INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRONICS AND COMMUNICATION 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	Ms G. Indrani				
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 Out-come	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. 1. Anjana Tiwari, "*Communication Skills in English,* ", Khanna Publishing House: New Delhi, 2022.

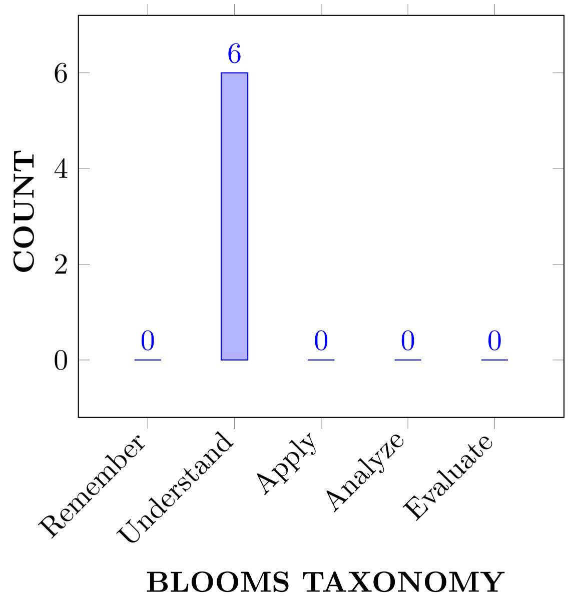
REFERENCE BOOKS:

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

S.No	Topics to be covered	CO's	Reference
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
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

S.No	Topics to be covered	CO's	Reference
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
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.

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

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

3 = High; 2 = Medium; 1 = Low

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

	PROGRAM OUTCOMES												PSO'S		
COURSE OUTCOMI	PO 1	PO 2	PO 3	PO 4	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	QUALITY EDUCATION	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	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 ——————————.

Signature of Course Coordinator **HOD**
Ms. G Indrani, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MATRICES AND CALCULUS

COURSE TEMPLATE

1	Department	**ELECTRONICS AND COMMUNICATION 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 $\checkmark$	Professional Elective -	Open Elective -	VAC -	MOOCs -
9	Course Offered	Odd Semester $\checkmark$		Even Semester $\times$		
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	Dr. S. Jagadha				
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	Cours 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	Build embedded software and digital circuit development platform for robotics, embedded systems and signal processing applications
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.

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	Build embedded software and digital circuit development platform for robotics, embedded systems and signal processing applications.	-	-
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	-	-

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

3 = High; 2 = Medium; 1 = Low

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
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

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

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRONICS AND COMMUNICATION 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. G Kiran Kumar				
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 Outcome	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	Cours 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	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.

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

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

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 1	Understand features of procedural as well as object-oriented programming while writing and analyzing computer programs in the areas related to Machine Learning, Big data, and Artificial Intelligence.	4
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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PSO 1	Apply features of procedural as well as object-oriented programming while writing and analyzing computer programs in the areas related to machine learning, big data, and artificial intelligence.	5
	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 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
	PSO 1	Summarize indexing mechanisms to design and develop efficient real-time computational problems.	6
	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
	PSO 1	Demonstrate different modules to understand, design, and analyze computer programs in reducing the time and space complexities 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 string handling mechanisms for various applications to become a successful professional in the domains.	2
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
	PSO 1	Develop design and analyze object-oriented programming in the areas of the concept of passing of parameters and arguments in functions to do modular programming.	6
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
	PO 12	Identify the need for object-oriented principles for the preparation and the ability to engage in independent and lifelong learning	6
	PSO 1	Focus on writing programs using procedural and object-oriented concepts for applications such as computational geometry, machine learning, big data, and artificial intelligence by understanding and applying the engineering principles of learning.	6
	PSO 3	Acquire sufficient knowledge of object-oriented concepts and apply it in real-time to build a successful career and pursue higher studies.	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	-	-	-	3	-	-	-	-	1	-	-	3	-	-
CO 2	3	2	3	-	3	-	-	-	-	3	-	-	3	-	3
CO 3	3	-	3	-	3	-	-	-	-	-	-	-	3	-	3
CO 4	3	-	3	-	3	-	-	-	-	2	-	3	3	-	3
CO 5	3	2	3	-	3	-	-	-	-	-	-	-	3	-	-
CO 6	3	3	3	-	3	-	-	-	-	2	-	3	3	-	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	66.6	0.0	0.0
CO 2	100	50	80	0.0	100	0.0	0.0	0.0	0.0	60	0.0	0.0	83.3	0.0	100
CO 3	100	0.0	60	0.0	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100	0.0	100
CO 4	100	0.0	80	0.0	100	0.0	0.0	0.0	0.0	40	0.0	88	83.3	0.0	100
CO 5	100	80	70	0.0	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100	0.0	0.0
CO 6	100	80	70	0.0	100	0.0	0.0	0.0	0.0	40	0.0	75	100	0.0	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

1-5 $< C \leq 40\%$ – Low/ Slight

2 - $40\ \% < C < 60\%$ –Moderate

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

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

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
TOTAL	18	7	15	-	18	-	-	-	-	8	-	6	18	-	12
AVERAGE	3	2.3	3	-	3.0		-	-	-	2.0	-	3.0	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		

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 ECE**
Mr. G Kiran Kumar, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRONICS AND COMMUNICATION ENGINEERING**				
2	Course Title	**ELECTRICAL CIRCUITS**				
3	Course Code	AEED02				
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	Ms.V.Bindusree				
12	Date Approved by BOS	05/01/2024				
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	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.

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 Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	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
	PO 4	Conduct Investigations of Complex Problems with AC and DC excitation Use research methods including design of experiments.	5

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
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	Analyse the two port networks for graphical representation and focus on the Application Specific Integrated Circuit (ASIC) Prototype designs and systems.	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 - $0 \leq C \leq 5\%$ – 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	-	-	-	-	-	-	-	-	-	-	-	-	-
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,ECE**
Ms.V.Bindusree, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRONIC AND COMMUNICATION 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	Ms G.Indrani			
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.

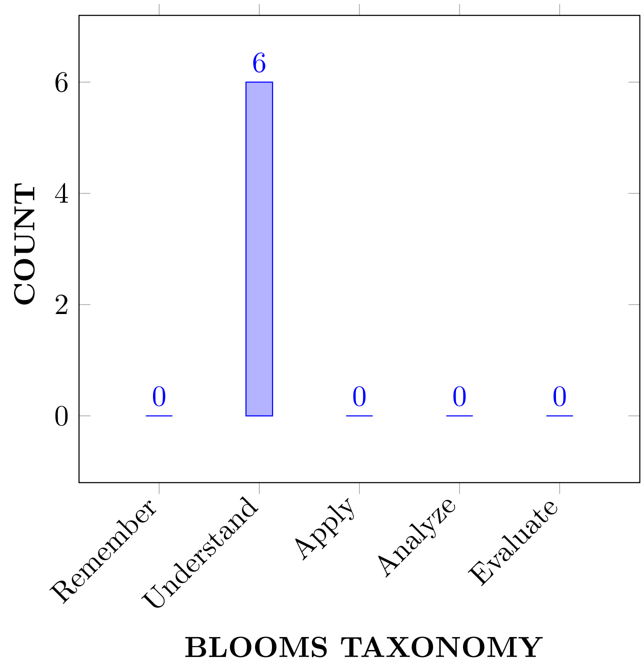
REFERENCE BOOKS:

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

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

3 = High; 2 = Medium; 1 = Low

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**
Ms. G Indrani Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

OBJECT ORIENTED PROGRAMMING WITH JAVA LABORATORY

COURSE TEMPLATE

<table>
<tr><td>1</td><td>Department</td><td colspan="4">ELECTRONICS & COMMUNICATION ENGINEERING</td></tr>
<tr><td>2</td><td>Course Title</td><td colspan="4">OBJECT ORIENTED PROGRAMMING WITH JAVA</td></tr>
<tr><td>3</td><td>Course Code</td><td colspan="4">ACSD02</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">I 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. B. Surekha Reddy</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 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	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.

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 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	2	LAB PROGRAMS/CIE/SEE
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	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

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 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	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
	PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	3
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
	PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	3
	PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	1
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
	PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	3
	PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	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	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO 2	1	7	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	1	7	-	-	-	-	-	-	-	-	-	-	4	-	-
CO 4	-	7	6	-	-	-	-	-	-	-	-	-	3	-	-
CO 5	-	7	-	-	-	1	-	-	-	-	-	-	3	1	-
CO 6	-	7	-	-	-	3	-	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	-	-	-	100	-	-	-	-	-	-	-	-	-	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 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	33.3	70	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	33.3	70	-	-	-	-	-	-	-	-	-	-	66.6	-	-
CO 4	-	70	60	-	-	-	-	-	-	-	-	-	50	-	-
CO 5	-	70	-	-	-	20	-	-	-	-	-	-	50	50	-
CO 6	-	70	-	-	-	60	-	66.6	-	-	-	-	50	50	-

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	-	-	-	-	-	-	-	-	-	-
CO 2	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	1	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO 4	-	3	3	-	-	-	-	-	-	-	-	-	2	-	-
CO 5	-	3	-	-	-	1	-	-	-	-	-	-	2	2	-
CO 6	-	3	-	-	-	3	-	3	-	-	-	-	2	2	-
TOTAL	3	15	3	-	3	4	-	3	-	-	-	-	9	4	-
AVERAGE	1	3	3	-	3	2	-	3	-	-	-	-	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.

X	NO POVERTY	
X	ZERO HUNGER	
X	GOOD HEALTH AND WELL-BEING	
✓	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,ECE**
Dr. B. Surekha Reddy, Assistant Professor

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

COURSE TEMPLATE

1	Department	**ELECTRONICS AND COMMUNICATION ENGINEERING**			
2	Course Code	AEED04			
3	Course Title	**ELECTRICAL CIRCUITS LABORATORY**			
4	Semester	I			
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	Ms.V.Bindusree			
9	Date Approved by BOS	05/01/2024			
10	Course Webpage	https://www.iare.ac.in/sites/default/files/BT23/AEED04.pdf			
11	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**
		Intermediate	-	-	Physics

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	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.

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

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 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	1	CIE/Quiz/AAT

3 = High; 2 = Medium; 1 = Low

24. 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	✓	✓	-	-	✓	-	-	-	-	✓	-	-	-	✓	

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.	5
	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	3
	PSO 2	Verify the various electrical circuits and designs laws using computing tools like MATLAB.	2
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	3
	PSO 2	Verify mesh and nodal analysis using computing tools like Simulink	2
CO 3	PO 1	Apply the basics of mathematics, engineering sciences and other sciences to understand the network theorems	3

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	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	3
	PSO 2	Verify the superposition principle, reciprocity and maximum power transfer condition for the electrical network with DC excitation using computing tools like Simulink	2
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	3
	PSO 2	Verify Thevenin's and Norton's theorems for the electrical network with DC excitation using computing tools like Simulink	2
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
	PO 10	Improve the documentation skills for their problem-solving approaches, calculations, and findings, resulting in well-structured and informative reports	3
	PSO 2	Study the frequency response characteristics of series resonance circuit and plot the waveforms using computing tools like Simulink	1

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
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 2	Evalute the two port network parameters in various electrical circuits using computing tools like Simulink	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	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	-	-	-	18.1	-
CO 2	100	50	-	-	100	-	-	-	-	60	-	-	-	18.1	-
CO 3	100	50	-	-	100	-	-	-	-	60	-	-	-	18.1	-
CO 4	100	50	-	-	100	-	-	-	-	60	-	-	-	18.1	-
CO 5	100	50	-	-	100	-	-	-	-	60	-	-	-	18.1	-
CO 6	100	50	-	-	100	-	-	-	-	60	-	-	-	18.1	-

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	-	-	-	-	18	-	-	-	6	-
AVERAGE	3	2	-	-	3	-	-	-	-	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.

1		
2		
3		

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	**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** 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,ECE**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	ELECTRONICS AND COMMUNICATION ENGINEERING			
2	Course Code	AMED02			
3	Course Title	MANUFACTURING PRACTICE			
4	Semester	I			
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	Mr. K Arun Kumar			
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	✓	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	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.

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 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	2	Lab Exercises

3 = High; 2 = Medium; 1 = Low

24. 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	✓	-	-	-	✓	-	-	-	-	-	✓	-	-	✓	-

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
	PSO 2	Focus on Application specific experiments and applying the theoritical knowledge, learning the procedure and outcomes of the experiment.	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
	PSO 2	Concentrate on conducting experiments specific to applications and applying theoretical knowledge, understanding the experimental procedures and outcomes..	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
	PSO 2	Emphasize conducting experiments tailored to specific applications and the practical application of theoretical knowledge. Learn the experimental procedures and outcomes in the process.	2

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
CO 4	PO 1	Apply the knowledge of engineering fundamentals to make the casting product from given materials according to given sketch to develop required shape.	1
	PO 3	Conversion of given design into a practical output using design solution for complex engineering problems and design system components	2
	PO 11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	2
CO 5	PO 5	Develop the given resources and engineering tools into required shape as given in the diagrammatical representation	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
	PSO 2	Emphasize conducting application-specific experiments and applying theoretical knowledge, while gaining an understanding of the experimental procedures and outcomes	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	-	-	2	-
CO 2	1	-	-	-	1	-	-	-	-	-	2	-	-	2	-
CO 3	1	-	-	-	1	-	-	-	-	-	-	-	-	2	-
CO 4	1	-	2	-	-	-	-	-	-	-	2	-	-	-	-

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

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	-	-	3	-
CO 2	1	-	-	-	-	-	-	-	-	-	1	-	-	3	-
CO 3	1	-	-	-	3	-	-	-	-	-	-	-	-	3	-
CO 4	1	-	1	-	-	-	3	-	-	-	-	-	-	-	-
CO 5	-	-	-	-	3	-	-	-	-	-	1	-	-	-	-
CO 6	1	-	-	-	3	-	3	-	-	-	1	-	-	3	-
Total	5	-	2	-	12	-	-	-	-	-	4	-		12	-
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	NO POVERTY	
2	ZERO HUNGER	
3	GOOD HEALTH AND WELL-BEING	
4	QUALITY EDUCATION	**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	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:** 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	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, AE**
Mr. K Arun Kumar, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRONICS AND COMMUNICATION ENGINEERING**				
2	Course Title	**ENGINEERING CHEMISTRY**				
3	Course Code	AHSD03				
4	Program	B.Tech				
5	Semester	II Semester				
6	Regulation	BT-23				
7	Structure of the course	Theory			Practical	
		Lecture	Tutorials	Credits	Lab	Credits
		3	0	3	-	-
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: 64 hours		Tutorials: .... hours		Practical: .... hours	
11	Course Coordinator	Dr.V Anitha Rani				
12	Date Approved by BOS	24/08/2023				
13	Course Webpage	https://www.iare.ac.in/sites/default/files/BT23/AHSD03.pdf				
14	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**	
		Intermediate	-	-	-	
		B.Tech	-	-	-	

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

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

3 = High; 2 = Medium; 1 = Low

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 $CaCO_3$ 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 $CaCO_3$ 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 - $0 \leq C \leq 5\%$ – 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	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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	NO POVERTY	
2	ZERO HUNGER	
3	GOOD HEALTH AND WELL-BEING	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	QUALITY EDUCATION	The fundamental principles of water treatment and its applications in industry, apply electrochemical principle in batteries
5	GENDER EQUALITY	

6		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 electricity is provided by clean energy sources such as solar, wind and hydropower.
8		
9		
10		
11		Renewable energy systems for sustainable cities
12		Renewable energy systems for sustainable cities

13		Non-renewable energy resources release harmful greenhouse gases into the atmosphere, creating the greenhouse effect which causes global warming.
14		
15		The biodegradable plastics material focuses on creating a more sustainable and greener world with a smaller environmental imprint.
16		
17		

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

Signature of Course Coordinator **HOD,ECE**
Dr.V.Anitha Rani, Associate Professor

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

COURSE TEMPLATE

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

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

3 = High; 2 = Medium; 1 = Low

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
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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	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≤ 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	-	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		
2		
3		
4		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		

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		
15		
16		
17		

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

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

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

COURSE TEMPLATE

1	Department	**ELECTRONICS AND COMMUNICATION ENGINEERING**				
2	Course Title	**DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS**				
3	Course Code	AHSD08				
4	Program	B.Tech				
5	Class/Semester	II				
6	Regulation	BT-23				
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 Instructor	Dr. G. SRINIVASU				
12	Date Approved by BOS	23/08/2023				
13	Course Webpage	www.iare.ac.in/—-/—-				
14	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**	
		B.Tech	AHSD02	I	Matrices and Calculus	

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 Out-come	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 Out-come	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	Build Embedded Software and Digital Circuit Development Platform for Robotics, Embedded Systems and Signal Processing applications.

PSO 2	Focus on the Application Apecific Integrated Circuit (ASIC) Prototype design, Virtual Instrumentation and System on Chip (SOC) designs.
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modelling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.

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	Build Embedded Software and Digital Circuit Development Platform for Robotics, Embedded Systems and Signal Processing applications.		
PSO 2	Focus on the Application Apecific Integrated Circuit (ASIC) Prototype design, Virtual Instrumentation and System on Chip (SOC) designs.		
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modelling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.		

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 Instructor **HOD**
Dr. G. SRINIVASU, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

<table>
<tr><td>1</td><td>Department</td><td colspan="5">ELECTRONICS AND COMMUNICATION ENGINEERING</td></tr>
<tr><td>2</td><td>Course Title</td><td colspan="5">ESSENTIALS OF PROBLEM SOLVING</td></tr>
<tr><td>3</td><td>Course Code</td><td colspan="5">ACSD05</td></tr>
<tr><td>4</td><td>Class / Semester</td><td colspan="5">B.Tech II Semester</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
0</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: 0 hours</td><td colspan="2">Practical: – hours</td></tr>
<tr><td>10</td><td>Course Coordinator</td><td colspan="5">Ajitha G</td></tr>
<tr><td>11</td><td>Date Approved by BOS</td><td colspan="5">22/08/2023</td></tr>
<tr><td>12</td><td>Course Webpage</td><td colspan="5">https://www.iare.ac.in/?q=pages/btech-course-syllabi-bt23-cse</td></tr>
<tr><td rowspan="2">13</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>-</td><td>-</td><td>-</td><td colspan="2">-</td></tr>
</table>

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

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	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	3	Tech talk
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	3	Tech talk

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 2	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 2	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 2	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 2	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	-	-	-	-	-	-	-	-	-	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 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	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**	**12**	**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		**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		
6		
7		
8		**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:** 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 22-08-2023.

Signature of Course Coordinator **HOD, ECE**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRONICS AND COMMUNICATION 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	24/08/2023			
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	**U**se conductivity meter and potentiometer for measurement of conductance and electromotive force of solutions
CO2	**U**se PH meter for measurement of Strength of Acidic Solutions.
CO3	**M**ake use of the principles of water analysis for domestic and industrial applications.
CO4	**P**redict the Properties of polymeric materials by synthesizing the monomers
CO5	**U**se different types of lubricants to know its properties for the proper lubrication of machinery in industries.
CO6	**I**nterpret 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

S.No	Topics to be covered	CO's	Reference
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
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

Program Outcomes	
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
Program Specific Outcomes	
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.

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

3 = High; 2 = Medium; 1 = Low

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	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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	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
	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≤ 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	-	-	-	-	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	**Quality Education:** Enhancement in the additional skills for the students with analytical tools.
5	GENDER EQUALITY	
6	CLEAN WATER AND SANITATION	**Clean Water and Sanitation:** Ensures the availability to clean water through hard water analysis and its removal with chemical methodology
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	**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	LIFE ON LAND	
16	PEACE, JUSTICE AND STRONG INSTITUTIONS	
17	PARTNERSHIPS FOR THE GOALS	

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

Signature of Course Coordinator **HOD,CE**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRONICS AND COMMUNICATION 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. Surya Sharma N V			
10	Date Approved by BOS	24/08/2023			
11	Course Webpage	www.iare.ac.in/?q=pages/btech-course-syllabi-bt23-it			
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
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.

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

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
PSO 1	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	-	-
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	-	-

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

3 = High; 2 = Medium; 1 = Low

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	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
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	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**

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**Electronics and Communication Engineering**			
2	Course Title	**Programming for problem solving laboratory**			
3	Course Code	ACSD06			
4	Program	B.Tech			
5	Semester	II 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	Dr.V.Kishen Ajay Kumar			
10	Date Approved by BOS	22/08/2023			
11	Course Webpage	https://www.iare.ac.in/?q=pages/btech-course-syllabi-bt23-eee			
12	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**
		UG	ACSD01	I	Object oriented programming

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

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	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications..	2	LAB PROGRAMS/CIE/SEE
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	2	LAB 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	**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	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	**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,ECE**
Dr.V.Kishen Ajay Kumar, Associate Professor

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

COURSE TEMPLATE

1	Department	**ELECTRONICS AND COMMUNICATION 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. R. Srinivas			
10	Date Approved by BOS	/ /			
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.
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	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.

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

3 = High; 2 = Medium; 1 = Low

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
CO 2	PO 7	Understand the impact of the engineering graphics in societal and environmental contexts for sustainable development.	1

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	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
	PO 10	Communicate effectively on complex engineering drawing to write effective reports and design documentation.	2

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	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:** 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		
6		**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:** 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:** 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:** 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		
11		**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		
13		

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

Signature of Course Faculty **HOD, ECE**
Mr. R. Srinivas, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRONICS AND COMMUNICATION 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. B.Madhavidevi			
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	
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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	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications..	2	LAB PROGRAMS/CIE/SEE

3 = High; 2 = Medium; 1 = Low

24. 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	✓	✓	✓	-	✓	-	-	✓	-	✓	-	✓	-	-	-

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 for Robotics, Embedded Systems and Signal Processing Applications. 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 webfor Robotics, Embedded Systems and Signal Processing Applications. 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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	3
	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$\leq$ 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	-	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	**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	LIFE BELOW WATER	
X	LIFE ON LAND	
✓	PEACE, JUSTICE AND STRONG INSTITUTIONS	**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	**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,ECE**
Dr.B.Madhavidevi, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRONICS AND COMMUNICATION ENGINEERING**				
2	Course Title	**COMPLEX ANALYSIS AND SPECIAL FUNCTIONS**				
3	Course Code	AHSD12				
4	Program	B.Tech				
5	Semester	III Semester				
6	Regulation	BT-23				
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	Dr. A. Parandhama, Associate Professor				
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	AHSD02	I	Matrices and Calculus	
		B.Tech	AHSD08	II	D E V C	

15. Course Overview

The course focuses on more advanced Engineering Mathematics topics which provide with the relevant Mathematical tools required in the analysis of problems in engineering and scientific professions. The course includes complex functions and differentiation, complex integration, power series expansion of complex functions, and special functions. The mathematical skills derived from this course form a necessary base for analytical and design concepts encountered in the program.

16. COURSE OBJECTIVES:

The students will try to learn:

I	The applications of a complex variable in two-dimensional complex potential theories.
II	The fundamental calculus theorems and criteria for the independent path on contour integral used in problems of engineering.
III	The concepts of special functions and their application for solving the partial differential equation in mathematical physics and engineering.
IV	The mathematics of combinatorial enumeration by using generating functions and Complex analysis for understanding the numerical growth rates.

17. COURSE OUTCOMES:

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

CO 1	Identify the fundamental concepts of analyticity and differentiability for finding complex conjugates of complex transformations.	Understand
CO 2	Apply integral theorems of complex analysis and its consequences for the analytic function with derivatives of all orders in simple connected regions.	Apply
CO 3	Extend the Taylor's and Laurent's series for expressing the function in terms of complex power series.	Apply
CO 4	Apply Residue theorem for computing definite integrals by using the singularities and poles of real and complex analytic functions over closed curves.	Apply
CO 5	Determine the characteristics of special functions for obtaining the proper and improper integrals for obtaining the proper and improper integrals.	Apply
CO 6	Apply the role of Bessel functions in the process of obtaining the series solutions for second order differential equation.	Apply

18. Topic Learning Outcome (TLOs):

S No	TOPIC NAME	TLO No	Topic Learning Outcome's	Course Outcome	Blooms Level
1	Fundamentals of Differentation and Analicity of complex functions	TLO 1	**Determine** the solution of Complex functions by using continuty and differentation.	CO 1	Understand
		TLO 2	**Explain** basic fundamentals of complex functions and analycity through a procedural approach.	CO 1	Understand
2	Cauchy Riemann Equations; Harmonic functions	TLO 3	**Apply** the C-R equations whether the Complex function is analytic or not.	CO 1	Apply

S No	TOPIC NAME	TLO No	Topic Learning Outcome's	Course Out-come	Blooms Level
		TLO 4	**Use** the Laplacian equation to veriefy the function is Harmonic or not .	CO 1	Apply
3	Milne -Thomson method.	TLO 5	**Apply** the Milne - Thomson method for obtaining the analytic function	CO 1	Apply
4	Line integrals on Complex functions	TLO 6	**Apply** standard definite line integrals on Analytical Complex functions over the simpled closed curves.	CO 1	Apply
5	Cauchy's integral theorem - Cauchy's integral formula - Generalization of Cauchy's Integral Formula	TLO 7	**Apply** Cauchy's integral theorem to obtain the solution of closed integrals on complex functions	CO 2	Apply
		TLO 8	**Using** the Cauchy's integral formula to obtain the function value of the analytic function at the interior point of the region R .	CO 3	Apply
		TLO 9	**Compute** the derivatives of an analytic function at interior points of a domain R using Generalization of Cauchy's Integral Formula.	CO 3	Apply
6	Expansion of the complex function in Taylor's series - Maclaurin's series - Laurent's series	TLO 10	**Expand** the analytic function within C by using Taylor's series method.	CO 3	Apply
		TLO 11	**Compute** the Maclaurien's series expansion of analytic function by using Taylor's series method at the origon point.	CO 3	Apply
		TLO 12	**Expand** the function about a point where the function is not analytic by using Lauren's series method.	CO 3	Apply
7	Singularities, Residues, Cauchy Residue Theorem	TLO 13	**Determine** the singular points of the analytic functions where the function is not analytic.	CO 4	Understand

S No	TOPIC NAME	TLO No	Topic Learning Outcome's	Course Out-come	Blooms Level
		TLO 14	**Use** the residue theorem to obtain the function value at the pole points of the analytic function.	CO4	Apply
		TLO 15	**Solve** the definite integrals of the analytic functions by using Cauchy's Residue Theorem.	CO 4	Apply
		TLO 16	**Solve** the integrals of the type $\int_0^{2\pi} f(\cos\theta, \sin\theta)d\theta$ by using Cauchy's Residue Theorem.	CO 4	Apply
8	Improper integrals - Beta and Gamma functions	TLO 17	**Interpret** the Improper and Proper integrals to compare with Beta function	CO 5	Understand
		TLO 18	**Apply** the relation of Beta and Gamma functions for solving improper integrals	CO 5	Apply
9	Bessel's Differential equation.	TLO 19	**Recall** the second order Bessel's Differential equation and obtain the series solution by principles of Mathematics	CO 6	Remember
10	Bessel function - generating function	TLO 20	**Apply** generating function of Bessel's function to obtain Jacobi series of some functions $cos(xsin\theta)$ and $cos(xcos\theta)$.	CO 6	Understand
11	Orthogonality of Bessel function - Trigonometric expansions.	TLO 21	**Make use of Bessel's Differential Equations** to obtain the solution of the definite integral of Bessel's function by applying the principles of Mathematics.	CO 6	Apply

19. Employability Skills

Complex Analysis: Employability/ Skill development: Uses the basic of Complex Analysis calculation concept in the field of engineering.
Special Functions: Employability/ Skill development: Uses the concept of Special Functions 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), 05 marks for each Definition and Terminology / Quiz, and the 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 in the 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	**FUNCTIONS OF A COMPLEX VARIABLE | Number of Lectures: 10**
	Functions of a complex variable; the concept of limits, continuity, and differentiability of complex function, analyticity, Cauchy-Riemann equations (without proof); harmonic functions, constructions of analytic function, Milne-Thomson method.
MODULE II	**COMPLEX INTEGRATION | Number of Lectures: 10**
	Line integral: Evaluation along a path and by indefinite integration; Cauchy's integral theorem; Cauchy's integral formula; generalized Cauchy integral formula

MODULE III	**POWER SERIES OF COMPLEX FUNCTIONS |Number of Lectures: 09**
	Expansion of the complex function in Taylor's series, Maclaurin's series, and Laurent's series (all theorems without proof); Singularities. Residues: Cauchy Residue Theorem (without proof); Evaluation of integrals of the type $\int_0^{2\pi} f(\cos\theta, \sin\theta)d\theta$ by residues
MODULE IV	**SPECIAL FUNCTIONS-I | Number of Lectures: 09**
	Improper integrals; Beta and Gamma functions: Definitions; Properties of Beta and Gamma function; Standard forms of Beta functions; Relationship between Beta and Gamma functions
MODULE V	**SPECIAL FUNCTIONS-II | Number of Lectures: 10**
	Bessel's Differential equation and its solution (without proof), Bessel function, properties of Bessel function, Recurrence relations of Bessel function, generating function and Orthogonality of Bessel function, Trigonometric expansions involving Bessel function.

' **TEXTBOOKS**

1. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley and Sons, 2014.

REFERENCE BOOKS:

1. R. K. Jain and S. R. K. Iyengar, "*Advanced Engineering Mathematics*", 3/ed, Narosa Publications, 5th edition, 2016.
2. Peter O'Neil, "*Advanced Engineering Mathematics,*", Cengage Learning.
3. B.V. Ramana, "*Higher Engineering Mathematics,*", McGraw Hill Education.
4. N.P. Bali and Manish Goyal,"*A text book of Engineering Mathematics,*", Laxmi Publications, Reprint, 2008.

ELECTRONICS RESOURCES:

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

MATERIALS 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. Powerpoint presentations

23 COURSE PLAN:

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

S.No	Topics to be covered	Course outcomes	Reference
OBE DISCUSSION			
1	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping.		
CONTENT DELIVERY (THEORY)			
2	Understanding the complex function in Argand plane	CO 1	T1:12.4, R1:4.13
3	Apply the limit of a complex function	CO 1	T1:12.4, R1:4.13
4	Apply the continuity of a complex function	CO 1	T1:12.4, R1:4.13
5	Apply the differentiability and analyticity of a complex function	CO 1	T1:12.4, R1:4.13
6	Identify and Apply the of Cauchy-Riemann conditions in Cartesian and Polar forms	CO 1	T1:12.4, R1:4.13
7	Evaluate the Harmonic Conjugates	CO 1	T1:12.4, R1:4.13
8	Apply the Milne-Thomson method to find the Analytic function	CO 1	T1:12.4, R1:4.13
9	Apply the properties of Bilinear transformation for complex functions.	CO 1	T1:12.5, R1:8.8
10	Evaluate the Line Integral for a given path	CO 2	T1:13.1, R1:5.3
11	Apply the Cauchy's integral theorem in a given plane	CO 3	T1:13.1, R1:5.3
12	Apply the Cauchy's integral formula for evaluating contour integration	CO 3	T1:13.1, R1:5.3
. 13	Apply the Cauchy's general integral formula for evaluating contour integration.	CO 3	T1:13.1, R1:5.3

14	Define the Power series expansions of complex functions and contour Integration	CO 4	T1:14.1, R1:6.1
15	Evaluate the Radius of convergence of power series complex function	CO 4	T1:14.1, R1:6.1
16	Identify the types of power series expansions	CO 4	T1:14.1, R1:6.1
17	Define the types of Singularities and its nature	CO 4	T1:15.2 , R1:6.6
18	Define the concept of Residues	CO 4	T1:15.2 , R1:6.6
19	Evaluate the Residues of complex functions.	CO 4	T1:15.2 , R1:6.6
20	Evaluate of contour integrals by Residue theorem.	CO 4	T1:15.2 , R1:6.6
21	Definite integrals of the Type -I	CO 5	T2: 7.14, R1:1.6
22	Indefinite integrals of Type-I(Problems)	CO 5	T2: 7.14, R1:1.6
23	Improper integrals; Beta and Gamma functions	CO 5	T2: 7.14, R1:1.6
24	Definitions; Properties of Beta	CO 5	T2: 7.14, R1:1.6
25	Standard forms1,2,3 of Beta functions	CO 5	T2: 16.6, R1:7.36
26	Standard forms 4,5,6, ,of Beta functions;	CO 5	T2: 16.8, R1:7.41
27	Definitions; Properties Gamma function	CO 5	T2: 16.9, R1:7.42
28	Relationship between beta and gamma functions	CO 6	T2: 16.9, R1:7.42
29	Theorems of gamma functions	CO 6	T2: 16.9, R1:7.42
30	Complex functions differentiation and integration: Complex functions and its representation on argand plane	CO 2	T2: 16.9, R1:7.42
31	Concepts of limit, continuity	CO 1	T1:12.4, R1:4.13
32	Problems related to beta functions	CO 5	T2: 7.14, R1:1.6
33	Problems related to gamma functions	CO 5	T2:7.15, R1:16.5
34	Properties of Beta and Gamma function	CO 5	T2:11.3, R1:16.5,

35	Bessel's Differential equation: Bessel function, properties of Bessel function	CO 6	T2: 16.5, R1:7.32,
36	Solutions of Bessel differential equation by power series method.	CO 6	T2: 16.6, R1:16.9,
37	Generating function	CO 6	T2: 11.4 ,R1:16.18
38	Recurrence relations-I, II, III of Bessel function	CO 6	T2: 11.4 ,R1:16.18
39	Recurrence relations IV, V, VI of Bessel function	CO 6	T1:17.5-17.6, R1:16.3.1
40	Generating function	CO 6	T2: 16.9, R1:7.422
41	Orthogonality of Bessel function	CO 6	T1:13.4, R1:5.10
PROBLEM SOLVING/ CASE STUDIES			
42	Problems on generalized integral formula	CO 2	T1:14.1, R1:6.1
43	Problems on cahchy's generalized integral formula	CO 2	T1:14.1, R1:6.1
44	Problems on power series expansions of complex functions Expansion in Taylor's series	CO 3	T1:14.1, R1:6.1
45	Problems on Maclaurin's series	CO 3	T1:15.2 , R1:6.6
46	Problems on Laurent series	CO 3	T1:15.3, R1:7.9
47	Problems on types of singularities, pole of order m	CO 4	T1:15.3, R1:7.9
48	Problems on evaluation of residue by Laurent Series	CO 3	T1:15.3, R1:7.9
49	Problems on Residue Theorem.	CO 4	T1:14.1, R1:6.1
50	Problems on definite integrals of the type -I	CO 3	T1:15.3, R1:7.9
51	Problems on indefinite integrals of type-II	CO 4	T1:15.3, R1:7.9
52	PSolving problems on Cauchy's Residues Theorem	CO 5	T2: 16.9, R1:7.42
53	Solving problems on Definite integrals of the type -I, II	CO 5	T2: 16.9, R1:7.42
54	Solving problems on Trigonometric expansions involving Bessel function	CO 6	T2: 16.9, R1:7.42
55	Solving problems on beta and gamma functions	CO 5	T2: 16.7, R1:7.36

56	Definitions and terminology Cauchy-Riemann conditions in Cartesian and Polar forms	CO 1, CO 2	T1:12.4, R1:4.13
DISCUSSION OF DEFINITION AND TERMINOLOGY			
57	Definitions and terminology the differentiability and analyticity of a complex function	CO 1, CO 2	T1:12.4, R1:4.13
58	Definitions and terminology Milne-Thomson method to find the Analytic function	CO 1,CO 2	T1:12.4, R1:4.13
59	Definitions and terminology on Cauchy's general integral formula for evaluating contour integration, on types of singularities, pole of order m	CO 4	T1:13.4, R1:5.10
60	Definitions and Terminology on special functions-I module IV	CO 5	T1:15.2, R1:6.6
61	Definitions and Terminology on special functions-II module V	CO 6	T1:12.4, R1:4.13
DISCUSSION OF QUESTION BANK			
62	Discussion of Question Bank of Module I Complex functions and differentiation	CO 1, CO 2	T1:12.3, R1:4.4
63	Discussion of Question Bank of Module II complex integration	CO 3	T1:12.5, R1:8.8
64	Discussion of Question Bank of Module III power series expansion of complex function	CO 4	T1:15.1, R1:7.4
65	Discussion of Question Bank of Module IV special functions-I	CO 5	T2: 7.15, R1:1.65
66	Discussion of Question Bank of Module V special functions-I	CO 6	T2: 16.9, R1:7.42

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 public health and safety, and the cultural, societal, and Environmental considerations

PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
Program Specific Outcomes	
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems, and Signal Processing Applications.
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation, and System on Chip (SOC) designs.
PSO 3	Make use of a High-Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.

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.	1	CIE/Quiz/AAT

26.HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

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

3 = High; 2 = Medium; 1 = Low

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**	Identify the basic properties of analytic functions that are closed with respect to the fundamental operations of arithmetic (knowledge), algebra, and applicability in solving the majority of functions in various engineering problems by applying Mathematical principles.	2
CO 2	**PO 1**	Apply the integral theorem of complex analysis (knowledge) and its consequences to the analytic function for solving complex problems by applying the principal problems of mathematics.	2
	PO 2	Identify the problem statement to build extensions of Cauchy's theorem and application of necessary condition to vanish a contour integral around the simple connected regions from the provided information and data in reaching substantiated conclusions by using principles of mathematics.	4
	PO 4	Apply quantitative methods to simplify the calculation of certain contour integrals (knowledge) on simply connected regions to solve engineering problems.	2
CO 3	**PO 1**	Apply the knowledge of geometric series that enable us to use Cauchy's integral formula for understanding power series representations of analytic functions by applying the principles of mathematics.	2
	PO 2	IdeIdentify the problem formulation and abstraction of rational complex functions for expressing in negative or positive terms of power series (knowledge) using Laurent's series and Taylor's series by applying the principles of mathematics.	4
CO 4	**PO 1**	Apply the method of finding residues of given real or complex integrand (knowledge) the singular points and poles of complex functions and applicability of Residue theorem to solve definite and indefinite complex integrals by applying the principles of mathematics.	2
	PO 4	Make use of the quantitative methods of finding residues for evaluating line integrals (length of curve) of analytic functions over closed curves and applicability of Residue theorem by applying the principles of mathematics.	2
CO 5	**PO 1**	Identify the characteristics of beta and gamma functions as a generalization to the elementary factorial function (knowledge) and applicability for solving improper integrals by applying the principles of mathematics..	2

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 2	Identify the given problem and formulate the relationship between beta and gamma functions (knowledge) and their applicability for solving improper integrals by transforming by applying the principles of mathematics.	4
CO 6	**PO 1**	Recognize the Bessel functions as the series solution of second order differential equation (knowledge) and find its generating function and use it to prove some useful standard results and recurrence relations by applying the principles of mathematics.	2
	PO 2	Identify the given problem and formulate relationship between beta and gamma functions (knowledge) and their applicability for solving improper integrals by transforming by applying the principles of mathematics.	4

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

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

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

	PROGRAM OUTCOMES												PSO'S		
COURSE OUTCOMES	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	66.7	-	-	-	-	-	-	-	-	-	-		-	-	-
CO 2	66.7	40.0	-	20	-	-	-	-	-	-	-	-	-	-	-
CO 3	66.7	40.0	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	66.7	-	-	20		-	-	-	-	-	-		-	-	-
CO 5	66.7	40.0	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 6	66.7	40.0	-	-		-	-	-	-	-	-		-	-	-

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

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

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**
Dr. A. Parandhama, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**Electronics and Communication Engineering**				
2	Course Title	**Electronic Devices and Circuits**				
3	Course Code	AECD01				
4	Program	B.Tech				
5	Semester	III Semester				
6	Regulation	BT-23				
7	Structure of the course	Theory			Practical	
		Lecture 3	Tutorials 0	Credits 3	Lab 2	Credits 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. V.R.Seshagiri Rao				
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	AEED02	I	Electrical Circuits	
		B.Tech	AHSD07	II	Applied Physics	

15. Course Overview

This course provides the constructional and operational aspects of diodes, bipolar and unipolar transistors. Biasing and Compensation techniques to provide temperature stability for proper amplification are covered. It includes applications of devices as - rectifiers, clippers, voltage regulators, clampers and amplifiers.

16. Course Objectives:

The students will try to learn:

I	The operational principles, characteristics of semiconductor devices and circuits for rectifiers, oscillators and amplifiers.
II	The analytical skills needed to model analog and digital integrated circuits (IC) at discrete and micro circuit level.

III	The fundamentals of basic electronics required for building complex electronic hardware.

17. Course Outcomes:

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

CO 1	**Describe** the operational features of PN junction, Light Emitting, Tunnel and Varicap diodes using the volt ampere characteristics	Understand
CO 2	**Construct** diode circuits for rectification, voltage multiplication and non-linear wave shaping.	Apply
CO 3	**Examine** the DC and AC load lines of BJT and FET amplifiers for optimal operating selection to avoid output signal distortion.	Analyze
CO 4	**Calculate** the characteristic parameters of BJT amplifier circuits using the low frequency hybrid model.	Apply
CO 5	**Analyze** the FET and MOSFET amplifier circuits using the V-I characteristics and small signal models.	Analyze
CO 6	**Build** voltage regulators using the Zener diodes for optimum line and rugulation factors.	Apply

18. Topic Learning Outcome (TLOs):

S.No	Topic(s)	TLO No	Topic Learning Outcome's	Course Out-come	Blooms Level
1	PN Junction diode	1	**Describe** operation of diodes in forward and reverse bias conditions using V-I characteristics	CO 1	Understand
		2	**Differentiate** between transition and diffusion capacitances with derivation using the fundamental concepts of physics	CO 1	Understand
		3	**Describe** the principle of operation of Light emitting, Varicap and Tunnel diodes using the fundamental concepts of physics.	CO 1	Understand
2	Rectifiers	4	**Outline** the operation of Halfwave rectifier using the VI characteristics and fundamentals of diodes	CO 2	Understand
		5	**Calculate** rectifier parameters for the full wave rectifiers with and without filters	CO 2	Understand

S.No	Topic(s)	TLO No	Topic Learning Outcome's	Course Out-come	Blooms Level
3	Zener Voltage Regulator	6	**Explain** the operation of Zener diode for voltage regulating applications.	CO 6	Understand
		7	**Compare** zener and avalanche breakdowns using the V-I Characteristics	CO 6	Understand
4	Non-linear wave shaping circuits:	8	**Build** clippers, clampers, multiplier circuits using diodes and passive components	CO 2	Apply
5	Bipolar Junction Transistors	9	**Outline** the construction and operation of BJT for using as an amplifier in different configurations.	CO 3	Understand
		10	**Identify** the various transistor biasing circuits for reducing the drift in operating point with time and temperature.	CO 3	Apply
6	BJT Biasing	11	**Explain** the role of temperature variations on the performance of the BJT with necessary measures to be taken in deign to stabilize the amplifier.	CO 3	Apply
7	Transistor Hybrid parameter model	12	**Examine** CB,CE,CC configurations using transister hybrid models.	CO 3	Understand
		13	**Analyze** the low frequency response of BJT Amplifiers, for CE amplifier and effect of coupling and bypass capacitors.	CO 3	Analyze
8	JFET and its characteristics	14	**Calculate** the drain resistance & amplification parameters using JFET V-I characteristics	CO 5	Apply
		15	**Analyze** the performance of FETs on the basis of their operation and working.	CO 5	Analyze
9	MOSFETS	16	**Describe** enhancement and depletion type MOSFETs using their structural aspects	CO 5	Understand
10	JFET Amplifier	17	**Compare** CS, CD, CG JET amplifiers using the small signal models	CO 5	Analyze

19. Employability Skills

Example: Communication skills / Programming skills / Project based skills /
Few activities an electronics and communication engineer perform: Do research, design and develop electronic equipment used in different systems. Look after the manufacturing of communication and broadcast systems. Conceptualise and design electronic equipment like radio, television, computer.

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	SEMICONDUCTOR DIODES | Number of Lectures: 10
	P-type and N-type semiconductors, Formation of PN-junction diode, Diode I-V Characteristics, ideal versus practical diodes, diode resistances, diode equivalent circuits, transition and diffusion capacitances. **Special Diodes:** Zener diode, Light Emitting diode, Tunnel diode and Varactor diode.

MODULE II	DIODE CIRCUITS | Number of Lectures: 09
	Block diagram of a regulated power supply, Half-wave, Full wave and Bridge rectifier circuits with and without capacitor filter. Zener diode as voltage regulator. **Non-linear wave shaping circuits:** Clippers and Clampers, clamping circuit theorem, Voltage multiplier circuits.
MODULE III	BJT AND BIASING | Number of Lectures: 10
	Construction and operation of PNP and NPN transistors, CB, CE and CC transistor configurations, input and output characteristics, hybrid parameters calculations. **Biasing:** Need for biasing, load line, operating Point, DC analysis of Fixed bias, Collector Feedback bias, Emitter Feed Back bias, Voltage divider bias circuits, Stability factors, Thermal runaway, condition for thermal stability, stabilization techniques.
MODULE IV	BJT AMPLIFIERS | Number of Lectures: 09
	Transistor as an Amplifier, transistor Hybrid parameter model, small signal analysis of CE, CC, CB Amplifiers using exact and approximate h-parameter model, analysis of CE Amplifier with emitter resistance. low frequency response of BJT Amplifiers.
MODULE V	FIELD-EFFECT TRANSISTORS | Number of Lectures: 09
	Junction Field Effect Transistor (JFET) – Structure, principle of operation and characteristics, pinch off voltage and drain saturation current. Metal Oxide Semiconductor Field-Effect Transistor (MOSFET) – Structure, principle of operation and characteristics. Small Signal Model of JFET and analysis of CS, CD and CG JFET Amplifiers.

TEXTBOOKS

1. S Salivahanan, N Suresh Kumar " Electronic Devices and Circuits", 2nd Edition, 2018, McGraw Hill Education.

2. J. Millman and Christos C. Halkias, "Integrated Electronics", International Student Edition , 2008, Tata McGraw Hill Publications.

3. David A. Bell, "Electronic Devices and Circuits", 5th Edition, Oxford University Press.

REFERENCE BOOKS:

1. R.L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuits", 9th Edition, 2006, PEI/PHI.

2. B.P.Singh, Rekha Singh, "Electronic Devices and Circuits", 2nd Edition, 2013, Pearson Publisher.

3. K. Lal Kishore, "Electronic Devices and Circuits", 2nd Edition, 2005,BS Publisher.

4. Anil K. Maini and Varsha Agarwal, “Electronic Devices and Circuits”, 1stEdition, 2009, Wiley India Pvt. Ltd.

MATERIALS ONLINE:

1. NPTEL :: Electrical , Electronics and Communication: Semiconductor Devices and Circuits
2. NPTEL :: Physics - NOC: Introduction to Solid State Physics
3. NPTEL :: Physics - NOC: Solid State Physics
4. https://khub.nthu.edu.tw/
5. NPTEL :: Electrical , Electronics and Communication: Fundamental of Semiconductor Devices

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)			
2	P-type and N-type semiconductors	CO 1	T1: 2.1
3	Formation of PN-junction diode	CO 1	T1: 2.1
4	Diode I-V Characteristics	CO 1	T1: 2.6
5	Ideal versus practical diodes	CO 1	T1: 2.6
6	Diode resistances, diode equivalent circuits	CO 1	T1: 2.6
8	Transition capacitances	CO 1	T1: 2.7
9	Diffusion capacitances	CO 1	T1: 2.7
10	Special Diodes: Zener diode	CO 6	T1: 2.9,2.11
11	Light Emitting diode and Varactor diode	CO 6	T1: 2.19,2.18
12	Tunnel diode	CO 6	T1: 2.12
13	Block diagram of a regulated power supply, Half-wave Rectifier	CO 2	T1: 3.2.1
14	Full wave Rectifier	CO 2	T1: 3.2.2.
15	Bridge rectifier circuits	CO 2	T1: 3.2.3
16	Full wave Rectifier with capacitive Filter	CO 2	T1: 3.6
18	Zener diode as voltage regulator	CO 2	T1: 3.6
20	Clippers	CO 2	T1: 6.15
21	Clampers	CO 2	R5: 8.5-8.6
22	Clamping circuit theorem, Voltage multiplier circuits.	CO3	R5: 8.5-8.6
25	Construction and operation of PNP and NPN transistors	CO 3	T1: 4.4
26	CB configuration, input and output characteristics	CO 3	T1: 4.4

S.No	Topics to be covered	CO's	Reference
27	CE configuration, input and output characteristics	CO 3	T1: 4.4
28	CC configuration, input and output characteristics	CO 3	T1: 4.4
30	Hybrid parameters calculations	CO 3	T1: 6.3
31	Need for biasing, load line, operating Point	CO 3	T1: 5.4, 5.5
32	Stability factors DC analysis of Fixed bias	CO 3	T1: 5.4.1
33	Collector Feedback bias	CO 3	T1: 7.2-7.3
34	Emitter Feed Back bias, Voltage divider bias circuits	CO 3	T1:5.4.3
37	Thermal runaway, Condition for thermal stability	CO 3	T1: 5.6
38	Stabilization techniques	CO 3	T1: 5.6
39	Transistor as an Amplifier, Transistor Hybrid parameter model	CO 4	T1: 6.6
40	Small signal analysis of CE using exact analysis	CO 4	T1: 6.6
41	Small signal analysis of CE using approximate analysis	CO 4	T1: 6.6
42	Small signal analysis of CB using exact analysis	CO 4	T1:6.8 T1: 6.6
43	Small signal analysis of CB and CC using approximate analysis	CO 4	T1: 6.6
44	Analysis of CE Amplifier with emitter resistance and low frequency response of BJT Amplifiers	CO 4	T1: 6.9
48	JFET Structure, principle of operation	CO5	T1:4.12
49	J FET V-I Characteristics	CO 5	T1:4.13
50	Pinch off voltage and drain saturation current.	CO 5	T1:4.13
51	N MOSFET – Structure and Principle of operation	CO 5	T1: 4.15
52	PMOSFET – Structure and Principle of operation	CO 5	T1:4.16
53	Small Signal Model of JFET and analysis of CS JFET Amplifiers	CO 5	T1:6.16
54	CD and CG JFET Amplifiers.	CO 5	T1:6.17
55	CS JFET Amplifiers.	CO 5	T1: 6.18
PROBLEM SOLVING/ CASE STUDIES			
7	Related to Diode current and its resistance calculation	CO 1	T1: 2.3
17	Rectifier parameters estimation	CO 1	T2:2.6
19	Zener diode regulator	CO 6	T1: 2.11
23	Clipper circuits	CO 2	T2:2.9, 2.10
24	Clamper circuits	CO 2	T2:2.9, 2.10
29	Current gain of transistor configuration	CO 1	T1:4.3
35	Transistor fixed biasing	CO 4	T2:5.4.1
36	Transistor collector to base biasing	CO 1	T1: 2.6
45	CE Transistor amplifier analysis	CO5	T1:6.14
46	CB Transistor amplifier analysis	CO 5	T1:6.14
47	CC Transistor amplifier analysis	CO 5	T1:6.14
55	CS Amplifier analysis	CO 5	T1: 6.17 R5: 4.4

S.No	Topics to be covered	CO's	Reference
56	CD Amplifier analysis	CO 5	T1: 6.17 R5: 4.4
DISCUSSION OF DEFINITION AND TERMINOLOGY			
58	Semiconductor diodes	CO 1	DT
59	Diode circuits	CO 2	DT
60	Bipolar junction transistor and biasing	CO 3	DT
61	BJT amplifiers	CO 4	DT
62	Field-effect transistors	CO 5	DT
DISCUSSION OF QUESTION BANK			
63	Semiconductor diodes	CO 1	T1: 2.1-2.7, T1: 3.2 - 3.6
64	Diode circuits	CO 2	T1:4.2 - 4.4
65	Bipolar junction transistor and biasing	CO 3	T1: 5.2, 6.6 - 6.13
66	BJT amplifiers	CO 4	T1: 4.12-4.16
67	Field-effect transistors	CO 5	T1: 6.15 - 6.18, 2.9 - 2.18

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.

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

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	SEE/CIE/AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	SEE/CIE/AAT

PO 3	**Design/Development of Solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	SEE/CIE/AAT
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	2	SEE/CIE/AAT

26. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

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

3 = High; 2 = Medium; 1 = Low

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	Illustrate the volt-ampere characteristics **(knowledge)** of semiconductor devices to derive **mathematical model** for diode current, static and dynamic resistance by applying the principles of **mathematics** and **scientific principles** for solving complex engineering problems.	2

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 static and dynamic resistance from the volt-ampere characteristics of the semiconductor devices using **experimental design**	3
	PO 10	**Communicate orally** on semiconductior device functionalities and **write** effective reports on characteristics of diode,BJT and MOSFEts	2
CO 2	PO 1	Apply the pn junction characteristics for the diode applications of diode as switch, clippers, Clampers and rectifiers by analyzing complex engineering problems using the principles of **mathematics, scintific principles and methodology**	2
	PO 2	Understand the given the diode application **problem statement** and finding the **implementation** of rectifier,clipper and clamper circuits by using diode	2
	PO 3	Undertsnad the **user needs**, then define a **problem and identify the constraints** then **manage the design process** using diode as rectifiers for **awareness of the framework of relevant engineering activities, safety issues**	4
	PO 10	**Communicate orally** on appliactions of semiconductor diode and **write** effective reports on electronic circuits using diode	2
	PSO 1	Formulate and Evaluate the rectifier circuit applications in the field of **Intelligent Embedded and robotics**	2
CO 3	PO 1	Understand DC and AC load line analysis of different amplifiers for optimal operating level by applying **mathematical, science principles and methodology** for solving the optimum operating point in amplifiers	2
	PO 2	Understand the given **problem statement** for DC and AC load line analysis using **experimental design** for **validating** the amplifier analysis.	3
	PO 10	**Communicate orally** on load line analysis of semiconductor devices and **write** effective reports on optimum operating point of amplifiers	2
CO 4	PO 1	Understand the **mathematical principles** for design the biasing techniques for BJT, JFET and MOSFETs amplifier circuits for stable operation by applying the **methodology**	2
	PO 2	Understand the **problem statement** of biasing techniques for BJT, JFET and MOSFETs amplifier and **formulation** of proper operating point for **validating** the amplifiers and **interpret** the results.	4

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 3	**Define a problem and identify constraints** of amplifier circuits to satisfy the **user needs** to develop the **sustainable development** in amplifiers.	3
	PO 10	**Communicate orally** on biasing methids for BJT and FETS and **write** effective reports on stability factors with biasing approaches for transistors	2
	PSO 1	Formulate the amplifier circuits using BJT and FET for **developing real time problems** and **digital circuits**	2
CO 5	PO 1	Estimate the characteristic parameters of BJT, FET amplifier circuits using **mathematical principles** for solving complex engineering problems using low frequency model by applying **Scientific methodology.**	2
	PO 2	Analyze small signal analysis **problem statements** of BJT, FET amplifier circuits for **experimental design** for **validation** and **interpretation** of results.	4
	PO 10	**Effective presentation and speaking style** on small signal analysis and **write subject matter effectively** on amplifiers using BJT and FETS.	2
CO 6	PO 1	understand the working principle of special purpose semiconductor devices by applying **Scientific principles and methodology.**	1
	PO 10	**Effective presentation and speaking style** on zener diode, tunnel diode , SCR and UJT then **write subject matter effectively** on characteristics of special semiconductor devices.	2

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

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	30	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 2	66.7	20	40	-	-	-	-	-	-	40	-	-	40	-	-
CO 3	66.7	30	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 4	66.7	40	30	-	-	-	-	-	-	40	-	-	40	-	-
CO 5	66.7	40	-	-	-	-	-	-	-	40	-	-	-	-	-
CO 6	33.3	-	-	-	-	-	-	-	-	40	-	-	-	-	-

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	1	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 2	3	1	2	-	-	-	-	-	-	2	-	-	2	-	-
CO 3	3	1	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 4	3	2	1	-	-	-	-	-	-	2	-	-	2	-	-
CO 5	3	2	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 6	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-
Total	**16**	**7**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**12**	**-**	**-**	**4**	**-**	**-**
Average	**2.7**	**1.4**	**1.5**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**2**	**-**	**-**

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

34. 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 of usage of electronics and communications in day-to-day life. Electronics and communications plays a key role in: High-speed internet connectivity and tailored online educational content delivered via satellite Electronic attendance monitoring and provision of incentives for parents to reduce dropout rates. Remote learning, e-learning and lifelong learning opportunities for remote and isolated communities
5		
6		

7	AFFORDABLE AND CLEAN ENERGY	**Affordable and Clean Energy:** Understanding electronic 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 contributes to designing safer, more durable, and environmentally friendly infrastructure projects. VLSI 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 chip manufacturing systems.
10	REDUCED INEQUALITIES	
11	SUSTAINABLE CITIES AND COMMUNITIES	
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 ——————————.

Signature of Course Coordinator **HOD,ECE**
Dr. V.R.Seshagiri Rao, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

<table>
<tr><td>1</td><td>Department</td><td colspan="5">ELECTRONICS AND COMMUNICATION ENGINEERING</td></tr>
<tr><td>2</td><td>Course Title</td><td colspan="5">SIGNALS AND STOCHATIC PROCESS</td></tr>
<tr><td>3</td><td>Course Code</td><td colspan="5">AECD02</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="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
0</td><td>Credits
0</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: .... 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. J. Mohan</td></tr>
<tr><td>12</td><td>Date Approved by BOS</td><td colspan="5">22/08/2023</td></tr>
<tr><td>13</td><td>Course Webpage</td><td colspan="5">https://www.iare.ac.in/sites/default/files/BT23/AECD02.pdf</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>AHSD08</td><td>II</td><td colspan="2">DE and VC</td></tr>
</table>

15. Course Overview

This course introduces students to learn the fundamental concepts and techniques used in the analysis and processing of signals. The second part focus on the basic concepts of random processes, random signals, and their interaction with the electrical or electronic systems. The course forms the basis for the next level courses of an electronics engineer such as communications, digital signal processing, radar systems, machine learning and data science.

16. COURSE OBJECTIVES:

The students will try to learn:

I	The Fourier transform, Laplace and their properties to analyze the signals and systems.
II	The temporal and spectral characteristics of random process and the extraction of signal from noise by filtering.
III	The characteristics of 1-Dimensional stationary random signals in time and frequency domains.
IV	Analysis of the response of a linear time invariant (LTI) system driven by 1-Dimensional stationary random signals useful for subsequent design and analysis of communication systems.

17. COURSE OUTCOMES:

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

CO 1	**Utilize** the concept of convolution and correlation to determine the response of an LTI system for different signals.	Understand
CO 2	**Make** use of Fourier series and Fourier transforms for calculating spectral characteristics of periodic and aperiodic signals.	Understand
CO 3	**Apply** the Laplace transform for analyzing the frequency domain representation of continuous time signals and systems respectively.	Apply
CO 4	**Extend** the random variable concept to random process and its sample functions for demonstrating the time domain and frequency domain characteristics.	Understand
CO 5	**Develop** the auto-power and cross- power spectral densities to solve the related problems of random processes using correlation functions and the Fourier transform.	Apply
CO 6	**Discover** the frequency domain characteristics of a linear time invariant (LTI) system response driven by stationary random processes using the relationship between correlation functions and power density spectra.	Analyze

18. Topic Learning Outcome (TLOs):

S.No	**Topic(s)**	**TLO No**	**Topic Learning Outcome's**	**Course Out-come**	Blooms Level
1	Signal Analysis:	1	**Interpret** the fundamental concepts of signal analysis through a procedural approach	CO 1	Understand
		2	**Aware** the signal Vectors with in the class room	CO 1	Understand

S.No	Topic(s)	TLO No	Topic Learning Outcome's	Course Out-come	Blooms Level
		3	**Identify** the Orthogonal Signal Space within the classroom as well as outside the classroom.	CO 1	Understand
2	Orthogonal functions.	4	**Practice** to find mean square error in signal using vectors with in the class room	CO 1	Understand
		5	**To Understand** the concepts of Orthogonal function signal analysis through a procedural approach	CO 1	Understand
		6	**To Aware** Orthogonality and complex function signal through a procedural approach	CO 1	Understand
3	Classification of Signals	7	**Examine** Concept of signals,impulse function,step function, signum function within the classroom and outside world	CO 1	Understand
		8	**Examine** sinusoidal continues signal and Exponential signal within the classroom and outside world	CO 1	Understand
4	Operations on signals	9	**Familiar** with Concept of Operation of Signals through a procedural approach	CO 1	Understand
		10	**Understand** the Concept of Mathematical operation and able to explore the signal operations	CO 1	Understand
6	Linear System	11	**Describe** the concept of Linearity of LTI Systems within the classroom and outside world	CO 1	Understand
		12	**Understand** Impulse response of system within the classroom and outside world	CO 1	Understand
7	Linear Time Variant (LTV) System	13	**Understand** concept of linear time varying in system for CT and DT within the classroom and outside world	CO 1	Understand
		14	**Understand** Causality and Transfer function of CT and DT system within the classroom and outside world	CO 1	Understand
8	Concept of convolution	15	**Understand** the convolution both time and frequency within the classroom	CO 1	Understand
		16	**Demonstrate** the graphical representation of convolution in CT and DT system within the classroom	CO 1	Understand
9	Fourier series:	17	**Understand** Fourier series, Continuous time periodic signals and to solve the CT and DT signal Coefficients	CO 2	Understand

S.No	**Topic(s)**	**TLO No**	**Topic Learning Outcome's**	**Course Out-come**	Blooms Level
		18	Property's of Fourier serious and prove the properties in class room approach	CO 4	Understand
10	Fourier Transforms:	19	**Understand** Fourier Transform Continuous time periodic signals and to solve the CT and DT signal Coefficients	CO 2	Understand
		20	**Derive** the Fourier Transform form Fourier series within the classroom approach	CO 2	Understand
11	Laplace Transforms	21	**Understand** Concept of Laplace transform and property of through a procedural approach	CO 3	Understand
		22	**Understand** Concept of ROC in Laplace transform in Class room approach	CO 2	Understand
		23	**Understand** Concept of ROC in Laplace transform in Class room approach	CO 2	Understand
12	Relation between L.T and F.T of a signal	24	**Find** relation between Laplace transform and Fourier trans form in through a procedural approach	CO 3	Understand
13	Random variables and operations	25	**Describe** the concept of random variables , distribution and density functions through a procedural approach	CO 3	Understand
		26	**Understand** the concept binomial,Poisson,uniform,Gaussian and Rayleigh concept through a mathematical approach	CO 3	Understand
14	Random Random Process	26	**Understand** the concept of distribution, density Functions, Stationary and Statistical Independent variable	CO 4	Understand
		27	**Determine** the first, second Order, Wide-Sense Stationarity and Ergodicity, Mean-Ergodic, Autocorrelation Function through a procedural approach	CO 4	Understand
15	Gaussian and Poisson Processes	28	**illustrate** the covariance of Gaussian function using random and poisson process through a mathematical approach	CO 4	Apply
		29	**Outline** the Autocorrelation,Cross-Correlation between input and output through a procedural approach	CO 4	Apply
16	The Power Spectrum	30	**Interpret** the Properties, Relationship between Power Spectrum and Autocorrelation Function through a class room approach	CO 5	Analysis

S.No	Topic(s)	TLO No	Topic Learning Outcome’s	Course Out-come	Blooms Level
		31	**Outline** the Cross-Power Density Spectrum Properties, Relationship through a procedural approach	CO 6	Apply
17	Spectral Characteristics of System Response	32	**illustarte** to calculate the Noise Bandwidth of Power Density Spectrum Response through a class room approach	CO 6	Analysis
		33	**Examine** the noise bandwidth of Cross-Power Density Spectrums of Input and Output random process through a procedural approach	CO 6	Apply

19. Employability Skills

Example: Communication skills / Programming skills / Project based skills /
From Signal and Probability theories one can develop analytical thinking, technical proficiency in signal analysis, and system design using tools like MATLAB. It enhances problem-solving, attention to detail, and critical thinking, while also strengthening communication, teamwork, and project management abilities. Adaptability and research skills are also cultivated, making students valuable in fields like telecommunications, electronics, and control systems

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	**SIGNAL ANALYSIS** ‘ . | **Number of Lectures: 09**
	Signal Analysis: Analogy between Vectors and Signals, Orthogonal Signal Space, Signal approximation using Orthogonal functions, Mean Square Error, Closed or complete set of Orthogonal functions, Orthogonality in Complex functions, Classification of Signals , Exponential and Sinusoidal signals, Concepts of Impulse function, Unit Step function, Signum function ,Operations on signals. Signal Transmission through Linear Systems: Linear System, Impulse response, Response of a Linear System, Linear Time Invariant (LTI) System, Linear Time Variant (LTV) System, Causality, Transfer function of a LTI system, Filter characteristic of Linear System, Distortion less transmission through a system, Signal bandwidth, System Bandwidth, Concept of convolution in Time domain and Frequency domain, Graphical representation of Convolution
MODULE II	**FOURIER SERIES, TRANSFORMS** | **Number of Lectures: 10**
	Fourier series: Representation of Fourier series, Continuous time periodic signals, Properties of Fourier Series,Dirichlet's conditions, Trigonometric Fourier Series and Exponential Fourier Series, Complex Fourier spectrum. Fourier Transforms: Deriving Fourier Transform from Fourier series, Fourier Transform of arbitrary signal, Fourier Transform of standard signals, Fourier Transform of Periodic Signals, Properties of Fourier Transform, Fourier Transforms involving Impulse function and Signum function.

MODULE III	**LAPLACE TRANSFORMS AND RANDOM VARIABLES** . | **Number of Lectures: 10**
	Laplace Transforms: Review of Laplace Transforms (L.T), Partial fraction expansion, Inverse Laplace Transform, Concept of Region of Convergence (ROC) for Laplace Transforms, Constraints on ROC for various classes of signals, Properties of L.T, Relation between L.T and F.T of a signal, Laplace Transform of certain signals using waveform synthesis. Random variables and operations on random variables: Random Variables: Definition, Types of Random Variable, Distribution and Density functions: Definition and Properties, Binomial, Poisson, Uniform, Gaussian, Exponential, Rayleigh, random variables, Methods of defining Conditioning Event, Conditional Distribution, Conditional Density and their Properties, Expected Value of a Random Variable, Function of a Random Variable, Standard and Central Moments
MODULE IV	**RANDOM PROCESSES – TEMPORAL CHARACTERISTICS** . | **Number of Lectures: 09**
	Random Process: Definition and Classification, Distribution and Density Functions, Stationarity and Statistical Independence., First- Order, Second-Order, Wide-Sense Stationarities (N-Order) and Strict-Sense Stationarity, Time Averages and Ergodicity, Mean-Ergodic and Correlation-Ergodic Processes, Autocorrelation Function and Its Properties, Cross-Correlation Function and Its Properties, Covariance Functions, Gaussian and PoissonRandom Processes. Response of Linear Systems to Random Process input, Mean and MS value of System Response, Autocorrelation Function of Response, Cross- Correlation between Input and Output
MODULE V	**Random Processes – Spectral Characteristics** . | **Number of Lectures: 10**
	The Power Spectrum: Properties, Relationship between Power Spectrum and Autocorrelation Function, The Cross-Power Density Spectrum, Properties, Relationship between Cross-Power Spectrum and Cross-Correlation Function. Spectral Characteristics of System Response: Power Density Spectrum of Response, Cross-Power Density Spectrums of Input and Output, Noise Bandwidth.

TEXTBOOKS

1. B.P. Lathi, "*Signals, Systems and Communications*", BSP, 3 th Edition, 2013.

2. A.V. Oppenheim, A.S. Willsky and S.H. Nawabi, "*Signals and Systems*", PHI, 2nd Edition 2010.

3. Peyton Z. Peebles, "*Probability, Random Variables and Random Signal Principles*", TMH, 4th Edition, 2001.

REFERENCE BOOKS:

1. Simon Haykin and Van Veen, "*Signals and System*", Wiley Publications, 2nd Edition 2010.

2. Michel J. Robert, "*Fundamentals of Signals and Systems*",MGH International Edition. 2nd Edition, 2008

3. Bruce Hajck, "*Random Processes for Engineers*", Cambridge Unipress, 2015.

4. Athanasios Papoulis and S. Unnikrishna Pillai, "*Probability, Random Variables and Stochastic Processes*", PHI, 4th Edition,2002.

5. K.Murugesan, P. Guruswamy, "*Probability, Statistics and Random Processes*", Anuradha Agencies, 3 rd Edition, 2003

MATERIALS ONLINE:

1. https://www.edx.org/course/discrete-time-signal-processing-mitx-6-341x-1
2. https://www.mooc-list.com/course/digital-signal-processing-coursera
3. www.britannica.com/topic/probability-theory
4. www.math.uiuc.edu/ r-ash/BPT.html
5. www.ma.utexas.edu/users/gordanz//introduction$_to_stochastic_processes.pdfnptel.ac.in/courses/$111102014
6. http://vceece2k10.blogspot.in/p/semester-2-1.html
7. 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	**Signal Analysis:** : Analogy between Vectors and Signals, Orthogonal Signal Space, Signal approximation using Orthogonal functions.	CO 1	T1:1.1-1.5, R1:1.1-1.9
2	Mean Square Error, Closed or complete set of Orthogonal functions, Orthogonality in Complex functions.	CO 1	T1:1.1-1.5, R1:1.1-1.9
3	Classification of Signals , Exponential and Sinusoidal signals, Concepts of Impulse function.	CO 1	T1:2.0-2.1
4	Unit Step function, Signum function ,Operations on signals.	CO 1	T1:2.2-2.5, R1:2.3-2.4
5	**Signal Transmission through Linear Systems:** Linear System, Impulse response, Response of a Linear System, Linear Time Invariant (LTI) System.	CO 1	T1:2.2-2.5, R1:2.3-2.4

S.No	Topics to be covered	CO's	Reference
6	Linear Time Variant (LTV) System, Causality, Transfer function of a LTI system.	CO 1	T1:2.2-2.5, R1:2.3-2.4
7	Filter characteristic of Linear System.	CO 1	T1:2.6, R1:2.7
8	Distortion less transmission through a system, Signal bandwidth, System Bandwidth.	CO 1	T1:3.0-3.2, R1: 3.3-3.5
9	Concept of convolution in Time domain and Frequency domain, Graphical representation of Convolution.	CO 1	T1:3.0-3.2, R1: 3.3-3.5
10	**Fourier series:** Representation of Fourier series, Continuous time periodic signals	CO 2	T1:3.0-3.2, R1: 3.3-3.5
11	Properties of Fourier Series,Dirichlet's conditions	CO 2	T1:3.3, R1: 3.6
12	Trigonometric Fourier Series and Exponential Fourier Series.	CO 2	T1:3.4, R1: 3.8
13	Complex Fourier spectrum.	CO 2	T1:4.0-4.4,3
14	**Fourier Transforms:** Deriving Fourier Transform from Fourier series	CO 2	T1:4.0-4.4, R2: 4.2-4.3
15	Fourier Transform of arbitrary signal,Fourier Transform of standard signals.	CO 2	T1:4.5, R2: 4.4
16	Fourier Transform of Periodic Signals.	CO 2	T1:4.5, R2: 4.4
17	Properties of Fourier Transform.	CO 2	T1:4.6-4.7, R1: 4.6-4.7
18	Fourier Transforms involving Impulse function and Signum function.	CO 2	T1:5.0-5.1, R1: 5.2-5.3
19	**Laplace Transforms:** Review of Laplace Transforms (L.T), Partial fraction expansion, Inverse Laplace Transform.	CO 3	T1:5.0-5.1, T1: 5.2-5.3
20	Concept of Region of Convergence (ROC) for Laplace Transforms	CO 3	T1:5.0-5.1,
21	Properties of L.T,Relation between L.T and F.T of a signal.	CO 3	T1:5.0-5.1,
22	Laplace Transform of certain signals using waveform synthesis.	CO 3	T1:5.0-5.1,
23	**Random variables and operations on random variables:** Random Variables: Definition, Types of Random Variable.	CO 3	T1:5.0-5.1,
24	Distribution and Density functions: Definition and Properties.	CO 3	T1:5.0-5.1,
25	Binomial, Poisson, Uniform, Gaussian, Exponential, Rayleigh, rarandom variable	CO 3	T1:5.0-5.1,
26	Methods of defining Conditioning Event, Conditional Distribution, Conditional Density and their Properties	CO 3	T1:5.0-5.1,

S.No	Topics to be covered	CO's	Reference
27	Expected Value of a Random Variable, Function of a Random Variable, Standard and Central Moments.	CO 3	T1:5.0-5.1,
28	**Random Process:** : Definition and Classification, Distribution and Density Functions, Stationarity and Statistical Independence., First- Order, Second- Order, Wide-Sense Stationarities (N-Order) and Strict-Sense Stationarity.	CO 5	T3:5.0-5.1,
29	Time Averages and Ergodicity, Mean-Ergodic and Correlation-Ergodic Processes,Autocorrelation Function and Its Properties.	CO 5	T3:6.1-6.2, R3: 6.7-6.9
30	Cross-Correlation Function and Its Properties, Covariance Functions.	CO 5	T1:6.1-6.2, R1: 6.7-6.9
31	Gaussian and PoissonRandom Processes. Response of Linear Systems to Random Process input	CO 5	T3:6.1-6.2, R1: 6.7-6.9
32	Mean and MS value of System Response, Autocorrelation Function of Response	CO 5	T3:6.3, R1: 6.10- 6.12
33	Cross- Correlation between Input and Output.	CO 4	T3:6.4, R1: 6.10- 6.12
34	**The Power Spectrum:** Properties	CO 5	T3:7.1-7.2, R3: 7.2-7.5
35	Relationship between Power Spectrum and Autocorrelation Function.	CO 5	T1:7.1-7.2, R3: 7.2-7.5
36	The Cross-Power Density Spectrum.	CO 6	T3:7.1-7.2, R3: 7.2-7.5
37	Cross-Power Density Spectrum- Properties	CO 6	T3:7.1-7.2, R3: 7.2-7.5
38	Relationship between Cross-Power Spectrum and Cross-Correlation Function.	CO 6	T3:7.1-7.2, R3: 7.2-7.5
39	Spectral Characteristics of System Response Power Density Spectrum of Response.	CO 6	T3:7.1-7.2, R3: 7.2-7.5
40	Noise Bandwidth.	CO 6	T3:7.1-7.2, R3: 7.2-7.5
PROBLEM SOLVING/ CASE STUDIES			
41	Problem on Mean Square Error.	CO 1	T1:3
42	Problem solving on convolution in Time domain	CO 1	T1:2
43	Problems on of LTI System	CO 1	T1:2
44	Problem on Unit Step function, Signum function,	CO 2	T1:3
45	Problem on Graphical representation of Convolution,	CO 2	T1:3
46	Problem on Response of a Linear System, Linear Time Invariant (LTI) System,	CO 2	T1:3
47	Given Linear Time Invariant (LTI) System causal or not.	CO 2	T1:3
48	find a given Linear Time Invariant (LTI) System linear are not.	CO 2	T1:3

S.No	Topics to be covered	CO's	Reference
49	Problem on Fourier series coefficient.	CO 3	T1:3
50	Problems on Fourier series	CO 3	T3:3
51	Problems on complex Fourier series	CO 3	T3:3
52	Problems on Fourier Transforms	CO 3	T3:3
53	Problems in Region of Convergence (ROC) for Laplace Transforms	CO 3	T3:3
54	Problem on Autocorrelation Function	CO 4	T3:3
55	Problem Power Spectrum Density	CO 5	T3:4
DISCUSSION OF TUTORIAL QUESTION BANK			
56	Find the Fourier transform of the signal x(t) = 5cos 5t+10 sin 15t and sketch its magnitude and phase spectra.	CO 1, CO2	R4:2.1
57	Compute the output y(t) for a continuous LTI system whose impulse response h(t) and the input x(t) are given by h(t)= e-at u(t) and x(t)= eat u(-t).	CO2	T4:7.3
58	Determine the initial value and final value of Laplace transform of signal	CO 4	R4:5.1
59	A filter has an input x(t)= u(t) and transfer function, H(w)=1/(1+jw). Find the ESD of the output?	CO 5	T3:7.5
60	Power Density Spectrum	CO 6	T3: 4.1
DISCUSSION OF DEFINITION AND TERMINOLOGY			
61	Concepts of Impulse function	CO 1	T1:1
62	Linear Time Invariant (LTI) System	CO 1	T1:1
63	Constraints on ROC for various classes of signals	CO 2	T1:1
64	Types of Random Variable, Distribution and Density functions:	CO 2	T3:1
65	Exponential, Rayleigh, random variables	CO 1	T1:1
66	Function of a Random Variable.	CO 3	T3:4,5
67	Correlation-Ergodic Processes	CO 4	T3:6

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

Program Outcomes	
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
Program Specific Outcomes	
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.
PSO 3	GMake use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.

25. 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	SEE/Quiz/AAT
PO 2	**Problem analysis:** Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	SEE/Quiz/AAT
PO 4	**Conduct Investigations of Complex Problems:** Design/Development of Solutions: Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and Environmental considerations	2	SEE/Quiz/AAT

26. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Strength	Proficiency Assessed by
PSO 2	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.	1	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	Classify (knowledge) basic concepts of orthogonal signals from the vector algebra using principles of mathematics, signals such as exponential, sinusoidal, impulse, unit step, signum for performing mathematical operations on signals scientific methodology mathematical operations on signals (by applying the principles of science for engineering problems.) etc.	3
	PO 2	Extend(knowledge, understand, apply) the linearity and time invariance concepts to linear time invariant system for analyzing, formulate,(apply)and state a(complex) problem, to the behavior of LTI system in both time and frequency domains by applying the principles of mathematics and science for engineering problem (problems) and interpret and document the results.	3
	PO 4	Demonstrate and develop the given problem statement , identification , and formulate to design simple LTI system,in both time and frequency domains.	3
CO 2	PO 1	Understand the given problem statement and identification of the Fourier transform and apply the problem formulation of spectral characteristics of continuous time aperiodic signals and design the frequency response of the given system.	3
	PO 2	Develop the Fourier transform of magnitude and phase using Modern tools and analyze to complex engineering problems.	1
	PO 4	Demonstrate the ablility to communicate effectively in writing design documentation and make effective presentation.	6
CO 3	PO 1	Define (knowledge) the transformation and/or the expectation operation on random variables and their functions, to formulate the definition of moments of a random variable using mathematical principles and demonstrate (understand) the use of the characteristic and moment generating functions(knowledge) to analytically derive the standard moments(by means of scientific principles and methodology) useful for identifying (understand) various noises encountered in communication systems and electronic circuits to support the other courses of the program(own engineering discipline).	3

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 2	Demonstrate(understand) the physical significance of the characteristic and moment generating functions and develop (apply) the Nth order standard and central moments using the above functions to identify, formulate and state a problem, and develop solution that uses moments as features and interpret and document the results.	6
	PO 4	Develop the solutions for complex Engineering problems and design system components using the multiple random variables, understand customer and user needs and identify the cost limitations for the selection of parameters, use creativity in applying the methods of model analyses for the use of multiple random variables	5
CO 4	PO1	Define (knowledge)the random process as the extension (understand) of scalar random variables using mathematical principles and explain (understand) the meaning of correlation and co variance using scientific principles and methodology and interpret (understand) them for supporting the study of interdisciplinary courses such as digital image processing (own engineering discipline) and data sciences (other engineering disciplines)	3
	PO 2	Demonstrate(understand) the physical significance of the random process and develop (apply) the Nth order distribution and density functions using the random variable concept to identify, formulate and state a problem, and develop solution that uses co-variance and correlation as features.	5
	PO4	Develop the solutions for complex Engineering problems and design system components using the random process, understand customer and user needs and identify the cost limitations for the selection of parameters, use creativity in applying the methods of model analyses the use of random process.	5
CO 5	PO 1	Relate (understand) the correlation and co-variance (knowledge) of random process to the linear and time invariant systems using the mathematical principles and demonstrate (understand) the system response and its physical significance using scientific methodology and integrate these concepts into the study of communication systems (own engineering discipline) and (complex) signal processing systems.	3

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO2	Demonstrate(understand) the physical significance of the random process and develop (apply) the reponse of LTI system using the random process concept to identify, formulate and state a problem, and develop solution that uses co-variance and correlation as features.	5
	PO4	Develop solutions for complex Engineering problems and design system components using random process for customer and user needs and identify the cost limitations for the selection of parameters, use creativity in applying the methods of model analyses for the analysis of linear time invariant systems in time domain.	5
CO 6	PO 1	Define (knowledge) the auto power spectral density and cross power spectral density functions, to formulate the response of LTI systems using mathematical principles and demonstrate (understand) the use of the joint characteristic and joint moment generating unctions(knowledge) to analytically derive the power spectral densities of the LTI system (by means of scientific principles and methodology and for supporting(own engineering discipline) some image processing algorithms.	3
	PO 2	Demonstrate(understand) the physical significance of the random process and develop (apply) the response of LTI system in frequency domain using the random process concept to identify and develop solution that uses Fourier transform properties	2
	PO 4	Develop the solutions for complex Engineering problems and design system components using the power spectral density functions, understand customer and user needs.	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	3	-	3	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	1	-	6	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	6	-	5	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	5	-	5	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	5	-	5	-	-	-	-	-	-	-	-	-	-	1
CO 6	3	2	-	3	-	-	-	-	-	-	-	-	-	-	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	100	30	-	27	-	-	-	-	-	-	-	-	-	-	-
CO 2	100	10	-	55	-	-	-	-	-	-	-	-	-		-
CO 3	100	60	-	46	-	-	-	-	-	-	-	-	-	-	-
CO 4	100	50	-	46	-	-	-	-	-	-	-	-	-	-	-
CO 5	100	50	-	46	-	-	-	-	-	-	-	-	-	-	14
CO 6	100	20	-	27	-	-	-	-	-	-	-	-	-	-	14

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	1	-	1	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	1	-	2	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	3	-	2	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	2	-	2	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	2	-	2	-	-	-	-	-	-	-	-	-	-	1
CO 6	3	1	-	1	-	-	-	-	-	-	-	-	-	-	1
TOTAL	18	10	-	10	-		-	-	-	-	-	-	-	-	2
AVERAGE	3	1.67	-	1.67	-		-	-	-	-	-	-	-	-	0.3

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

34. Relevance to Sustainability goals

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

1		
2		
3		**Good Health and Well-Being:** These subject contribute to the development of advanced diagnostic tools and medical imaging techniques, while probability theories support accurate predictions of disease trends and patient risks. By improving diagnostic precision and forecasting health needs, they enhance the overall effectiveness of healthcare systems and promote better health outcomes.
4		**Quality Education:** These principles will enable the development of innovative educational technologies, such as adaptive learning systems and data-driven educational assessments, ensuring that education is inclusive, equitable, and responsive to diverse learning needs. By integrating these theories, educational tools and strategies can be optimized for more effective teaching and learning outcomes, thereby contributing to the global pursuit of quality education for all.
5		
6		**Clean Water and Sanitation:** These concepts help in the development of predictive models for water quality assessment, early detection of contamination, and optimization of water treatment processes. Through data-driven approaches, it contribute to ensuring safe, reliable, and sustainable access to clean water and sanitation for everyone.

7	AFFORDABLE AND CLEAN ENERGY	**Affordable and Clean Energy:** These concepts aid in the development of smart grids, optimize the use of renewable energy, and support accurate forecasting of energy needs. By refining energy distribution and reducing inefficiencies, they help make clean energy more widely available and affordable for diverse populations.
8	DECENT WORK AND ECONOMIC GROWTH	
9	INDUSTRY, INNOVATION AND INFRASTRUCTURE	**Industry, Innovation, and Infrastructure:** These methodologies enable the creation of automated systems, enhance quality control through predictive analytics, and support the design of resilient structures. By boosting operational efficiency and driving technological progress, they help build sustainable and innovative industries and infrastructure.
10	REDUCED INEQUALITIES	
11	SUSTAINABLE CITIES AND COMMUNITIES	
12	RESPONSIBLE CONSUMPTION AND PRODUCTION	
13	CLIMATE ACTION	**Climate Action:** These technologies facilitate real-time monitoring of environmental conditions, improve the accuracy of climate predictions, and support efficient dissemination of climate information. By enabling effective communication and data-driven strategies, they help in crafting responsive actions and policies to combat climate change and its impacts.
14	LIFE BELOW WATER	**Life Below Water:** Signals and systems provide the technology for real-time monitoring of ocean conditions and marine life, while probability theories aid in predicting ecological shifts and the impacts of human activities. This integration helps in developing effective strategies to protect marine biodiversity and ensure the long-term health of our oceans.

15	LIFE ON LAND	**Life On Land:** These approaches enhance the analysis of ecological data, support efficient land management, and enable early detection of habitat changes. By leveraging sophisticated data techniques, they aid in preserving biodiversity and promoting sustainable land use practices.
16	PEACE, JUSTICE AND STRONG INSTITUTIONS	
17	PARTNERSHIPS FOR THE GOALS	

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

Signature of Course Coordinator **HOD-ECE**
Dr. J.Mohan, Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRONICS AND COMMUNICATION 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	Dr. B Ravi 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**	
		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 Python.
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)	TLO 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. Rance D. Necaise, —Data Structures and Algorithms using Python, Wiley Student Edition.
2. Benjamin Baka, David Julian, —Python Data Structures and Algorithms, Packt Publishers, 2017.

REFERENCE BOOKS:

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

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	T1:1.1.3 R2 : 1.4
2	Classification of data structures, Operations on data Structures	CO 1	T1:1.1.3 R2 : 1.4
3	Recursive algorithm, Performance Analysis	CO 1	T1:1.2 T1:5.1
4	Searching techniques: Linear search, binary search	CO 2	T1:5.1
5	Searching techniques: Uniform binary search and interpolation search	CO 2	T1:5.1
6	Searching techniques: Fibonacci search and comparison	CO 2	T1:5.1
7	Sorting techniques: Bubble sort, selection sort	CO 2	R1:14.5
8	Sorting techniques: Insertion sort, Quick sort	CO 2	T1:5.2 R2: 10.2
9	Sorting techniques: Merge sort and Radix sort, Shell sort and comparison of sorting algorithms	CO 2	T1:5.2 R2 : 10.2
10	Stacks ADT, definition and operations, implementation of stacks using Arrays	CO 3, CO 6	T1:7.1
11	Applications of stacks, arithmetic expression conversion and evaluation	CO 4, CO 6	T1:7.2
12	Queues: Primitive operations; Implementation of queues using Array	CO 3	T1:8.1
13	Applications of linear queue, circular queue	CO 4	T1:8.4
14	Double ended queue (deque)l	CO 3	R2 : 5.4
15	Linked lists: Introduction, singly linked list, representation of a linked list in memory	CO 3	T1:9.1
16	Operations on a single linked list, Applications of linked lists - Polyomial representation	CO 3	T1:9.2
17	Sparse matrix manipulation	CO 4, CO 6	T1:9.3

S.No	Topics to be covered	CO's	Reference
18	Types of linked lists:Circular linked lists	CO 3	T1:9.3
19	double linked lists	CO 3	T1:9.4
20	Linked list representation and operations of Stack	CO 3	T1:9.4
21	Linked list representation and operations of queue	CO 3	T1:9.4
22	Trees: Basic concept, Binary Tree	CO 3	T1:13.1
23	Binary tree representation using array	CO 3	T1:13.2
24	Binary tree representation using linked list	CO 3	T1:13.2
25	Binary tree traversal	CO 3	T1:13.2
26	Binary tree variants	CO 3	T1:13.2
27	Threaded binary tree	CO 3	T1:13.2
28	Application of trees	CO 4	T1:13.2.3
29	Graphs: Basic concept, graph terminology	CO 3	R2 : 8.2
30	Graph representation- Adjacency matrix, adjacency list	CO 3	R2 : 8.2
31	Graph implementation	CO 3	R2 : 8.2
32	Graph traversals BFS	CO 3, CO 4, CO 6	T2:6.2
33	Graph traversals :DFS	CO 3, CO 4, CO 6	T2:6.2
34	Application of graphs	CO 3, CO 4, CO 6	T2:6.2
35	Minimum Spanning Trees-Prims and Kruskal algorithms	CO 3, CO 4, CO 6	T1:6.1 T2:5.6
36	Binary search trees, properties and operations	CO 3	T1:13.2.3
37	AVL trees	CO 3	T1:13.2.3
38	M- Way search trees, B trees	CO 3, CO 4, CO 6	T1:14.3
39	B trees	CO 3	T1:14.3
40	Hashing, Collision	CO 5	R2 : 6.4
	Problem Solving/Case Studies		
1	Problems on linear search, binary search and Fibonacci search.	CO 2	T1:5.1
2	Problems on bubble sort, selection and insertion sort	CO 2	T1:5.2 R2 : 10.2
3	Problems on quick and merge sort	CO 2	T1:5.2 R2 : 10.2
4	Problems on Arithmetic expression conversion and evaluation	CO 4 CO 4	T1:7.2
5	Problems on single linked list to add, delete element	CO 3, CO 4	T1:9.8
6	Problems on double linked list to add, delete element	CO 3, CO 4	T1:9.8
7	Problems on circular linked list to add, delete element	CO 3, CO 4	T1:9.4
8	Problems on double linked list to add, delete element	CO 3, CO 4	T1:9.3
9	Problems on stack using linked list	CO 3, CO 4	T1:9.7

S.No	Topics to be covered	CO's	Reference
10	Problems on queue using linked list	CO 3, CO 4	T1:9.8
11	Problems on Binary tree :creation ,insertion and deletion of a node	CO 3	T1:13.2
12	Problems on Graph Traversal: DFS and BFS	CO 3, CO 4	T2:6.2
13	Problems on MST: Prim's and Kruskal's	CO 3, CO 4	T1:6.1 14:5.6
14	Problems on Binary search tree	CO 4	T1:14.3
15	Problems oh hashing	CO 5	R2 : 6.4
Definition and Terminology			
1	Data Structures, Searching and Sorting	CO 1,CO2,CO 3	T1:1 R1:14
2	Linear Data Structures - Stack, Queue	CO 3	T1:7,.T1:8
3	Linked Lists - Single Linked List, Double Linked List, Circular Linked Lists	CO 3	T1:9
4	Non Linear data Structures - Trees, Graphs	CO 3	T1:7.5
5	Binary Trees, Binary Search Tree, Hashing and Collision	CO 3 CO 5	T1:14
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	T1:9
3	Linked Lists	CO 3,CO 4,CO 6	T1:2.5
4	Non Linear Data Structures	CO 3,CO 4,CO 6	T1: 4.1
5	Binary Trees and Hashing	CO 3,CO 5,CO 6	T1: 5.1

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

Program Outcomes	
PO 4	**Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-Long Learning:** Recognize the need for and having the preparation and ability to engage in independent and life-long learning in the broadest context of technological change
Program Specific Outcomes	
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.

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 1	**Understand** , design and analyze computer programs in the areas related to Algorithms, System Software, Web design, Big data, Artificial Intelligence, Machine Learning and Networking.	3	CIE/ SEE/ Tech Talk/ Open ended experiments
PSO 2	**Focus on** Focus on improving software reliability, network security or information retrieval systems.	3	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 conventional digital communication system and (understand) various types of pulse analog modulation techniques for signals analysis by applying the principles of **mathematics, science,** and **engineering fundamentals**.	3
	PO 2	**Problem Analysis** on different types of algorithms to analyze space and time complexities.	4
	PO 3	**Design the Solutions** for finding space and time complexities of a complex algorithm and representing it by asymptotic notations	2
	PO 10	**Subject matter and speaking style** assessed in explanation of various algorithms, algorithm complexity.	2

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PSO1	**Design and analyze** complex algorithms and specify its space and time complexities and representing it by asymptotic notations for faster processing of data.	3
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
	PSO1	**Understand**complex problems and analyzing it and apply appropriate sorting and searching techniques for data processing.	4
	PSO2	**Applying**various selecting and sorting techniques while designing and developing information retrieval systems and its applications	2
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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	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
	PSO1	**Understand** complex problems and analyzing it and apply appropriate operations on linear or nonlinear data structures for Developing the solution.	5
	PSO2	**Applying** various linear or nonlinear data structures while designing and developing information retrieval systems and its applications	2
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
	PSO1	**Understand** complex problems and analyzing it and apply appropriate operations on linear or nonlinear data structures for solving real time applications.	5
	PSO2	**Applying** various linear or nonlinear data structures while designing and developing information retrieval systems and its applications	1
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

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 3	**Design the Solution** for efficiently accessing data with respect to performance by using hashing techniques and collision resolution methods	2
	PO 5	**Implementation of** hashing techniques and collision resolution methods for efficiently accessing data with respect to performance with the help of computer software	1
	PO 10	**Subject matter and speaking style** assessed in explanation of Hashing, Collision techniques	2
	PSO1	**Understand** complex problems and analyzing it and apply appropriate hashing techniques and collision resolution methods for efficiently accessing data with respect to performance.	4
	PSO2	**Applying** various hashing techniques and collision resolution methods while designing and developing information retrieval systems and its applications	1
CO 6	PO 1	**Understand** various types of data structures in terms of implementations and choose appropriate data structure for specified problem domain using knowledge of mathematics, science and engineering fundamentals	3
	PO 2	**Problem Analysis:** Recognize the importance of suitable data structures in checking the efficiency of algorithms used for complex engineering problems.	7
	PO 3	**Design the Solution** complex problems or efficiently accessing data with respect to performance by using hashing techniques and collision resolution methods	5
	PO 4	**Conduct Investigations of Complex Problems:** Ability to apply operations on linear or nonlinear data structures in order to solve real time applications.	4
	PO 5	**Understand** the Implementation of various types of data structures with the help of computer software	1
	PO 10	**Subject matter and speaking** style assessed in explanation of Implementation of various types of data structures.	2
	PO 12	**Keeping current in CSE** and advanced engineering concepts of Implementation of various types of data structures by tech talk, concept videos and open ended experiments	3
	PSO 1	**Understand** complex problems and analyzing it and apply Implementation of various types of data structures.	5
	PSO 2	**Applying** Implementation of various types of data structures while designing and developing information retrieval systems and its applications	1

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

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

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

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

1 - $5\ \% < C < 40\%$ – Low/ Slight

2 - $40 \leq C \leq 60\%$ – Moderate

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

COURSE OUTCOMES	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
	PROGRAM OUTCOMES												PSO'S		
CO 1	1	1	1	-	-	-	-	-	-	1	-	-	2	-	-
CO 2	1	2	1	-	3	-	-	-	-	1	-	-	2	3	-
CO 3	3	3	2	1	3	-	-	-	-	1	-	-	3	3	-
CO 4	3	3	1	1	3	-	-	-	-	1	-	-	2	2	-
CO 5	1	-	1	-	3	-	-	-	-	1	-	-	3	2	-
CO 6	3	3	2	1	3	-	-	-	-	1	-	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
TOTAL	12	12	8	3	15	-	-	-	-	6	-	1	15	12	-
AVERAGE	2.0	2.4	1.3	1.0	3.0	-	-	-	-	1	-	1	2.5	2.4	-

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		
3		

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		
11		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		
13		
14		
15		

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

Approved by: Board of Studies in the meeting conducted on 13-08-2024.

Signature of Course Coordinator **HOD, ECE**
Dr. B Ravi Kumar, Associate Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

<table>
<tr><td>1</td><td>Department</td><td colspan="5">Electronics and Communication Engineering</td></tr>
<tr><td>2</td><td>Course code</td><td colspan="5">AECD03</td></tr>
<tr><td>3</td><td>Course Title</td><td colspan="5">Digital system Design</td></tr>
<tr><td>4</td><td>Class / Semester</td><td colspan="5">II / I</td></tr>
<tr><td>5</td><td>Regulation</td><td colspan="5">BT-23</td></tr>
<tr><td rowspan="3">6</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>-</td><td>-</td></tr>
<tr><td rowspan="2">7</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>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: 0 hours</td><td colspan="2">Practical: – hours</td></tr>
<tr><td>10</td><td>Course Coordinator</td><td colspan="5">C.Radhika</td></tr>
<tr><td>11</td><td>Date Approved by BOS</td><td colspan="5">28/08/2023</td></tr>
<tr><td>12</td><td>Course Webpage</td><td colspan="5">https://www.iare.ac.in/?q=pages/btech-course-syllabi-bt23-cse</td></tr>
<tr><td rowspan="2">13</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>-</td><td>AECD03</td><td>III</td><td colspan="2">-</td></tr>
</table>

14. Course Overview

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

15. Course Objectives:

The students will try to learn:

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

16. Course Outcomes:

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

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

17. Topic Learning Outcome (TLOs):

S No	Topic(s)	TLO No	Topic Learning Outcome	Course Out-come	Blooms Level
1	Review of number system	1	**Understand** fundamental concepts of Digital Logic gates like AND,OR etc through a procedural approach.	CO 1	Understand
		2	**Differentiate** between Binary and Decimal number system in logic implification	CO 1	Understand
2	Review of Boolean Algebra	3	**Gain knowledge** fundamental in the development of digital electronics systems as they all use the concept of Boolean Algebra to execute boolean functions.	CO 1	Remember

S No	Topic(s)	TLO No	Topic Learning Outcome	Course Out-come	Blooms Level
		4	**Discuss** Boolean algebra in is one of the branches of algebra which performs operations using variables that can take the values of binary numbers	CO 1	Understand
3	De Morgan's Theorem	5	**Learn** how to use DeMorgan's Theorems to convert between NAND and NOR gates and simplify Boolean expressions.	CO 1	Remember
		6	**Apply** applying these laws, engineers can reduce the number of gates and simplify the overall circuit designto break a program into smaller pieces.	CO 1	Apply
		7	**Implement** DeMorgan's Theorem developed to show the relationship between two variable AND, OR gates	CO 6	Apply
4	Karnaugh maps up to 6 variables:	8	**Interpret** knowledge by defining 6 variable kmap and 4 variable kmap reduce a Boolean function in six variables and 4 variable	CO 2	Understand
		9	**Instantiate** combinational logic circuits to understand the relationship among various logic gates.	CO 2	Remember
5	Code conversion	10	**Learn** how to convert binary code to gray code using digital circuits or algorithms.	CO 2	Remember
6	Binary codes	11	**Learn** Binary codes to represent 8421 Codes 2421 Codes 5211 Codes Excess-3 Codes Gray Codes	CO 2	Apply
7	Sequential Logic Design	12	**Fundamentals** of digital systems applying the logic design and development techniques.	CO 3	Remember
		13	**Design** various types of combinational and sequential circuits and improve the performance by reducing the complexities.	CO 2	Apply
		14	**Use** Sequential Logic Design to describe the structure and operation of Datapath components such as adder, comparator	CO 6	Apply

S No	Topic(s)	TLO No	Topic Learning Outcome	Course Out-come	Blooms Level
8	Ripple and Synchronous counters	15	**Draw** a circuit diagram of a ripple counter using J-K flip-flops. .	CO 3	Remember
		16	**Illustrate** ripple counters to manage operations in the classes such as closing files, releasing locks, or cleaning up cached data.	CO 6	Apply
9	Shift registers	17	**Define** what a shift register is, including its purpose and basic operation.	CO 3	Understand
		18	**Identify** different types of shift registers for serial-in serial-out (SISO)	CO 3	Understand
10	Finite state machines,	20	**Differentiate** between Mealy and Moore machines understand the characteristics of both machines.	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	Pseudo Random Binary Sequence generator	22	**Explain** what a Pseudo Random Binary Sequence is including its characteristics and how it differs from truly random sequences.	CO 4	Understand
12	Vlsi design flow	23	**Learn** how to create and interpret design specifications for VLSI projects including functional and performance requirements.	CO 4	Remember
		24	**Design entry** Understand the process of creating a high-level architecture	CO 4	Understand
13	Behavioral Modeling	25	**Describe** the behavior of a digital circuit without specifying the exact structure or hardware implementation	CO 5	Understand
		26	**Label** objects to store them in files and deserialize them to recreate objects from files.	CO 5	Remember

S No	Topic(s)	TLO No	Topic Learning Outcome	Course Out-come	Blooms Level
		27	**Demonstrate** file-handling operations to enrich programming capabilities to create more sophisticated applications that interact with VHDLprogramming effectively.	CO 5	Understand
		28	**Use** output with manipulators and predefined manipulatorsfor formatting input and output data.	CO 6	Apply
14	Synthesis and Simulation	29	**Interpret** software systems and applications to Simulation Before Synthesis and Post-Synthesis and Timing Simulation.	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.

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

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**	

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	**LOGICS IMPLIFICATION AND COMBINATIONAL LOGIC DESIGN | Number of Lectures: 10**
	Review of decimal, binary, octal and hexadecimal number system and conversions , Review of Boolean Algebra and De Morgan's Theorem, SOP and POS forms, Canonical forms, Karnaugh maps up to 6 variables, Binary codes, Code Conversion
MODULE II	**MSI DEVICES | Number of Lectures: 12**
	MSI devices like Comparators, Multiplexers, Encoder, Decoder, Driver and Multiplexed Display, Half and Full Adders, Subtractors, Full adder using Half adders ,Full subtractor using Half subtractors, Serial and Parallel Adders, BCD Adder, Barrelshifter and ALU.
MODULE III	**SEQUENTIAL LOGIC DESIGN . |Number of Lectures: 10**
	Building blocks like S-R, T FF, D FF, JK and Master-Slave JK FF, Edge triggered FF, Characteristics and Excitation of SR, JK, T, D FF, Ripple and Synchronous counters, Shift registers.
MODULE IV	**LOGIC FAMILIES AND SEMICONDUCTOR MEMORIES | Number of Lectures: 12**
	Properties of random numbers, Generation of pseudo-random numbers, Techniques for generating random numbers, Tests for random numbers, Inverse-transform technique, Acceptance-rejection technique, Special properties.
MODULE V	**VLSI DESIGN FLOW | Number of Lectures: 9**
	Design entry: Schematic, FSM and HDL, different modeling styles in VHDL, Data types and objects, Dataflow, Behavioral and Structural Modeling, Synthesis and Simulation VHDL constructs and codes for combinational and sequential circuits.

TEXTBOOKS

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

REFERENCE BOOKS:

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

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

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	Introduction to number systems	CO 1	T1:1.1 to 1.5 R1:3.1 to 3.5
2	Base conversion methods	CO 1	T1:2.1 to 2.6 R2:2.8 to 3.5
3	Complements of numbers	CO 1	T1:4.1 to 4.9 R2:2.1 to 2.4
4	Codes- binary codes	CO 1	T1:6.1 to 6.5 R2:7.1 to 7.7
5	BCD code and its properties	CO 1	T1:8.1 to 8.4 R2:4.1 to 4.8
6	Unit distance code	CO 1	T1:8.8 to 8.9 R2:3.3 to 3.7
7	Alphanumeric codes	CO 1	T2:3.1 to 3.2 R2: 2.7 to 2.9
8	Error detecting and correcting codes	CO 1	T2:4.1 to 4.9

S.No	Topics to be covered	CO's	Reference
9	Basic theorems and its properties	CO 1	T2:5.1 to 5.2 R1:3.1 to 3.5
10	Switching functions	CO 1	T2:5.3 to 5.5 R2:5.1 to 5.8
11	Canonical form	CO 1	T2:3.1 to 3.5 R1:2.1 to 2.5
12	Standard form	CO 1	T2:3.1 to 3.6 R2:2.8 to 3.5
13	Algebraic simplification of digital logic gates	CO 1	T2:4.1 to 4.9 R2:2.1 to 2.4
14	Properties of XOR gates	CO 1	T2:6.1 to 6.5 R2:7.1 to 7.7
15	Universal gates	CO 2	T2:7.1 to 7.4 R2:4.1 to 4.8
16	Multilevel NAND/NOR realizations	CO 2	T2:7.8 to 7.9 R2:3.3 to 3.7
17	Combinational design	CO 2	T3:3.1 to 3.2 R2: 2.7 to 2.9
18	Arithmetic circuits- adders	CO 2	T3:4.1 to 4.8
19	Subtractors	CO 2	T3:5.1 to 5.2 R1:3.1 to 3.5
20	Serial adder	CO 2	T3:5.3 to 5.5 R2:5.1 to 5.8
21	1's complement subtractor	CO 2	T3:6.1 to 6.5 R1:3.1 to 3.5
22	2's complement subtractor	CO 2	T3:6.6 to 6.8 R2:2.8 to 3.5
23	Combinational and sequential circuits	CO 2	T3:6.9 to 6.10 R2:2.1 to 2.4
24	The binary cell	CO 3	T3:7.1 to 7.5 R2:7.1 to 7.7
25	The fundamentals of sequential machine operation	CO 3	T3:7.6 to 7.7 R2:4.1 to 4.8
26	Flip-flop	CO 3	T3:7.8 to 7.10 R2:3.3 to 3.7
27	D-Latch Flip-flop	CO 3	T3:7.11 to 7.12 R2: 2.7 to 2.9

S.No	Topics to be covered	CO's	Reference
28	Clocked T Flip-flop	CO 3	T1:4.1 to 4.9
29	Clocked JK flip-flop	CO 4	T1:5.1 to 5.2 R1:3.1 to 3.5
30	Design of a clocked flip-flop conversion from one type of flip-flop to another	CO 4	T1:5.3 to 5.5 R2:5.1 to 5.8
31	Registers and counters	CO 4	T1:1.1 to 1.5 R1:3.1 to 3.5
32	Analyze TTL NAND gate, specifications	CO 4	T1:2.1 to 2.6 R2:2.8 to 3.5
33	Noise margin, propagation delay	CO 5	T1:4.1 to 4.9 R2:2.1 to 2.4
34	Fan-in, fan-out	CO 5	T1:6.1 to 6.5 R2:7.1 to 7.7
35	Implement tristate TTL, ECL.	CO 5	T2:5.1 to 5.4 R2:4.1 to 4.8
36	CMOS families and their interfacing, memory elements	CO 6	T1:2.8 R2:3.3 to 3.7
37	Understand concept of programmable logic devices like FPGA	CO 6	T3:3.7 to 3.8 R2: 2.7 to 2.9
38	Logic implementation using programmable devices	CO 6	T3:4.1 to 4.9
39	Design entry: Schematic, FSM & HDL, different modeling styles in VHDL	CO 6	T3:5.1 to 5.2 R1:3.1 to 3.5
40	Understand data types and objects, dataflow, behavioral and structural modeling	CO 6	T3:5.3 to 5.5 R2:5.1 to 5.8
PROBLEM SOLVING/ CASE STUDIES			
41	Multilevel NAND/NOR realizations	CO 1	T1:1.1 to 1.5 R1:3.1 to 3.5
42	Combinational design	CO 1	T1:2.1 to 2.6 R2:2.8 to 3.5
43	Arithmetic circuits-adders	CO 1	T1:4.1 to 4.9 R2:2.1 to 2.4
44	1's complement subtractor	CO 2	T1:6.1 to 6.5 R2:7.1 to 7.7
45	2's complement subtractor	CO 2	T2:5.1 to 5.4 R2:4.1 to 4.8
46	Combinational and sequential circuits	CO 3	T1:2.8 to 2.9 R2:3.3 to 3.7
47	Clocked T Flip-flop	CO 3	T3:3.7 to 3.8 R2: 2.7 to 2.9

S.No	Topics to be covered	CO's	Reference
48	Clocked JK flip-flop	CO 4	T1:4.1 to 4.9
49	Design of a clocked flip-flop conversion	CO 4	T1:5.1 to 5.2 R1:3.1 to 3.5
50	Registers and counters	CO 5	T1:5.3 to 5.5 R2:5.1 to 5.8
51	Analyze TTL NAND gate, specifications	CO 5	T1:1.1 to 1.5 R1:3.1 to 3.5
52	Implement tristate TTL, ECL	CO 5	T1:2.1 to 2.6 R2:2.8 to 3.5
53	CMOS families, memory elements	CO 6	T1:4.1 to 4.9 R2:2.1 to 2.4
54	Programmable logic devices.	CO 6	T1:6.1 to 6.5 R2:7.1 to 7.7
55	Schematic, FSM & HDL, different modeling styles in VHDL.	CO 6	T2:5.1 to 5.4 R2:4.1 to 4.8
DISCUSSION OF DEFINITION AND TERMINOLOGY			
56	Universal gates	CO 1	T1:1.1 to 1.5 R1:3.1 to 3.5
57	Multilevel NAND/NOR realizations	CO 2	T1:2.1 to 2.6 R2:2.8 to 3.5
58	Combinational design	CO 4	T1:4.1 to 4.9 R2:2.1 to 2.4
59	Arithmetic circuits-adders	CO 5	T1:6.1 to 6.5 R2:7.1 to 7.7
60	Logic implementation using programmable devices	CO 6	T2:5.1 to 5.4 R2:4.1 to 4.8
DISCUSSION OF QUESTION BANK			
61	Design of a clocked flip-flop conversion	CO 1	T1:1.1 to 1.5 R1:3.1 to 3.5
62	Registers and counters	CO 2	T1:2.1 to 2.6 R2:2.8 to 3.5
63	Analyze TTL NAND gate, specifications	CO 3	T1:4.1 to 4.9 R2:2.1 to 2.4
64	Implement tristate TTL, ECL.	CO 4	T1:6.1 to 6.5 R2:7.1 to 7.7
65	CMOS families, memory elements	CO 5	T2:5.1 to 5.4 R2:4.1 to 4.8

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.
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	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.

Program Outcomes	
PSO 2	Focus on the practical experience of ASIC prototype designs, virtual instrumentation and SoC designs.
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating the Patch and Smart Antennas for Wired and Wireless Communication Applications.

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	SEE / CIE / AAT
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	3	SEE / CIE / AAT
PO 3	**Design / development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	SEE / CIE / AAT
PO 4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	SEE / CIE / AAT

25. How program-specific outcomes are assessed:

Program Specific Outcomes		Strength	Proficiency Assessed by
PSO 2	Focus on the practical experience of ASIC prototype designs, virtual instrumentation and SoC designs.	2	SEE / CIE / 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	Understand the number systems, Boolean operations, code conversion code by applying its **own engineering discipline, science principles and methodology.**	2
	PO 2	Understand the given **problem statement** and **formulate** the design (complex) engineering problems in detecting and correcting errors in the received data in **reaching substantiated conclusions by the interpretation of results.**	4
CO 2	PO 1	Demonstrate the design procedures of various adder circuits with **own engineering discipline, science principles and methodology.**	2
	PO 2	Understand the given **problem statement** and **formulate** the (complex) engineering problems on adder circuit design **translate the information** into the model using type of adder from the provided **information and data, develop solutions** based on the functionality of the circuit, **validate** the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	7
	PO 3	**Understand the customer needs, use creativity and manage design process** in realization of combinational circuits using logic gates and **evaluate outcomes.**	3
CO 3	PO 1	Apply the **knowledge** of flipflops and latches (**engineering fundamentals**) to understand synchronous and asynchrnous sequential circuits(**own engineering discipline, mathematical and science principles and methodology.**) to design registers,counters and memory applications.	3

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 (complex) engineering problems on adder circuit design **translate the information** into the model using type of adder from the provided **information and data**, develop solutions based on the functionality of the circuit, **validate** the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	6
	PO 3	**Understand the customer needs, investigate and define a problem, use creativity** and **establish innovative solutions** in designing the sequential circuits using flipflops and latches	4
CO 4	PO 1	Understand the mealy and moore machines (**engineering knowledge**) for **complex sequential sircuits** used in pulse train generator, psuedo random binary sequence genrator and clock generation.(**own engineering discipline, mathematical and science principles and methodology.**)	3
	PO 2	Understand the given **problem statement** and **formulate** the (complex) engineering problems on adder circuit design **translate the information** into the model using type of FSM from the provided **information and data**, develop solutions based on the functionality of the sequential circuit, **validate** the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	7
	PO 3	Design the FSM using mealy/moore models (**understand the customer needs, investigate and define a problem, use creativity** and **establish innovative solutions**) for complex sequential circuits like clock generation, psuedo random generator etc	5
	PO 4	Implement (**complex sequential apllications** psuedo random generator, clock generator and pulse train generator **using mealy/moore FSMs**	2
	PSO 2	**Design ASIC prototypes** by **adopting engineering professional code in VHDL** for the implementation of FSM to **familiarize with the ASIC design flow**, **realize RTL schematic** and **analyze the synthesis of SOC**	5
CO 5	PO 1	Explore the concept of logic families, memories, programmable logic devices for understanding architectural blocks of FPGA using the **own engineering discipline, science principles and methodology.**	2

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 (complex) engineering problems on PLDs and logic families **translate the information** into the model using type of PLDs from the provided **information and data**, develop solutions based on the functionality of the circuit, **validate** the output of the circuit in reaching substantiated conclusions by the **interpretation of results.**	7
	PO 3	**Understand the customer needs, investigate and define a problem, use creativity** and **establish innovative solutions** in designing PLDs and FPGA	3
	PSO 2	**Design ASIC prototypes** by **adopting engineering professional code in VHDL** for the implementation of real time applications to **familiarize with the ASIC design flow**, **realize RTL schematic** and **analyze the synthesis of SOC**	5
CO 6	PO 1	Understand data types and objects, dataflow, behavioral and structural modeling for realizing the hardware modeling of the sequential, combinational blocks using the **own engineering discipline, Science principles and methodology.**	2
	PO 2	Understand the given **problem statement** and **formulate** the design (complex) engineering problems of digital logic design, **translate the information** into hardware circuit programming from provided **information and data, develop solutions** based on the simulation result, **validate** the results **reaching substantiated conclusions** by the **interpretation of results.**	7
	PO 3	**Develop** digital system design **based on customer needs for design of** combinational, sequential circuits to **establish innovative solutions**and **evaluate outcomes of the designs.**	5
	PO 4	Use the knowledge of VHDL design **laboratory skills**to combinational and sequential circuits and analyze the output to **synthesis of the information to provide valid conclusions** to design complex digital circuits.	2

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	4	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	7	3	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	6	4	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	2	7	5	2	-	-	-	-	-	-	-	-	-	5	-
CO 5	2	7	3	-	-	-	-	-	-	-	-	-	-	5	-
CO 6	2	7	5	2	-	-	-	-	-	-	-	-	-	-	-

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	67	40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 2	67	70	30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 3	100	60	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 4	67	70	50	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.5	0.0
CO 5	67	70	30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.5	0.0
CO 6	67	70	50	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	3	1	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	3	2	1	-	-	-	-	-	-	-	-	-	2	-

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

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		

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:** The ability to design and simulate digital systems allows industries to develop more advanced products, such as smart devices, IoT-enabled machines, and custom hardware solutions.
10	REDUCED INEQUALITIES	

11		**Sustainable cities and communities:**The design and infrastructure for EVs are heavily reliant on digital systems, from the vehicles themselves to the charging networks that support them. Smart charging stations, for example, can balance load demands and integrate with renewable energy sources.
12		
13		
14		
15		
16		

17	PARTNERSHIPS FOR THE GOALS	

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

Signature of Course Coordinator **HOD ECE**
C.Radhika, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRONICS AND COMMUNICATION ENGINEERING**			
2	Course Title	**ELECTRONIC DEVICES AND CIRCUITS LABORATORY**			
3	Course Code	AECD06			
4	Program	B.Tech			
5	Semester	III Semester			
6	Regulation	BT23			
7	Structure of the course	Practical			
		Lecture Hours		Practical Hours	
		-		2	
8	Course Offered	Odd Semester ✓		Even Semester ×	
9	Course Coordinator	Ms.P Shamili Srimani			
10	Date Approved by BOS	DD/MM/YYYY			
11	Course Webpage	www.iare.ac.in/?q=pages/ece-btech-course-syllabi-ug20			
12	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**
		B.Tech	AEED04	I	Electrical Circuits Laboratory

13. Course Overview

This course provides the hands-on experience on designing circuits using Diodes, Bipolar Junction Transistors, Field Effect Transistors. Measure the gain, band width and input output impedances of BJT and FET amplifiers. Provides the capability to extract the characteristics of semiconductor devices and circuits with simulation tools (Multisim).

14.Course Objectives:

The students will try to learn:

I	The behavior and characteristics of semiconductor devices for designing the semiconductor circuits such as amplifier and rectifiers.
II	Estimation of device characteristics like gain, bandwidth, input and output resistance of bipolar junction transistors and field effect transistors amplifiers to derive appropriate small-signal model analysis of basic amplifier circuits.
III	The analytical skills to model analog and digital integrated circuits at discrete and micro circuit level.

15. Course Outcomes:

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

CO 1	**Demonstrate** the electronic instruments for measuring voltage, current and phase parameters.	Understand
CO 2	**Determine** the parameters of rectifiers and voltage regulators using the diode characteristics.	Apply
CO 3	**Examine** the input and output characteristics of transistor (BJT and FET) configurations for determining the input - output resistances.	Analyze
CO 4	**Characterize** BJT and FET amplifiers for estimating the voltage gain and Current gain.	Analyze
CO 5	**Analyze** the transistor biasing circuits for a proper operation of transistors in electronic circuits.	Analyze
CO 6	**Develop** a regulated power supply circuit for the specified voltage and current requirements.	Create

16. Employability Skills

1. **Employment advantage:** This can give competitive advantage when seeking employment as PCB circuits Designing Engineer.
2. **Problem-Solving and Analytical Thinking:** Electronic devices and circuits laboratory course is an essential part of electrical and electronics engineering education. This fosters the capacity to analyze critically and develop inventive solutions in designing, building, testing, and troubleshooting electronic circuits.
3. **Safety Awareness:** The analysis, decides the safety factor for maintaining proper spacing and isolation between high-voltage and low-voltage components or traces to prevent arcing or short circuits.Graduates should maintain a steadfast commitment to safety awareness in every engineering industry where safety takes precedence..

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
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.

19. Course Content:

CO 1	**Demonstrate the electronic instruments for measuring voltage, current and phase parameters.**
	1. Plot volt-ampere characteristics of silicon and germanium p-n junction diodes. Find cut-in voltage, static and dynamic resistances in forward and reverse biased conditions using hardware. 2. Compare silicon and germanium diodes for cut-in voltage and magnitudes of diode currents from V-I characteristics using digital simulation. 3. With experimental set up, determine knee voltage, breakdown voltage and line and load regulation characteristics for zener diode.
CO 2	**Determine the parameters of rectifiers and voltage regulators using the diode characteristics.**
	1. Design zener voltage regulator circuit with 6V output voltage using digital simulation. Choose the current limiting resistor and load resistor considering minimum break down current. 2. Draw input and output characteristics of half wave rectifier and observe the effect of cut in voltage on the peak output voltage using hardware. 3. With capacitor and inductor filters observe the variation in ripple voltage for small, medium and high load currents for half wave rectifier using digital simulation. 4. For full wave rectifier with centre tapped transformer draw the input and output waveforms using hardware. 5. Design full wave rectifier with appropriate filter so that ripple voltage is independent of load current using digital simulation. 6. Design a full-wave bridge rectifier circuit and determine the output waveform for the network and analyze the rectifier output with and without a filter.
CO 3	**Examine the input and output characteristics of transistor (BJT and FET) configurations for determining the input - output resistances.**

	1. Determine the input and output characteristics of CB configuration and compute the following h – parameters. i) Input resistance (hib) Ohms ii) Reverse voltage transfer ratio (hrb) iii) Output admittance (hob) Mhos iv) Forward current gain (hfb) Also clearly identify active, cutoff and saturation regions on V-I characteristics using hardware. 2. Demonstrate the characteristics of pnp transistor in CB configuration, identifying active, cutoff and saturation regions with digital simulation. Mark the collector-emitter voltage (VCE) when transition from saturation to active region occurs. 3. For CE configuration, compare the h – parameters i) input resistance (hie) Ohms ii) reverse Voltage transfer Ratio (hre) iii)Output admittance (hoe) Mhos. iv) Forward current gain (hfe) with those of CB configuration using hardware. 4. Design an electronic switch using CE configuration using digital simulation. 5. From the observation table, draw the drain and transfer characteristics of field effect transistor using hardware. From the characteristics, calculate the values of dynamic resistance (rD) and trans-conductance (gm). 6. Demonstrate how FET can be used as voltage variable resistor (VVR) for small ac signals using digital simulation.
CO 4	**Characterize BJT and FET amplifiers for estimating the voltage gain and Current gain.**

	1. Assess the gain and bandwidth of CE amplifier using hardware. 2. Model CE amplifier with voltage gain of -24 and current gain -50 using digital simulation. 3. Construct CC amplifier and determine the gain and bandwidth using hardware. 4. Design a CC amplifier with current gain of 40 with suitable assumptions using digital simulation. 5. Observe the frequency response of CB amplifier and determine the gain and bandwidth using hardware. 6. With appropriate selection of components, design a CB amplifier with voltage gain of 50 using digital simulation. 7. Observe frequency response of common source FET amplifier using hardware and determine the gain and bandwidth. 8. Design common source amplifier with voltage gain -10 and output impedance of 7 kW using digital simulation. 9. For common drain FET amplifier, draw the gain vs frequency graph using hardware and determine the bandwidth. 10. Construct common source follower amplifier with output impedance of 300 kW. Measure phase difference between input and output using digital simulation.
CO 5	**Analyze the transistor biasing circuits for a proper operation of transistors in electronic circuits.**
	1. Design a fixed bias circuit and determine their stability factors. 2. Design a Collector to base bias circuit and determine their stability factors. 3. Design a Self-bias circuit and determine their stability factors.
CO 6	**Develop a regulated power supply circuit for the specified voltage and current requirements**
	1. Design a DC regulated power supply and determine the load regulation and efficiency of the regulated power supply. 2. Design an experiment to set up a basic PA system. Include a microphone, amplifier, and speakers.

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

TEXTBOOKS

1. J. Millman, C.C.Halkias, Millman's, "*Integrated Electronics*", Tata McGraw Hill, 2nd Edition, 2001.

2. K.A. Navas, "*electronics lab manual* ", volume 1 , 5th edition,2015.

3. J.Millman, C.C.Halkias and satyabrata Jit, "*Millman's Electronic Devices and circuits*",Tata McGraw Hill, 2nd edition, 1998.

REFERENCE BOOKS:

1. Mohammad Rashid, "*Electronic Devices and Circuits*", Cengage learning, 1st Edition, 2014.
2. David A. Bell, "*Electronic Devices and Circuits*", Oxford University Press, 5th Edition, 2009.

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	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	-	-
2	Getting Started Exercises-Introduction to MULTISIM	CO 1	T1: 3.1
3	Exercises on pn junction diode Characteristics	CO 1	T2: 2.1
4	Exercises on Zener Diode Characteristics and Voltage Regulator	CO 1	T2: 2.2
5	Exercises on Half wave and full wave rectifier with and without filter	CO 2	T2: 2.4
6	Exercises on Bridge Rectifier	CO 2	T2: 2.4
7	Exercises on Clippers and Clampers	CO 2	T2: 2.7
8	Exercises on Transistor Characteristics	CO 3	T2: 2.11
9	Exercises on Transistor Biasing	CO 5	T2: 3.1
10	Exercises on Frequency Response of Common Emitter and Common Collector Amplifier	CO 4	T2: 3.4
11	Exercises on FET Characteristics	CO 3	T2: 2.13
12	Exercises on frequency response of Common Source and Common Drain amplifier	CO 4	T2: 3.4

S.No	Topics to be covered	CO's	Reference
13	Exercises on Regulated Power Supply	CO 6	T2: 3.10
14	Exercises on Public Addressing System	CO 6	T2: 3.13

Experiments for enhanced learning (EEL):

S.No	Design Oriented Experiments
1	Design high pass filter using bipolar junction transistor to produce the gain of 150.
2	Construct and verify the JFET's ability to behave as a voltage-controlled current regulator.
3	Design and verify the functionality of waveform clipper using Zener diode.
4	Construct and verify Battery Charger using SCR
5	Design the relaxation oscillator using Uni Junction Transistor.
6	Plot the V-I Characteristics of germanium diode and find the cut in voltage of diode.
7	Design diode acts as switch and plot the switching times of diode.
8	Design a zener voltage regulator circuit to drive a load of 6V, 100mW from an unregulated input supply of Vmin = 8V, Vmax = 12V using a 6V zener diode?
9	Design square wave generator using zener diode.
10	Design for a Zener Transistor series voltage regulator circuit to drive a load of 6V, 1W, from a supply of 10V with a 3V ripple voltage
11	Design half wave rectifier with an applied input a.c. power is 100 watts, and it is to deliver an output power is 40 watts.
12	Design half wave rectifier with an a.c. supply of 230 V is applied through a transformer of turn ratio 10:1. Observe the output d.c. voltage, peak inverse voltage and identify dc output voltage if transformer turns ratio changed to 20:1.
13	Design a full wave rectifier with step down transformer and center tapped transformer. Justify the operation.
14	Design Full wave rectifier with capacitive filter using 10uF and 1uF. Observe the ripple factor.
15	Describe, based on your observations, the I-V curves of npn transistor. At approximately what collector-emitter voltage (VCE) does the transition from saturation to active region occur?
16	Demonstrate the characteristics of Common base PNP transistor to determine the h parameters.
17	Design a Sustainable Relay Driving Circuit Using BJT.
18	Design an electronic switch using CE configuration.
19	Measure the DC voltages to make sure the BJT is in the forward active region. If it's not in forward active, adjust your resistor values to compensate.
20	Measure the voltage gain. Adjust the input signal from your wavetek to approximately 10mV amplitude, with a frequency of 100 kHz. What is the voltage swing?
21	Connect the common collector amplifier circuit you designed. Set the values of capacitors C1, C2, and C3 to 1uF each. Set RL to be 1 kW and the supply voltage to 15V DC. Measure the DC bias voltages on the base, emitter and the collector. Calculate the collector current. Compare the measured voltages with the design intent and calculation. Tabulate the measured versus the calculated bias voltages and current.

22	Measure the frequency response of the amplifier starting from 100 Hz. change the test frequency to cover the upper cut-off frequency of the amplifier. Throughout the measurement of the frequency response, apply low input signal levels (in the order of few milli-Volts) to ensure that the output signal is not distorted. Monitor both input and output waveforms on the oscilloscope.
23	Design and observe the characteristics of relaxation oscillator using Uni-Junction Transistor.
24	Design Voltage sensing with a unijunction transistor and observe the characteristics.
25	Design battery charger circuit using silicon control rectifier.
26	Observe the characteristics of RC half wave and full wave Firing Circuit using silicon control rectifier.
27	Obtain the transistor drain characteristics in the saturated region, by applying the VMAX is 40V, IMAX is 20 mA and PMAX is 0.4W.
28	Junction field-effect transistors (JFETs) are normally-on devices, the natural state of their channels being passable to electric currents. Thus, a state of cutoff will only occur on command from an external source. Explain what must be done to a JFET, specifically, to drive it into a state of cutoff.
29	Build the CS amplifier circuit using VDD = VSS = 5 V. Select 50 kW potentiometer and adjust it to obtain 250 A bias current. Select RS = 10 kW.
30	Obtain the frequency response of MOSFET amplifier in common source configuration.
31	Design and Plot the frequency response of single stage RC coupled amplifier using JFET.
32	Design a MOSFET amplifier and plot frequency response based on the given specifications. Both the input and the output should be AC coupled. Dual Supply Voltage = 5V Load Resistance, RL = 100W 0-to-Peak Output Swing is greaterthan or equal to 2V Voltage Gain= 50 Input Resistance= 10kW

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.

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

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.	2	Lab Experiments / CIE / SEE

PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	Lab exercises/CIE/SEE
PO 5	**Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the limitations.	2	Lab exercises/CIE/SEE
PO 10	**Communication:** Communicate effectively on complex Engineering activities with the Engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	1	day-to-day evaluation

3 = High; 2 = Medium; 1 = Low

23. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Strength	Proficiency Assessed by
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	1	Lab exercises/CIE/SEE

3 = High; 2 = Medium; 1 = Low

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

	PROGRAM OUTCOMES												PSO'S		
COURSE OUTCOMES	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 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	Learn to use the Instruments knowledge for measuring the voltage, current and signal parameters with the information from other engineering disciplines, mathematics, and scientific methodologies.	2
	PO 10	Demonstrate the ability to communicate effectively by using the electronic instruments for measurement of signal properties.	1
CO 2	PO 1	Determine the parameters of rectifiers and voltage regulators using the diode characteristicswith support from other engineering disciplines, mathematics, and scientific methodologies.	2
	PO 10	Demonstrate the ability to analyze halfwave and full wave rectifiers for higher efficiency and voltage regulation	1
	PSO 2	Formulate and Evaluate the protection circuits applications in the field of Intelligent Embedded and Semiconductor technologies	3
CO 3	PO 1	Examine the input and output characteristics of transistor BJT and FET configurations knowledge with the support of Elecronic Circuit theory.	1
	PO 2	Formulate and analyze Problem for complex Engineering problems for power supplies knowledge consisting of rectifiers using first principles of mathematics and Engineering sciences.	5
	PO 10	Explain forming half wave and full wave rectifiers with necessary interconnections.	1
CO 4	PO 1	Design amplifiers knowledge consisting of BJTs and FETs with the support of VLSI engineering tools such as stick diagrams and layouts.	1
	PO 2	Formulate and analyze Problem analysis and complex Engineering problems for amplfiers knowledge consisting of multiplexers using first principles of mathematics and Engineering sciences.	5
	PO 5	Develop amplifiers knowledge of Electronic circuits using modern Engineering and IT tools to high SNR.	1
	PO 10	Explain calculation of voltage and current gains for BJT and FET amplifiers with clarity.	1
CO 5	PO 1	Understand the structure and operation of uni-junction transistor knowledge by applying the oscillation fundamentals with support from other engineering disciplines, mathematics, and scientific methodologies.	3

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 2	Formulate and analyze Problem analysis and complex Engineering problems of UJT circuits knowledge using first principles of mathematics and Engineering sciences.	5
	PO 10	Explain calculation of intrinsic standoff ratio parameters for UJT with clarity.	1
CO 6	PO 1	Examine and determine the holding, latching current and break over voltage of silicon controlled rectifier using volt - ampere characteristics knowledge with data from mathematics and engineering sciences.	2
	PO 2	Formulate and analyze Problem analysis and complex Engineering problems for protection circuits using SCRs knowledge using first principles of mathematics and Engineering sciences.	5
	PO 10	Focus on writing the lab reports and work sheets with clarity.	1
	PSO 2	Formulate and Evaluate the protection circuits applications in the field of Intelligent Embedded and Semiconductor technologies.	3

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

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

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

	PROGRAM OUTCOMES												PSO'S		
COURSE OUTCOMES	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	66	-	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 2	66	-	-	-	-	-	-	-	-	20	-	-	-	27	-
CO 3	33	50	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 4	33	50	-	-	100	-	-	-	-	20	-	-	-	-	-

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 5	100	50	-	-	-	-	-	-	-	20	-	-	-	-	-
CO 6	66	50	-	-	-	-	-	-	-	20	-	-	-	27	-

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	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 2	3	-	-	-	-	-	-	-	-	1	-	-	-	1	-
CO 3	1	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 4	1	2	-	-	3	-	-	-	-	1	-	-	-	-	-
CO 5	3	2	-	-	-	-	-	-	-	1	-	-	-	-	-
CO 6	3	2	-	-	-	-	-	-	-	1	-	-	-	1	-
TOTAL	**14**	**8**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**6**	**0**	**0**	**0**	**2**	**0**
AVERAGE	**2.3**	**2**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**

29. ASSESSMENT METHODOLOGY DIRECT:

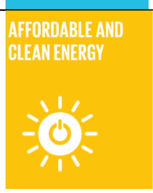
CIE Exams	✓	SEE Exams	✓	Laboratory Practices	✓
Certification	-	Student Viva	✓	Open Ended Experiments	-

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: Integrating Sustainability into Curriculum:** By incorporating sustainability principles into the course, students receive a holistic education that prepares them to address environmental challenges through electronics and circuit design. **Ethical Engineering Practices:** Encouraging students to consider the ethical implications of their designs, such as the environmental and social impact of electronic waste, aligns with the goal of providing a quality education.
5		
6		**Clean Water and Sanitation:** Water-Saving Technologies: Exploring the development of electronic devices that can monitor and reduce water usage, or that can be part of water purification systems, connects electronics with sustainability in water management..
7		**Affordable and Clean Energy:** Students can focus on designing and testing circuits that consume less power, contributing to the development of more energy-efficient electronic devices. **Renewable Energy Integration:** Incorporating renewable energy sources like solar or wind power into electronic circuit designs supports the transition to clean energy..

8		**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:** Encouraging students to innovate in the design of electronic devices can lead to the development of more sustainable technologies and infrastructure. **Sustainable Manufacturing Practices:** Teaching sustainable practices in the production and disposal of electronic components can reduce environmental impact.
10		
11		
12		
13		**Reducing Carbon Footprint:** Designing low-power and energy-efficient circuits contributes to the reduction of greenhouse gas emissions associated with energy use. **Awareness of Environmental Impact:** Educating students on the environmental impact of electronic devices and encouraging designs that mitigate these effects supports climate action
14		

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 ——————————.

Signature of Course Coordinator **HOD ECE**
Ms.P Shamili Srimani, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRONICS AND COMMUNICATION ENGINEERING**			
2	Course Title	**DIGITAL SYSTEM DESIGN LABORATORY**			
3	Course Code	AECD07			
4	Program	B.Tech			
5	Semester	III Semester			
6	Regulation	BT-23			
7	Structure of the course	Practical			
		Lecture Hours		Practical Hours	
		-		36	
8	Course Offered	Odd Semester ✓		Even Semester ×	
9	Course Coordinator	Mrs Veena M Kurup			
10	Date Approved by BOS	15/04/2024			
11	Course Webpage	www.iare.ac.in			
12	Course Prerequistes	**Level**	**Course Code**	**Semester**	**Prerequisites**
		-			

13. Course Overview

The digital system design laboratory introduces the hardware description language for the design and development of digital integrated circuits and field programmable devices. It provides VHDL language elements, synthesizable register transfer logic models in structuaral, dataflow, behavioral modeling of combinational and sequential circuits. Includes applications in the area of VLSI system design.

14. Course Objectives:

The students will try to learn:

I	The fundamental principles of the VHDL and its constructs used in design implementation of digital logic systems.
II	The concepts of behavioral, dataflow and structural modeling of fundamental digital logic circuits using VHDL.
III	To expertise various stages of a typical state of the art CAD VLSI tool for simulation, synthesis, place and route, layout and power and clock routing modules.

15. Course Outcomes:

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

CO 1	**Utilize** the concept of Boolean algebra to verify the truth table of Boolean expressions using logic gates in Hardware Description Language.	Apply
CO 2	**Make use** of dataflow, structural and behavioral modelling styles of HDL for simulating the combinational logic circuits.	Apply
CO 3	**Analyze** the truth tables and characteristic equations of flip flops for the functional simulation and timing analysis of sequential circuits.	Analyze
CO 4	**Design**the synchronous and asynchronous sequential circuits using the flip flops.	Apply
CO 5	**Model** a finite state machine for detecting or generating a given sequence.	Apply
CO 6	**Investigate** the functionality of Vending machine conroller,real time traffic light controller, chess clock controller FSM, elevator operations using HDL code.	Analyze

16. Employability Skills

1. **Employment advantage:** This can give competitive advantage when seeking employment as Design Engineer.
2. **Problem-Solving and Analytical Thinking:**DSD lab provides VHDL modeling of digital ICs .This cultivates the ability to think critically and find innovative solutions, which is a fundamental skill sought by employers before fabrication of ICs in industries.

17. Content Delivery / Instructional Methologies:

✓	Day to Day lab evaluation	✓	23.png 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
					20

Table 5: Programming based

Objective	Analysis	Design	Conclusion	Viva voce	Total
4	4	4	4	4	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	**Utilize the concept of Boolean algebra to verify the truth table of Boolean expressions using logic gates in Hardware Description Language.**
	1. Getting Started Exercises 2. Exercises on Gate Realization
CO 2	**Make use of dataflow, structural and behavioral modelling styles of HDL for simulating the combinational logic circuits.**
	1. Exercises on Multiplexers and Demultiplexers 2. Exercises on Decoders and Encoders 3. Exercises on Adders and Subtractors 4. Exercises on barrel shifter and ALU 5. Exercises on CARRY-LOOK AHEAD ADDER
CO 3	**Analyze the truth tables and characteristic equations of flip flops for the functional simulation and timing analysis of sequential circuits.**
	1. Exercises on Latches and Flip-flops
CO 4	**Construct the synchronous and asynchronous sequential circuits using the flip flops.**
	1. Exercises on counters and shift registers
CO 5	**Model a finite state machine with melay and moore machines for generating a given sequence.**
	1. Exercises on case study: Pseudo random generator
CO 6	**Examine the functionality of Vending-Machine Controller ,real time traffic light controller, chess clock controller FSM, elevator operations using HDL code.**
	1. Vending Machine Controller 2. Exercises on case study: ROM DESIGN

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

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	Course Description on Outcome Based Education (OBE): Course Objectives, Course Outcomes (CO), Program Outcomes (PO) and CO-PO Mapping	CO 1	
2	Getting Started Exercises	CO 1	T2:5.6 R1:1.12.3
3	Exercises on Gate Realization:	CO 1	T2:5.10 R1:1.15
4	Exercises on Adders and Subtractors:	CO 2	T2:5.15 R1:1.16
5	Exercises on Multiplexers and Demultiplexers	CO 2	T2:5.17 R1:1.13.1
6	Exercises on Decoders:	CO 2	T2:5.18 R1:1.13.2
7	Exercises on encoders and priority encoders:	CO 2	T2:5.19 R1:1.13.3
8	Exercises on barrel shifter and ALU:	CO 2	T2:5.20 R1:1.7.1
9	Exercises on Latches and Flip-flops:	CO 3	T2:5.24 R1:1.17.3
10	Exercises on counters and shift registers	CO 4	T2:6.3 R1:2.6.1
11	Exercises on case study: Pseudo random generator	CO 5	T2:6.5 R1:2.6.2
12	Exercises on CARRY-LOOK AHEAD ADDER	CO 2	T2:7.7 R1:2.10
13	Exercises on Vending-Machine Controller	CO 6	T2:7.11
14	Exercises on Gray-Encoded Counter	CO 6	T2:7.11
15	Exercises on RAM design	CO 6	T2:15.2 R1:8.2

21. Experiments for Enhanced Learning (EEL):

S.No	Design Oriented Experiments
1	Implementation of binary multiplier and simulate using simulation tool
2	Design and simulation of 8-bit Booth's multiplier

Textbooks

1. Douglas Perry, "*VHDL*", Tata McGraw Hill, 4th Edition, 2002.
2. W.H. Gothmann, "*Digital Electronics- An introduction to theory and practice*", PHI, 2nd Edition,2006.

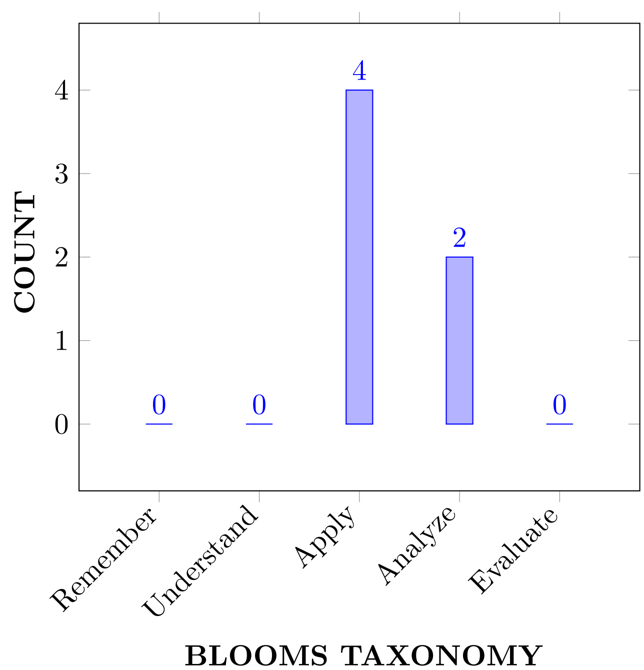
Reference Books:

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

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

22. Course Knowledge Competency Level



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.

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

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 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	Seminar / Conferences / Research papers
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	Seminar / Conferences / Research papers
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	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.	2	Seminar / Conferences / Research papers

25.How program specific outcomes are assessed:

Program Specific Outcomes		Strength	Proficiency Assessed by
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	2	Lab Experiments / 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	Apply the mathematical principles, scientific principles and methodology of boolean algebra to understand the function of logic gates	2
	PO 2	Understand the given problem statement and formulate the engineering problems related to minimization of boolean functions, translate the information into the model and prototype systems from the provided information and data, develop solutions based on the functionality of the data translation, validate the output of the circuit in reaching substantiated conclusions by the interpretation of results.	4
	PO5	Create a program for boolean expressions in VHDL and verify the outputs using modern engineering tool.	1
	PO10	Describe the basic function of logic gates and implementation of boolean functions primitives by giving effective presentations and take clear instructions.	1
CO 2	PO 1	Apply the mathematical principles, scientific principles and methodology of combinational circuits for simulating them in data flow,structural and behavioral modelling styles	3

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 engineering problems related to combinational logic circuits, translate the information into the model and prototype systems from the provided information and data, develop t the VHDL code and validate the output of the circuit in reaching substantiated conclusions by the interpretation of results.	5
	PO 3	Understand the customer needs, investigate and define a problem, use creativity and manage design process to model the complex combinational logic circuits making use of dataflow, behavioral and structural modeling styles in VHDL with the help of modern engineering tools.	5
	PO 5	Simulate the combinational circuits in VHDL using data flow or structural or behavioral models using modern engineering tool.	5
	PO 10	Describe the implementation of combinational logic circuits using three modelling styles in VHDL by giving effective presentations and take clear instructions	5
CO 3	PO 2	Understand the given problem statement and formulate the engineering problems related to sequential logic circuits, translate the information into the model and prototype systems from the provided information and data, develop the VHDL code and validate the output of the circuit in reaching substantiated conclusions by the interpretation of results. .	4
	PO 5	Verify the functional simulation and timing analysis sequential circuits using modern engineering tool.	1
	PO 10	Describe the implementation of sequential logic circuits using three modelling styles in VHDL by giving effective presentations and take clear instructions	1
CO 4	PO 1	Apply the mathematical principles, scientific principles and methodology of combinational circuits for simulating them in data flow,structural and behavioral modelling styles	
	PO 2	Understand the given problem statement and formulate the engineering problems in shift registers and counters, translate the information into the model and prototype systems from the provided information and data, develop the VHDL code and validate the output of the circuit in reaching substantiated conclusions by the interpretation of results.	4
	PO 5	Analyze the functional simulation and timing analysis of shift registers using modern engineering tools.	4

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PO 10	Describe the implementation of shift registers in VHDL by giving effective presentations and take clear instructions	1
CO 5	PO 2	Understand the given problem statement and formulate the engineering problems in the design and implementation of finite state machines, translate the information into the model and prototype systems from the provided information and data, develop t the VHDL code and validate the output of the circuit in reaching substantiated conclusions by the interpretation of results.	2
	PO 3	Understand the customer needs, investigate and define a problem, use creativity and manage design process and establish innovative solutions in designing the finite state machines using VHDL with the help of modern engineering tools.	1 2
	PO 5	Model the finite state machines and verify functional simulation using modern engineering tool	1
	PO 10	Describe the implementation of FSM in VHDL by giving effective presentations and take clear instructions	1
	PSO 2	Design ASIC prototypes by adopting engineering professional code in VHDL for the implementation of FSM to familiarize with the ASIC design flow, realize RTL schematic and analyze the synthesis of SOC	1
CO 6	PO 2	Understand the given problem statement and formulate the engineering problems in the design and implementation of finite state machines, translate the information into the model and prototype systems from the provided information and data, develop t the VHDL code and validate the output of the circuit in reaching substantiated conclusions by the interpretation of results..	4
	PO 3	Understand the customer needs, investigate and define a problem, use creativity and manage design process and establish innovative solutions in basic real time applications of the digital circuits like traffic light controller ,chess clock controller, elevator using modern engineering tools.	2
	PO 5	Build the real time applications of digital circuits and simulate in VHDL using modern engineering tool.	2
	PO 9	improves the ability work with teams includes all levels of people, independently, maturely giving self directions while performing the lab experiments	2
	PO 10	Describe the implementation of real time applications as traffic light controller, chess clock controller and elevator in VHDL by giving effective presentations and take clear instructions	2

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PSO 2	Design ASIC prototypes by adopting engineering professional code in VHDL for the implementation of FSM to familiarize with the ASIC design flow, realize RTL schematic and analyze the synthesis of SOC	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	2	5	-	-	1	-	-	-	-	2	-	-	-	-	-
CO 2	2	5	5	-	1	-	-	-	-	2	-	-	-	-	-
CO 3	-	5	-	-	1	-	-	-	-	2	-	-	-	-	-
CO 4	2	5	-	-	1	-	-	-	-	2	-	-	-	-	-
CO 5	-	5	6	-	1	-	-	-	-	2	-	-	-	5	-
CO 6	-	5	6	-	1	-	-	-	5	2	-	-	-	5	-

29. Percentage of key competencies for CO – (PO, PSO): COURSE OUTCOMES

COURSE OUTCOMES	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	66.6	50	-	-	100	-	-	-	-	40	-	-	-	-	-
CO 2	66.6	50	-	-	100	-	-	-	-	40	-	-	-		-
CO 3	-	50	50	-	100	-	-	-	-	40	-	-	-	-	-
CO 4	66.6	50	-	-	100	-	-	-	-	40	-	-	-	-	-
CO 5	-	50	60	-	100	-	-	-	-	40	-	-	-	45.5	-
CO 6	-	50	60	-	100	-	-	-	41.6	40	-	-	-	45.5	-

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	-	-	3	-	-	-	-	2	-	-	-	-	-
CO 2	3	2	-	-	3	-	-	-	-	2	-	-	-	-	-
CO 3	-	2	2	-	3	-	-	-	-	2	-	-	-	-	-
CO 4	3	2	-	-	3	-	-	-	-	2	-	-	-	-	-
CO 5	-	2	2	-	3	-	-	-	-	2	-	-	-	2	-
CO 6	-	2	2	-	3	-	-	-	2	2	-	-	-	2	-
TOTAL	9	12	6	-	18	-	-	-	2	12	-	-	-	4	-
AVERAGE	3	2	2	0	3	0	0	0	2	2	0	0	0	1	0

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

33. Relevance to Sustainability goals

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

1		
2		
3		

4	QUALITY EDUCATION	**Quality Education:** The 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	
7	AFFORDABLE AND CLEAN ENERGY	**Affordable and Clean Energy:** Design low-power digital systems that consume less energy during operation. Use energy-efficient algorithms and hardware that reduce power consumption in embedded systems, processors, and communication devices.
8	DECENT WORK AND ECONOMIC GROWTH	**Decent Work and Economic Growth:** The course 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	
10	REDUCED INEQUALITIES	
11	SUSTAINABLE CITIES AND COMMUNITIES	**Sustainable Cities and Communities** Implement strategies for the safe disposal or recycling of outdated or non-functional digital systems. Support take-back programs and recycling initiatives.
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 15/04/2024

Signature of Course Coordinator **HOD,ECE**
Veena M Kurup, Asst Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

COURSE TEMPLATE

1	Department	**ELECTRONICS & COMMUNICATION ENGINEERING**			
2	Course Title	**DATA STRUCTURES LABORATORY**			
3	Course Code	ACSD11			
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	Ajitha G			
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	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.

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

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 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	3	LAB PROGRAMS/CIE/SEE
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	2	LAB PROGRAMS/CIE/SEE
PSO 3	Make use of modern computer tools for creating innovative career paths, to be an entrepreneur and desire for higher studies.	2	LAB PROGRAMS/CIE/SEE

3 = High; 2 = Medium; 1 = Low

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

COURSE OUTCOMI	PROGRAM OUTCOMES												PSO'S		
	PO 1	PO 2	PO 3	PO 4	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
	PSO1	**Design and analyze** complex algorithms and specify its space and time complexities and representing it by asymptotic notations for faster processing of data. To interpret algorithm complexity is critical for the development of embedded software and digital circuits in robotics and signal processing applications.	3
	PSO3	**Make use of modern** Algorithm complexity interpretation aids in evaluating the performance of algorithms used in HFSS simulations, particularly for optimizing antenna designs.	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
	PSO1	**Understand** effective searching and sorting algorithms are vital in embedded systems for tasks such as real-time data processing in robotics, where speed and accuracy are crucial for system performance.	4
	PSO2	**Applying** the concepts in the design of ASICs and SoCs, selecting optimal searching and sorting techniques is critical for developing fast, low-power hardware implementations, particularly in high-speed data processing applications.	2
	PSO3	**Make use of** efficient searching and sorting techniques enhances the simulation accuracy in HFSS, leading to better optimization of wired and wireless communication systems by enabling faster convergence and data handling which are necessary for engineering practices and higher studies or become an entrepreneur.	1

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
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
	PSO1	**Understand** linear data structures are fundamental in organizing memory efficiently in embedded software, allowing for predictable and quick access to data, which is crucial for robotics and signal processing tasks that require real-time responsiveness.	5
	PSO2	**Applying** linear data structures helps in optimizing memory usage and access times in ASIC and SoC design, implementing operations on essential for designing high-performance, resource-efficient hardware.	2
	PSO3	**Make use of** linear data structures in HFSS supports the efficient organization of simulation data, which is necessary for the accurate and fast evaluation of patch and smart antennas in communication systems.	1
CO 4	PO 1	**Make use of** linear and nonlinear data structures for solving real time applications by applying the basic knowledge of mathematics, science, engineering fundamentals	3
	PO 2	**Problem analysis:**Solving real time applications by performing the operations on linear or nonlinear data structures.	7

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
	PSO1	**Understand** nonlinear data structures like trees and graphs enable complex data relationships to be modeled efficiently in embedded systems, essential for tasks such as sensor data processing and decision-making in robotics and signal processing applications.	5
	PSO2	**Applying** nonlinear data structures allow in ASIC and SoC designs, for the efficient handling of complex data flows, critical in the design of advanced, high-throughput systems that meet real-time application demands.	1
	PSO3	**Make use of** nonlinear data structures in HFSS helps in accurately modeling and simulating complex antenna configurations, which is vital for the design and optimization of sophisticated communication systems which are necessary for engineering practices and higher studies or become an entrepreneur.	1
CO 5	PO 1	**Understand** the knowledge of hashing techniques and collision resolution methods and implementing for specified problem domain using knowledge of mathematics, science and engineering fundamentals	1
	PO 3	**Design the Solution** for efficiently accessing data with respect to performance by using hashing techniques and collision resolution methods	2
	PO 5	**Implementation of** hashing techniques and collision resolution methods for efficiently accessing data with respect to performance with the help of computer software	1
	PO 10	**Subject matter and speaking style** assessed in explanation of Hashing, Collision techniques	2

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PSO1	**Understand** balanced data structures, such as AVL trees, are key to ensuring that embedded systems can manage data efficiently, providing quick access and updates that are crucial for maintaining real-time performance in robotics and signal processing applications.	4
	PSO2	**Applying** balanced data structures are integral in ASIC and SoC design, enabling efficient data storage and retrieval processes that are critical for maintaining high performance and reliability in embedded hardware systems.	1
	PSO3	**Build** balanced data structures to support the efficient handling of large datasets, improving the accuracy and speed of simulations for antenna design and evaluation in wired and wireless communication applications.	1
CO 6	PO 1	**Understand** various types of data structures in terms of implementations and choose appropriate data structure for specified problem domain using knowledge of mathematics, science and engineering fundamentals	3
	PO 2	**Problem Analysis:** Recognize the importance of suitable data structures in checking the efficiency of algorithms used for complex engineering problems.	7
	PO 3	**Design the Solution** complex problems or efficiently accessing data with respect to performance by using hashing techniques and collision resolution methods	5
	PO 4	**Conduct Investigations of Complex Problems:** Ability to apply operations on linear or nonlinear data structures in order to solve real time applications.	4
	PO 5	**Understand** the Implementation of various types of data structures with the help of computer software	1
	PO 10	**Subject matter and speaking** style assessed in explanation of Implementation of various types of data structures.	2
	PO 12	**Keeping current in CSE** and advanced engineering concepts of Implementation of various types of data structures by tech talk, concept videos and open ended experiments	3
	PSO 1	**Understand** the selection of the appropriate data structures is essential for developing embedded systems that meet the specific performance and operational requirements of robotics and signal processing applications, ensuring that the systems are both efficient and scalable.	5

COURSE OUTCOMES	PO'S PSO'S	Justification for mapping (Students will be able to)	No. of Key Competencies
	PSO 2	**Applying** designs, the choice of data structures directly affects the performance, power consumption, and complexity of the hardware, making it crucial to select structures that align with the system's design goals and constraints.	1
	PSO 3	**Build** sufficient knowledge Implementation of various types of data structures so that new product can be developed, which leads to become successful entrepreneur in the present market.	1

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	-	-	3	-	1
CO 2	1	5	2	-	1	-	-	-	-	2	-	-	4	2	1
CO 3	2	7	5	4	1	-	-	-	-	2	-	-	5	2	1
CO 4	3	7	2	4	1	-	-	-	-	2	-	-	5	1	1
CO 5	1	-	2	-	1	-	-	-	-	2	-	-	4	1	1
CO 6	3	7	5	4	1	-	-	-	-	2	-	3	5	1	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	-	-	50	-	50
CO 2	33.3	50	20	-	100	-	-	-	-	40	-	-	66.6	100	50
CO 3	66.6	70	50	36.3	100	-	-	-	-	40	-	-	83.3	100	50
CO 4	100	70	20	36.3	100	-	-	-	-	40	-	-	66.6	50	50
CO 5	33.3	-	20	-	100	-	-	-	-	40	-	-	66.6	50	50
CO 6	100	70	50	36.3	100	-	-	-	-	40	-	25	83.3	50	50

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

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	**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	
✓	PEACE, JUSTICE AND STRONG INSTITUTIONS	**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	**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,ECE**
Ms Ajitha G, Assistant Professor