intelligent Embedded** and **robotics**	2
CO 3	PO 1	**Describe** various types of feedback amplifiers like voltage series, voltage shunt, current series and current shunt by applying **knowledge of mathematics and engineering fundamentals** to the solution of complex engineering problems.	2
	PO 2	**Understand** the given **problem statement** and **formulate** the complex engineering problems of feedback amplifiers from the provided **information**, **develop solutions** based on the functionality of the circuit, **validate** the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	6
CO 4	PO 1	**Obtain** the expression to find frequency of oscillations for different oscillator circuits by applying **knowledge of mathematics and engineering fundamentals** to the solution of complex engineering problems.	2
	PO 2	**Understand the problem statement** of RC oscillators and **formulate** the complex engineering problems of RC oscillators from the provided **information, develop solutions** based on the functionality of the circuit, **validate** the output of the circuit in reaching substantiated conclusions by the **interpretation of results**.	6
	PO 3	Design solutions for complex engineering problems and design system components of oscillators that **meet the specified customer and user needs** with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	1
	PSO 1	Focus on the **Application Specific Integrated Circuit (ASIC) prototype designs** using analog and pulse circuits in the field of analog electronics.	1
CO 5	PO 1	**Recall** the basic function of transistor and to an extent appreciate the importance of differential amplifier and the characteristics by **applying the own Engineering discipline, Science principles and methodology.**	2

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 2	**Understand** the given **problem statement and formulate** the of improving DC, AC characteristics of an operational, **translate the information** into the model from the provided **information and data, develop solutions** as compensation techniques, **validate** the arithmetic operations by the **interpretation of results**.	7
	PSO 1	Design the differential amplifier circuit in different forms to **Communicate effectively on complex engineering activities** with engineering community	1
CO 6	PO 1	**Recall** Discuss the drawback of using discrete components for design of circuit and appreciate the importance of Op-Amp IC ,its characteristics ,application of open loop Op-Amp by **applying the own Engineering discipline , Science principles** and **methodology**	3
	PO 2	Understand the given **problem statement** and **formulate** the of improving DC, AC characteristics of an operational, **translate the information** into the model from the provided **information and data, develop solutions** as compensation techniques, **validate** the frequency response, stability of the circuit by the **interpretation of results**	7
	PO 10	Realize the DC and AC characteristic circuits of operational amplifier to **Communicate effectively on complex engineering activities with engineering community**	1

29. 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	3	-	-	-	-	-	-	2	-	-	2	-	-
CO 2	2	2	4	-	-	-	-	-	-	2	-	-	2	-	-
CO 3	2	6	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	6	1	-	-	-	-	-	-	-	-	-	1	-	-
CO 5	2	7	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 6	3	7	-	-	-	-	-	-	-	1	-	-	-	-	-

30. 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	30	-	-	-	-	-	-	40	-	-	40	-	-
CO 2	66.6	20	40	-	-	-	-	-	-	40	-	-	40		-
CO 3	66.6	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	66.6	60	10	-	-	-	-	-	-	-	-	-	20	-	-
CO 5	66.6	70	-	-	-	-	-	-	-	-	-	-	20	-	-
CO 6	100	70	-	-	-	-	-	-	-	20	-	-	-	-	-

31. 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		
	PO 1	PO 2	PO 3	PO 4	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	-	-	-	-	-	-	2	-	-	2	-	-
CO 2	3	1	2	-	-	-	-	-	-	2	-	-	2	-	-
CO 3	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	3	1	-	-	-	-	-	-	-	-	-	1	-	-
CO 5	3	3	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 6	3	3	-	-	-	-	-	-	-	1	-	-	-	-	-
TOTAL	18	15	4	-	-		-	-	-	5	-	-	4	-	-
AVERAGE	3	2.5	1.3	-	-		-	-	-	1.6	-	-	1.3	-	-

32. ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Seminars	-
Term Paper	-	5 Minutes Video	✓	Open Ended Experiments	-
Assignments	✓	Quiz	✓		

33. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

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

31. Relevance to Sustainability goals

Write brief description about the course and how its relevance to SDGs.

1		
2		
3		
4		**Quality Education:** This subject will improve the quality education in engineers and gives the awareness in electrical usage in day-to-day life.
5		
6		
7		**Affordable and Clean Energy:** Understanding electrical circuits is crucial for developing sustainable energy solutions. Students who learn to design and optimize circuits can contribute to the development of efficient and clean energy systems, such as renewable energy sources and smart grids.

8	DECENT WORK AND ECONOMIC GROWTH	
9	INDUSTRY, INNOVATION AND INFRASTRUCTURE	**Industry, Innovation, and Infrastructure: :** Engineering drawing principles is crucial for developing and maintaining sustainable infrastructure and technological innovations. It contribute to designing safer, more durable, and environmentally friendly infrastructure projects.Electrical circuits are the foundation of modern technology and infrastructure. The skills gained in this course are essential for creating and maintaining advanced infrastructure, including telecommunications, transportation, and manufacturing systems.
10	REDUCED INEQUALITIES	
11	SUSTAINABLE CITIES AND COMMUNITIES	
12	RESPONSIBLE CONSUMPTION AND PRODUCTION	**Responsible Consumption and Production** This subject impacts the demand of electricity and need for saving energy
13	CLIMATE ACTION	
14	LIFE BELOW WATER	
15	LIFE ON LAND	

16		
17		

Approved by: Board of Studies in the meeting conducted on ——————————.

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

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRICAL AND ELECTRONICS ENGINEERING**			
2	Course Title	**ELECTRICAL NETWORKS AND SIMULATION**			
3	Course Code	AEED08			
4	Program	B.Tech			
5	Semester	III Semester			
6	Regulation	BT-23			
7	Structure of the course	Practical			
		Tutorial Hours		Practical Hours	
		1		2	
8	Course Offered	Odd Semester ✓		Even Semester ×	
9	Course Coordinator	Mr.P.Mallikarjun			
10	Date Approved by BOS	25/08/2023			
11	Course Webpage	www.iare.ac.in/—-/—-			
12	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**
		B.Tech	AEED02	II	-
		-	-	-	-

13. 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

14. 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.

15. 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.	Apply
CO 3	Analyze the virtual instrumentation (VI) using control loops, arrays, charts and graphs.	Analyze
CO 4	Determine various alternating quantities ofsingle phase and three phase signals generated in MATLAB/ LabVIEW.	Apply
CO 5	Understand the working of various sensors for measuring electrical and non-electrical quantities through digitalsimulation.	Understand .
CO 6	Understand the The performance of single phase and three phase circuits using Lab View.	Understand

16. EMPLOYABILITY SKILLS

1. **Problem-Solving and Critical Thinking:** Students learn to analyze complex problems, analyze solutions using Matlab code.

17. CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES

✓	Day to Day lab evaluation	✓	Demo Video	✓	Expected Viva Voce questions	✓	Open Ended Experiments
X	Competitions	X	hackathons	✓	Certifications	✓	Probing Further Questions

18. EVALUATION METHODOLOGY

Each laboratory will be evaluated for a total of 100 marks consisting of 40 marks for internal assessment and 60 marks for semester end lab examination. Out of 40 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance including viva voce, 10 marks for the final internal lab assessment and remaining 10 marks for The remaining 10 marks are for Laboratory Report/Project and Presentation, which consists of the Design (or) Software / Hardware Model Presentation (or) App Development (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 40 marks (Table 1), with 20 marks for continuous lab assessment during day-to-day performance including viva voce, 10 marks for final internal lab assessment and remaining 10 marks for Laboratory Report / Project and Presentation.

Table 3: CIA marks distribution

Component				
Type of Assessment	Day to Day performance and viva voce examination	Final internal lab assessment	Laboratory Report / Project and Presentation	Total Marks
CIA marks	20	10	10	40

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.

Table 4: Experiment based

Objective	Analysis	Design	Conclusion	Viva voce	Total
					20

Table 5: Programming based

Objective	Analysis	Program	Results	Viva voce	Total
4	4	6	4	2	20

Semester End Examination:
The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the other colleges which will be decided by the Head of the institution.
In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

1. 10 marks for write-up
2. 15 for experiment/program
3. 15 for evaluation of results
4. 10 marks for presentation on another experiment/program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course.

19. COURSE CONTENT

CO 1	**Identify the symbols, tool kits̕ and connections in Simulink environment for computing the quantities associated with electrical circuits.**
	1. Getting Started Exercises 2. Introduction to matlab
CO 2	**Examine the transfer function for studying transient response of RL, RC and RLC circuits.**
	1. Exercises on RL circuit 2. Exercises on RC circuit 3. Exercises on RLC circuit
CO 3	**Analyze the virtual instrumentation (VI) using control loops, arrays, charts and graphs..**
	1. Exercises on loops,arrays 2. Exercises on charts,graphs 3. More (Difficult) Exercises
CO 4	**Determine various alternating quantities ofsingle phase and three phase signals generated in MATLAB/ LabVIEW.**
	1. Exercises on single phase and three phase signals using matlab.
CO 5	**Understand the working of various sensors for measuring electrical and non-electrical quantities through digitalsimulation.**
	1. Exercises on different sensors for measuring electrical parameters.
CO 6	**Understand the The performance of single phase and three phase circuits using Lab View.**
	1. Exercises on singlephase and three phase using labVIEW.

Note: One Course Outcome may be mapped to multiple number of experiments.

Text Books

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.

Materials Online

1. https://www.tutorialspoint.com/networktheory
2. https://byjus.com/physics/network-analysis/

20. COURSE PLAN

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

S.No	Topics to be covered	CO's
1	Check the symbols, tool kits and connections related to electrical circuits in MATLAB.	CO 1
2	Plot the time varying characteristics of series circuits using MATLAB	CO 1
3	Obtain the solution of differential equation representing electric network using MATLAB.	CO 2
4	Determine the transfer function of electrical circuit using MATLAB.	CO 2
5	Plot the time varying characteristics of parallel circuits using MATLAB.	CO 2
6	Generate the three phase AC wave form for different phase differences and phase sequences using MATLAB.	CO 2
7	Determine the electrical quantities of three phase wave form using MATLAB.	CO 2
8	Editing and building a Virtual Instrumentation (VI), creating a sub VI.	CO 2
9	AC Signal generation and display of wave form, minimum and maximum values of waveform and modulation	CO 3
10	Measure the frequency of unknown signal using Lissajious pattern in LAB View.	CO 3
11	Using FOR loop, WHILE loop, charts and arrays, graph and analysis to analyze VIs.	CO 3
12	Plot the characteristics of low pass and high pass filters using MATLAB	CO 4
13	Design the electric and electronic circuit of sensor using labVIEW	CO 5
14	Measure the speed of the machine with proximity sensor in labVIEW	CO 6

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.

21. PROGRAM OUTCOMES & PROGRAM SPECIFIC 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
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.

22. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	LAB PROGRAMS/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.	1	LAB PROGRAMS/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 limitation.	1	LAB PROGRAMS/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 PROGRAMS/CIE/SEE

23. 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	LAB PROGRAMS/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.	1	LAB PROGRAMS/CIE/SEE

3 = High; 2 = Medium; 1 = Low

24. 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	✓	-	-	-	-	-	-	-	-	-	-	✓	✓	-	✓

25. 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 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.	1

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 2	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 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 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 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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	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 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
CO 6	PO 1	Design the electric and electronic circuit of sensor with the knowledge of mathematics and engineering fundamentals.	3
	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.	3
	PSO 3	Simulate the electrical system to by designing the electric and electronic circuit of sensor	1

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

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

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

27. 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	-	-	-	-	-	-	50	50	-	33.33
CO 2	100	-	-	-	50	-	-	-	-	-	-	50	50	-	33.33
CO 3	100	-	-	-	50	-	-	-	-	-	-	50	50	-	33.33
CO 4	100	50	-	-	50	-	-	-	-	-	-	50	50	-	33.33
CO 5	100	-	-	-	50	-	-	-	-	-	-	50	50	-	33.33
CO 6	100	-	-	-	-	-	-	-	-	-	-	50	50	-	33.33

28. 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≤ 40% – Low/ Slight

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

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

29. ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Laboratory Practices	✓
Certification	-	Student Viva	✓	Open Ended Experiments	-

30. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

31.RELEVANCE TO SUSTAINABILITY GOALS

Write brief description about the course and how its relevance to SDGs.

X		
X		
X		
✓		**Quality Education:** The students can gain a deeper understanding of how technology can be harnessed to address global challenges. This promotes quality education by fostering critical thinking and problem-solving skills in the context of sustainable development.
X		
X		

X	AFFORDABLE AND CLEAN ENERGY	
X	DECENT WORK AND ECONOMIC GROWTH	
✓	INDUSTRY, INNOVATION AND INFRASTRUCTURE	**Industry, Innovation, and Infrastructure:** Java programming skills are essential for developing innovative software solutions. Students working on projects related to sustainable development can contribute to building resilient infrastructure and promoting inclusive and sustainable industrialization.
X	REDUCED INEQUALITIES	
✓	SUSTAINABLE CITIES AND COMMUNITIES	**Sustainable Cities and Communities:** Java programming plays a crucial role in developing applications for smart cities, efficient transportation, and waste management systems. Through projects in the lab, students can explore ways to create more sustainable urban environments.
X	RESPONSIBLE CONSUMPTION AND PRODUCTION	
✓	CLIMATE ACTION	**Climate Action:** Students can create climate-related applications, such as carbon footprint calculators or climate data analysis tools, using Java programming. This directly contributes to SDG 13 by raising awareness and facilitating climate action.
X	LIFE BELOW WATER	

X	LIFE ON LAND	
X	PEACE, JUSTICE AND STRONG INSTITUTIONS	
✓	PARTNERSHIPS FOR THE GOALS	**Partnerships for the Goals:** Collaborative projects can foster partnerships among students, educators, and local communities. These partnerships enhance knowledge sharing and the development of innovative solutions that align with multiple SDGs.

Approved by: Board of Studies in the meeting conducted on ——————————.

Signature of Course Coordinator **HOD,CSE**
Mr. P.Mallikarjun, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

<table>
<tr><td>1</td><td>Department</td><td colspan="4">ELECTRICAL AND ELECTRONICS ENGINEERING</td></tr>
<tr><td>2</td><td>Course Title</td><td colspan="4">DC MACHINES LABORATORY</td></tr>
<tr><td>3</td><td>Course Code</td><td colspan="4">AEED09</td></tr>
<tr><td>4</td><td>Program</td><td colspan="4">B.Tech</td></tr>
<tr><td>5</td><td>Semester</td><td colspan="4">III Semester</td></tr>
<tr><td>6</td><td>Regulation</td><td colspan="4">BT-23</td></tr>
<tr><td rowspan="3">7</td><td rowspan="3">Structure of the course</td><td colspan="4">Practical</td></tr>
<tr><td colspan="3">Tutorial Hours</td><td>Practical Hours</td></tr>
<tr><td colspan="3">1</td><td>2</td></tr>
<tr><td>8</td><td>Course Offered</td><td colspan="2">Odd Semester ✓</td><td colspan="2">Even Semester ×</td></tr>
<tr><td>9</td><td>Course Coordinator</td><td colspan="4">Dr.G.Seshadri</td></tr>
<tr><td>10</td><td>Date Approved by BOS</td><td colspan="4">25/08/2023</td></tr>
<tr><td>11</td><td>Course Webpage</td><td colspan="4">www.iare.ac.in/—-/—-</td></tr>
<tr><td rowspan="3">12</td><td rowspan="3">Course Prerequistes</td><td>Level</td><td>Course Code</td><td>Semester</td><td>Prerequisites</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td></tr>
</table>

13. 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.

14. 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

15. 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 .
CO 6	Understand the The performance of single phase and three phase DC machines.	Understand

16. EMPLOYABILITY SKILLS

1. **Problem-Solving and Critical Thinking:** Students learn to analyze complex problems, analyze solutions for different types of solutions .

17. CONTENT DELIVERY / INSTRUCTIONAL METHODOLOGIES

✓	Day to Day lab evaluation	✓	Demo Video	✓	Expected Viva Voce questions	✓	Open Ended Experiments
X	Competitions	X	hackathons	✓	Certifications	✓	Probing Further Questions

18. EVALUATION METHODOLOGY

Each laboratory will be evaluated for a total of 100 marks consisting of 40 marks for internal assessment and 60 marks for semester end lab examination. Out of 40 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance including viva voce, 10 marks for the final internal lab assessment and remaining 10 marks for The remaining 10 marks are for Laboratory Report/Project and Presentation, which consists of the Design (or) Software / Hardware Model Presentation (or) App Development (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 40 marks (Table 1), with 20 marks for continuous lab assessment during day-to-day performance including viva voce, 10 marks for final internal lab assessment and remaining 10 marks for Laboratory Report / Project and Presentation.

Table 3: CIA marks distribution

Component				
Type of Assessment	Day to Day performance and viva voce examination	Final internal lab assessment	Laboratory Report / Project and Presentation	Total Marks
CIA marks	20	10	10	40

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.

Table 4: Experiment based

Objective	Analysis	Design	Conclusion	Viva voce	Total
					20

Table 5: Programming based

Objective	Analysis	Program	Results	Viva voce	Total
4	4	6	4	2	20

Semester End Examination:
The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the other colleges which will be decided by the Head of the institution.
In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

1. 10 marks for write-up
2. 15 for experiment/program
3. 15 for evaluation of results
4. 10 marks for presentation on another experiment/program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course.

19. COURSE CONTENT

CO 1	**Analyze the performance characteristics of dc machine under various loading conditions.**
	1. Analyze the performance characteristics of dc machine under various loading conditions.
CO 2	**Determine the critical field resistance and speed of dc shunt generator using open circuit characteristics..**
	1. Determine the critical field resistance and speed of dc shunt generator using open circuit characteristics.
CO 3	**Analyze the virtual instrumentation (VI) using control loops, arrays, charts and graphs..**
	1. Examine the performance of DC shunt machine with different speed control techniques and predetermine the efficiency.
CO 4	**Determine various alternating quantities ofsingle phase and three phase signals generated in MATLAB/ LabVIEW.**
	1. Estimate and separate the core losses in dc machine by conducting a suitable test.
CO 5	**Understand the working of various sensors for measuring electrical and non-electrical quantities through digitalsimulation.**
	1. Examine the performance and speed control of dc machines using simulation tools.
CO 6	**Understand the The performance of single phase and three phase transformers using Lab View.**
	1. Exercises on singlephase and three phase transformers using labVIEW.

Note: One Course Outcome may be mapped to multiple number of experiments.

Text Books

1. 1. J B Guptha "Theory and performance of Electrical machiines", S.K.Kataria and Sons Publishers 14th Edition, 2009
2. 2. M G Say, E O Taylor, "Direct Current Machines", Longman Higher Education, 1st Edition,1985

Reference Books

1. 1. P S Bimbhra, R.P., —Electrical Machinery, Khanna Publishers, New Delhi 2011
2. 2. I J Nagrath and D P Kothari., Electric Machines, McGraw Hill Education Co. Ltd., 2010.
3. 3. A E Fitzgerald and C Kingsley, ”Electric Machinery”, New York, McGraw Hill Education, 1st Edition, 2013.

Materials Online

1. https://www.tutorialspoint.com/dcmachin
2. https://byjus.com/physics/network-analysis/

20. COURSE PLAN

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

S.No	Topics to be covered	CO's
1	Magnetization characteristics of DC shunt generator	CO 1
2	Determination of efficiency by load test in DC shunt generator.	CO 1
3	Determination of efficiency by load test on DC series generator	CO 2
4	Determination of efficiency by load test on DC compound generator	CO 2
5	Study the performance characteristics of two identical DC shunts machines.	CO 2
6	Study the performance characteristics of two identical DC series machines.	CO 2
7	Predetermine the efficiency and study the characteristics of DC shunt machine with different speed control techniques.	CO 2
8	Study the performance characteristics of DC compound motor	CO 2
9	Study the performance characteristics of DC shunt motor by brake test.	CO 3
10	Study the performance characteristics by using retardation test on DC shunt motor.	CO 3
11	Study the method used for separation of losses in DC shunt motor.	CO 3
12	Study the magnetization characteristics of DC shunt generator using digital simulation	CO 4
13	Perform the load test on DC shunt generator using digital simulation	CO 5
14	Verify the speed control techniques of DC motor using digital simulation.	CO 6

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

21. PROGRAM OUTCOMES & PROGRAM SPECIFIC 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
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.

22. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	LAB PROGRAMS/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.	1	LAB PROGRAMS/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 PROGRAMS/CIE/SEE
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	2	LAB PROGRAMS/CIE/SEE
PO 5	**Modern Tool Usages:** 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 PROGRAMS/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 PROGRAMS/CIE/SEE
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice..	2	LAB PROGRAMS/CIE/SEE
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings..	2	LAB PROGRAMS/CIE/SEE
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	LAB PROGRAMS/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 PROGRAMS/CIE/SEE

23. 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	LAB PROGRAMS/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.	1	LAB PROGRAMS/CIE/SEE

3 = High; 2 = Medium; 1 = Low

24. 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	✓	-	-	-	-	-	-	-	-	-	-	✓	✓	-	✓

25. 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	3
	PO 2	Understand the working of electrical machines using mathematical model under loaded and unloaded conditons with problem statement by analyzing complex engineering problems.	1
	PO 3	Demonstrate the given power electronic components voltage current characteristics for design solutions of complex engineering problems	1
	PO 4	Understand the working of electrical machines using mathematical model under loaded and unloaded conditions with analysis and interpretation of data	1
	PO 6	Illustrate the working of electrical machines using mathematical model under loaded and unloaded conditions for safety issues in professional engineering practice	1
	PO 8	Understand the working of electrical machines using mathematical model under loaded and unloaded conditions with ethical principles, professional ethics and responsibilities	1
	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	1
	PO 10	Interpret working of electrical machines using mathematical model under loaded and unloaded conditions with communication of complex engineering practices	1
	PO 12	Understand the working of electrical machines using mathematical model under loaded and unloaded conditions in life long learning in technological change	3
	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	2

	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	1
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	3
	PO 2	Understand the load sharing capabilities and reliability of DC generators using parallel operation under various loading conditions withproblem statement by analyzing complex engineering problems.	1
	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	1
	PO 4	Understand the load sharing capabilities and reliability of DC generators using parallel operation under various loading conditions with analysis and interpretation of data	1
	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	1
	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	1
	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	1
	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	1
	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	3
	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	2

	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	1
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	3
	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.	3
	PO 3	Demonstrate magnetization characteristics of dc shunt generator for calculating the critical resistance and critical speed for design solutions of complex engineering problems	
	PO 4	Understand magnetization characteristics of dc shunt generator for calculating the critical resistance and critical speed with analysis and interpretation of data	3
	PO 5	Understand magnetization characteristics of dc shunt generator for calculating the critical resistance and critical speed modelling using IT tools such as MATLAB	3
	PO 6	Illustrate magnetization characteristics of dc shunt generator for calculating the critical resistance and critical speed for safety issues in professional engineering practice	3
	PO 8	Understand magnetization characteristics of dc shunt generator for calculating the critical resistance and critical speed with ethical principles, professional ethics and responsibilities	3
	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	3
	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	3
	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	2

	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	1
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	3
	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.	3
	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	3
	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	3
	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	3
	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	3
	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	3
	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	3
	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	3
	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	2

	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	1
CO 5	PO 1	Observe the core losses of DC shunt machines for dividing the set losses using principles of mathematics and engineering science	3
	PO 2	Understand the core losses of DC shunt machines for dividing the set losses with problem statement by analyzing complex engineering problems.	3
	PO 3	Demonstrate the core losses of DC shunt machines for dividing the set losses for design solutions of complex engineering problems	3
	PO 4	Understand the core losses of DC shunt machines for dividing the set losses with analysis and interpretation of data	2
	PO 6	Illustrate the core losses of DC shunt machines for dividing the set lossesfor safety issues in professional engineering practice	3
	PO 8	Understand the core losses of DC shunt machines for dividing the set losses with ethical principles, professional ethics and responsibilities	3
	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	3
	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	1
	PSO 1	Demonstrate the core losses of DC shunt machines for dividing the set losses in the electrical systems involved in power generation, transmission and distribution	2
	PSO 3	Illustrate the core losses of DC shunt machines for dividing the set losses in automation process using PLC and process controllers	1
CO 6	PO 1	Observe the core losses of Transformers for dividing the set losses using principles of mathematics and engineering science	3
	PO 12	Understand the core losses of Transformers for dividing the set losses in life long learning in technological change	1

	PSO 1	Demonstrate the core losses of Transformers for dividing the set losses in the electrical systems involved in power generation, transmission and distribution	2
	PSO 3	Illustrate the core losses of Transformersfo r dividing the set losses in automation process using PLC and process controllers	1

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

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

27. 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	-	-	-	-	-	-	50	50	-	33.33
CO 2	100	-	-	-	50	-	-	-	-	-	-	50	50	-	33.33
CO 3	100	-	-	-	50	-	-	-	-	-	-	50	50	-	33.33
CO 4	100	50	-	-	50	-	-	-	-	-	-	50	50	-	33.33
CO 5	100	-	-	-	50	-	-	-	-	-	-	50	50	-	33.33
CO 6	100	-	-	-	-	-	-	-	-	-	-	50	50	-	33.33

28. 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	3	3	3	3	-	2	-	3	2	2	-	2	2	-	1

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

29. ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Laboratory Practices	✓
Certification	-	Student Viva	✓	Open Ended Experiments	-

30. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

31.RELEVANCE TO SUSTAINABILITY GOALS

Write brief description about the course and how its relevance to SDGs.

X		
X		
X		

✓	QUALITY EDUCATION	**Quality Education:** The students can gain a deeper understanding of how technology can be harnessed to address global challenges. This promotes quality education by fostering critical thinking and problem-solving skills in the context of sustainable development.
X	GENDER EQUALITY	
X	CLEAN WATER AND SANITATION	
X	AFFORDABLE AND CLEAN ENERGY	
X	DECENT WORK AND ECONOMIC GROWTH	
✓	INDUSTRY, INNOVATION AND INFRASTRUCTURE	**Industry, Innovation, and Infrastructure:** Java programming skills are essential for developing innovative software solutions. Students working on projects related to sustainable development can contribute to building resilient infrastructure and promoting inclusive and sustainable industrialization.
X	REDUCED INEQUALITIES	
✓	SUSTAINABLE CITIES AND COMMUNITIES	**Sustainable Cities and Communities:** Java programming plays a crucial role in developing applications for smart cities, efficient transportation, and waste management systems. Through projects in the lab, students can explore ways to create more sustainable urban environments.

X		
✓		**Climate Action:** Students can create climate-related applications, such as carbon footprint calculators or climate data analysis tools, using Java programming. This directly contributes to SDG 13 by raising awareness and facilitating climate action.
X		
X		
X		
✓		**Partnerships for the Goals:** Collaborative projects can foster partnerships among students, educators, and local communities. These partnerships enhance knowledge sharing and the development of innovative solutions that align with multiple SDGs.

Approved by: Board of Studies in the meeting conducted on ——————————.

Signature of Course Coordinator **HOD,EEE**
Dr. G.Seshadri, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRICAL & ELECTRONICS ENGINEERING**			
2	Course Title	**DATA STRUCTURES LABORATORY**			
3	Course Code	ACSD08			
4	Program	B.Tech			
5	Semester	III Semester			
6	Regulation	BT-23			
7	Structure of the course	Practical			
		Tutorial Hours		Practical Hours	
		1		2	
8	Course Offered	Odd Semester ✓		Even Semester ×	
9	Course Coordinator	Mr. S. Srikanth			
10	Date Approved by BOS	25/08/2023			
11	Course Webpage	www.iare.ac.in/—-/—-			
12	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**
		UG	ACSD02	I	OPS with JAVA
		-	-	-	-

13. 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.

14. 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.

15. 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 finding effective solution of given problem.	Apply
CO 3	Construct programs to perform operations on linear data structures for memory organization of data.	Apply
CO 4	Make use of nonlinear data structures for solving real time applications.	Apply
CO 5	Demonstrate operations on Balanced Data Structures for efficient storage and retrieval of data.	Understand
CO 6	Choose suitable data structures based on implementation, operations and performance while solving real world problems.	Apply

16. Employability Skills

1. **Problem-Solving and Critical Thinking:** Students learn to analyze complex problems, design solutions using Java's object-oriented principles, and translate real-world scenarios into code.
2. **Debugging and Troubleshooting:** Debugging challenges in the lab help students master error identification, interpretation, and use of debugging tools, essential for real-world software development.

17. Content Delivery / Instructional Methologies:

✓	Day to Day lab evaluation	✓	Demo Video	✓	Expected Viva Voce questions	✓	Open Ended Experiments
X	Competitions	X	hackathons	✓	Certifications	✓	Probing Further Questions

18. Evaluation Methodology:

Each laboratory will be evaluated for a total of 100 marks consisting of 40 marks for internal assessment and 60 marks for semester end lab examination. Out of 40 marks of internal assessment, continuous lab assessment will be done for 20 marks for the day to day performance including viva voce, 10 marks for the final internal lab assessment and remaining 10 marks for The remaining 10 marks are for Laboratory Report/Project and Presentation, which consists of the Design (or) Software / Hardware Model Presentation (or) App Development (or) Prototype Presentation submission which shall be evaluated after completion of laboratory course and before semester end practical examination.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 40 marks (Table 1), with 20 marks for continuous lab assessment during day-to-day performance including viva voce, 10 marks for final internal lab assessment and remaining 10 marks for Laboratory Report / Project and Presentation.

Table 3: CIA marks distribution

Component				
Type of Assessment	Day to Day performance and viva voce examination	Final internal lab assessment	Laboratory Report / Project and Presentation	Total Marks
CIA marks	20	10	10	40

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.

Table 4: Experiment based

Objective	Analysis	Design	Conclusion	Viva voce	Total
					20

Table 5: Programming based

Objective	Analysis	Program	Results	Viva voce	Total
4	4	6	4	2	20

Semester End Examination:
The Semester End Examination shall be conducted with an external examiner and the laboratory teacher. The external examiner shall be appointed from the other colleges which will be decided by the Head of the institution.
In the Semester End Examination held for 3 hours, total 60 marks are divided and allocated as shown below:

1. 10 marks for write-up
2. 15 for experiment/program
3. 15 for evaluation of results
4. 10 marks for presentation on another experiment/program in the same laboratory course and
5. 10 marks for viva-voce on concerned laboratory course.

19 COURSE CONTENT

CO 1	**Interpret the complexity of algorithm using the asymptotic notations.**
	1. Getting Started Exercises
CO 2	**Select appropriate searching and sorting technique for finding effective solution of given problem.**
	1. Exercises on Searching 2. Exercises on Sorting 3. Exercises on Divide and Conquer
CO 3	**Construct programs to perform operations on linear data structures for memory organization of data.**
	1. Exercises Stack Data Structures 2. Exercises on Queue Data Structures 3. Exercises on Linked Lists 4. Exercises on Circular and Doubly Linked Lists
CO 4	**Make use of nonlinear data structures for solving real time applications.**
	1. Exercises on Trees 2. Exercises on BST
CO 5	**Demonstrate operations on Balanced Data Structures for efficient storage and retrieval of data.**
	1. Exercises on AVL Trees 2. Exercises on Graph Traversal
CO 6	**Choose suitable data structures based on implementation, operations and performance while solving real world problems.**
	1. Exercises on Data Structures based Applications 2. Exercises on Minimum Cost Spanning Tree

Note: One Course Outcome may be mapped to multiple number of experiments.

TEXTBOOKS

1. Mark Allen Weiss,"*Data Structures and Problem Solving using Java*", Pearson Fourth Edition.
2. Michael T. Goodrich and Roberto Tamassia "*Data Structures and Algorithms in Java*" , John Wiley Sons, Inc., Fourth Edition

REFERENCE BOOKS:

1. Deitel, Paul and Deitel, Harvey. "*Java: How to Program*", Pearson, 11th Edition,2018.
2. Evans, Benjamin J. and Flanagan, David. "*Java in a Nutshell*", O'Reilly Media, 7th Edition, 2018.

MATERIALS ONLINE:

1. https://www.codechef.com/certification/data-structures-and-algorithms/prepare
2. https://www.geeksforgeeks.org/java
3. https://www.tutorialspoint.com/java/index.htm
4. https://online-learning.harvard.edu/course/data-structures-and-algorithms

20.COURSE PLAN:

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

S.No	Topics to be covered	CO's
1	Getting Started Exercises	CO 1
2	Exercises on Searching	CO 2
3	Exercises on Sorting	CO 2
4	Exercises onDivide and Conquer	CO 2
5	Exercises on Stacks	CO 3
6	Exercises on Queues	CO 3
7	Exercises on Linked Lists	CO 3
8	Exercises on Circular and Doubly Linkde Lists	CO 3
9	Exercises on Trees	CO 4
10	Exercise on BST	CO 4
11	Exercises on AVL trees	CO 5
12	Exercises on Graph Traversal Techniques	CO 4
13	Exercises on Spanning Trees	CO 6

Experiments for enhanced learning (EEL):

S.No	Design Oriented Experiments
1.	Write a function to determine if two trees are identical or not: (Two trees are identical when they have the same data and the arrangement of data is also the same)
2.	Given a binary search tree, task is to find Kth largest element in the binary search tree.
3.	Ind Strongly Connected Components (SCCs) of Given Graph G. .
4.	Given an array of pairs, find all symmetric pairs in it. (wo pairs (a, b) and (c, d) are said to be symmetric if c is equal to b and a is equal to d. For example, (10, 20) and (20, 10) are symmetric. Given an array of pairs find all symmetric pairs in it)
5.	Find distance between two nodes of a Binary Tree.

21. PROGRAM OUTCOMES & PROGRAM SPECIFIC 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
Program Specific Outcomes	
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.

Program Outcomes	
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.

22. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Strength	Proficiency Assessed by
PO 1	**Engineering knowledge:** Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	2	LAB PROGRAMS/ CIE/SEE
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	3	LAB PROGRAMS/ 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 PROGRAMS/ 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.	3	LAB PROGRAMS/ CIE/SEE
PO 5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	3	LAB PROGRAMS/ 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	Viva voce /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	1	Viva Voce/ CIE/SEE

23. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		**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 PROGRAMS/CIE/SEE

3 = High; 2 = Medium; 1 = Low

24. 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	✓	✓	✓	✓	✓	-	-	-	-	✓	-	✓	-	-	✓

25. 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**
CO1	PO 1	**Understand** (knowledge) the concept of Algorithm Analysis and Types of Notations used to represent Time and Space Complexities (Understand) by applying principles of **mathematics** 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

COURSE OUTCOMES	PO'S PSO'S	**Justification for mapping (Students will be able to)**	No. of Key Competencies
	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
	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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 10	**Subject matter and speaking style** assessed in explanation of linear and nonlinear data structures like linked lists, stacks and queues	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.	2
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
	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.	2
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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	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 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

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

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

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	33.3	40	20	-	-	-	-	-	-	40	-	-	-	-	15
CO 2	33.3	50	20	-	100	-	-	-	-	40	-	-	-	-	15
CO 3	66.6	70	50	36.3	100	-	-	-	-	40	-	-	-	-	30
CO 4	100	70	20	36.3	100	-	-	-	-	40	-	-	-	-	30
CO 5	33.3	-	20	-	100	-	-	-	-	40	-	-	-	-	15
CO 6	100	70	50	36.3	100	-	-	-	-	40	-	25	-	-	15

28. 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		
	PO 1	PO 2	PO 3	PO 4	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	-	-	-	-	1
CO 2	1	2	1	-	3	-	-	-	-	1	-	-	-	-	1
CO 3	3	3	2	1	3	-	-	-	-	1	-	-	-	-	1
CO 4	3	3	1	1	3	-	-	-	-	1	-	-	-	-	1
CO 5	1	-	1	-	3	-	-	-	-	1	-	-	-	-	1

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

29. ASSESSMENT METHODOLOGY DIRECT:

CIE Exams	✓	SEE Exams	✓	Laboratory Practices	✓
Certification	-	Student Viva	✓	Open Ended Experiments	-

30. ASSESSMENT METHODOLOGY INDIRECT:

x	Assessment of Mini Projects by Experts	✓	End Semester OBE Feedback

31. Relevance to Sustainability goals

Write brief description about the course and how its relevance to SDGs.

X		
X		
X		
✓		**Quality Education:** The students can gain a deeper understanding of how technology can be harnessed to address global challenges. This promotes quality education by fostering critical thinking and problem-solving skills in the context of sustainable development.

X	GENDER EQUALITY	
X	CLEAN WATER AND SANITATION	
X	AFFORDABLE AND CLEAN ENERGY	
X	DECENT WORK AND ECONOMIC GROWTH	
✓	INDUSTRY, INNOVATION AND INFRASTRUCTURE	**Industry, Innovation, and Infrastructure:** Java programming skills are essential for developing innovative software solutions. Students working on projects related to sustainable development can contribute to building resilient infrastructure and promoting inclusive and sustainable industrialization.
X	REDUCED INEQUALITIES	
✓	SUSTAINABLE CITIES AND COMMUNITIES	**Sustainable Cities and Communities:** Java programming plays a crucial role in developing applications for smart cities, efficient transportation, and waste management systems. Through projects in the lab, students can explore ways to create more sustainable urban environments.
X	RESPONSIBLE CONSUMPTION AND PRODUCTION	

✓		**Climate Action:** Students can create climate-related applications, such as carbon footprint calculators or climate data analysis tools, using Java programming. This directly contributes to SDG 13 by raising awareness and facilitating climate action.
X		
X		
✓		**Peace, Justice, and Strong Institutions:** Java programming skills can be applied to create tools for transparency, accountability, and data security. By focusing on ethical coding practices, the lab can contribute to strong and just institutions.
✓		**Partnerships for the Goals:** Collaborative projects can foster partnerships among students, educators, and local communities. These partnerships enhance knowledge sharing and the development of innovative solutions that align with multiple SDGs.

Approved by: Board of Studies in the meeting conducted on ____________________.

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