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

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**Matrices and Calculus**
Course Code	AHSE01
Course Start	First Semester
Course Type	Foundation
Regulation	IARE - BT 25
Prerequisite Courses	Basic Mathematics
Department	ECE
Number of Credits	4 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Theory
Course Administrator	**Mr. Satyanarayana G** Assistant Professor of Mathematics IARE10774 g.satyanarayana@iare.ac.in
Course Coordinator's Name	**Dr. P Srilatha,** Associate Professor of Mathematics IARE10161 p.srilatha@iare.ac.in
Prior Learning Assessment and Recognition (PLAR)	Students interested in PLAR pathways for open learning can register one semester prior to the start of semester. Students will receive the necessary contact information one semester in advance.
Open Learning Faculty Member Information	Open Learning Faculty (OLF) is available to assist students. Students will receive the necessary contact information at the start of the course.
Course Webpage	https://akanksha.iare.ac.in/index?route=course/details&course_id=2160
Course Description	This course Matrices and Calculus is a foundation course of mathematics for all engineering branches. The course covers the concepts of Matrices, Eigen Values, Eigen Vectors, Functions of Multi variable Calculus, and Multiple Integrals. This course is applicable for simulations, colour imaging process, finding optimal solutions in all fields of industries.
Course Objectives	a. The concept of the rank of a matrix, the system of linear equations, eigen values, eigen vectors. b. The geometrical approach to the mean value theorems and their application to the mathematical problems c. The various methods for maxima and minima of functions of two and three variables d. The evaluation of multiple integrals and their applications.
Text and Reference Books	**Text Books** 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*, 3/ed, Narosa Publications, 5th Edition, 2016. 2. N. P. Bali, "Engineering Mathematics", Laxmi Publications, 9th Edition, 2016. 3. S. C. Gupta, V. K. Kapoor, "Fundamentals of Mathematical Statistics", S. Chand and Co., 10th Edition, 2000 4. Richard Arnold Johnson, Irwin Miller and John E. Freund, "Probability and Statistics for Engineers", Prentice Hall, 8th Edition, 2013.
Learning Resources	**Course full stack** is made available in IARE learning management portal – Akansha, which includes lecture notes, tutorial question bank, definition and terminology, tech-talk topics, assignments, Model question papers (2 sets), complex engineering problem solving statements, power point presentations (PPTs) and ELRV lecture recordings at: • https://youtube.com/playlist?list=PLzkMouYverAIiMqEW7abuaE71GPCLoqFq&si=rYt4oprDBSyvrjBm • https://youtube.com/playlist?list=PLzkMouYverALWPADXlSjbKV8WVkUnnPuO&si=di2g1LRQQRYVl0b-
Supplemental Materials	**Readings, Videos, and Links** 1. https://onlinecourses.nptel.ac.in/noc23_ma88/preview 2. 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
Learning and Teaching Strategies	Online material will provide the foundation of the learning resources, requiring the students to log in and engage regularly throughout the sixteen weeks of the course. There will be a mix of suggested readings, discussions and video content containing embedded digital content and undertake the assessment tasks.

SECTION 2: Teaching Learning Scheme

At least 48 lecture hours of scheduled teaching and learning activities (TLA) will be delivered in person, with the remaining hours for scheduled and self-scheduled teaching and learning activities delivered either in person or online.

Notional Study Time: 90 Hours (Lecture hours: 48, Tutorial hours:16, Scheduled revision session hours: 2, Homework / Programming assignment hours: 10, Course project / Preparation for complex problem-solving hours: 14)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA 1	Lectures	48	01	48
TLA 2	Tutorials	16	01	16
TLA 3	Case Study			
TLA 4	Problem Solving			14
TLA 5	Demonstration			
TLA 6	Scheduled revision sessions	02	01	02
TLA 7	Guided independent study: Directed viewing of video materials / PPTs			
TLA 8	Independent private study			

TLA 9	Laboratory Exercises	0	0	0
TLA 10	Homework assignments / Programming assignments			10
TLA 11	Placement / work based learning or Specific practical training	0	0	0
TLA 12	Presentation / Seminar Preparation			
TLA 13	Course Project / Preparation for Complex Problem Solving			
TLA 14	Technical visit			
TLA 15	Field activities	0	0	0
			Total study hours	**90**
			Expected total study hours	**90**

SECTION 3A: Course Outcomes

After successfully completing this course, the student will be able to:

Outcome Number	Course Outcomes	Learning Domain
CO1	**Determine** the rank and solutions of linear equations with elementary operations.	Understand
CO2	**Utilize** the Eigen values, Eigen vectors for developing spectral matrices.	Apply
CO3	**Make use of** Cayley-Hamilton theorem for finding powers of the matrix.	Apply
CO4	**Apply** the mean value theorems for finding analytical problems involving derivatives.	Apply
CO5	**Interpret** the maxima and minima of given functions by finding the partial derivates.	Apply
CO6	**Determine** the area of solid bounded regions by using the integral calculus.	Understand

SECTION 3B: Cognitive Levels

Blooms Taxonomy Level	Cognitive Level in Percentage (%)
Remember	0
Understand	33
Apply	67
Analyse	0
Evaluate	0
Create	0

SECTION 4: Content and Context of Matrices and Calculus

CO1	Determine the rank and solutions of linear equations with elementary operations
	This course helps students understand elementary row operations and their use in matrix calculations. Students will learn how to apply row operations such as row interchange, row scaling, and row addition to simplify matrices. Using these concepts, they will be able to determine the rank of a matrix and solve systems of linear equations. The course also introduces standard methods for solving matrices, including the use of row echelon form and reduced row echelon form. Students will understand how to use these techniques to analyze and solve linear systems efficiently. Learners will be trained to determine whether a system of equations is consistent or inconsistent by comparing the rank of the coefficient matrix and the augmented matrix. The course will also cover

	methods for solving typical problems involving matrices, including cases with unique or infinite solutions. Students will be introduced to the Gauss–Seidel method, an important iterative technique used to solve systems of linear equations, especially in applied problems. The course focuses on building a strong foundation in matrix operations, rank determination, and systematic approaches to solving linear equations.
CO2	**Utilize the Eigen values, Eigen vectors for developing spectral matrices**
	The students to understand the concepts of eigenvalues and eigenvectors and their importance in matrix theory. It extends these ideas to the diagonalization of matrices and the computation of the inverse of a matrix. Students will learn how to find eigenvalues and eigenvectors and use them to diagonalize matrices. Learners will study important concepts such as the orthogonality of matrices and the nature of quadratic forms. They will also understand how these concepts are applied in simplifying matrix operations. Students will learn how to use eigenvalues and eigenvectors to obtain particular solutions through diagonalization and to compute matrix inverses efficiently. These methods are especially useful in solving engineering and applied mathematics problems. The course builds a strong foundation in eigen concepts, matrix transformations, and their practical applications.
CO3	**Make use of Cayley-Hamilton theorem for finding powers of the matrix.**
	The learners to the Cayley–Hamilton theorem and its applications in matrix algebra. Students will understand that every square matrix satisfies its own characteristic equation. Learners will be taught how to use the Cayley–Hamilton theorem to simplify complex matrix computations, including finding higher powers of matrices and computing the inverse of a matrix. The course develops the mathematical principles and techniques required to apply this theorem effectively. Students will gain the ability to reduce complicated matrix expressions into simpler forms. Learners will understand the importance of the Cayley–Hamilton theorem in practical fields such as control systems, computer graphics, and numerical methods. The course strengthens problem-solving skills and provides efficient methods for handling advanced matrix operations
CO4	**Apply the mean value theorems for finding analytical problems involving derivatives.**
	Learners should have a basic understanding of the Mean Value Theorem and how it connects theoretical calculus with real-world applications. The course provides an in-depth study of the Mean Value Theorem and its role in analyzing functions. Students will learn how results derived from this theorem can be used to estimate and predict future values of functions. The course emphasizes the practical use of Mean Value Theorem in solving real-life problems. Learners will also explore applications of these concepts in fields such as physics, engineering, and optimization. Through this, they will develop strong analytical and problem-solving skills. The course helps students apply these techniques to data analysis and modelling, enabling them to interpret and solve practical problems effectively.
CO5	**Interpret the maxima and minima of given functions by finding the partial derivates**
	Learners should have a basic understanding of partial derivatives and their application in finding the maxima and minima of multivariable functions. The course explains how these concepts are used to analyze functions with more than one variable. Students will develop the ability to apply these techniques to real-world problems, such as optimization in engineering design, cost minimization, and efficiency maximization. The course also strengthens skills in mathematical modelling, analysis, and problem-solving, enabling learners to interpret and solve practical problems effectively. The learner will gain a solid foundation in multivariable calculus and its applications in various engineering and scientific contexts
CO6	**Determine the area of solid bounded regions by using the integral calculus**
	Learners should have a basic understanding of integral calculus and its fundamental principles. The course focuses on determining the area of bounded regions and the volume of solids using integration techniques.

	Students will learn how to calculate the area under curves and between surfaces, which are key applications of definite integrals. They will also study methods for finding volumes of complex geometrical and physical shapes. The importance of these methods in solving real-world engineering problems such as fluid storage, structural analysis, and land measurement. Learners will be trained to apply integration techniques to model and analyze real-world situations, enhancing their mathematical and problem-solving skills. The course builds a strong foundation in applying integral calculus to practical and engineering contexts.

SECTION 5: Complex Engineering Problem Solving

Complex Problem Solving

There is one piece of assessed coursework, involving a mixture of theoretical work. We encourage the students to get the ability to solve complex engineering problems using advanced mathematics can give companies and countries a competitive edge in the global market, driving economic growth and innovation.

Complex engineering problems in mathematics involve highly intricate and multifaceted challenges that require advanced mathematical techniques, interdisciplinary knowledge, and innovative problem-solving strategies. These problems often arise in real-world applications and demand a deep understanding of mathematical modelling, optimization, numerical methods, and computational techniques.

Complex engineering problems in mathematics are at the core of modern technological advancements. They require a blend of theoretical knowledge and computational skills to develop innovative solutions for real-world challenges. With the rise of artificial intelligence and computational power, engineers and mathematicians continue to tackle increasingly sophisticated problems, pushing the boundaries of what is possible in science and engineering.

SECTION 6A: Assessment Methods – Direct

Item	Evaluation Components	Week in / out	Marks
AAT: 1 – 1	Tech-Talk	Week – 2 / 5	05
AAT: 1 – 2	Assignments/open-ended problems	Week – 4 / 7	05
AAT: 2 – 1	Complex Engineering Problem Solving	Week – 9 / 12	05
AAT: 2 - 2	Assignments/open-ended problems	Week – 12 / 15	05
CIE – 1	2 hours - Answer 4 out of 5 questions	Week – 9	10
CIE – 2	2 hours - Answer 4 out of 5 questions	Week – 17	10
SEE	3 hours - Answer 1 from each module	Week – 18	60
		Total Marks	**100**

Department's Late Submission Policy:

1. 1 – 24 hours: 25% of the mark will be deducted
2. > 24 hours: Not accepted

SECTION 6B: Assessment Methods –Indirect

Course End Survey (End Semester OBE Feedback)	✓

SECTION 7: Engineering Competencies (ECs) Focused Please tick (✓) relevant engineering competency profile covered			
EC Number	**Attributes**	**Profiles**	**(✓)**
EC1	Depth of knowledge required (CP)	Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill-founded, illogical, erroneous, unreliable or unrealistic requirements applicable to the engineering discipline	✓
EC2	Depth of analysis required (CP)	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	✓
EC3	Design and development of solutions (CA)	Support sustainable development solutions by ensuring functional requirements, minimize environmental impact and optimize resource utilization throughout the life cycle, while balancing performance and cost effectiveness.	-
EC4	Range of conflicting requirements (CP)	Competently addresses complex engineering problems which involve uncertainty, ambiguity, imprecise information and wide-ranging or conflicting technical, engineering and other issues.	-
EC5	Infrequently encountered issues (CP)	Conceptualizes alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.	-
EC6	Protection of society (CA)	Identifies, quantifies, mitigates and manages technical, health, environmental, safety, economic and other contextual risks associated to seek achievable sustainable outcomes with engineering application in the designated engineering discipline.	-
EC7	Range of resources (CA)	Involve the coordination of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies) in the timely delivery of outcomes	-
EC8	Extent of stakeholder involvement (CP)	Design and develop solution to complex engineering problem considering a very perspective and taking account of stakeholder views with widely varying needs.	-
EC9	Extent of applicable codes, legal and regulatory (CP)	Meet all level, legal, regulatory, relevant standards and codes of practice, protect public health and safety in the course of all engineering activities.	-
EC10	Interdependence (CP)	High level problems including many component parts or sub-problems, partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then re-combines to form a whole, with the integrity and performance of the overall system as the top consideration.	-
EC11	Continuing professional development (CPD) and lifelong learning (CA)	Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.	-
EC12	Judgement (CA)	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Require judgement in decision making in the course of all complex engineering activities.	-

SECTION 8: Employability Skills

Example: Communication skills / Programming skills / Project based skills

There is one piece of assessed coursework, Studying Matrices and calculus enhance the ability to model dynamic systems, and contribute to advancements in various fields. This expertise is particularly valuable in problem solving, analytical, and computational skills.

STEM (Science, Technology, Engineering, and Mathematics) careers, where analytical and technical skills are in high demand.

Employability Skills:

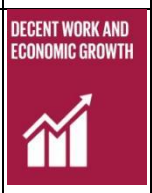
- Enhances analytical thinking for solving complex engineering and technical problems.
- Develops strong problem-solving skills applicable to real-world scenarios.
- Improves numerical computation abilities essential in data analysis and simulations.
- Builds skills in modelling complex systems for engineering and technological applications.
- Strengthens matrix-based computation capabilities for structural analysis and machine learning.
- Equips learners with optimization skills for efficient engineering and operational solutions.
- Develops predictive modelling skills for forecasting and system analysis.
- Enhances engineering design and systems modelling proficiency.
- Improves competence in physical modelling, fluid mechanics, and structural computations.
- Prepares learners for real-world technical decision-making and applied problem-solving.

Project Management:

- Analytical Decision-Making.
- Modelling and Optimization.
- Critical Thinking and Forecasting.
- Resource and Process Optimization.
- Quantitative Analysis and Reporting.

SECTION 9: Relevance to Sustainability goals

Brief description about the course and its correlation with Sustainability Development Goal (SDGs).

SDG Goals		Correlation with SDG
4		**Quality Education:** This subject equips students with problem-solving and analytical skills, fostering innovation and critical thinking. These mathematical tools are essential for training the next generation of scientists, engineers, and policymakers to tackle sustainability challenges.
8		**Decent Work and Economic Growth:** The students with analytical and computational skills essential for modelling, optimization, and decision-making in industries, finance, and technology. These mathematical tools enable efficient resource allocation, economic forecasting, and problem-solving, supporting sustainable economic growth and productive, skilled employment opportunities.
9		**Industry, Innovation, and Infrastructure:** Matrices and calculus are essential for modelling, analyzing, and optimizing engineering and industrial systems. They support innovation, efficient infrastructure development, and advanced technological solutions.

SECTION 10A: Mapping between COs and POs / PSOs														
Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO2	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO4	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO5	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO6	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-

Outcomes		WKS and Indicators of attainment and Justification for mapping (students will be able to)																																						IAs Count
COs	POs	WK 1	WK 2								WK 3			WK 4			WK 5						WK 6			WK 7				WK 8							WK 9						
		a	a	b	c	d	e	f	g	h	a	b	c	a	b	c	a	b	c	D	e	f	a	b	c	a	b	c	d	a	b	C	D	e	f	g	a	b	c	d	e	f	
CO 1	PO 1	•	•	•		•	•	•			•	•		•																												9
	PO 2	•	•	•		•	•	•			•	•		•																												9
	PO 3																																									
	PO 11																																									
	PSO 1																																									
CO2	PO 1	•	•	•		•	•	•			•	•		•																												9
	PO 2																																									
	PO 3																																									
	PO 4																																									
	PO 5																																									
	PO 11																																									
	PSO 1																																									
	PSO 3																																									
CO3	PO 1	•	•	•		•	•	•			•	•		•																												9
	PO 2	•	•	•		•	•	•			•	•		•																												9
	PO 3																																									
	PO 4																																									
	PO 5																																									
	PO 11																																									
	PSO 1																																									
	PSO 2																																									
	PSO 3																																									
CO4	PO 1	•	•	•		•	•	•			•	•		•																												9
	PO 2	•	•	•		•	•	•			•	•		•																												9
	PO 3																																									

	PO 4																																														
	PO 5																																														
	PO 11																																														
	PSO 1																																													
	PSO 2																																														
	PSO 3																																														
CO 5	PO 1	•	•	•		•	•	•			•	•		•																															9
	PO 2	•	•	•		•	•	•			•	•		•																															9
	PO 3																																														
	PO 4																																														
	PO 5																																														
	PO 11																																														
	PSO 1																																														
	PSO 2																																														
	PSO 3																																														
CO 6	PO 1	•	•	•		•	•	•			•	•		•																															9
	PO 2	•	•	•		•	•	•			•	•		•																															9
	PO 3																																														
	PO 4																																														
	PO 5																																														
	PO 6																																														
	PO 11																																														
	PSO 1																																														
	PSO 2																																														
	PSO 3																																														

SECTION 10B: Indicators of Attainment with COs to POs and PSOs															
Course Outcomes	**Percentage of Indicators of Attainments (IA) with POs and PSOs**														
	PO												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**		**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	60	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	60	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	60	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	60	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO6	60	60	-	-	-	-	-	-	-	-	-	-	-	-	-

SECTION 10C: Course Articulation Matrix of COs to POs														
0 No Contribution (0-5%)			**1** Low (≥5 - <40%)				**2** Moderate (≥40 - <60%)					**3** High (≥60%)		
Course Outcomes	**Program Outcomes (POs)**											**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO6	3	3	-	-	-	-	-	-	-	-	-	-	-	-
Total	18	15	-	-	-	-	-	-	-	-	-	-	-	-
Average	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

SECTION 10D: Level of Contribution of the COs to POs and PSOs			
Number	**Programme Outcomes**	**Proficiency Assessed by**	**Contribution Level (from 1 to 3)**
PO 1	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**.	CIE / SEE / AAT:1 – 2 Assignments / Open-ended problems	**3**
PO 2	Identify, formulate, review research literature and analyse **complex engineering problems** reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).	CIE / SEE / AAT:1 – 2	**3**
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..		

SECTION 11: Course Content	
MODULE - I	**MATRICES**
	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. Gauss Seidel iteration method.
MODULE - II	**EIGEN VALUES AND EIGEN VECTORS**
	Linear transformation and orthogonal transformation: Eigen values, Eigen vectors and their properties, diagonalization of a matrix, Cayley-Hamilton theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton theorem, Quadratic forms and nature of the Quadratic forms, reduction of Quadratic form to canonical form by orthogonal transformation
MODULE - III	**SINGLE VARIABLE CALCULUS**
	Limit and continuous of functions and its properties. mean value theorems: Rolle's theorem, Lagrange's mean value theorem with their geometrical interpretation and applications. Cauchy's mean value theorem, Taylor's series (all the theorems without proof). **Curve Tracing**: Curve tracing in cartesian coordinates
MODULE - IV	**MULTIVARIABLE CALCULUS**
	Definitions of limit and continuity, partial differentiation: Euler's theorem, total derivative, Jacobian, functional dependence & independence. Applications: maxima and minima of functions of two variables and three variables using method of Lagrange multipliers
MODULE - V	**MULTIPLE INTEGRALS**
	Evaluation of double integrals (cartesian and polar coordinates), change of order of integration (only cartesian form), change of variables for double integrals (cartesian to polar). evaluation of triple integrals, change of variables for triple integrals (cartesian to spherical and cylindrical polar coordinates). Applications: areas by double integrals and volumes by triple integrals.

SECTION 12: Tentative Schedule of Instructions		
Week Number	**Topics**	**Duration (Hours)**
1	1.1 Introduction to matrices 1.2 Rank of a matrix 1.3 Rank of a matrix by Echelon form	3
2	2.1 Rank of a matrix by Normal form 2.2 Inverse of non-singular matrices by Gauss-Jordan method 2.3 System of linear equations	3
3	3.1 Solving system of homogeneous equations 3.2 Solving system of non-homogeneous equations 3.3 Gauss Seidel iteration method	3
4	4.1 Introduction of Eigen values 4.2 Introduction of Eigen vectors 4.3 Properties of Eigen values and Eigen vectors	3
5	5.1 Diagonalization of a matrix 5.2 Introduction of Cayley-Hamilton theorem 5.3 Finding inverse of a matrix by Cayley-Hamilton theorem	3
6	6.1 Power of a matrix by Cayley-Hamilton theorem 6.2 Introduction of Quadratic forms 6.3 Nature of the Quadratic forms	3

7	7.1 Reduction of Quadratic form to canonical form by orthogonal transformation 7.2 Limit and continuous of functions and its properties 7.3 Introduction to Rolles theorem	3
8	8.1 Solutions of Rolle's theorem 8.2 introduction of Lagrange mean value theorem 8.3 Solutions of Lagrange mean value theorem	3
CONTINIUOUS INTERNAL EXAMINATION (CIE- I)		
9	9.1 Introduction of Cauchy's mean value theorem 9.2 Solutions of Cauchy's mean value theorem 9.3 Solution of Taylors series	3
10	10.1 Introduction of curve tracing in cartesian coordinates 10.2 Definitions of limit and continuity 10.3 Partial differentiation	3
11	11.1 Problems on Eulers theorem, total derivative 11.2 Problems on Jacobian 11.3 Problems on functional dependence and independence	3
12	12.1 Introduction of maxima and minima of functions of two variables 12.2 Problems on maxima and minima of functions of two variables 12.3. Problems on maxima and minima of functions of three variables	3
13	13.1 Introduction to Lagrange multipliers 13.2 Problems on Lagrange multipliers 13.3 Introduction on double integrals	3
14	14.1 Evaluation of double integrals of cartesian coordinates 14.2 Evaluation of double integrals of polar coordinates 14.3 Change of order of integration	3
15	15.1 Change of variables for double integrals 15.2 Introduction of triple integrals 15.3 Evaluation of triple integrals	3
16	16.1 Change of variables for triple integrals 16.2 Areas by double integrals 16.3 Volumes by triple integrals	3
	Total	**48**

SECTION 14: Specific Goals for the Course

The following table shows the knowledge and skills covered by the unit outcomes:

Knowledge	Skills
Learners should understand: • Types of matrices, their properties, rank, and determinants • Eigenvalues, eigenvectors, diagonalization, and Cayley-Hamilton theorem • Quadratic forms and reduction to canonical forms by orthogonal transformations • Limits, continuity, Mean Value Theorems, Taylor series, and curve tracing • Multivariable calculus: partial derivatives, Jacobian, maxima/minima, Lagrange multipliers • Multiple integrals and their applications to areas and volumes	**Learners can:** • Perform matrix operations, determine rank, and solve linear systems using Gauss-Jordan and Gauss-Seidel methods • Compute eigenvalues/eigenvectors, diagonalize matrices, and find matrix powers and inverses • Analyze quadratic forms and simplify using orthogonal transformations for engineering applications • Differentiate, integrate, approximate functions, and trace curves for mathematical and engineering analysis. • Optimize multivariable functions and solve maxima/minima problems in engineering and real-world contexts

	• Evaluate double/triple integrals, calculate areas and volumes, and model real-world problems in engineering and physics

Administrative Information

SECTION 15: History of changes		
Regulations	**Description of Change**	**BOS Date**
R 16	From R15 JNTUH, Hyderabad to R16 IARE regulations	24.07.2016
R 18	Changes from R16 to R18 regulation • Vector differential and integral calculus vector differential calculus: Scalar and vector point functions; Definitions of Gradient, divergent and curl with examples; Solenoidal and irrotational vector point functions; Scalar potential function. • Vector integral theorems: Line integral, surface integral and volume integral, Green's theorem in a plane, Stake's theorem and Gauss divergence theorem without proofs.	16.07.2018
UG 20	Changes from R18 to UG 20 regulation Module –V: Fourier series Fourier expansion of periodic function in a given interval of length 2π; Fourier series of even and odd functions; Fourier series in an arbitrary interval, Half- range Fourier sine and cosine expansions.	17.11.2020
BT 23	Incorporated the following additions in BT 23 regulations • Credit weightage is reduced from 4 to 3. • Module – V: Multiple integrals Evaluation of double integrals (cartesian and polar coordinates), change of order of integration (only cartesian coordinates), evaluation of triple integrals (only cartesian coordinates).	21.08.2023
BT25	Changes as per JNTUH Syllabus	

Course Outline Approvals	
Course Coordinator Name: Dr. P. Srilatha Signature: Date:	**Head of the Department** Name: Dr. P. Srilatha Signature: Date:
Course Outline Approvals: The course outline description approved by Outcome Based Teaching Learning (OBTL) committee on *date* in meetings *IARE - OBTL – COD /104/25*	
Dean of Outcome Based Teaching and Learning Name: Dr. Ch. Srinivasulu Signature: Date:	**Dean of Academics** Name: Dr. G. Chandrasekhar Signature: Date:

Check List		
Section	**Description**	**Please tick (✓)**
1	General Information about the Course	
2	Notional Study Time	
3	A. Course Outcomes	
	B. Cognitive Levels	
4	Content and Context of the Course	
5	Complex Engineering Problem Solving	
6	A. Assessment Methods – Direct	
	B. Assessment Methods – Indirect	
7	Content Delivery / Instructional Methodologies	
8	Engineering Competencies (ECs) Focused	
9	Employability Skills	
10	Relevance to Sustainability goals	
11	A. Mapping between COs and POs / PSOs	
	B. Indicators of Attainment with COs to POs and PSOs	
	C. Course Articulation Matrix of COs to POs	
	D. Level of Contribution of the COs to POs and PSOs	
12	Syllabus	
13	Tentative Schedule of Instructions	
14	Specific Goals for the Course	
15	History of Changes	

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

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**Engineering Physics**
Course Code	AHSE02
Course Start	Second Semester
Course Type	Core
Regulation	IARE - BT 25
Prerequisite Courses	Intermediate
Department	ECE
Number of Credits	3 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Theory
Course Administrator	**Dr. Rizwana,** Associate Professor of Physics IARE10147 dr.rizwana@iare.ac.in
Course Coordinator's Name	**Dr. Rizwana,** Associate Professor of Physics IARE10147 dr.rizwana@iare.ac.in
Prior Learning Assessment and Recognition (PLAR)	Students interested in PLAR pathways for open learning can register one semester prior to the start of semester. Students will receive the necessary contact information one semester in advance.
Open Learning Faculty Member Information	Open Learning Faculty (OLF) is available to assist students. Students will receive the necessary contact information at the start of the course.
Course Webpage	https://www.iare.ac.in/sites/default/files/BT23/AHSD07.pdf
Course Description	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.
Course Objectives	**The students will try to learn:** a. Fundamental concepts needed to explain a crystal structure in terms of atom positions, unit cells, and crystal symmetry. b. 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. c. The metrics of optoelectronic components, lasers, optical fiber communication and be able to incorporate them into systems for optimal performance. d. The appropriate magnetic, superconducting and nanomaterials required for various engineering applications.
Text and Reference Books	**Textbooks**

	1. Arthur Beiser, Shobhit Mahajan and Rai Choudhary, "Concepts of Modern Physics", TataMcGraw 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.
Learning Resources	**Course full stack** is made available in IARE learning management portal – Akansha, which includes lecture notes, tutorial question bank, definition and terminology, tech-talk topics, assignments, Model question papers (2 sets), complex engineering problem solving statements, power point presentations (PPTs) and ELRV lecture recordings at: • https://www.youtube.com/watch?v=wtcPOIiOGeY&list=PLzkMouYverAJBXkAe4S6SEDdjKLbxo2du • https://www.youtube.com/playlist?list=PLzkMouYverAI9IvTTpixG2GL2jpT8HQsW
Supplemental Materials	**Readings, Videos, and Links** 1. NPTEL :: Physics - NOC: Quantum Mechanics 2. NPTEL :: Physics - NOC: Introduction to Solid State Physics 3. NPTEL :: Physics - NOC:Solid State 4. https://nptel.ac.in/courses/104104085 5. NPTEL :: Metallurgy and Material Science - NOC:Nanotechnology, Science and Applications
Learning and Teaching Strategies	Online material will provide the foundation of the learning resources, requiring the students to log in and engage regularly throughout the sixteen weeks of the course. There will be a mix of suggested readings, discussions and video content containing embedded digital content and undertake the assessment tasks.

SECTION 2: Teaching Learning Scheme

At least 48 lecture hours of scheduled teaching and learning activities (TLA) will be delivered in person, with the remaining hours for scheduled and self-scheduled teaching and learning activities delivered either in person or online.

Notional Study Time: 90 Hours (Lecture hours: 48, Tutorial hours: 8, Scheduled revision session hours: 2, Guided independent study hours: 15, Homework / Assignment hours: 10, Course project / Preparation for complex problem solving hours: 15)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA1	Lectures	48	01	48
TLA 2	Tutorials	08	01	08
TLA 3	Case Study			
TLA 4	Problem Solving	10	01	10
TLA 5	Demonstration			
TLA 6	Scheduled revision sessions	02	01	02
TLA 7	Guided independent study: Directed viewing of video materials / PPTs			15

TLA 8	Independent private study			
TLA 9	Laboratory Exercises	0	0	0
TLA 10	Homework assignments			10
TLA 11	Placement / work based learning or Specific practical training	0	0	0
TLA 12	Presentation / Seminar Preparation	5	1	5
TLA 13	Course Project / Preparation for Complex Problem Solving			
TLA 14	Technical visit			
TLA 15	Field activities	0	0	0
			Total study hours	**90**
			Expected total study hours	**90**

SECTION 3A: Course Outcomes

After successfully completing this course, the student will be able to:

Outcome Number	Course Outcomes	Learning Domain
CO1	Use the general rules of indexing of directions and planes in lattices to identify the crystal systems and the Bravais lattices.	Apply
CO2	Extend the principles of dual nature of matter and Schrodinger wave equation to a particle enclosed in simple systems.	Apply
CO3	Analyze the concepts of laser with normal light in terms of mechanism for applications in different fields and scientific practices.	Understand
CO4	Comprehend the knowledge on functionality of components in optical fiber communication system by using the basics of signal propagation, attenuation and dispersion.	Understand
CO5	Gain knowledge on properties of magnetic and superconducting materials suitable for engineering applications.	Understand
CO6	Formulate the principle factors, fabrication, characterization techniques and the applications of nanomaterials.	Understand

SECTION 3B: Cognitive Levels

Blooms Taxonomy Level	Cognitive Level in Percentage (%)
Remember	0
Understand	66
Apply	34
Analyse	0
Evaluate	0
Create	0

SECTION 4: Content and Context of Engineering Physics

CO1	**Use the general rules of indexing of directions and planes in lattices to identify the crystal systems and the Bravais lattices.**
	Crystallography plays a vital role in understanding the structural properties of materials, which is essential for various engineering and scientific applications. This course outcome enables students to apply the general rules of indexing directions and planes in crystal lattices to systematically identify different crystal systems and Bravais lattices, forming the foundation for materials science and solid-state physics. • **The seven fundamental crystal systems:**

	o Cubic, Tetragonal, Orthorhombic, Hexagonal, Trigonal, Monoclinic, and Triclinic serve as the classification framework for different material structures. o Each of these systems exhibits unique symmetry and lattice parameters that define the arrangement of atoms within the crystal. • **14 Bravais lattices:** o They represent the distinct three-dimensional lattice types that define the periodicity of a crystalline solid. o These Bravais lattices serve as a fundamental classification scheme for all possible crystal structures. o Each crystal system can have different lattice types (primitive, body-centered, face-centered, and base-centered), leading to the 14 unique Bravais lattices. • **Lattice Planes:** o Lattice planes are imaginary planes passing through lattice points in a crystal structure. They help in understanding the arrangement of atoms and the symmetry of the crystal. o The orientation of lattice planes is described using Miller indices (hkl) • **Miller indices:** o Miller indices (h k l) are a set of three integers derived from the reciprocal of the intercepts of the plane with the crystal axes. o The concept of Miller indices (hkl) is crucial for indexing crystal planes, allowing students to determine crystallographic orientations and interplanar spacings, which are significant for diffraction studies and material characterization. • **Interplanar spacing (d)** o Interplanar spacing (d) is the perpendicular distance between adjacent parallel planes of atoms in a crystal lattice o It plays a crucial role in understanding diffraction patterns and material properties. By mastering the rules of indexing, students will gain the ability to analyze and differentiate lattice structures, predict material properties, and apply their knowledge to real-world applications such as X-ray diffraction (XRD) analysis and semiconductor technology. This course outcome ensures that students develop a strong conceptual and analytical understanding of crystal structures, enabling them to bridge theoretical concepts with practical applications in engineering and material sciences. By accurately identifying and indexing directions and planes in lattices, they will be equipped to contribute to advancements in materials research, nanotechnology, and condensed matter physics.
CO2	**Extend the principles of dual nature of matter and Schrodinger wave equation to a particle enclosed in simple systems.**
	Learners focus on the fundamental concepts of quantum mechanics, particularly the dual nature of matter and the Schrodinger wave equation, and their applications to particles confined within simple potential systems. The wave-particle duality, as proposed by de Broglie, suggests that particles exhibit both wave-like and particle-like properties. This concept forms the foundation of quantum mechanics and is crucial in understanding microscopic systems such as electrons in atoms, molecules, and nanostructures. A significant part of this, learners involve applying the Schrödinger wave equation to determine the allowed energy states and wave functions of particles in different confinement scenarios. The study begins with the formulation of the time-independent Schrodinger equation and its application to simple potential models, such as the particle in a one-dimensional box or an infinite potential wells. These models help in understanding quantization of energy levels, probability distributions, and the behavior of quantum systems under boundary conditions. By extending these principles, learners will develop an understanding of the significance of quantization in physical systems and how the confinement of particles leads to discrete energy levels. These concepts are foundational to various advanced topics in physics, including semiconductor physics, nanotechnology, and quantum computing. The course equips students with analytical and problem-solving skills necessary to apply quantum mechanical principles to real-world applications in engineering and technology. Students gain an in-depth comprehension of quantum confinement effects, enabling them to explore further advancements in applied physics, materials science, and emerging quantum technologies.

CO3	**Analyze the concepts of laser with normal light in terms of mechanism for applications in different fields and scientific practices.**
	Learners study the fundamental concepts of laser technology in comparison to normal light, emphasizing their underlying mechanisms and applications in various scientific and industrial fields. Students will gain a comprehensive understanding of the differences in coherence, intensity, monochromaticity, and directionality between laser light and normal light. Through theoretical discussions and practical applications, learners will develop insights into how these properties make lasers indispensable tools in modern technology. Learners cover essential topics such as the principles of spontaneous and stimulated emission, population inversion, optical cavities, and laser types, including gas and solid-state lasers. Additionally, it provides a comparative analysis of normal light sources such as incandescent, fluorescent, and LED lights. By studying these differences, students will appreciate why lasers are uniquely suited for high-precision applications. Applications of laser technology in medicine, telecommunications, manufacturing, military, and scientific research are thoroughly examined. Students will learn about laser-based surgeries, optical fiber communications, laser cutting and welding, laser guidance systems, and spectroscopy. Practical sessions will include laser divergence experiments. Learners will have a solid foundation in laser physics and its practical implications across multiple disciplines. They will be equipped to analyze and apply laser technology effectively in their respective fields, whether in research, engineering, medical physics, or industrial applications. This knowledge will enhance their problem-solving skills and innovative thinking in real-world technological challenges.
CO4	**Comprehend the knowledge on functionality of components in optical fiber communication system by using the basics of signal propagation, attenuation and dispersion.**
	Learners will gain a comprehensive understanding of the fundamental principles governing optical fiber communication systems. By exploring the essential concepts of signal propagation, attenuation, and dispersion, students will gain the knowledge necessary to analyze and assess the performance of optical communication networks effectively. Students will begin by understanding the fundamental principles of optical fibers, including their structure, types, and operational mechanisms. Through in-depth study, learners will explore how optical signals propagate through fibers, the factors influencing their transmission, and the mechanisms that ensure efficient signal transport over long distances. A key aspect of this outcome is the study of attenuation, which refers to the loss of signal strength as it travels through the fiber. Students will learn about various sources of attenuation, including absorption, scattering, and bending losses, and how these factors impact communication efficiency. Another critical topic covered is dispersion, which affects signal quality by spreading out light pulses as they travel through the fiber. Students will examine different types of dispersion, such as chromatic and modal dispersion, and their effects on data transmission. By understanding these phenomena, learners will be equipped to analyze and implement strategies to mitigate dispersion-related issues, ensuring high-speed and reliable communication. Students will have a solid grasp of the functionality of components within an optical fiber communication system. They will be able to apply their knowledge to real-world applications, such as designing and optimizing fiber optic networks, troubleshooting communication issues, and understanding advancements in fiber optic technologies. This knowledge will be essential for students pursuing careers in telecommunications, photonics, and other related fields in applied physics and engineering.
CO5	**Gain knowledge on properties of magnetic and superconducting materials suitable for engineering applications.**
	Students will develop a comprehensive understanding of the fundamental properties of magnetic and superconducting materials and their relevance to engineering applications. This course outcome ensures that learners acquire theoretical knowledge and practical insights into how these materials function and contribute to technological advancements. Learners will explore the principles of magnetism, including types of magnetic materials such as ferromagnetic, paramagnetic, and diamagnetic substances. They will study concepts such as magnetic domains, hysteresis, permeability, and coercivity, which are crucial for designing and optimizing

	devices like transformers, electric motors, and magnetic storage systems. Understanding these principles will enable students to analyze material selection and performance in real-world applications. Additionally, learners will explore into the fascinating world of superconductivity, a phenomenon where materials exhibit zero electrical resistance below a critical temperature. They will study different types of superconductors, including Type I and Type II, and understand key parameters like critical temperature, critical magnetic field, and Meissner effect. These concepts are essential in designing high-performance applications such as MRI machines, MAGLEV trains, power transmission lines, and quantum computing technologies. Students will also gain hands-on experience with experimental techniques used to characterize magnetic and superconducting materials. This practical knowledge will empower them to apply their understanding in research, development, and industrial applications. By mastering the properties and engineering implications of these materials, students will be well-equipped to contribute to advancements in electrical, mechanical, and materials engineering fields.
CO6	**Formulate the principle factors, fabrication, characterization techniques and the applications of nanomaterials.**
	Teach the students with a comprehensive understanding of nanomaterials by exploring their fundamental principles, synthesis techniques, characterization methods, and wide-ranging applications. Students will grasp the core scientific concepts governing nanomaterials, including quantum effects, surface-to-volume ratio, size-dependent properties, and their impact on material behavior at the nanoscale. This understanding is crucial for designing materials with tailored physical, chemical, and mechanical properties. Learners will explore various nanomaterial synthesis methods, including top-down approaches (e.g., ball milling) and bottom-up approaches (e.g., sol-gel synthesis). These fabrication techniques are essential for producing nanomaterials used in diverse technological applications. Students used advanced tools for analyzing nanomaterials, such as Transmission Electron Microscopy (TEM) and X-ray Diffraction (XRD). These techniques allow students to assess material structure, morphology, and properties at the nanoscale. Learners will explore the real-world applications of nanomaterials in fields such as electronics, medicine, energy storage, environmental science, and materials engineering. Specific applications include nanomedicine (drug delivery systems), nanoelectronics (high-performance transistors), and energy-efficient materials (solar cells, batteries). Learners will develop essential knowledge and practical skills in nanoscience and nanotechnology, which are critical for advancements in various scientific and engineering fields.

SECTION 5: Complex Engineering Problem Solving
NA

SECTION 6A: Assessment Methods – Direct			
Item	**Evaluation Components**	**Week in / out**	**Marks**
AAT: 1 - 1	Tech-Talk	Week – 2 / 5	05
AAT: 1 - 2	Assignments	Week – 4 / 7	05
AAT: 2 - 1	Concept Video	Week – 9 / 12	05
AAT: 2 - 2	Definitions & Terminology	Week – 12 / 15	05
CIE - 1	2 hours - Answer 4 out of 5 questions	Week - 9	10
CIE - 2	2 hours - Answer 4 out of 5 questions	Week - 17	10
SEE	3 hours - Answer 1 from each module	Week - 18	60
		Total Marks	**100**

Department's Late Submission Policy: **Department's Late Submission Policy:** 1. 1 – 24 hours: 25% of the mark will be deducted 2. > 24 hours: Not accepted

SECTION 6B: Assessment Methods –Indirect	
Course End Survey (End Semester OBE Feedback)	✓

SECTION 7: Engineering Competencies (ECs) Focused
Please tick (✓) relevant engineering competency profile covered

EC Number	Attributes	Profiles	(✓)
EC1	Depth of knowledge required (CP)	Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill-founded, illogical, erroneous, unreliable or unrealistic requirements applicable to the engineering discipline	✓
EC2	Depth of analysis required (CP)	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	-
EC3	Design and development of solutions (CA)	Support sustainable development solutions by ensuring functional requirements, minimize environmental impact and optimize resource utilization throughout the life cycle, while balancing performance and cost effectiveness.	-
EC4	Range of conflicting requirements (CP)	Competently addresses complex engineering problems which involve uncertainty, ambiguity, imprecise information and wide-ranging or conflicting technical, engineering and other issues.	-
EC5	Infrequently encountered issues (CP)	Conceptualizes alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.	-
EC6	Protection of society (CA)	Identifies, quantifies, mitigates and manages technical, health, environmental, safety, economic and other contextual risks associated to seek achievable sustainable outcomes with engineering application in the designated engineering discipline.	-
EC7	Range of resources (CA)	Involve the coordination of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies) in the timely delivery of outcomes	-
EC8	Extent of stakeholder involvement (CP)	Design and develop solution to complex engineering problem considering a very perspective and taking account of stakeholder views with widely varying needs.	-
EC9	Extent of applicable codes, legal and regulatory (CP)	Meet all level, legal, regulatory, relevant standards and codes of practice, protect public health and safety in the course of all engineering activities.	-
EC10	Interdependence (CP)	High level problems including many component parts or sub-problems, partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then re-combines to form a whole, with the integrity and performance of the overall system as the top consideration.	-
EC11	Continuing professional development (CPD) and lifelong learning (CA)	Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.	✓
EC12	Judgement (CA)	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Require	-

		judgement in decision making in the course of all complex engineering activities.	

SECTION 8: Employability Skills

Example: Communication skills / Project based skills

Studying Applied physics significantly enhances an engineering student's employability by providing a deep understanding of fundamental physical principles, which can be directly applied to solve complex engineering problems, develop new technologies, and excel in research and development roles, thus making them highly valuable to a wide range of industries across engineering fields.

Employability Skills:

- Problem-solving skills.
- Logical and analytical thinking.
- Conceptual foundation for engineering design.
- Experimental skills and data analysis.
- Adaptability to emerging technologies.

SECTION 9: Relevance to Sustainability goals

Brief description about the course and its correlation with Sustainability Development Goal (SDGs).

SDG Goals		Correlation with SDG
4		**Quality Education:** This course prepares graduates who are skilled in physics can 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.

SECTION 10A: Mapping between COs and POs / PSOs

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	✓	✓												
CO2	✓	✓		✓										
CO3	✓	✓												
CO4	✓	✓		✓										
CO5	✓													
CO6	✓	✓												

Outcomes		WKS and Indicators of attainment and Justification for mapping (students will be able to)																																						IAs Count
COs	POs	WK 1	WK 2								WK 3			WK 4			WK 5						WK 6			WK 7				WK 8							WK 9						
		a	a	b	c	d	e	f	g	h	a	b	c	a	b	c	a	b	c	d	e	f	a	b	c	a	b	c	d	a	b	c	d	e	f	g	a	b	c	d	e	f	
CO 1	PO 1	•	•	•			•		•		•	•	•		•																											9
	PO 2	•	•	•			•		•		•	•	•		•																											9
CO2	PO 1	•	•	•			•		•		•	•	•		•																											9
	PO 2	•	•	•			•		•		•	•	•		•																											9

	PO 4																												•	•		•		•									4
CO3	PO 1	•	•	•			•		•		•	•		•																													9
	PO 2	•	•	•			•		•		•	•		•																													9
CO4	PO 1	•	•	•			•		•		•	•		•																													9
	PO 2	•	•	•			•		•		•	•		•																													9
	PO 4																												•	•		•		•									4
CO 5	PO 1	•	•	•			•		•		•	•		•																													9
CO 6	PO 1	•	•	•			•		•		•	•		•																													9
	PO 2	•	•	•			•		•		•	•		•																													9

SECTION 10B: Indicators of Attainment with COs to POs and PSOs															
Course Outcomes	Percentage of Indicators of Attainments (IA) with POs and PSOs														
	PO												PSO		
	1	2	3	4	5	6	7		8	9	10	11	1	2	3
CO1	60	60													
CO2	60	60		57											
CO3	60	60													
CO4	60	60		57											
CO5	60														
CO6	60	60													

SECTION 10C: Course Articulation Matrix of COs to POs														
0 No Contribution (0-5%)			1 Low (≥5 - <40%)				2 Moderate (≥40 - <60%)					3 High (≥60%)		
Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	3												
CO2	3	3		2										
CO3	3	3												
CO4	3	3		2										
CO5	3													
CO6	3	3												
Total	18	15		4										
Average	**3**	**3**		**2**										

SECTION 10D: Level of Contribution of the COs to POs and PSOs			
Number	**Programme Outcomes**	**Proficiency Assessed by**	**Contribution Level (from 1 to 3)**
PO 1	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**.	CIE / SEE / AAT:1 – 2 Tech talk/Assignments	3

PO 2	Identify, formulate, review research literature and analyse **complex engineering problems** reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).	CIE / SEE / AAT:1 – 2 Tech Talk	**3**
PO 3	Design creative solutions for **complex engineering problems** and design / develop systems / components/ processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)	-	-
PO 4	Conduct investigations of **complex engineering problems** using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)	CIE / SEE / AAT:2 – 1 Assignment/Quiz/Concept video	**2**
PO 5	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve **complex engineering problems**. (WK2 and WK6).	-	-
PO 6	Analyze and evaluate societal and environmental aspects while solving **complex engineering problems** for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7)	-	-
PO 11	Recognize the need and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)	-	-
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.	-	-

SECTION 11: Course Content	
MODULE - I	**CRYSTAL STRUCTURES**
	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**
	Waves and particles, de Broglie hypothesis, matter waves, Davisson and Germer's experiment, Schrödinger's time independent wave equation, physical significance of the wave function, infinite square well potential.
MODULE - III	**LASERS AND FIBER OPTICS**

	Characteristics of lasers, spontaneous and stimulated emission of radiation, population inversion, lasing action, Ruby laser, He-Ne laser, applications of lasers. Principle and construction of an optical fiber, acceptance angle, numerical aperture, types of optical fibers (Single mode, multimode, step index, graded index), optical fiber communication system with block diagram, applications of optical fibers.
MODULE - IV	**MAGNETIC AND SUPERCONDUCTING PROPERTIES**
	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, Hysteresis curve. Superconductivity, general properties, Meissner effect, effect of magnetic field, type-I & type-II superconductors, BCS theory, applications of superconductors.
MODULE - V	**NANOTECHNOLOGY**
	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 electron microscopy, applications of nanomaterials.

SECTION 12: Tentative Schedule of Instructions

Week Number	Topics	Duration (Hours)
1	1.1 Introduction to crystal structures, space lattice 1.2 Basis, unit cell, lattice parameter 1.3 Bravais lattices	3
2	2.1 crystal systems 2.2 structure and packing fractions of simple cubic crystal 2.3 structure and packing fraction of body centered cubic crystal	3
3	3.1 structure and packing fraction of face centered cubic crystal 3.2 Directions and planes in crystals 3.3 Miller indices	3
4	4.1 separation between successive [h k l] planes 4.2 Quantum Physics: Waves and particles 4.3 de Broglie hypothesis	3
5	5.1 de Broglie hypothesis 5.2 Matter waves 5.3 Davisson and Germer's experiment	3
6	6.1 Schrödinger's time independent wave equation 6.2 Physical significance of the wave function 6. 3 Infinite square well potential	3
7	7.1 Infinite square well potential 7.2 Lasers and Fiber Optics: Characteristics of lasers 7.3 spontaneous and stimulated emission of radiation	3
8	8.1 Population inversion, lasing action 8.2 Ruby laser 8.3 He-Ne laser, Applications of lasers.	3
CONTINIUOUS INTERNAL EXAMINATION (CIE- I)		
9	9.1 Principle and construction of an optical fiber 9.2 Acceptance angle, numerical aperture 9.3 Types of optical fibers (Single mode, multimode, step index, graded index)	3
10	10.1 Optical fiber communication system with block diagram 10.2 Applications of optical fibers. 10.3 Magnetic and Superconducting Properties: Permeability, field intensity, magnetic field induction, magnetization, magnetic susceptibility	3
11	11.1 Origin of magnetic moment, Bohr magneton 11.2 Classification of magnetic materials on the basis of magnetic moment 11.3 Hysteresis curve	3
12	12.1 Superconductivity, general properties	3

	12.2 Meissner effect 12.3 Effect of magnetic field	
13	13.1 Type-I & type-II superconductors 13.2 BCS theory 13.3 Applications of superconductors	3
14	14.1 Nanoscale, quantum confinement, surface area to volume ratio 14.2 bottom-up fabrication: sol-gel, precipitation 14.3 Combustion methods	3
15	15.1 top-down fabrication: Ball milling, 15.2 Physical vapor deposition 15.3 Chemical vapor deposition	3
16	16.1 Characterization techniques: X-ray diffraction 16.2 Transmission electron microscopy 16.3 Applications of nanomaterials	3
	Total	**48**

SECTION 14: Specific Goals for the Course

The following table shows the knowledge and skills covered by the unit outcomes:

Knowledge	Skills
Learners should understand: • The difference between amorphous and various crystalline materials in solids • How to investigate the innovative things to engage in scientific questioning • How the concepts cover the topics for crystallinity in solid state physics. • How the concepts cover the topics in modern physics. • How the concepts cover the topics in Superconductors. • How to fabricate nanomaterials using knowledge of nanoscience and technology	**Learners can:** • Identify crystalline and amorphous and materials in solids. • Use the general principles of indexing in planes for directions in Bravais lattices. • Produce Schrodinger wave equation for a particle by dual nature of radiation. • Produce the normal light in terms of mechanism for different applications of lasers for scientific practices. • Able to understand the different types of lasers and guiding medium for the propagation of laser. • Strengthen the skill by using different types of signal propagation and its components for fiber optic communication • Distinguish between the reflection and total internal reflection for fiber optics without attenuation. • Produce superconducting materials that are suitable for engineering applications by deeper knowing of magnetic properties. • Produce the materials by fabricating low dimension using principal factors. • Characterize the fabricated material in nanotechnology and techniques for the engineering application.

Administrative Information

<table>
<tr><th colspan="3">SECTION 15: History of changes</th></tr>
<tr><th>Regulations</th><th>Description of change</th><th>BOS Date</th></tr>
<tr><td>R 16</td><td>Changes from JNTUH to R16 regulation

<table>
<tr><th colspan="3">Branches: AE/ME/CE</th></tr>
<tr><th>JNTUH</th><th>R16</th><th>% of syllabus change</th></tr>
<tr><td>Engineering Physics</td><td>Applied Physics (I SEM)
Modern Physics (II SEM)</td><td>35% of syllabus changed
(Change of course name)</td></tr>
<tr><th colspan="3">Branches: ECE/EEE/CSE/IT</th></tr>
<tr><th>JNTUH</th><th>R16</th><th>% of syllabus change</th></tr>
<tr><td>Engineering Physics</td><td>Engineering Physics (I SEM)</td><td>50% of syllabus changed</td></tr>
</table></td><td>24.07.2016</td></tr>
<tr><td>R 18</td><td>Changes from R16 to R18 regulation
<table>
<tr><th colspan="3">Branches: AE/ME/CE</th></tr>
<tr><th>R16</th><th>R18</th><th>% of syllabus change</th></tr>
<tr><td>Applied Physics (I SEM)
Modern Physics (II SEM)</td><td>Waves and Optics</td><td>75% of syllabus changed
(Change of course name)</td></tr>
<tr><th colspan="3">Branches: ECE/EEE</th></tr>
<tr><th>R16</th><th>R18</th><th>% of syllabus change</th></tr>
<tr><td>Engineering Physics</td><td>Waves and Optics</td><td>65% of syllabus changed
(Change of course name)</td></tr>
<tr><th colspan="3">Branches: CSE/IT</th></tr>
<tr><td>Engineering Physics</td><td>Semiconductor Physics</td><td>50% of syllabus changed
(Change of course name)</td></tr>
</table></td><td>16.07.2018</td></tr>
<tr><td>UG 20</td><td>Changes from R18 to UG 20 regulation

<table>
<tr><th colspan="3">Branches: AE/ME/CE/ECE/EEE</th></tr>
<tr><th>R18</th><th>UG20</th><th>% of syllabus change</th></tr>
<tr><td>Waves and Optics</td><td>Engineering Physics</td><td>10% of syllabus changed
(Change of course name)</td></tr>
<tr><th colspan="3">Branches: CSE/IT/CSE(AI&ML)/CSE(CS)/CSE(DS)/CSIT</th></tr>
<tr><th>R18</th><th>UG20</th><th>% of syllabus change</th></tr>
<tr><td>Semiconductor Physics</td><td>Applied Physics</td><td>10% of syllabus changed
(Change of course name)</td></tr>
</table></td><td>17.11.2020</td></tr>
<tr><td>BT 23</td><td>Changes from UG 20 to BT 23 regulation

<table>
<tr><th colspan="3">Branches: AE/ME/CE/ECE/EEE/IT/CSE(AI&ML)</th></tr>
<tr><th>UG 20</th><th>BT 23</th><th>% of syllabus change</th></tr>
<tr><td>Engineering Physics</td><td>Applied Physics</td><td>70% of syllabus changed
(Change of course name)</td></tr>
<tr><th colspan="3">Branches: CSE/CSE(DS)</th></tr>
<tr><th>UG 20</th><th>BT 23</th><th>% of syllabus change</th></tr>
<tr><td>Applied Physics</td><td>Applied Physics</td><td>50% of syllabus changed</td></tr>
</table></td><td>21.08.2023</td></tr>
</table>

Course Outline Approvals	
Course Coordinator Name: Dr. Rizwana Signature: Date:	**Head of the Department** Name: Dr. Rizwana Signature: Date:
Course Outline Approvals: The course outline description approved by Outcome Based Teaching Learning (OBTL) committee on *date* in meetings *IARE - OBTL – COD /104/25*	
Dean of Outcome Based Teaching and Learning Name: Dr. Ch Srinivasulu Signature: Date:	**Dean of Academics** Name: Dr. G Chandrasekhar Signature: Date:

Check List		
Section	**Description**	**Please tick (✓)**
1	General Information about the Course	✓
2	Notional Study Time	✓
3	A. Course Outcomes	✓
	B. Cognitive Levels	✓
4	Content and Context of the Course	✓
5	Complex Engineering Problem Solving	
6	A. Assessment Methods – Direct	✓
	B. Assessment Methods – Indirect	✓
7	Content Delivery / Instructional Methodologies	✓
8	Engineering Competencies (ECs) Focused	✓
9	Employability Skills	✓
10	Relevance to Sustainability goals	✓
11	A. Mapping between COs and POs / PSOs	✓
	B. Indicators of Attainment with COs to POs and PSOs	✓
	C. Course Articulation Matrix of COs to POs	✓
	D. Level of Contribution of the COs to POs and PSOs	✓
12	Syllabus	✓
13	Tentative Schedule of Instructions	✓
14	Specific Goals for the Course	✓
15	History of Changes	✓

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

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**Professional Communication**
Course Code	AHSE04
Course Start	I Semester
Course Type	Foundation
Regulation	BT-25
Prerequisite Courses	1. Functional English Grammar 2. Basic Communication Skills
Department	ECE
Number of Credits	3
Academic Year	2025-26
Method(s) of Instruction	Theory and laboratory
Course Administrator	**Dr. Jetty Wilson,** Associate Professor of English IARE10510 jettywilson@iare.ac.in
Course Coordinator's Name	**Dr. Jetty Wilson,** Associate Professor of English IARE10510 jettywilson@iare.ac.in
Prior Learning Assessment and Recognition (PLAR)	Students interested in PLAR pathways for open learning can register one semester prior to the start of semester. Students will receive the necessary contact information one semester in advance.
Open Learning Faculty Member Information	Open Learning Faculty (OLF) is available to assist students. Students will receive the necessary contact information at the start of the course.
Course Webpage	https://akanksha.iare.ac.in/index?route=course/details&course_id=1242
Course Description	This course is designed to enhance students' ability to communicate effectively in English across a variety of contexts. Emphasizing both written and spoken communication, students will develop essential skills such as active listening, clear articulation, vocabulary building, and effective presentation techniques. Through practical exercises, participants will gain confidence in expressing ideas, engaging in conversations, and delivering professional communications. The course also covers strategies for improving reading comprehension, writing clarity, and understanding different communication styles. Ideal for individuals looking to strengthen their English communication abilities in academic, social, and professional settings.
Course Objectives	**The students will try to learn:** 1. Mastering standard pronunciation, correct word stress, and appropriate intonation patterns to enhance effective communication, with a focus on achieving academic and professional goals. 2. Suitable grammatical structures and efficiently utilizing punctuation to enhance practical communication. 3. Critical aspects of speaking and reading involve interpreting in-depth meanings between sentences.

	4. Conceptual awareness of writing focuses on unity, content, coherence, and linguistic accuracy.
Text and Reference Books	**Text Books** 1. Anjana Tiwari, *Communication Skills in English*, Khanna Publishing House: New Delhi,2022. **Reference Books** 1. Norman Whitby, *Business Benchmark: Pre-Intermediate to Intermediate* – BECPreliminary, 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, 2ndEdition, 2010. 4. Raymond Murphy, *Essential English Grammar with Answers*, Cambridge UniversityPress, 2nd Edition, 2010.
Learning Resources	**Course full stack** is made available in IARE learning management portal – Akansha, which includes lecture notes, tutorial question bank, definition and terminology, tech-talk topics, assignments, Model question papers (2 sets), power point presentations (PPTs) and ELRV lecture recordings at: 1. https://akanksha.iare.ac.in/index?route=course/details&course_id=954 2. https://akanksha.iare.ac.in/index?route=course/details&course_id=10 3. https://akanksha.iare.ac.in/index?route=course/details&course_id=352 4. https://akanksha.iareac.in/index?route=publicprofile&id=5075
Supplemental Materials	**Readings, Videos, and Links** 1. Cambridge online pronunciation dictionary 2. https://dictionary.cambridge.org/ 2. Fluentu website 3. https://www.fluentu.com/ 3. Repeat after us 4. https://brycs.org/clearinghouse/3018/ 4. Language lab 5. https://brycs.org/clearinghouse/3018/ 5. Oxford online videos
Learning and Teaching Strategies	Online material will provide the foundation of the learning resources, requiring the students to log in and engage regularly throughout the sixteen weeks of the course. There will be a mix of suggested readings, discussions and video content containing digital content and undertake the assessment tasks.

SECTION 2: Teaching Learning Scheme

At least 48 lecture hours of scheduled teaching and learning activities (TLA) will be delivered in person, with the remaining hours for scheduled and self-scheduled teaching and learning activities delivered either in person or online.

Notional Study Time: 90 Hours (Lecture hours: 48, Tutorial hours: 8, Scheduled revision session hours: 2, Guided independent study hours: 15, Homework / Programming assignment hours: 10, Course project / Preparation for complex problem-solving hours: 15)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA 1	Lectures	48	01	48
TLA 2	Tutorials	0	0	0

TLA 3	Case Study			6
TLA 4	Problem Solving			
TLA 5	Demonstration			
TLA 6	Scheduled revision sessions	10	01	10
TLA 7	Guided independent study: Directed viewing of video materials / PPTs			10
TLA 8	Independent private study			10
TLA 9	Laboratory Exercises	0	0	0
TLA 10	Homework assignments / Programming assignments			
TLA 11	Placement / work based learning or Specific practical training	0	0	0
TLA 12	Presentation / Seminar Preparation			6
TLA 13	Course Project / Preparation for Complex Problem Solving			
TLA 14	Technical visit			
TLA 15	Field activities	0	0	0
			Total study hours	**90**
			Expected total study hours	**90**

SECTION 3A: Course Outcomes

After successfully completing this course, the student will be able to:

Outcome Number	Course Outcomes	Learning Domain
CO1	**Demonstrate** the essential listening and communication skills required for academic and non-academic purposes.	Understand
CO2	**Explain** ideas and discuss issues effectively in spoken English with a high level of fluency and accuracy across different social contexts.	Understand
CO3	**Enhance** language proficiency to strengthen life skills and effectively navigate challenges in a professional environment.	Understand
CO4	**Interpret** grammatical and lexical forms of English and apply them in specific communicative contexts.	Understand
CO5	**Develop** the ability to comprehend, analyze, and interpret a variety of texts, enhancing critical thinking, vocabulary, and the application of reading strategies for academic, professional, and personal growth.	Understand
CO6	**Improve** the ability to produce clear, coherent, and well-structured written content and organization for academic, professional, and creative tenacities.	Understand

SECTION 3B: Cognitive Levels

Blooms Taxonomy Level	Cognitive Level in Percentage (%)
Remember	0
Understand	100
Apply	0
Analyse	0
Evaluate	0
Create	0

SECTION 4: Content and Context of	
CO1	**Demonstrate the essential listening and communication skills required for both academic and non-academic purposes.**
	1. Improved Active Listening • Develop the ability to listen attentively, understand, and retain key information in various contexts, whether academic or everyday life. • Enhance focus and comprehension in lectures, discussions, meetings, and social settings. **2. Effective Communication in Diverse Contexts** • Gain the ability to tailor communication styles for different audiences, ensuring clarity and appropriateness in both formal and informal situations. • Improve verbal and non-verbal communication skills, contributing to clearer, more effective exchanges. **3. Increased Confidence in Public Speaking and Discussions** • Build confidence in expressing thoughts, ideas, and opinions clearly in both academic presentations and casual conversations. • Learn how to contribute effectively to group discussions, both in educational and professional environments. **4. Stronger Interpersonal Skills** • Develop rapport-building skills that enhance relationships in academic settings, as well as in professional and social situations. • Improve understanding of body language, tone, and other non-verbal cues for more meaningful interactions. **5. Enhanced Critical Thinking and Analytical Skills** • Sharpen the ability to analyze and interpret spoken information, leading to better decision-making and problem-solving in real-world situations. • Improve the ability to follow complex arguments and evaluate the credibility of information shared in conversations or lectures. **6. Better Academic Performance** • Improve comprehension and retention of information from lectures, podcasts, and other academic resources. • Become more effective at note-taking, summarizing key points, and engaging with academic content through active listening and thoughtful communication. **7. Adaptability Across Different Environments** • Strengthen the ability to navigate both formal and informal communication settings with ease. • Become more adaptable in varying social, professional, and academic environments, fostering smoother transitions between different communication demands. **8. Preparation for Career Success** • Equip students with the communication skills needed for professional networking, client meetings, and interviews. • Foster the ability to interact with colleagues, supervisors, and clients with clarity and professionalism in various work settings.
CO2	**Explain issues and ideas in spoken English with a reasonable degree of fluency and accuracy in various social settings.**
	1. Improved Verbal Expression • Develop the ability to express ideas clearly and logically in English, enhancing fluency and confidence in conversations. • Master the articulation of thoughts, making it easier to engage in discussions on a wide range of topics. **2. Enhanced Social Interaction** • Gain confidence in communicating with peers, teachers, and professionals in social settings. • Learn how to navigate informal conversations, formal meetings, and group discussions with ease. **3. Cultural and Contextual Adaptability**

	• Adapt language use to different social contexts, understanding when to adjust tone, formality, and vocabulary based on the situation. • Understand social cues and how to adjust communication styles to fit various cultural and professional environments. **4. Stronger Listening and Response Skills** • Develop the ability to actively listen and respond thoughtfully, which is crucial for effective communication in social and professional settings. • Improve conversational flow by learning how to provide relevant and accurate responses. **5. Increased Self-Confidence** • Gain the self-assurance needed to participate in discussions, debates, and casual conversations in English without fear of making mistakes. • Feel more comfortable speaking in public, during presentations, or in group discussions. **6. Vocabulary and Pronunciation Enhancement** • Build a broader vocabulary to express ideas more precisely and effectively. • Improve pronunciation and speech patterns, making communication clearer and easier to understand by others. **7. Better Social Networking** • Strengthen the ability to network and form connections through effective verbal communication, essential for both personal and professional growth. • Improve rapport-building with peers, colleagues, and other social groups. **8. Critical Thinking and Idea Organization** • Enhance the ability to think critically and organize ideas logically before speaking, leading to more coherent and persuasive explanations. • Strengthen reasoning skills to support ideas, making arguments more convincing and clearer. **9. Preparation for Professional Opportunities** • Equip students with the necessary communication skills to confidently present ideas in job interviews, meetings, and networking events. • Prepare for public speaking and professional presentations by improving clarity, fluency, and accuracy.
CO3	**Enhance effective language skills to develop life skills and overcome challenges in a professional setting.**
	1. Improved Professional Communication • Develop the ability to communicate clearly, persuasively, and confidently in professional environments, including meetings, presentations, and written correspondence. • **Master language skills that help convey ideas and solutions effectively in various professional contexts.** **2. Stronger Problem-Solving and Critical Thinking** • Enhance the ability to articulate challenges and propose solutions in a clear, structured manner, improving decision-making and collaboration. • Build the confidence to express ideas, engage in discussions, and brainstorm solutions to challenges in the workplace. **3. Better Workplace Relationships** • Improve interpersonal communication, fostering stronger relationships with colleagues, supervisors, and clients. • Develop listening and empathy skills to better understand others' perspectives and respond appropriately to workplace dynamics. **4. Enhanced Confidence in Professional Settings** • Gain the self-assurance to handle difficult conversations, present ideas effectively, and manage conflicts in a professional environment. • Overcome the fear of public speaking, participating in meetings, and contributing to group discussions. **5. Adaptability in Communication**

	• Learn how to adjust language and tone based on the professional context, whether formal or informal, ensuring effective communication in diverse work environments. • Enhance flexibility in responding to unexpected challenges and adapting communication strategies accordingly. **6. Conflict Resolution Skills** • Develop the language and strategies necessary to address and resolve conflicts professionally and diplomatically. • Build the ability to communicate calmly and effectively under pressure, helping to maintain positive working relationships. **7. Stronger Leadership and Teamwork Abilities** • Improve the ability to lead and motivate teams through clear, concise, and effective communication. • Learn to express goals, delegate tasks, and provide constructive feedback that encourages productivity and team collaboration. **8. Improved Time Management and Organizational Skills** • Learn to communicate deadlines, set expectations, and manage tasks efficiently in a professional setting. • Use effective language to prioritize responsibilities and ensure clear understanding among team members. **9. Enhanced Professional Image** • Develop a polished communication style that boosts credibility and professionalism. • Improve written communication (emails, reports, proposals) and verbal communication (meetings, presentations) to leave a positive impact on peers, clients, and superiors. **10. Preparation for Career Advancement** • Build the language skills necessary for career growth, including networking, self-promotion, and navigating office politics. • Enhance the ability to express achievements, goals, and aspirations clearly, increasing opportunities for professional development and advancement.
CO4	**Interpret grammatical and lexical forms of English and apply them in specific communicative contexts.**
	1. Improved Grammatical Accuracy • Strengthen understanding of grammatical rules and structures, leading to more precise and accurate use of English in both spoken and written communication. • Enhance sentence construction, verb tense usage, and overall syntactical correctness for clear communication. **2. Expanded Vocabulary** • Develop a broader range of vocabulary, enabling students to express ideas more clearly and with greater nuance. • Learn how to choose the most appropriate words based on context, improving both understanding and expression. **3. Contextual Adaptability** • Gain the ability to apply correct grammar and vocabulary in various situations, from formal presentations to casual conversations. • Tailor language use to fit specific communicative contexts, whether academic, professional, or social. **4. Enhanced Reading and Writing Skills** • Improve comprehension of complex texts, understanding how grammatical and lexical choices affect meaning. • Strengthen writing skills by applying appropriate grammar and vocabulary in essays, reports, emails, and other forms of communication. **5. Increased Confidence in Communication** • Build confidence in speaking and writing, knowing that students have the ability to use English correctly and effectively. • Reduce hesitation and uncertainty by mastering the use of grammatical structures and vocabulary in different scenarios. **6. Greater Precision and Clarity**

	• Improve the ability to convey ideas clearly and concisely by choosing the right words and structures, minimizing misunderstandings. • Develop the ability to modify language for greater clarity, making communication more effective. **7. Better Listening and Interpretation Skills** • Improve the ability to understand spoken English by recognizing how grammar and vocabulary are used in different contexts. • Develop critical listening skills to identify key grammatical structures and word choices in conversations, lectures, or presentations. **8. Cultural Sensitivity in Language Use** • Understand how language varies across cultures, and use the right expressions and forms to communicate respectfully and appropriately in different cultural settings. • Learn how to apply language skills in a culturally sensitive manner in both professional and personal contexts. **9. Enhanced Academic and Professional Performance** • Gain the ability to interpret academic texts more effectively and apply correct grammatical structures and vocabulary in assignments and presentations. • Improve professional communication, using accurate grammar and terminology to enhance credibility and clarity in the workplace. **10. Stronger Analytical and Critical Thinking** • Develop the ability to analyze language usage critically, understanding how grammar and lexical choices impact meaning and tone. • Strengthen analytical thinking skills by evaluating language in real-life contexts, which enhances problem-solving abilities in both academic and professional settings.
CO5	**Develop the ability to comprehend, analyze, and interpret a variety of texts, enhancing critical thinking, vocabulary, and the application of reading strategies for academic, professional, and personal growth.**
	1. Improved Reading Comprehension • Strengthen the ability to understand and retain key information from academic, professional, and general texts, leading to better academic performance and well-rounded knowledge. • Learn to identify main ideas, supporting details, and the overall structure of different types of texts, enhancing both understanding and recall. **2. Enhanced Critical Thinking** • Develop the ability to analyze and evaluate texts critically, questioning assumptions, identifying biases, and recognizing different perspectives. • Strengthen problem-solving skills by learning how to approach texts with a critical mindset, which can be applied to various contexts, including academic research, decision-making, and problem-solving in the workplace. **3. Expanded Vocabulary** • Build a larger and more diverse vocabulary through exposure to a wide range of texts, from academic journals to professional reports and literary works. • Improve the ability to interpret new words in context, making it easier to understand and use advanced vocabulary both in writing and speaking. **4. Improved Analytical Skills** • Learn how to break down complex texts into manageable parts, identifying key arguments, evidence, and conclusions. • Develop the ability to synthesize information from multiple sources, an essential skill in both academic research and professional tasks like report writing and project development. **5. Better Academic Performance** • Enhance academic reading skills, allowing for more effective study, research, and examination of academic texts. • Improve the ability to write well-supported arguments, as understanding and analyzing texts is crucial for research papers, essays, and other academic tasks. **6. Stronger Professional Skills**

	• Acquire the ability to read and interpret professional documents, such as reports, memos, and proposals, with greater efficiency and understanding. • Strengthen the ability to identify important details, extract key information, and apply reading strategies in a workplace setting, improving productivity and decision-making. **7. Increased Focus and Concentration** • Improve the ability to maintain focus and attention while reading, even with complex or lengthy materials, which is critical for success in both academic and professional environments. • Develop strategies to better manage reading workload, prioritize information, and overcome challenges like distractions and information overload. **8. Better Writing and Communication** • Develop the ability to interpret and incorporate information from diverse sources into writing, enhancing clarity, depth, and relevance in academic papers, business reports, and other professional documents. • Strengthen overall communication skills by learning how to organize and articulate ideas more effectively, informed by careful reading and analysis. **9. Adaptability to Different Text Types** • Gain the ability to understand and interpret a variety of text types, including technical documents, scholarly articles, literature, and business communications. • Learn how to adapt reading strategies depending on the genre, purpose, and audience of the text, making reading more efficient and effective. **10. Personal Growth and Lifelong Learning** • Cultivate a love for reading and lifelong learning, allowing students to continue expanding their knowledge and understanding across various subjects. • Gain the confidence to tackle unfamiliar topics, enhancing both personal growth and professional adaptability in a fast-paced world.
CO6	**Improve the ability to produce clear, coherent, and well-structured written content and organization for academic, professional, and creative tenacities.**
	1. Enhanced Writing Clarity and Precision • Develop the ability to write in a clear and straightforward manner, ensuring that ideas are easily understood by a variety of audiences. • Learn to express thoughts with precision, avoiding ambiguity and improving the effectiveness of communication in all contexts. **2. Improved Structure and Organization** • Master the skill of organizing written content logically, with clear introductions, well-structured body paragraphs, and effective conclusions. • Learn to structure academic essays, business reports, and creative works in a way that enhances readability and flow. **3. Stronger Argumentation and Critical Thinking** • Improve the ability to build and support arguments with relevant evidence, ensuring that writing is persuasive and well-founded. • Develop critical thinking skills by organizing thoughts logically, leading to stronger analysis and synthesis of ideas. **4. Increased Professionalism in Writing** • Gain proficiency in writing for professional contexts such as emails, reports, proposals, and presentations, ensuring that all content adheres to formal standards. • Learn to adapt writing tone, style, and formality based on the audience, enhancing professionalism in workplace communication. **5. Improved Academic Writing Skills** • Enhance the ability to write research papers, essays, and reports that meet academic standards for clarity, coherence, and argumentation. • Learn how to properly cite sources, structure academic arguments, and present research findings effectively. **6. Increased Creativity and Expression** • Develop creative writing skills, allowing students to produce engaging stories, poetry, and other creative works that are well-organized and coherent.

- Learn how to blend creativity with structure, ensuring that imaginative ideas are clearly conveyed in writing.

7. **Better Editing and Revision Skills**
   - Learn to revise and edit written work effectively, improving clarity, grammar, and style.
   - Gain the ability to self-edit and refine content, ensuring the final product is polished and free of errors.
8. **Stronger Focus and Cohesion**
   - Improve the ability to maintain focus on the main idea throughout a piece of writing, avoiding unnecessary tangents or irrelevant information.
   - Develop coherence in writing, ensuring that each paragraph and sentence logically follows from the previous one, creating a smooth reading experience.
9. **Increased Confidence in Writing Tasks**
   - Build confidence in tackling writing tasks of various types and lengths, from short business emails to long academic papers or creative pieces.
   - Gain the skills needed to approach writing assignments with a structured process, leading to less anxiety and more efficient work.
10. **Improved Communication Across Diverse Contexts**
    - Become adept at adjusting writing style and structure for different purposes, whether academic, professional, or creative.
    - Gain the flexibility to communicate effectively across various contexts, helping students excel in academic, workplace, and personal writing projects.
11. **Preparation for Career Advancement**
    - Learn the writing skills necessary for career success, such as drafting professional emails, writing reports, proposals, and delivering clear presentations.
    - Strengthen the ability to write persuasively, a skill that is crucial for advancing in most professional fields.

SECTION 5: The role of English language in Complex Engineering Problem Solving

The role of the **English language** in complex engineering problem-solving is crucial, as English has become the dominant global language for communication, especially in technical and scientific fields. Here's how the English language plays a significant role in solving complex engineering problems:

1. Global Communication

- **International Collaboration**: Engineering projects often involve teams from different parts of the world. English serves as a common language, allowing engineers from diverse backgrounds to communicate effectively. This is especially important in multinational projects, where collaboration between different countries and cultures is essential.
- **Cross-Disciplinary Communication**: In complex engineering problems, multiple fields of expertise (e.g., mechanical, electrical, software engineering) come together. English is often the common ground for professionals from different disciplines, enabling them to share ideas, solutions, and expertise.

2. Access to Knowledge and Resources

- **Research and Literature**: A large percentage of scientific papers, journals, textbooks, and technical documents are published in English. Engineers must be proficient in English to access the latest research, case studies, and technological

advancements in their field. Without understanding English, engineers would be restricted from accessing valuable knowledge, which is essential for solving complex problems.

- **Technical Documentation**: Manuals, blueprints, schematics, specifications, and other technical documents are usually written in English. Understanding these documents is critical for problem-solving, especially when engineers are developing or troubleshooting systems and devices.

3. Problem Definition and Clear Communication

- **Precise Language**: Engineering problems often require precise and clear definitions. English, with its technical vocabulary, enables engineers to describe complex issues and solutions accurately. Ambiguity in language can lead to misinterpretation, which could derail a project. A good command of English ensures that all stakeholders (from clients to technical staff) understand the problem and the proposed solutions.
- **Clear Instructions**: English is used to communicate instructions, whether it's for building, operating, or maintaining complex systems. Engineers rely on the clarity of written and verbal instructions in English to ensure that every stage of the project is executed correctly.

4. Standardization and Global Best Practices

- **Industry Standards**: Many engineering standards and codes, such as those from ISO (International Organization for Standardization), IEEE (Institute of Electrical and Electronics Engineers), and other global bodies, are published in English. Engineers must understand and apply these standards to solve problems and ensure that solutions meet international requirements.
- **Best Practices and Innovation**: Innovation in engineering often emerges from a global exchange of ideas. English serves as the medium through which best practices, new technologies, and methodologies are shared, contributing to the development of solutions for complex problems.

5. Technical Meetings and Conferences

- **Conferences and Workshops**: Engineers often attend conferences, workshops, and seminars to exchange ideas, learn about new technologies, and collaborate with peers. These events are generally conducted in English, and being proficient in English allows engineers to engage fully in discussions, presentations, and networking.
- **Team Meetings**: Multinational teams working on a project rely on English for meetings, brainstorming sessions, and decision-making. The ability to articulate ideas and understand others ensures that all team members contribute to the problem-solving process effectively.

6. Problem-Solving and Documentation

- **Writing Reports**: Engineers must document their findings, analyses, and solutions in reports and papers. These documents are often shared globally and need to be written in clear, formal English to communicate the details effectively. A good

command of English ensures that the engineering solution can be understood by others, reviewed, and built upon.

- **Design Documentation**: Engineering designs are usually represented using standardized formats and terminology in English. For instance, CAD (Computer-Aided Design) software often uses English terms, and engineers must be proficient in understanding and using this language for design and troubleshooting.

7. Technical Software and Tools

- **Software Interfaces**: Most engineering software, such as MATLAB, AutoCAD, SolidWorks, or even complex simulation tools, have their interfaces, documentation, and troubleshooting instructions in English. Being proficient in English allows engineers to use these tools effectively, interpret results accurately, and modify simulations or designs.
- **Programming Languages**: In fields like software engineering, the language used for coding is often in English (such as Python, Java, C++, etc.). Understanding the English syntax and keywords in programming languages is essential for engineers to solve complex computational problems.

8. Training and Education

- **Educational Materials**: Much of the educational material, including textbooks, online courses, and tutorials, is available in English. Engineers often need to understand complex concepts taught in English to advance their knowledge and keep up with emerging technologies.
- **Continuous Learning**: The engineering field is constantly evolving, and professionals must engage in continuous learning to stay competitive. Since most of the world's cutting-edge innovations and educational content are presented in English, mastering the language is essential for engineers to access this knowledge.

9. Global Innovation and Problem-Solving Networks

- **Collaboration with Experts**: Complex engineering problems often require input from experts in various subfields. English is the language that connects these experts globally. Whether through online forums, research collaborations, or problem-solving networks, engineers can access a global pool of expertise by communicating in English.
- **Problem-Solving Platforms**: Platforms like Stack Exchange, GitHub, or other collaborative online spaces where engineers seek advice and share solutions predominantly use English. Engineers can turn to these platforms for assistance with solving complex problems, benefiting from global insight.

In complex engineering problem-solving, English plays a foundational role in communication, accessing knowledge, collaboration, and using technical tools. Engineers must not only understand the language but also master the technical vocabulary and communication techniques required to effectively solve problems in a global, interconnected engineering world. By leveraging English proficiency, engineers can access the wealth of resources and expertise necessary to tackle the most challenging engineering problems efficiently and innovatively.

SECTION 6A: Assessment Methods – Direct			
Item	**Evaluation Components**	**Week in / out**	**Marks**
AAT: 1 - 1	Tech-Talk	Week – 2 / 5	05
AAT: 1 - 2	Hack-a-thon	Week – 4 / 7	05
AAT: 2 - 1	Complex Engineering Problem Solving	Week – 9 / 12	05
AAT: 2 - 2	Hack-a-thon	Week – 12 / 15	05
CIE – 1	2 hours - Answer 4 out of 5 questions	Week - 9	10
CIE – 2	2 hours - Answer 4 out of 5 questions	Week - 17	10
SEE	3 hours - Answer 1 from each module	Week - 18	60
		Total Marks	**100**
Department's Late Submission Policy: 1. 1 – 24 hours: 25% of the mark will be deducted 2. > 24 hours: Not accepted			
SECTION 6B: Assessment Methods –Indirect			
Course End Survey (End Semester OBE Feedback)			✓

SECTION 7: Engineering Competencies (ECs) Focused Please tick (✓) relevant engineering competency profile covered			
EC Number	**Attributes**	**Profiles**	**(✓)**
EC1	Depth of knowledge required (CP)	Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill-founded, illogical, erroneous, unreliable or unrealistic requirements applicable to the engineering discipline.	-
EC2	Depth of analysis required (CP)	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	-
EC3	Design and development of solutions (CA)	Support sustainable development solutions by ensuring functional requirements, minimize environmental impact and optimize resource utilization throughout the life cycle, while balancing performance and cost effectiveness.	-
EC4	Range of conflicting requirements (CP)	Competently addresses complex engineering problems which involve uncertainty, ambiguity, imprecise information and wide-ranging or conflicting technical, engineering and other issues.	-
EC5	Infrequently encountered issues (CP)	Conceptualizes alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.	-
EC6	Protection of society (CA)	Identifies, quantifies, mitigates and manages technical, health, environmental, safety, economic and other contextual risks associated to seek achievable sustainable outcomes with engineering application in the designated engineering discipline.	-
EC7	Range of resources (CA)	Involve the coordination of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies) in the timely delivery of outcomes	-
EC8	Extent of stakeholder involvement (CP)	Design and develop solution to complex engineering problem considering a very perspective and taking account of stakeholder views with widely varying needs.	-
EC9	Extent of applicable codes,	Meet all level, legal, regulatory, relevant standards and codes of practice, protect public health and safety in the course of all engineering activities.	-

	legal and regulatory (CP)		
EC10	Interdependence (CP)	High level problems including many component parts or sub-problems, partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then re-combines to form a whole, with the integrity and performance of the overall system as the top consideration.	-
EC11	Continuing professional development (CPD) and lifelong learning (CA)	Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.	-
EC12	Judgement (CA)	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Require judgement in decision making in the course of all complex engineering activities.	-

SECTION 8: Employability Skills

Example: Communication skills / Programming skills / Project based skills

Studying Professional Communication equips the students with a range of employability skills that are highly valued in industries.

Effective English language and communication skills are essential in various aspects of life, including education, business, workplace, and social interactions. Proficiency in English allows individuals to express themselves clearly, understand others, and participate in meaningful conversations. As the global lingua franca, English proficiency is a highly valued skill in the international job market. One of the key advantages of learning English is its ability to enhance career opportunities and open doors to diverse professional prospects.

Employability Skills:

1. Enhanced Verbal and Written Communication

- **Benefit**: Students learn to articulate ideas clearly and persuasively in both spoken and written formats.
- **Relevance to Industries**: Effective communication is critical for presentations, report writing, emails, customer interactions, and team collaboration.

2. Active Listening and Interpersonal Skills

- **Benefit**: Students develop the ability to listen attentively, understand others' perspectives, and respond appropriately.
- **Relevance to Industries**: Active listening enhances teamwork, client relationships, and conflict resolution in workplace settings.

3. Problem-Solving and Critical Thinking

- **Benefit**: Communication training helps students analyze situations, think critically, and articulate solutions effectively.
- **Relevance to Industries**: Problem-solving is essential for roles in project management, decision-making, and innovation-driven sectors.

4. Teamwork and Collaboration

- **Benefit**: Students learn how to work collaboratively by communicating ideas, delegating tasks, and resolving conflicts.

- **Relevance to Industries**: Industries prioritize teamwork as most projects involve cross-functional collaboration.

5. Adaptability in Communication Styles

- **Benefit**: Students become adept at tailoring communication to suit different audiences and contexts, including formal and informal settings.
- **Relevance to Industries**: Adaptability ensures effective interactions with diverse stakeholders, such as clients, team members, and management.

6. Professionalism and Etiquette

- **Benefit**: Training in communication skills instills a sense of professionalism in written and verbal interactions.
- **Relevance to Industries**: Professional communication reflects positively on individuals and organizations, enhancing trust and credibility.

7. Presentation and Public Speaking Skills

- **Benefit**: Students gain confidence in delivering engaging presentations and public speaking.
- **Relevance to Industries**: These skills are invaluable for pitching ideas, leading meetings, and representing the company at events.

8. Time Management and Organizational Skills

- **Benefit**: Students learn to organize thoughts and present information effectively within time constraints.
- **Relevance to Industries**: Clear and concise communication saves time and ensures productivity in fast-paced work environments.

9. Leadership and Persuasion Skills

- **Benefit**: Students are trained to inspire and persuade others through effective communication.
- **Relevance to Industries**: Strong leaders are great communicators who can motivate teams, drive decisions, and influence outcomes.

10. Cross-Cultural Competence

- **Benefit**: Exposure to diverse communication practices helps students navigate cultural differences effectively.
- **Relevance to Industries**: In globalized workspaces, cross-cultural communication is crucial for fostering inclusivity and understanding.

11. Conflict Resolution and Negotiation Skills

- **Benefit**: Students learn how to address and resolve disagreements professionally.
- **Relevance to Industries**: Conflict resolution ensures smoother workplace dynamics and successful negotiations with clients or partners.

12. Networking and Relationship Building

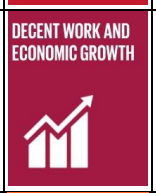
- **Benefit**: Communication skills enable students to build and maintain professional relationships.
- **Relevance to Industries**: Networking is critical for career growth, partnerships, and opportunities in any field.

13. Digital Communication Proficiency

- **Benefit**: Students become skilled in virtual communication tools like emails, video conferencing, and online collaboration platforms.
- **Relevance to Industries**: With remote work and digital tools becoming commonplace, this skill is indispensable.

SECTION 9: Relevance to Sustainability goals

Brief description about the course and its correlation with Sustainability Development Goal (SDGs).

SDG Goals		Correlation with SDG
4		**Quality Education:** This subject will prepare students for modern technological challenges, improving educational tools, and promoting skills essential for global development.
8		**Decent Work and Economic Growth:** Prepares students for careers in technology-driven industries, boosting employability and fostering innovation in the digital economy.
9		**Industry, Innovation, and Infrastructure:** Supports the development of efficient algorithms and systems crucial for advancing technological infrastructure and innovation.
11		**Sustainable Cities and Communities:** Enables the creation of smart city technologies (e.g., optimized traffic systems, resource management) using graph and tree structures.
17		**Partnerships for the Goals:** Facilitates collaboration in data-driven research and global educational initiatives through scalable and efficient data processing.

SECTION 10A: Mapping between COs and POs / PSOs

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	✓	-	-	-	-	-
CO6	-	-	-	-	-	-	-	-	✓	-	-	-	-	-

Outcomes		WKS and Indicators of attainment and Justification for mapping (students will be able to)																																							IAs Count
COs	Pos	WK 1	WK 2								WK 3			WK 4			WK 5						WK 6			WK 7				WK 8							WK 9						
		a	a	b	c	d	e	F	g	h	a	b	c	a	b	C	a	b	c	d	e	f	a	b	c	a	b	c	d	a	b	c	d	e	f	g	a	b	c	d	e	f	
CO 1	PO 9	•																																			•	•		•	•		5
CO2	PO 9	•																																			•	•		•	•		5
CO3	PO 9	•																																			•			•			3
CO4	PO 9	•																																			•			•	•		4
CO 5	PO 9	•																																			•	•		•	•		5
CO 6	PO 9	•																																			•	•		•	•		5

SECTION 10B: Indicators of Attainment with COs to POs and PSOs

Course Outcomes	Percentage of Indicators of Attainments (IA) with POs and PSOs														
	PO												PSO		
	1	2	3	4	5	6	7		8	9	10	11	1	2	3
CO1	-	-	-	-	-	-	-		-	71	-	-	-	-	-
CO2	-	-	-	-	-	-	-		-	71	-	-	-	-	-
CO3	-	-	-	-	-	-	-		-	42	-	-	-	-	-
CO4	-	-	-	-	-	-	-		-	57	-	-	-	-	-
CO5	-	-	-	-	-	-	-		-	71	-	-	-	-	-
CO6	-	-	-	-	-	-	-		-	71	-	-	-	-	-

SECTION 10C: Course Articulation Matrix of COs to Pos

0	1	2	3
No Contribution (0-5%)	Low (≥5 - <40%)	Moderate (≥40 - <60%)	High (≥60%)

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	2	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	2	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	3	-	-	-	-	-
CO6	-	-	-	-	-	-	-	-	3	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	3	-	-	-	-	-
Average	-	-	-	-	-	-	-	-	**3**	-	-	-	-	-

SECTION 10D: Level of Contribution of the COs to POs and PSOs

Number	Programme Outcomes	Proficiency Assessed by	Contribution Level (from 1 to 3)
PO 1	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**.	CIE / SEE / AAT:1 – 2 Assignments / Open-ended problems	3
PO 2	Identify, formulate, review research literature and analyse **complex engineering problems** reaching	CIE / SEE / AAT:1 – 2 Hack-a-thon	3

	substantiated conclusions with consideration for sustainable development. (WK1 to WK4).		
PO 3	Design creative solutions for **complex engineering problems** and design / develop systems / components/ processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**3**
PO 4	Conduct investigations of **complex engineering problems** using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**3**
PO 5	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve **complex engineering problems**. (WK2 and WK6).	CIE / SEE / AAT:2 – 2 Hack-a-thon	**3**
PO 6	Analyze and evaluate societal and environmental aspects while solving **complex engineering problems** for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7)	CIE / SEE / AAT:2 – 2 Hack-a-thon	**3**
PO 11	Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**3**
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications..	AAT: 1 – 1 Tech-Talk	**2**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs..	AAT: 2 – 1 Complex Engineering Problem Solving	**3**
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.	AAT: 2 – 1 Complex Engineering Problem Solving	**3**

SECTION 11: Course Content	
MODULE - I	**Introduction of Communication and Listening Skills**
	Introduction to communication skills; communication process; elements of communication; soft skills and hard skills; importance of soft skills for engineers; significance of listening skills; stages of listening; barriers and effectiveness oflistening; listening comprehension.
MODULE - II	**Speaking Skills**
	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; oral presentation using power point slides.
MODULE - III	**Vocabulary and Grammar**
	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; active and passive voice; questions tags.
MODULE - IV	**Reading Skills**
	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 Skills**
	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.

SECTION 12: Tentative Schedule of Instructions		
Week Number	**Topics**	**Duration (Hours)**
	Discussion on Outcome Based Education, CO, POs and PSOs	1
1	Introduction to communication skills	1
2	Communication process	1
3	Elements of communication	1
4	Significance of listening skills	1
5	Different stages of listening	1
6	Barriers and effectiveness of listening	1
7	Listening comprehension	1
8	Introduction to phonetics	1
9	Significance of speaking skills	1
10	Essentials of speaking skills	1
11	Verbal and non-verbal communication	1
12	Generating talks based on visual prompts	1
13	Public speaking	1
14	Exposure to structured talks	1
15	Oral presentation using power-point slides	1
16	Soft skills and hard skills	1
17	Importance of soft skills for engineers	1
18	Concept of word formation	1
19	Idioms and phrases	1

20	One-word substitutes	1
21	Sentence structure	1
22	Usage of punctuation marks	1
23	Advanced level prepositions	1
24	Functions of tenses	1
25	Subject verb agreement	1
26	Degrees of comparison	1
27	Direct and indirect speech	1
28	Tenses	1
29	Question tags	1
30	Significance of reading skills	1
31	Techniques of reading	1
32	Skimming and Scanning	1
33	Intensive and extensive reading	1
34	Significance of writing skills	1
35	Effectiveness of writing	1
36	The role of a topic sentence	1
37	Supporting sentences to develop a paragraph	1
38	Organizing principles of paragraphs in a document	1
39	Writing introduction and conclusion	1
40	Usage of figurative language	1
41	Informal letter writing	1
42	Formal letter writing	1
43	Technicalities of writing of precis	1
44	E-mail writing	1
45	Report writing	1
	Total	**45**

SECTION 14: Specific Goals for the Course

The following table shows the knowledge and skills covered by the unit outcomes:

Knowledge	Skills
Learners should understand: When learning English, it's important for learners to understand several key aspects to progress effectively. Here are some important points to focus on: 1. **Vocabulary Building**: Expanding vocabulary helps learners express themselves clearly. It's essential to learn words in context rather than just memorizing them. This will help in using words appropriately in different situations. 2. **Grammar Fundamentals**: While it might seem tedious, understanding grammar rules (such as sentence structure, tenses, and parts of speech) forms the foundation for communicating clearly and correctly. 3. **Listening and Speaking**: Language learning isn't just about reading and writing. Practicing listening (by watching movies, listening to podcasts, etc.) and speaking (through conversation practice, language exchanges, etc.) builds fluency and comprehension. 4. **Cultural Context**: Language and culture are deeply connected. Understanding cultural references, idioms, and expressions helps learners grasp the nuances of the language and prevents miscommunication. 5. **Pronunciation**: Proper pronunciation is crucial for being understood. Learning how sounds are made, practicing intonation, and using stress correctly in words and sentences helps learners sound more natural. 6. **Practice and Consistency**: Learning a language requires regular practice. Encouraging learners to practice daily through reading, writing, speaking, and listening will help them retain and improve their skills. 7. **Patience and Persistence**: Language learning can be challenging, and it's important to remain patient. Mistakes are part of the process, and persistence will lead to progress over time. 8. **Confidence**: Encouraging learners to use English confidently, even if they make mistakes, will help them improve. Confidence boosts communication skills and encourages real-world practice. 9. **Exposure**: The more learners are exposed to English in different forms (movies, books, conversations, news, etc.), the better they can pick up on natural language patterns and vocabulary. 10. **Motivation and Goals**: Setting clear goals and having a strong motivation behind learning English keeps learners on track. Whether it's for travel, career advancement, or social interaction, understanding the "why" behind their learning can fuel their progress.	**Learners can**: Improve proficiency in English involves focusing on several key skills, including listening, speaking, reading, writing, grammar, and vocabulary. Here are some effective strategies for learners to enhance their English proficiency: 1. **Regular Practice** Speaking: Engage in conversations with native speakers or fellow learners. Platforms like language exchange programs, language meetups, or even online tools like conversation apps can be useful. **Listening:** Listen to podcasts, audiobooks, or watch movies and shows in English to improve listening comprehension. Start with subtitles and gradually move to listening without them. **Reading:** Read books, articles, newspapers, and websites in English. Start with easier texts and gradually challenge yourself with more complex ones. Reading out loud also helps improve pronunciation. **Writing:** Practice writing essays, stories, or journal entries. Focus on grammar, structure, and coherence. Feedback from teachers or peers can be very valuable in this process. 2. **Expand Vocabulary** Learn new words and phrases daily. Use flashcards, apps like Anki or Quizlet, or simply keep a vocabulary notebook. Pay attention to word collocations (which words often go together) to improve your use of vocabulary in context. Practice using newly learned words in your speaking and writing. 3. **Focus on Grammar** Study grammar rules regularly. Start with basic structures like sentence construction and gradually move to more complex aspects like tenses, conditionals, and modals. Practice grammar exercises and correct mistakes when writing or speaking. This helps reinforce the rules. 4. **Engage with Authentic Material** Use real-world materials like news articles, blogs, social media posts, or even song lyrics. This will expose you to natural language use, idioms, and cultural references. Follow content that interests you—this keeps learning fun and motivating. 5. **Set Specific Goals** Set achievable language-learning goals, such as mastering a specific number of vocabulary words per week or writing an essay on a particular topic. Break down larger goals, like achieving fluency, into smaller milestones, such as being able to

Focusing on these elements can help learners grasp English more effectively and enjoy the process of learning.	hold a 10-minute conversation or reading a book in English. 6. **Seek Feedback** Whether from teachers, tutors, or native speakers, regular feedback is crucial. They can point out areas of improvement, such as pronunciation or sentence structure, that you may not notice yourself. 7. **Immerse Yourself in the Language** Surround yourself with English as much as possible. Change the language on your devices to English, follow English-speaking social media accounts, or even travel to English-speaking countries if possible. Attend English language events or webinars and try to use English in real-world situations, even if you're still learning. 8. **Use Language Learning Apps** Apps like Duolingo, Babbel, Memorise, and Rosetta Stone are great tools for learners of all levels. They offer structured lessons and exercises to improve various skills in an interactive way. 9. **Be Consistent and Patient** Language learning is a gradual process. Consistency is key—try to engage with English every day, even if only for a short time. Celebrate your progress, no matter how small. Stay patient and motivated, as fluency takes time to develop. 10. **Engage in English-Speaking Communities** Participate in English-language forums, groups, and discussion boards (e.g., Reddit or language learning communities). This can help you practice both writing and understanding others' points of view. Video games, online classes, or social media platforms with an international user base also offer interactive spaces to improve language skills. By combining these methods with regular practice and immersion, learners can significantly improve their English proficiency over time. What specific area of language learning would you like to focus on?

Administrative Information

SECTION 15: History of changes		
Regulations	**Description of change**	**BOS Date**
R 16	•	
R 18	•	
UG 20	•	
BT 23	•	

Course Outline Approvals	
Course Coordinator Name: Dr. Jetty Wilson Signature: Date:	**Head of the Department** Name: Dr. Jetty Wilson Signature: Date:
Course Outline Approvals: The course outline description approved by Outcome Based Teaching Learning (OBTL) committee on *date* in meetings *IARE - OBTL – COD /104/25*	
Dean of Outcome Based Teaching and Learning Name: Signature: Date:	**Dean of Academics** Name: Signature: Date:

Check List		
Section	**Description**	**Please tick (✓)**
1	General Information about the Course	✓
2	Notional Study Time	✓
3	A. Course Outcomes	✓
	B. Cognitive Levels	✓
4	Content and Context of the Course	✓
5	The Role of English Language Complex Engineering Problem Solving	✓
6	A. Assessment Methods – Direct	✓
	B. Assessment Methods – Indirect	✓
7	Content Delivery / Instructional Methodologies	✓
8	Engineering Competencies (ECs) Focused	
9	Employability Skills	✓
10	Relevance to Sustainability goals	
11	A. Mapping between COs and POs / PSOs	✓
	B. Indicators of Attainment with COs to POs and PSOs	✓
	C. Course Articulation Matrix of COs to Pos	✓
	D. Level of Contribution of the COs to POs and PSOs	✓
12	Syllabus	✓
13	Tentative Schedule of Instructions	✓
14	Specific Goals for the Course	✓
15	History of Changes	✓

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

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**Electrical Circuits**
Course Code	**AEEE02**
Course Start	First Semester
Course Type	Core
Regulation	IARE - BT 25
Prerequisite Courses	Mathematics
Department	ECE
Number of Credits	3 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Theory
Course Administrator	**Dr. Damodhar Reddy** Professor of Electrical and Electronics Engineering IARE11115 dr.damodharreddy@iare.ac.in
Course Coordinator's Name	**Mr.T. Ravi Babu** Assistant Professor of Electrical and Electronics Engineering IARE10732 travibabu@iare.ac.in
Prior Learning Assessment and Recognition (PLAR)	Students interested in PLAR pathways for open learning can register one semester prior to the start of semester. Students will receive the necessary contact information one semester in advance.
Open Learning Faculty Member Information	Open Learning Faculty (OLF) is available to assist students. Students will receive the necessary contact information at the start of the course.
Course Webpage	https://www.iare.ac.in/sites/default/files/BT25/AEEE02.pdf
Course Description	This course introduces fundamental concepts of circuit laws, theorems, and various electrical elements. It covers steady-state analysis for both single-phase and three-phase circuits, along with concepts of resonance and power calculations. Students also explore network theorems and magnetic coupled circuits to enhance problem-solving skills. End the end of the course completion, learners will be able to analyze and design AC and DC electrical circuits using scientific and engineering principles
Course Objectives	**The students will try to learn:** a. The fundamental circuit laws and transformations in electrical networks b. The AC and DC circuits using network theorems and systematic methods like mesh and nodal analysis. c. The use of single-phase and three-phase circuits for balanced and unbalanced loads. d. The resonance, power concepts, and mutual inductance in circuits with energy-storing elements

Text and Reference Books	**Text Books** **1.** Chakravarthy A., "Circuit Theory", Dhanpat Rai & Co., First Edition, 1999 2. William Hayt H, Kimmerly Jack E. and Steven Durbin M, "Engineering Circuit Analysis", McGraw Hill,6th Edition, 2002. 3. Van Valkenburg M.E, "Network Analysis", Prentice Hall of India, 3rd Edition, 2000.. **Reference Books** 1. A Sudhakar, Shyammohan S Palli, "Circuits and Networks: Analysis and Synthesis", McGraw Hill, 5th Edition, 2017. 2. Ravish R Singh, "Network Analysis and Synthesis", McGraw Hill, 2nd Edition, 2019.
Learning Resources	-
Supplemental Materials	**Readings, Videos, and Links** 1. NPTEL :: NOC : Basic Electrical Circuits, IIT Madras https://nptel.ac.in/courses/117106108 2. https://www.youtube.com/watch?v=25Ycc8Md8Cc#:~:text=Watch%20the%20full%20video%20to,unacademy.com/...
Learning and Teaching Strategies	Online material will provide the foundation of the learning resources, requiring the students to log in and engage regularly throughout the sixteen weeks of the course. There will be a mix of suggested readings, discussions and video content containing embedded digital content and undertake the assessment tasks.

SECTION 2: Teaching Learning Scheme

At least 48 lecture hours of scheduled teaching and learning activities (TLA) will be delivered in person, with the remaining hours for scheduled and self-scheduled teaching and learning activities delivered either in person or online.
Notional Study Time: 90 Hours (Lecture hours: 48, Tutorial hours: 8, Scheduled revision session hours: 2, Guided independent study hours: 15, Homework / Programming assignment hours: 10, Course project / Preparation for complex problem-solving hours: 15)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA1	Lectures	48	01	48
TLA 2	Tutorials	08	01	08
TLA 3	Case Study			
TLA 4	Problem Solving			
TLA 5	Demonstration			
TLA 6	Scheduled revision sessions	02	01	02
TLA 7	Guided independent study: Directed viewing of video materials / PPTs			15
TLA 8	Independent private study			
TLA 9	Laboratory Exercises	0	0	0
TLA 10	Homework assignments / Programming assignments			10
TLA 11	Placement / work based learning or Specific practical training	0	0	0
TLA 12	Presentation / Seminar Preparation			
TLA 13	Course Project / Preparation for Complex Problem Solving			15
TLA 14	Technical visit			

TLA 15	Field activities	0	0	0
			Total study hours	**90**
			Expected total study hours	**90**

SECTION 3A: Course Outcomes		
After successfully completing this course, the student will be able to:		
Outcome Number	**Course Outcomes**	**Learning Domain**
CO1	**Identify and classify different electrical elements and apply Kirchhoff's laws, source, and Star-Delta transformations in network analysis.**	Understand
CO2	**Analyze AC single-phase circuits using phasor techniques and compute power, impedance, and resonance conditions**	Analyze
CO3	**Evaluate three-phase systems under balanced and unbalanced conditions and measure power using appropriate methods.**	Evaluate
CO4	**Apply various network theorems to simplify and solve complex AC and DC circuits.**	Apply
CO5	**Interpret and solve magnetic coupled circuits using concepts like mutual inductance, dot convention, and coefficient of coupling.**	Analyze

SECTION 3B: Cognitive Levels	
BloomsTaxonomyLevel	**Cognitive Level in Percentage (%)**
Remember	**0**
Understand	20
Apply	20
Analyze	40
Evaluate	20
Create	0

SECTION 4: Content and Context of Electrical Circuits	
CO1	**Identify and classify different electrical elements and apply Kirchhoff's laws, source, and Star-Delta transformations in network analysis.**
	Electrical network analysis involves identifying and classifying elements as active, passive, linear, or nonlinear. Kirchhoff's Current and Voltage Laws apply conservation principles for currents and voltages. Source transformations simplify circuits by converting between equivalent sources, while Star-Delta transformations reduce complex three-terminal networks, enabling accurate calculation of voltages, currents, and power. Network analysis is vital in electrical engineering to simplify and solve complex circuits. Classifying elements helps determine their function in energy flow. Kirchhoff's laws ensure conservation principles are applied. Source and Star-Delta transformations reduce networks into manageable forms, enabling accurate analysis, design, and optimization of electrical systems for practical applications.
CO2	**Analyze AC single-phase circuits using phasor techniques and compute power, impedance, and resonance conditions**
	AC single-phase circuit analysis uses phasor techniques to represent sinusoidal voltages and currents in complex form. Impedance combines resistance, inductive reactance, and capacitive reactance. Power analysis includes real, reactive, and apparent power. Resonance occurs when inductive and capacitive reactances cancel, minimizing impedance and maximizing current at a specific frequency. analyzing AC single-phase circuits is essential for understanding electrical power systems and appliances. Phasor techniques simplify sinusoidal calculations using complex numbers. Computing impedance aids in circuit design, while power analysis ensures efficiency. Studying resonance conditions is crucial for tuning, minimizing losses, and achieving desired performance in practical engineering applications.

CO3	**Evaluate three-phase systems under balanced and unbalanced conditions and measure power using appropriate methods**
	Three-phase systems consist of three sinusoidal voltages or currents, displaced by 120°. In balanced systems, magnitudes are equal and phase shifts are uniform, while unbalanced systems show unequal values. Power measurement is performed using two-wattmeter or three-wattmeter methods, enabling accurate evaluation of real, reactive, and apparent power in electrical networks. Three-phase system analysis is crucial in power generation, transmission, and distribution. Evaluating balanced and unbalanced conditions ensures stability and reliability of supply. Measuring power using methods like two-wattmeter and three-wattmeter techniques provides accuracy. Understanding these systems supports efficient energy utilization, fault analysis, and effective design of electrical power networks.
CO4	**Apply various network theorems to simplify and solve complex AC and DC circuits.**
	Network theorems simplify AC and DC circuit analysis by reducing complexity. Theorems such as Thevenin's, Norton's, Superposition, Maximum Power Transfer, and Reciprocity help determine voltages, currents, and power efficiently. By applying these theorems, complex circuits are transformed into simpler equivalents, enabling accurate solutions and effective design of electrical networks. Applying network theorems is essential for analyzing and designing electrical circuits. They provide systematic methods to handle complex AC and DC networks, ensuring accuracy and efficiency. By simplifying analysis, these theorems support learning, fault detection, and optimization in practical applications, making them vital tools in electrical engineering problem-solving.
CO5	**Interpret and solve magnetic coupled circuits using concepts like mutual inductance, dot convention, and coefficient of coupling.**
	Magnetically coupled circuits involve two or more coils linked by mutual flux. Mutual inductance defines the induced voltage in one coil due to current in another. The dot convention indicates the polarity of induced voltages, while the coefficient of coupling quantifies flux linkage, enabling accurate analysis and solution of coupled circuits. Magnetically coupled circuits are widely used in transformers, inductors, and communication systems. Understanding mutual inductance, dot convention, and coupling coefficient is essential for predicting circuit behavior. These concepts help analyze energy transfer, efficiency, and polarity in coupled coils, ensuring accurate design and application of electromagnetic devices in electrical engineering.

SECTION 5: Complex Engineering Problem Solving

Circuit theory provides tools to solve complex engineering problems across electrical systems,enables simplification of large networks using Kirchhoff's laws, transformations, and node/mesh analysis.Develops AC analysis through RMS values, phasors, impedance, power, and resonance, crucial in filters and communication. Addresses real-world power distribution challenges by analyzing balanced/unbalanced three-phase loads and power measurement. Uses network theorems to reduce complexity, optimize power transfer, and support fault diagnosis. Applies magnetic coupling concepts to transformers and inductors, solving problems in energy conversion, power electronics, and electromagnetic systems.

SECTION 6A: Assessment Methods – Direct

Item	Evaluation Components	Week in / out	Marks
AAT: 1	Tech-Talk	Week – 2 / 5	05
AAT: 1	Assignments	Week – 4 / 7	05
AAT: 2	Complex Engineering Problem Solving	Week – 9 / 15	10
CIE - 1	2 hours - Answer 4 out of 5 questions	Week - 9	10
CIE - 2	2 hours - Answer 4 out of 5 questions	Week - 17	10
SEE	3 hours - Answer 1 from each module	Week - 18	60
		Total Marks	**100**

Department's Late Submission Policy:

1. 1 – 24 hours: 25% of the mark will be deducted
2. > 24 hours: Not accepted

SECTION 6B: Assessment Methods –Indirect

Course End Survey (End Semester OBE Feedback)	✓

SECTION 7: Engineering Competencies (ECs) Focused Please tick (✓) relevant engineering competency profile covered			
EC Number	**Attributes**	**Profiles**	**(✓)**
EC1	Depth of knowledge required (CP)	Fundamental for all modules (laws, theorems, RLC elements, three-phase analysis) based on principles of circuit theory.	✓
EC2	Depth of analysis required (CP)	Needed for phasor analysis, resonance, unbalanced 3-phase, magnetic coupling — requires abstraction and modelling.	✓
EC3	Design and development of solutions (CA)	Less emphasized here since modules focus more on analysis than design/optimization.	✘
EC4	Range of conflicting requirements (CP)	Applicable in unbalanced circuits, resonance conditions, and power optimization where multiple constraints exist.	✓
EC5	Infrequently encountered issues (CP)	Relevant when applying advanced theorems (Tellegen, Compensation) or solving unusual unbalanced/complex networks.	✓
EC6	Protection of society (CA)	Not directly covered in this syllabus, more relevant to power systems & safety courses.	✘
EC7	Range of resources (CA)	Limited here, since focus is on theory and computation rather than multidisciplinary coordination.	✘
EC8	Extent of stakeholder involvement (CP)	Not relevant at this level.	✘
EC9	Extent of applicable codes, legal and regulatory (CP)	Not directly applicable here.	✘
EC10	Interdependence (CP)	Strongly relevant — networks are partitioned into sub-elements (mesh, node, star-delta) and recombined for whole-system integrity.	✓
EC11	Continuing professional development (CPD) and lifelong learning (CA)	Indirectly applicable, as mastering circuit theory builds foundation for advanced courses, lifelong adaptation.	✓
EC12	Judgement (CA)	Required in selecting theorems, choosing solution methods, and handling incomplete/approximate data in circuit problems.	✓

SECTION 8: Employability Skills

Example: Communication skills / Programming skills / Project based skills

Employability skills are the transferable skills and personal attributes that make an individual suitable for employment in the field of Electrical Circuits. They combine technical knowledge, problem-solving ability, and professional behaviour.

1. **Technical Skills**
   - Apply Kirchhoff's laws, mesh/node methods, and network theorems to solve AC/DC circuit problems.
   - Analyze and simulate single-phase and three-phase circuits for real-world applications.
   - Compute power, impedance, and resonance conditions for efficiency optimization.
   - Interpret and solve magnetic coupled circuits for transformers and inductive devices.
   - Use circuit simulation tools (MATLAB, PSPICE, LabVIEW) for validation.
2. **Communication Skills**
   - Present circuit analysis results (phasor diagrams, power factor correction, resonance graphs) clearly.
   - Write concise lab reports, technical documentation, and calculation sheets.

- Explain three-phase measurement techniques and resonance phenomena to peers and supervisors.

3. **Teamwork and Collaboration**
   - Work with peers in labs for experimental verification of circuit laws/theorems.
   - Collaborate in group projects analyzing balanced/unbalanced systems.
   - Support integration of circuit knowledge into multidisciplinary engineering tasks.
4. **Project and Time Management**
   - Manage small circuit design/analysis projects within timelines.
   - Organize problem-solving approaches using systematic methods (mesh, nodal, star-delta).
   - Prioritize tasks in experiments, simulations, and reporting to meet academic/industrial requirements.

SECTION 9: Relevance to Sustainability goals

Brief description about the course and its correlationwith Sustainability Development Goal (SDGs).

SDG Goals		Correlation with SDG
4		**Quality Education:** This subject will prepare students for modern technological challenges, improving educational tools, and promoting skills essential for global development.
8		**Decent Work and Economic Growth:** Prepares students for careers in technology-driven industries, boosting employability and fostering innovation in the digital economy.
9		**Industry, Innovation, and Infrastructure:** Supports the development of efficient algorithms and systems crucial for advancing technological infrastructure and innovation.
11		**Sustainable Cities and Communities:** Enables the creation of smart city technologies (e.g., optimized traffic systems, resource management) using graph and tree structures.
17		**Partnerships for the Goals:** Facilitates collaboration in data-driven research and global educational initiatives through scalable and efficient data processing.

SECTION 10A: Mapping between COs and POs / PSOs

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	✓	✓	-	-	-	-	-	-	-	✓	-	✓	-	✓
CO2	✓	✓	✓	-	✓	-	-	-	-	✓	-	✓	✓	-
CO3	✓	✓	-	-	✓	-	-	-	-	-	✓	✓	✓	-
CO4	✓	✓	✓	✓	✓	-	-	-	-	✓		✓	-	✓

CO5	✓	✓	✓	-	✓	-	-	-	-	✓	-	✓	✓	✓

Outcomes		WKS and Indicators of attainment and Justificationformapping(studentswillbeableto)																																									IAs Count
COs	POs	WK 1	WK 2								WK 3			WK 4			WK 5						WK 6			WK 7				WK 8							WK 9						
		a	a	b	c	d	e	f	g	h	a	b	c	a	b	c	a	b	c	d	e	f	a	b	c	a	b	c	d	a	b	c	d	e	f	g	a	b	c	d	e	f	
CO 1	PO 1	•	•	•	•	•	•		•						•																												12
	PO 2	•	•	•	•	•	•		•			•	•		•																												13
	PO 10																•	•	•			•																					4
	PSO 1																													•	•	•			•	•							5
	PSO 3																													•	•	•			•	•							5
CO2	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																•	•	•			•																					4
	PO 5																													•	•	•			•	•							5
	PO 10		•	•	•	•	•		•														•	•	•																		9
	PSO 1	•	•	•			•		•			•	•	•																													8
	PSO2	•	•	•			•		•			•	•	•																													8
CO3	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 5																•	•	•			•																					4
	PO 11																													•	•	•			•	•							5
	PSO 1																													•	•	•			•	•							5
	PSO 2																													•	•	•			•	•							5
CO4	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																													•	•	•			•	•							5
	PO 4		•	•	•	•	•		•														•	•	•																		9
	PO 5		•	•	•	•	•		•														•	•	•																		9
	PO 10																													•	•	•			•	•							5
	PO 11																													•	•	•			•	•							5
	PSO 1	•	•	•			•		•			•	•	•																													8
	PSO2	•	•	•			•		•			•	•	•																													8
	PSO3	•	•	•			•		•			•	•	•																													8
CO 5	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																•	•	•			•																					4
	PO 4																													•	•	•			•	•							5
	PO 5		•	•	•	•	•		•														•	•	•																		9

	PO 10																								•	•	•			•	•							5
	PSO 1																								•	•	•			•	•							5
	PSO 2																								•	•	•			•	•							5
	PSO 3																								•	•	•			•	•							5

SECTION 10B: Indicators of Attainment with COs to POs and PSOs

Course Outcomes	Percentage of Indicators of Attainments (IA) with POs and PSOs													
	PO											PSO		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	80	72	-	--	-	-	-	-	-	66	-	71	-	71
CO2	66	66	66	-	71	-	-	-	71	81	-	53	53	53
CO3	66	66	-	-	66	-	-	-	-	-	71	71	71	71
CO4	66	66	81	81	81	81	81	-	-	71	71	53	53	53
CO5	66	66	66	71	90	-	-	-	-	71	71	71	71	71
CO6	66	66	66	71	-	-	-	-	-	71	-	71	53	53

SECTION 10C: Course Articulation Matrix of COs to POs

0	1	2	3
No Contribution (0-5%)	Low (≥5 - <40%)	Moderate (≥40 - <60%)	High (≥60%)

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	3	-	-	-	-	-	-	-	3	-	3	-	3
CO2	3	3	3	-	3	-	-	-	3	3	-	2	2	2
CO3	3	3	-	-	3	-	-	-	-	-	-	3	3	3
CO4	3	3	3	3	3	3	3	-	-	3	3	2	2	2
CO5	3	3	3	3	3	-	-	-	-	3	3	3	3	3
CO6	3	3	3	3	-	-	-	-	-	3	3	3	2	2
Total	18	18	12	9	12	3	3	-	-	15	9	16	12	15
Average	**3**	**3**	**2**	**1.5**	2	**0.5**	**0.5**	**-**	**0.5**	**2.5**	**1.5**	**2.5**	**2**	**2.5-**

SECTION 10D: Level of Contribution of the COs to POs and PSOs

Number	Programme Outcomes	Proficiency Assessed by	Contribution Level (from 1 to 3)
PO 1	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**.	CIE / SEE / AAT:1 – 2 Assignments / Open-ended problems	**3**
PO 2	Identify, formulate, review research literature and analyse **complex engineering problems** reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).	CIE / SEE / AAT:1 – 2 Hack-a-thon	**3**
PO 3	Design creative solutions for **complex engineering problems** and design / develop systems / components/ processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**2**
PO 4	Conduct investigations of **complex engineering problems** using research-based knowledge	CIE / SEE / AAT:2 – 1 Complex Engineering	**1.5**

	including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)	Problem Solving	
PO5	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**.	CIE / SEE / AAT:1 – 2 Assignments / Open-ended problems	**2**
PO6	Identify, formulate, review research literature and analyse **complex engineering problems** reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).	CIE / SEE / AAT:1 – 2 Hack-a-thon	**0.5**
PO7	Design creative solutions for **complex engineering problems** and design / develop systems / components/ processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**0.5**
PO9	Conduct investigations of **complex engineering problems** using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**0.5**
PO 10	Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**2.5**
PO 11	Design creative solutions for **complex engineering problems** and design / develop systems / components/ processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**1.5**
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	AAT: 1 – 1 Tech-Talk	**2.5**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	AAT: 1 – 1 Tech-Talk	**2**
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.	AAT: 1 – 1 Tech-Talk	**2.5**

SECTION 11: Course Content

MODULE - I	**NETWORK ELEMENTS & LAWS**
	Network Elements: Active elements- Independent and dependent sources, Passive elements- R, L and C, Energy stored in Inductance and Capacitance, Laws: Kirchhoff's laws, Source transformation, Star-Delta transformation, Node voltage method, and Mesh current method.
MODULE - II	**SINGLE-PHASE CIRCUITS**
	Single-Phase Circuits: RMS and average values of periodic sinusoidal and non-sinusoidal waveforms, Phasor representation, j-Notation, Steady-state analysis of series, parallel circuits. Impedance, Admittance, Active and Reactive Powers, Complex Power. **Resonance:** Series and parallel circuits, Bandwidth and Q-factor.

MODULE - III	**THREE-PHASE CIRCUITS**
	Three-phase Circuits: Analysis of balanced and unbalanced three-phase circuits, Star and delta connections, Measurement of three-phase power for balanced and unbalanced loads.
MODULE - IV	**NETWORK THEOREMS**
	Network theorems: Superposition theorem, Thevenin's theorem, Norton's theorems, Maximum power transfer theorem, Tellegen's theorem, Compensation theorem, Millman's theorem and Reciprocity theorem. (AC & DC).
MODULE - V	**MAGNETIC COUPLED CIRCUITS**
	Magnetic Coupled circuits: Concept of self and mutual inductance, Dot convention, Coefficient of coupling, Analysis of circuits with mutual inductance.

SECTION 12: Tentative Schedule of Instructions

Week Number	Topics	Duration (Hours)
1	1.1 **MODULE – I**: Introduction to Network Elements: R,L, and C 1.2 Active elements, Passive elements. 1.3 Independent and dependent sources and problems 1.4 Kirchhoff's laws, Ohms Law	4
2	2. 1 Problems on Kirchhoff's laws, Ohms Law 2.2 Source transformation, voltage division, current division and problems. 2.3 Star-Delta transformation and problems 2.4 Mesh and Nodal analysis - problems	4
3	3.1 Super Mesh and Nodal analysis - problems 3.2 **MODULE – II**: RMS and average values of periodic sinusoidal and non-sinusoidal waveforms. 3.3 Problems on RMS and average values, Phasor representation, j-Notation. 3.4 Steady-state analysis of series, parallel circuits	4
4	4.1 Problem on Steady-state analysis of series, parallel circuits. 4.2 Impedance, Admittance, Active and Reactive Powers, Complex Power. 4.3 Problems on Impedance, Admittance, Active and Reactive Powers, Complex Power 4.4 **Resonance:** Series and parallel circuits	4
5	5.1 Problems on Series and parallel resonance. 5.2 Bandwidth and Q-factor, and problems. 5.3 **MODULE - III**: Introduction to Three-phase Circuits 5.4 Analysis of balanced and unbalanced three-phase circuits	4
6	6.1.Problems on Analysis of balanced and unbalanced three-phase circuits 6.2 Star and delta connections in three-phase circuits 6.3 Problems on Star and delta connections in three-phase circuits.	3
CONTINIUOUS INTERNAL EXAMINATION (CIE- I)		
7	7.1 Measurement of three-phase power for balanced loads. 7.2 Measurement of three-phase power for unbalanced loads. 7.3 Problems on three-phase power for balanced loads. 7.4 Problems on three-phase power for unbalanced loads.	4
8	8.1 Problems on three-phase power for balanced, unbalanced loads 8.2 **MODULE – IV:** Network theorems (AC & DC): Thevenin's theorem,problems 8.3 Norton's theorems and problem's 8.4 Superposition theorem and problem's	4
9	9.1 Reciprocity theorem and problems 9.2 Maximum power transfer theorem Introduction 9.3 Problems on Maximum power transfer theorem 9.4 Tellegen's theorem and problems	4
10	10.1 Compensation theorem and problems 10.2 Millman's theorem and problems.	4

	10.3 Problems on Network theorems (AC & DC) 10.4 **MODULE-V:** Magnetic Coupled Circuits: Introduction	
11	11.1 Concept of self and mutual inductance 11.2 Problems on self and mutual inductance 11.3 Concept of Dot convention 11.4 Problems on Dot convention	4
12	12.1 Coefficient of coupling 12.2 Problems on coefficient of coupling 12.3 Analysis of circuits with mutual inductance 12.4 Problems on analysis of circuits with mutual inductance	4
13	13.1 Additional Problems on Magnetic Coupled Circuits	1
	Total	**48**

SECTION 14: Specific Goals for the Course

The following table shows the knowledge and skills covered by the unit outcomes:

Knowledge	Skills
Learners should understand: • Understand the classification of active and passive elements, and the concept of energy storage in R, L, and C. • Explain Kirchhoff's laws, source transformation, star-delta transformation, and network simplification techniques. • Describe RMS, average values, phasor representation, complex power, and resonance in single-phase AC circuits. • Interpret the operation of balanced and unbalanced three-phase systems and methods of power measurement. • Explain fundamental network theorems and the concepts of self and mutual inductance in magnetic coupled circuits.	**Learners can:** • Apply circuit laws and transformations to analyze DC and AC electrical networks. • Perform steady-state phasor analysis of single-phase circuits and calculate different types of power. • Analyze resonance characteristics and determine bandwidth and Q-factor of circuits. • Solve problems in balanced and unbalanced three-phase systems, including power measurement. • Use network theorems and mutual inductance concepts to simplify, model, and analyze electrical circuits.

Administrative Information

SECTION 15: History of changes

Regulations	Description of change	BOS Date
R 18	Changes from R16 to R18 regulation: Removed topic :the Resonance: Series and parallel resonance, concept of band width and Q factor	09.07.2018
UG 20	Changes from R18 to UG20 regulation: : added the content two port network and graph theory	17.11.2020
BT 23	No change	21.08.2023
BT 25	Changes from BT23 to BT25 regulation: Added the content three-phase circuits, Resonance:	26-08-2025

Course Outline Approvals	
Course Coordinator Name: Mr. T Ravi Babu Signature: Date:04-07-2025	**Head of the Department** Name: Dr. Damodhar Reddy Signature: Date:04-07-2025
Course Outline Approvals: The course outline description approved by Outcome Based Teaching Learning (OBTL) committee on *date* in meetings *IARE - OBTL – COD /104/25*	
Dean of Outcome Based Teaching and Learning Name: Dr. CH Srinivasulu Signature: Date: 04-09-2025	**Dean of Academics** Name: Dr. G Chandra Sekhar Signature: Date: 04-07-2025

Check List		
Section	**Description**	**Please tick (✓)**
1	General Information about the Course	✓
2	Notional Study Time	✓
3	A. Course Outcomes	✓
	B. Cognitive Levels	✓
4	Content and Context of the Course	✓
5	Complex Engineering Problem Solving	✓
6	A. Assessment Methods – Direct	✓
	B. Assessment Methods – Indirect	✓
7	Content Delivery / Instructional Methodologies	✓
8	Engineering Competencies (ECs) Focused	✓
9	Employability Skills	✓
10	Relevance to Sustainability goals	✓
11	A. Mapping between COs and POs / PSOs	✓
	B. Indicators of Attainment with COs to POs and PSOs	✓
	C. Course Articulation Matrix of COs to POs	✓
	D. Level of Contribution of the COs to POs and PSOs	✓
12	Syllabus	✓
13	Tentative Schedule of Instructions	✓
14	Specific Goals for the Course	✓
15	History of Changes	✓

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

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	Object Oriented Programming
Course Code	ACSE01
Course Start	First Semester
Course Type	Core
Regulation	IARE - BT 25
Prerequisite Courses	-
Department	ECE
Number of Credits	3 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Theory and laboratory
Course Administrator	Name: Dr. M Lakshmi Prasad EmpID: IARE10862 Designation: Professor of Computer Science and Engineering Email ID: m.lakshmiprasad@iare.ac.in
Course Coordinator	Name: Dr. B. Surekha Reddy EmpID: IARE10795 Designation: Assistant Professor of Electronics and Communication and Engineering Email ID: b.surekhareddy@iare.ac.in
Prior Learning Assessment and Recognition (PLAR)	-
Open Learning Faculty Member Information	Open Learning Faculty (OLF) is available to assist students. Students will receive the necessary contact information at the start of the course.
Course Webpage	https://akanksha.iare.ac.in/index?route=course/details&course_id=1678
Course Description	This course introduces the principles of Object-Oriented Programming (OOP) and its role in solving complex problems effectively. It provides a solid foundation in object-oriented concepts such as abstraction, encapsulation, inheritance, polymorphism, and collaboration. The course also extends into file handling, exception management, and concurrent execution, preparing students to design, develop, and manage robust real-world applications. Course includes laboratory component for lab-based exercises. Key notions of object-oriented programming with a view for efficiency, maintainability, and code-reuse, are emphasized.
	The Java programming language will be used to demonstrate the concepts discussed in lecture, and students will demonstrate these skills by solving real-world problems in the Java language.

Course Objectives	The students will try to learn: a. The fundamental concepts and principles of object-oriented programming in high-level programming languages. b. The advanced concepts for developing well-structured and efficient programs that involve complex data structures, numerical computations, or domain-specific operations. c. The design and implementation of features such as inheritance, polymorphism, and encapsulation for tackling complex problems and creating well-organized, modular, and maintainable code. d. The usage of input/output interfaces to transmit and receive data to solve real-time computing problems.
Text and Reference Books	**Text Books** 1. Matt Weisfeld, *The Object-Oriented Thought Process*, Addison Wesley Object Technology Series, 4th Edition, 2013. 2. Grady Booch, Object-Oriented Analysis and Design with Applications, Addison-Wesley Professional, 3rd Edition, 2007. 3. Craig Larman, Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development, Addison-Wesley Professional, 3rd Edition, 2004. **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.
Learning Resources	Course full stack is made available in IARE learning management portal – Akansha, which includes lecture notes, tutorial question bank, definition and terminology, tech-talk topics, assignments, Model question papers (2 sets), complex engineering problem solving statements, power point presentations (PPTs) and ELRV lecture recordings at: 1. https://www.youtube.com/watch?v=ef5irlN2JxU 2. https://www.youtube.com/watch?v=J7RKLVqNX5c&pp=0gcJCbIJAYcqIYzv
Supplemental Materials	**Readings, Videos, and Links** 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/
Learning and Teaching Strategies	Online material will provide the foundation of the learning resources, requiring the students to log in and engage regularly throughout the sixteen weeks of the course. There will be a mix of suggested readings, discussions and video content containing embedded digital content and undertake the assessment tasks.

SECTION 2: Teaching Learning Scheme

At least 48 lecture hours of scheduled teaching and learning activities (TLA) will be delivered in person, with the remaining hours for scheduled and self-scheduled teaching and learning activities delivered either in person or online.

Notional Study Time: 90 Hours (Lecture hours: 48, Tutorial hours: 8, Scheduled revision session hours: 2, Guided independent study hours: 15, Homework / Programming assignment hours: 10, Course project/ Preparation for complex problem solving hours: 15)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA 1	Lectures	48	01	48
TLA 2	Tutorials	08	01	08
TLA 3	Case Study			
TLA 4	Problem Solving			
TLA 5	Demonstration			
TLA 6	Scheduled revision sessions	02	01	02
TLA 7	Guided independent study: Directed viewing of video materials / PPTs			15
TLA 8	Independent private study			
TLA 9	Laboratory Exercises	0	0	0
TLA 10	Homework assignments / Programming assignments			10
TLA 11	Placement / work based learning or Specific practical training	0	0	0
TLA 12	Presentation / Seminar Preparation			
TLA 13	Course Project / Preparation for Complex Problem Solving			15
TLA 14	Technical visit			
TLA 15	Field activities	0	0	0
			Total study hours	90
			Expected total study hours	90

SECTION 3A: Course Outcomes		
After successfully completing this course, the student will be able to:		
Outcome Number	**Course Outcomes**	**Learning Domain**
CO 1	**Identify** appropriate programming approaches to manage complexity.	Understand
CO 2	**Design** modular, reusable, and adaptable software systems.	Analyze
CO 3	**Apply** structured problem-solving techniques to build reliable and maintainable applications.	Apply
CO 4	**Demonstrate** the ability to handle data, manage errors, and ensure smooth program execution.	Apply
CO 5	**Develop** applications that are efficient, scalable, and suitable for real-world scenarios.	Evaluate
CO 6	**Develop** contemporary solutions to software design problems using object-oriented principles.	Create

SECTION 3B: Cognitive Levels	
Blooms Taxonomy Level	**Cognitive Level in Percentage (%)**
Remember	0
Understand	16.67
Apply	33.32
Analyse	16.67
Evaluate	16.67
Create	16.67

SECTION 4: Content and Context of Object Oriented Programming	
CO 1	**Identify appropriate programming approaches to manage complexity.**
	Help learners understand various programming paradigms and their use in managing software complexity. Introduce structured, procedural, and object-oriented programming approaches, with an emphasis on how each handles modularity, readability, and scalability. Explore how programming methodologies influence design and maintenance decisions.. **Students should be able to:** Identify different programming paradigms and when to apply them. Understand the trade-offs between structured and object-oriented programming. Recognize the role of abstraction in reducing code complexity. Match real-world problems to suitable programming models. Distinguish between top-down and bottom-up design strategies.
CO 2	**Design modular, reusable, and adaptable software systems**.
	Enable students to design software that follows modularity principles, supports code reuse, and adapts to changes. Emphasize concepts like separation of concerns, code refactoring, and interface design. Teach the importance of loosely coupled, highly cohesive modules that can evolve independently. **Students should be able to:** Apply modular design techniques in program structure. Build reusable functions, classes, and components. Use interfaces and design patterns to promote adaptability. Refactor code to improve readability and maintainability. Design for future extension without modifying existing code.
CO 3	**Apply structured problem-solving techniques to build reliable and maintainable applications.**
	Focus on structured analysis, problem decomposition, and algorithm design. Teach learners how to approach programming systematically — from understanding requirements to designing stepwise solutions. Emphasize traceability, documentation, and coding standards to ensure maintainability. **Students should be able to:** Break complex problems into manageable subproblems. Use flowcharts, pseudocode, and UML diagrams for planning. Implement step-by-step solutions using control structures. Apply testing and debugging techniques systematically. Write clean, well-documented, and maintainable code.

CO 4	**Demonstrate the ability to handle data, manage errors, and ensure smooth program execution.**
	This outcome reinforces the principles of different data types, structures, and input/output operations. Emphasize robust programming practices, including error detection, exception handling, and validation techniques to ensure fault-tolerant and stable execution. **Key abilities:** Handle various data formats and perform input/output operations. Implement error-checking and exception-handling mechanisms. Use control flow structures to manage execution logic. Debug runtime issues and prevent application crashes. Ensure predictable and safe program behavior under edge cases.
CO 5	**Develop applications that are efficient, scalable, and suitable for real-world scenarios.**
	Prepare learners to create programs that meet performance and scalability needs in real-world contexts. Discuss efficiency in terms of algorithm complexity and memory usage. Introduce basic principles of scalable software design, and how to profile and optimize applications. **Learners must:** Write optimized code with attention to time and space complexity. Choose appropriate data structures and algorithms for a given task. Evaluate performance trade-offs in implementation decisions. Apply coding practices that allow applications to grow in scale. Build user-centric applications suitable for real-world deployment.
CO 6	**Develop contemporary solutions to software design problems using object-oriented principles.**
	This is the capstone outcome, where students apply all OOP concepts to solve real-world problems. They must use **inheritance**, **polymorphism**, and **abstraction** to build flexible and extensible designs. **Students should be able to:** Implement class hierarchies using single, multiple, and multilevel inheritance. Use virtual functions and abstract classes to design polymorphic behavior. Resolve issues like method overriding, ambiguity in multiple inheritance, and constructor execution order. Demonstrate static vs dynamic polymorphism. Solve software problems using real-world modeling with OOP concepts.

SECTION 5: Complex Engineering Problem Solving

Programs, complex problem solving and programming projects

There is one piece of assessed coursework, involving a mixture of theoretical work and programming. We encourage to use the object oriented programming concepts in different languages — although they can use a single language, depending on the level of their ability. Programming assignments are a mandatory part of the course. Homework programs will concentrate on implementing fundamental programming concepts and techniques. Projects will be large scale programs implementing the concepts discussed in class. Programming Projects will be worth significantly more points than homework programs. All programs are individual assignments.

Programming exams/hack-a-thons will also be conducted. Student are required to complete these tasks during the class period with no assistance.

Object-Oriented Programming for Scalable Software Design: In addition to algorithmic thinking, learners will focus on applying object-oriented principles to build modular, maintainable, and scalable software systems. Students will explore real-world problem domains through object modeling and class design, emphasizing the binding of data and behavior using classes and objects. Core concepts such as encapsulation, inheritance, polymorphism, and abstraction will be reinforced through iterative development of software components.

Learners will be expected to create class hierarchies, manage access control through visibility specifiers, overload operators and functions, and apply dynamic polymorphism using virtual functions and abstract classes. Projects will challenge students to solve larger engineering problems where these concepts can be used to manage complexity and improve code reuse. This approach prepares learners to design systems that are not only functionally correct but also extensible, modular, and aligned with industry-standard practices in software engineering.

SECTION 6A: Assessment Methods – Direct

Item	Evaluation Components	Week in / out	Marks
AAT: 1 - 1	Tech-Talk	Week – 2 / 5	05
AAT: 1 - 2	Hack-a-thon	Week – 4 / 7	05
AAT: 2 - 1	Complex Engineering Problem Solving	Week – 9 / 12	05
AAT: 2 - 2	Hack-a-thon	Week – 12 / 15	05
CIE - 1	2 hours - Answer 4 out of 5 questions	Week - 9	10
CIE - 2	2 hours - Answer 4 out of 5 questions	Week - 17	10
SEE	3 hours - Answer 1 from each module	Week - 18	60
Total Marks			**100**

Department's Late Submission Policy:

1. 1 – 24 hours: 25% of the mark will be deducted
2. > 24 hours: Not accepted

SECTION 6B: Assessment Methods – Indirect

Course End Survey (End Semester OBE Feedback)

SECTION 7: Engineering Competencies (ECs) Focused			
EC Number	**Attributes**	**Profiles**	**()**
EC 1	Depth of knowledge required (CP)	Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill-founded, illogical, erroneous, unreliable or unrealistic requirements applicable to the engineering discipline	
EC 2	Depth of analysis required (CP)	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	
EC 3	Design and development of solutions (CA)	Support sustainable development solutions by ensuring functional requirements, minimize environmental impact and optimize resource utilization throughout the life cycle, while balancing performance and cost effectiveness.	
EC 4	Range of conflicting requirements (CP)	Competently addresses complex engineering problems which involve uncertainty, ambiguity, imprecise information and wide-ranging or conflicting technical, engineering and other issues.	-
EC 5	Infrequently encountered issues (CP)	Conceptualizes alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.	-
EC 6	Protection of society (CA)	Identifies, quantifies, mitigates and manages technical, health, environmental, safety, economic and other contextual risks associated to seek achievable sustainable outcomes with engineering application in the designated engineering discipline.	-
EC 7	Range of resources (CA)	Involve the coordination of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies) in the timely delivery of outcomes	-
EC 8	Extent of stakeholder involvement (CP)	Design and develop solution to complex engineering problem considering a very perspective and taking account of stakeholder views with widely varying needs.	
EC 9	Extent of applicable codes, legal and regulatory (CP)	Meet all level, legal, regulatory, relevant standards and codes of practice, protect public health and safety in the course of all engineering activities.	-
EC 10	Interdependence (CP)	High level problems including many component parts or sub-problems, partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then re-combines to form a whole, with the integrity and performance of the overall system as the top consideration.	

EC 11	Continuing professional development (CPD) and lifelong learning (CA)	Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.	
EC 12	Judgement (CA)	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Require judgement in decision making in the course of all complex engineering activities.	-

SECTION 8: Employability Skills

Example: Communication skills / Programming skills / Project based skills

Studying Object Oriented Programming helps the students with a wide range of employability skills that are highly valued in industries.

Employability Skills:

Problem-solving skills for designing efficient solutions.
Logical and analytical thinking for data organization.
Proficiency in programming languages like C / C++ / Java / Python.
Optimization skills for time and space complexity.
Knowledge of scalable and robust system design.
Teamwork and collaboration in software development.
Adaptability to learn and apply advanced data structures.

Project Management:

Planning and organizing project timelines and tasks.
Allocating resources efficiently.
Collaborating and communicating with team members.
Identifying and mitigating project risks.
Testing and validating system performance

SECTION 9: Relevance to Sustainability goals		
SDG Goals		Correlation with SDG
4		**Quality Education:** This subject will prepare students for modern technological challenges, improving educational tools, and promoting skills essential for global development.
8		**Decent Work and Economic Growth:** Prepares students for careers in technology-driven industries, boosting employability and fostering innovation in the digital economy.
9		**Industry, Innovation, and Infrastructure:** Supports the development of efficient algorithms and systems crucial for advancing technological infrastructure and innovation.
11		**Sustainable Cities and Communities:** Sustainable Cities and Communities: Enables the creation of smart city technologies (e.g., optimized traffic systems, resource management) using graph and tree structures.
17		**Partnerships for the Goals:** Facilitates collaboration in data-driven research and global educational initiatives through scalable and efficient data processing.

SECTION 10A: Mapping between COs and POs / PSOs														
COURSE OUTCOMES	Prgram Outcomes (PO's)											PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	✓	-	-	-	✓	-	-	-	-	✓	-	-	✓	-
CO 2	✓	✓	✓	-	✓	-	-	-	-	✓	-	-	✓	-
CO 3	✓	-	✓	-	✓	-	-	-	-	-	-	-	✓	-
CO 4	✓	-	✓	-	✓	-	-	-	-	✓	-	✓	✓	-
CO 5	✓	✓	✓	-	✓	-	-	-	-	-	-	-	✓	-
CO 6	✓	✓	✓	-	✓	-	-	-	-	✓	-	✓	✓	-

SECTION 10B: Indicators of Attainment with COs to POs and PSOs														
COURSE OUTCOMES	Percentage of Indicators of Attainments (IA) with POs and PSOs													
	Prgram Outcomes (PO's)											PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	67	-	-	-	82	-	-	-	-	71	-	-	90	-
CO 2	67	67	67	-	82	-	-	-	-	71	-	-	90	-
CO 3	67	-	67	-	82	-	-	-	-	-	-	-	90	-
CO 4	67	-	67	-	82	-	-	-	-	71	-	53	90	-

SECTION 10B: Indicators of Attainment with COs to POs and PSOs														
COURSE OUTCOMES	Percentage of Indicators of Attainments (IA) with POs and PSOs													
	Prgram Outcomes (PO's)											PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 5	67	67	67	-	82	-	-	-	-	-	-	-	90	-
CO 6	67	67	67	-	82	-	-	-	-	71	-	53	90	-

SECTION 10C: Course Articulation Matrix of COs to POs														
0 No Contribution (0-5%)				1 Low (≥5 - <40%)				2 Moderate (≥40 - <60%)				3 High (≥60%)		
COURSE OUTCOMES	Prgram Outcomes (PO's)											PSO'S		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO 1	3	-	-	-	3	-	-	-	-	3	-	-	3	-
CO 2	3	3	3	-	3	-	-	-	-	3	-	-	3	-
CO 3	3	-	3	-	3	-	-	-	-	-	-	-	3	-
CO 4	3	-	3	-	3	-	-	-	-	3	-	2	3	-
CO 5	3	3	3	-	3	-	-	-	-	-	-	-	3	-
CO 6	3	3	3	-	3	-	-	-	-	3	-	2	3	-
Total	18	9	15	-	18	-	-	-	-	12	-	4	18	-
Average	3	3	3	-	3	-	-	-	-	3	-	2	3	-

Outcomes		WKS and indicators for attaintment and justification for mapping(students will be able to)																																													IA'S
		WK 1	WK 2								WK 2			WK 3			WK 4			WK 5						WK 6			WK 7				WK 8								WK 9						
CO's	PO's	a	a	b	c	d	e	f	g	h	a	b	c	a	b	c	a	b	c	a	b	c	d	e	f	a	b	c	a	b	c	d	a	b	c	d	e	f	g	a	a	b	c	d	e	f	
CO 1	PO 1	•	•	•	•	•	•		•				•	•	•																																10
	PO 5	•	•	•	•	•	•		•				•	•	•																																10
	PO 10	•	•	•	•	•	•		•				•	•	•																																5
	PSO 1	•	•	•	•	•	•		•				•	•	•																																8
CO 2	PO 1	•	•	•	•	•	•		•				•	•	•																																10
	PO 2	•	•	•	•	•	•		•				•	•	•																																10
	PO 3	•	•	•	•	•	•		•				•	•	•																																4
	PO 5	•	•	•	•	•	•		•				•	•	•																																4
	PO 10	•	•	•	•	•	•		•				•	•	•																																5
	PSO 1	•	•	•	•	•	•		•				•	•	•																																8
	PSO 3	•	•	•	•	•	•		•				•	•	•																																8
CO 3	PO 1	•	•	•	•	•	•		•				•	•	•																																10
	PO 3	•	•	•	•	•	•		•				•	•	•																																4
	PO 5	•	•	•	•	•	•		•				•	•	•																																4
	PSO 1	•	•	•	•	•	•		•				•	•	•																																8
	PSO 3	•	•	•	•	•	•		•				•	•	•																																8
CO 4	PO 1	•	•	•	•	•	•		•				•	•	•																																10
	PO 3	•	•	•	•	•	•		•				•	•	•																																10
	PO 5	•	•	•	•	•	•		•				•	•	•																																4
	PO 10	•	•	•	•	•	•		•				•	•	•																																5
	PSO 1	•	•	•	•	•	•		•				•	•	•																																8
	PSO 3	•	•	•	•	•	•		•				•	•	•																																8
CO 5	PO 1	•	•	•	•	•	•		•				•	•	•																																10
	PO 2	•	•	•	•	•	•		•				•	•	•																																10
	PO 3	•	•	•	•	•	•		•				•	•	•																																4
	PO 5	•	•	•	•	•	•		•				•	•	•																																4

Outcomes		WKS and indicators for attaintment and justification for mapping(students will be able to)																																													IA'S
CO's	PO's	WK 1	WK 2								WK 2			WK 3			WK 4			WK 5						WK 6			WK 7				WK 8								WK 9						
		a	a	b	c	d	e	f	g	h	a	b	c	a	b	c	a	b	c	a	b	c	d	e	f	a	b	c	a	b	c	d	a	b	c	d	e	f	g	a	a	b	c	d	e	f	
	PSO 1	•	•	•	•	•	•		•				•	•	•																																	8
CO 6	PO 1	•	•	•	•	•	•		•				•	•	•																																	10
	PO 2	•	•	•	•	•	•		•				•	•	•																																	10
	PO 3	•	•	•	•	•	•		•				•	•	•																																	4
	PO 5	•	•	•	•	•	•		•				•	•	•																																	4
	PO 10	•	•	•	•	•	•		•				•	•	•																																	5
	PSO 1	•	•	•	•	•	•		•				•	•	•																																	8
	PSO 3	•	•	•	•	•	•		•				•	•	•																																	8

SECTION 10D: Level of Contribution of the COs to POs and PSOs			
Number	**Programme Outcomes**	**Proficiency Assessed by**	**(Contribution Level (from 1 to 3))**
PO 1	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.	CIE / SEE / AAT:1 – 2 Assignments / Open-ended problems	3
PO 2	Identify, formulate, review research literature and analyse complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).	CIE / SEE / AAT:1 – 2 Hack-a-thon	3
PO 3	Design creative solutions for complex engineering problems and design / develop systems / components/ processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	3
PO 4	Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	3
PO 5	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6).	CIE / SEE / AAT:2 – 2 Hack-a-thon	3
PO 6	Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7)	CIE / SEE / AAT:2 – 2 Hack-a-thon	3
PO 10	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. (WK8)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	3
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	AAT: 1 – 1 Tech-Talk	2
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	AAT: 2 – 1 Complex Engineering Problem Solving	3

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.	AAT: 2 – 1 Complex Engineering Problem Solving	3

SECTION 11: Course Content	
MODULE I	**Object-oriented concepts**
	Complex systems: definition, characteristics, and five attributes (hierarchy, abstraction, emergence, encapsulation, modularity). **Evolution of problem-solving:** procedural vs. object-oriented thinking. **Objects as fundamental building blocks:** state, behavior, and identity. Benefits of OOP in managing complexity, Applications of OOP in real-world systems.
MODULE II	**Abstraction, Encapsulation and Object Collaboration**
	Abstraction: forms of abstraction (procedural, data, control), abstraction layers, mechanisms. **Encapsulation:** information hiding, boundary definition, modularity. **Objects and message passing:** collaboration through responsibilities. **Relationships:** association, aggregation, composition, dependency.
MODULE III	**Inheritance and Generalization**
	Classification and taxonomy in object-oriented programming, Concepts of generalization and specialization. **Types of inheritance:** single, multiple, and hierarchical (conceptual). **Challenges in multiple inheritance:** ambiguity and the diamond problem (conceptual). Importance of generalization for adaptability and method reuse.
MODULE IV	**Polymorphism and Interfaces**
	Polymorphism: static vs dynamic polymorphism, Abstract classes, abstract operations, late binding, and dynamic dispatch. **Interfaces** as behavioral contracts, difference between interfaces and abstract classes (conceptual), Multiple realizations of interfaces (role-based modeling).
MODULE V	**File structures, Exception handling, Concurrent execution**
	Working with Files: Files, need for file handling, types, modes, operations and error handling. **Exception handling:** Detecting problems during execution and responding gracefully, preventing failures from crashing the system and ensuring smooth execution. **Concurrent execution:** Allowing multiple tasks to run simultaneously within a system, co-ordinating tasks to avoid conflicts when sharing resources.

SECTION 12: Tentative Schedule of Instructions		
Week Number	**Topics**	**Duration (Hours)**
1	1.1 Introduction to OOP 1.2 Complex systems: definition, characteristics 1.3 Introduction to OOP five attributes	3
2	2.1 Hierarchy, abstraction and emergence 2.2 Encapsulation and modularity 2.3 Evolution of problem-solving	3
3	3.1 Procedural Programming 3.2 Object-oriented thinking 3.3 Objects as fundamental building blocks	3
4	4.1 State, behavior, and identity 4.2 Benefits of OOP in managing complexity 4.3 Applications of OOP in real-world systems	3
5	5.1 Forms of abstraction (procedural) 5.2 Forms of abstraction (data) 5.3 Forms of abstraction (control)	3
6	6.1 Abstraction layers 6.2 Abstraction mechanisms 6.3 Encapsulation - information hiding	3
7	7.1 Encapsulation - Boundary definition 7.2 Encapsulation - modularity 7.3 Objects and message passing: collaboration through responsibilities	3
8	8.1 Relationships: association, aggregation 8.2 Relationships: composition, dependency 8.3 Classification and taxonomy in object-oriented programming	3
CONTINIUOUS INTERNAL EXAMINATION (CIE- I)		
9	9.1 Concepts of generalization and specialization 9.2 Types of inheritance 9.3 Single and multiple inheritance	3
10	10.1 Hierarchical (conceptual) inheritance 10.2 Challenges in multiple inheritance: ambiguity and the diamond problem (conceptual) 10.3 Importance of generalization for adaptability and method reuse	3
11	11.1 Polymorphism and Interfaces 11.2 Static vs dynamic polymorphism 11.3 Abstract classes	3
12	12.1 Abstract operations 12.2 Late binding and dynamic dispatch 12.3 Interfaces as behavioral contracts	3
13	13.1 Difference between interfaces and abstract classes (conceptual) 13.2 Multiple realizations of interfaces (role-based modeling)	3

SECTION 12: Tentative Schedule of Instructions		
Week Number	**Topics**	**Duration (Hours)**
	13.3 File Structures	
14	14.1 Need for file handling 14.2 File types and modes 14.3 File operations and error handling	3
15	15.1 Exception handling 15.2 Detecting problems during execution 15.3 Responding gracefully in exception handling	3
16	16.1 Preventing failures from crashing the system and ensuring smooth execution 16.2 Concurrent execution - Allowing multiple tasks to run simultaneously within a system 16.3 Co-ordinating tasks to avoid conflicts when sharing resources	3
	Total	48

SECTION 13: Specific Goals for the Course	
The following table shows the knowledge and skills covered by the unit outcomes:	
Knowledge	**Skills**
Learners should understand: the principles of object-oriented programming such as encapsulation, abstraction, inheritance, and polymorphism how object-oriented programming differs from procedural programming the process of designing classes, objects, and their interactions in real-world scenarios the role and use of access specifiers (public, private, protected) the concept and use of constructors and destructors, including different types (default, parameterized, copy, dynamic) the importance of function and operator overloading the use of inheritance to promote code reuse and polymorphic behavior the concept of virtual functions and pure virtual functions for achieving dynamic polymorphism abstraction through abstract classes and interfaces the use of file handling and stream-based input/output in object-oriented languages	**Learners can:** model real-world problems using class and object representations design and implement classes with appropriate attributes and methods define and use constructors and destructors effectively in class design apply access specifiers correctly to control data access and protection write programs that implement function and operator overloading use single, multiple, and multilevel inheritance to extend class functionality override base class methods and resolve ambiguity in multiple inheritance using virtual base classes apply dynamic polymorphism through virtual functions and abstract classes manage input/output using streams for console and file operations develop programs that integrate object-oriented features to solve moderately complex software problems evaluate when and how to apply object-oriented techniques for scalability and maintainability create and read class diagrams to visualize software structure

Administrative Information

SECTION 14: History of changes		
Regulations	**Description of change**	**BOS Date**
BT 23	This course was introduced in BT23 regulation. With this course the student is able: To transition learners from procedural to object-oriented thinking To prepare students for real-world software development using object models To enable scalable and reusable code through class-based design To promote modular programming practices for better code management To equip students with practical coding experience using Java — a widely used and industry-relevant programming language To bridge the gap between theoretical programming principles and applied software engineering	28.08.2023
BT 25	Incorporated the following modifications in BT 25 regulations: Many C++-specific topics like constructors/destructors, operator overloading, friend functions, console I/O, access specifiers, and memory allocation. More conceptual topics such as complex system attributes, abstraction layers, object collaboration (message passing, relationships), generalization/specialization, interfaces, exception handling, and concurrent execution are added. File handling is integrated with exception handling and concurrency rather than console I/O.	29.08.2025

Course Outline Approvals	
Course Coordinator	Head of the Department
Name:	Name:
Signature:	Signature:
Date:	Date:
Course Outline Approvals: The course outline description approved by Outcome Based Teaching Learning (OBTL) committee on date in meetings IARE - OBTL – COD /104/25	
Dean of Outcome Based Teaching and Learning	Dean of Academics
Name:	Name:
Signature:	Signature:
Date:	Date:

Check List		
Section	**Description**	**Please tick**
1	General Information about the Course	✓
2	Notional Study Time	✓
3	A. Course Outcomes	✓
	B. Cognitive Levels	✓
4	Content and Context of the Course	✓
5	Complex Engineering Problem Solving	✓
6	A. Assessment Methods – Direct	✓
	B. Assessment Methods – Indirect	✓
7	Content Delivery / Instructional Methodologies	✓
8	Engineering Competencies (ECs) Focused	✓
9	Employability Skills	✓
10	Relevance to Sustainability goals	✓
11	A. Mapping between COs and POs / PSOs	✓
	B. Indicators of Attainment with COs to POs and PSOs	✓
	C. Course Articulation Matrix of COs to POs	
	D. Level of Contribution of the COs to POs and PSOs	✓
12	Syllabus	✓
13	Tentative Schedule of Instructions	✓
14	Specific Goals for the Course	✓
15	History of Changes	✓

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

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**ENGLISH LANGUAGE COMMUNICATION SKILLS LABORATORY**
Course Code	AHSE07
Course Start	First Semester
Course Type	Core
Regulation	IARE - BT 25
Prerequisite Courses	-
Department	English
Number of Credits	1.5 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Theory and laboratory
Course Coordinator's Name	**Dr. K. Bhaskar,** Assistant Professor of English IARE11034 **k.bhaskar@iare.ac.in**
Prior Learning Assessment and Recognition (PLAR)	Students interested in PLAR pathways for open learning can register one semester prior to the start of semester. Students will receive the necessary contact information one semester in advance.
Open Learning Faculty Member Information	Open Learning Faculty (OLF) is available to assist students. Students will receive the necessary contact information at the start of the course.
Course Webpage	https://www.iare.ac.in/?q=pages/btech-course-syllabi-bt23-ae
Course Description	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.
Course Objectives	**The students will try to learn:** a. English speech sounds, word accent, intonation and stress patterns for effective pronunciation. b. Critical aspect of speaking and reading for interpreting in-depth meaning between the sentences. c. Language techniques for social interactions such as public speaking, group discussions and interviews. d. Computer-assisted multi-media instructions and independent language learning
Text and Reference Books	**Text 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.
Learning and Teaching Strategies	Online material will provide the foundation of the learning resources, requiring the students to log in and engage regularly throughout the sixteen weeks of the course. There will be a mix of suggested readings, discussions and video content containing embedded digital content and undertake the assessment tasks.

DELIVERY / INSTRUCTIONAL METHODOLOGIES:							
x	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

SECTION 2: Teaching Learning Scheme

At least 48 lecture hours of scheduled laboratories activities (TLA) will be delivered in person,

Notional Study Time:48 Hours (Laboratory Exercises)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA 1	Lectures	-	-	-
TLA 2	Tutorials	-	-	-
TLA 3	Case Study	-	-	-
TLA 4	Problem Solving	-	-	-
TLA 5	Demonstration	-	-	-
TLA 6	Scheduled revision sessions	-	-	-
TLA 7	Guided independent study: Directed viewing of video materials / PPTs	-	-	-
TLA 8	Independent private study	-	-	-
TLA 9	Laboratory Exercises	48	01	48
TLA 10	Homework assignments / Programming assignments	-	-	-
TLA 11	Placement / work based learning or Specific practical training	-	-	-
TLA 12	Presentation / Seminar Preparation	-	-	-
TLA 13	Course Project / Preparation for Complex Problem Solving	-	-	-
TLA 14	Technical visit	-	-	-
TLA 15	Field activities	-	-	-
			Total study hours	**48**
			Expected total study hours	**48**

SECTION 3A: Course Outcomes		
After successfully completing this course, the student will be able to:		
Outcome Number	**Course Outcomes**	**Learning Domain**
CO1	**Articulate** the use of draw, modify and dimension commands of AutoCAD for development of 2D and 3D drawings.	Understand
CO2	**Differentiate** stress shifts, syllabification and make use of past tense and plural markers effectively in connected speech; besides participate in role plays with confidence	Understand
CO3	**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
CO4	**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
CO5	**Strengthen** writing effective messages, notices, summaries and also able to write reviews very critically of art and academicals videos	Understand
CO6	**Argue** scholarly, giving the counters to open ended experiments, and also writing slogans for the products talentedly.	Understand

SECTION 3B: Cognitive Levels	
Blooms Taxonomy Level	**Cognitive Level in Percentage (%)**
Remember	0
Understand	33
Apply	17
Analyse	50
Evaluate	0
Create	0

SECTION 4: English Language Communication Skills Laboratory	
CO1	Recognise English speech sounds in order to execute formal and informal ‘communication
	• Introduction to pronunciation • Introducing self and introducing others and feedback • Introduction to phonetics, listening to English sounds, Vowel and Consonant sounds • Describing a person or place or a thing using relevant adjectives – feedback • Pronunciation practice
CO2	Construct required dialogues in role plays in verbal communication
	• Role plays on fixed expressions in various situations • Structure of syllables • Asking for directions and giving directions • Weak forms and strong forms • Intonation
CO3	Differentiate mother tongue influence while speaking English in JAM sessions, debates, group discussions and telephonic conversations.
	• 1. Word accent and stress shifts • JAM Sessions using public address system • Extempore-Picture • Etiquette • Debates • Listening comprehension

	• Group discussion
CO4	Pronounce past tense and plural markers and weak forms and strong forms as a native speaker.
	• Past tense and plural markers • Neutralization of Mother Tongue Influence (MTI) • Weak forms and strong forms • Common errors in pronunciation practice through tongue twisters • Minimal pairs
CO5	Demonstrate the techniques of writing leaflets, messages and notices
	• Writing slogan related to the image • Providing reviews and remarks • Writing slogan related to the image • Demonstration on how to write leaflets, messages and notices
CO6	Use language appropriately during interviews and oral presentations
	• Oral presentations • Techniques and methods to write summaries and reviews of videos • Information transfer • Open ended experiments-phonetics practice • Open ended experiments-text to speech

SECTION 5: Complex Engineering Problem Solving- NA
.

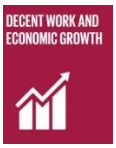
SECTION 6A: Assessment Methods – Direct			
Item	**Evaluation Components**	**Week in / out**	**Marks**
1	Day to day evaluation	Every week	20
2	Internal examination and Viva-voce	10 +10	20
3	Semester end examination (External)	Week – 17	60
		Total Marks	**100**
Department's Late Submission Policy: 1. 1 – 24 hours: 25% of the mark will be deducted 2. > 24 hours: Not accepted			
SECTION 6B: Assessment Methods –Indirect			
Course End Survey (End Semester OBE Feedback)			✓

SECTION 8: Engineering Competencies (ECs) Focused: NA Please tick (✓) relevant engineering competency profile covered			
EC Number	**Attributes**	**Profiles**	**(✓)**
EC1	Depth of knowledge required (CP)	Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill-founded, illogical, erroneous, unreliable or unrealistic requirements applicable to the engineering discipline	-
EC2	Depth of analysis	Have no obvious solution and require abstract thinking,	-

	required (CP)	originality in analysis to formulate suitable models.	
EC3	Design and development of solutions (CA)	Support sustainable development solutions by ensuring functional requirements, minimize environmental impact and optimize resource utilization throughout the life cycle, while balancing performance and cost effectiveness.	-
EC4	Range of conflicting requirements (CP)	Competently addresses complex engineering problems which involve uncertainty, ambiguity, imprecise information and wide-ranging or conflicting technical, engineering and other issues.	-
EC5	Infrequently encountered issues (CP)	Conceptualizes alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.	-
EC6	Protection of society (CA)	Identifies, quantifies, mitigates and manages technical, health, environmental, safety, economic and other contextual risks associated to seek achievable sustainable outcomes with engineering application in the designated engineering discipline.	-
EC7	Range of resources (CA)	Involve the coordination of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies) in the timely delivery of outcomes	-
EC8	Extent of stakeholder involvement (CP)	Design and develop solution to complex engineering problem considering a very perspective and taking account of stakeholder views with widely varying needs.	-
EC9	Extent of applicable codes, legal and regulatory (CP)	Meet all level, legal, regulatory, relevant standards and codes of practice, protect public health and safety in the course of all engineering activities.	-
EC10	Interdependence (CP)	High level problems including many component parts or sub-problems, partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then re-combines to form a whole, with the integrity and performance of the overall system as the top consideration.	-
EC11	Continuing professional development (CPD) and lifelong learning (CA)	Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.	-
EC12	Judgement (CA)	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Require judgement in decision making in the course of all complex engineering activities.	-

SECTION 9: Employability Skills
Example: Communication skills / Programming skills / Project based 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

SECTION 10: Relevance to Sustainability goals Brief description about the course and its correlationwith Sustainability Development Goal (SDGs).	
SDG Goals	**Correlation with SDG**

4		**English language** has become lingua franca across the globe. For that reason, it is compulsory to learn this language at advanced level. In MNC companies, those who have excellent communication skills, their career graph is going to high very quickly. Hence, the role of English language has become a part of the life.
8		.
9		
11		.
17		

SECTION 11A: Mapping between COs and POs / PSOs

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	-	-	-	-	-	-	-	-	-	✓	-	-	-	-
CO2	-	-	-	-	-	-	-	-	✓	✓	-	-	-	-
CO3	-	-	-	-	-	-	-	-	✓	✓	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	✓	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	✓	-	-	-	-
CO6	-	-	-	-	-	-	-	-	✓	✓	-	-	-	-

Outcomes		WKS and Indicators of attainment and Justification for mapping(students will be able to)																																				IAs Count
COs	POs	WK 1	WK 2									WK 3			WK 4			WK 5						WK 6			WK 7				WK 8							WK 9						
		A	a	b	c	D	e	f	g	h	a	b	c	a	b	c	a	b	c	d	e	f	a	b	c	a	b	c	d	a	b	c	d	e	f	g	a	b	c	d	e	f	
CO 1	PO 1	•	•	•	•	•	•	•				•	•	•	•																											11
	PO 2	•	•	•	•	•	•	•				•	•	•	•																											11
	PO 11																														•	•		•	•	•							4
	PSO 1	•	•	•	•	•	•	•				•	•	•	•																											11
CO2	PO 1	•	•	•	•	•	•	•				•	•	•	•																											11
	PO 2	•	•	•	•	•	•	•				•	•	•	•																											11
	PO 11																														•	•		•	•	•							4

	PSO 1	•	•	•	•	•	•				•	•	•	•																									11
CO3	PO 1	•	•	•	•	•	•				•	•	•	•																									11
	PO 2	•	•	•	•	•	•				•	•	•	•																									11
	PO 11																										•	•			•	•	•						4
	PSO 1	•	•	•	•	•	•				•	•	•	•																									11
CO4	PO 1	•	•	•	•	•	•				•	•	•	•																									11
	PO 2	•	•	•	•	•	•				•	•	•	•																									11
	PO 11																										•	•			•	•	•						4
	PSO 1	•	•	•	•	•	•	•			•	•	•	•																									11
CO 5	PO 1	•	•	•	•	•	•				•	•	•	•																									11
	PO 2	•	•	•	•	•	•				•	•	•	•																									11
	PO 11																										•	•			•	•	•						4
	PSO 1	•	•	•		•					•	•	•																										11
CO 6	PO 1	•	•	•	•	•	•				•	•	•	•																									11
	PO 2	•	•	•	•	•	•				•	•	•	•																									11
	PO 11																										•	•			•	•	•						4
	PSO 1	•	•	•	•	•					•	•	•	•																									11

SECTION 11B: Indicators of Attainment with COs to POs and PSOs															
Course Outcomes	Percentage of Indicators of Attainments (IA) with POs and PSOs														
	PO												PSO		
	1	2	3	4	5	6	7		8	9	10	11	1	2	3
CO1	-	-	-	-	-	-	-		-	-	100	-	-	-	-
CO2	-	-	-	-	-	-	-		-	100	100	-	-	-	-
CO3	-	-	-	-	-	-	-		-	100	100	-	-	-	-
CO4	-	-	-	-	-	-	-		-	-	100	-	-	-	-
CO5	-	-	-	-	-	-	-		-	-	100	-	-	-	-
CO6	-	-	-	-	-	-	-		-	100	100	-	-	-	-

SECTION 11C: Course Articulation Matrix of COs to POs			
0 No Contribution (0-5%)	1 Low (≥5 - <40%)	2 Moderate (≥40 - <60%)	3 High (≥60%)
-			

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO2	-	-	-	-	-	-	-	-	3	3	-	-	-	-
CO3	-	-	-	-	-	-	-	-	3	3	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO6	-	-	-	-	-	-	-	-	3	3	-	-	-	-

~~Total~~	-	-	-	-	-	-	-	-	9	18	-	-	-	-
Maximum value	-	-	-	-	-	-	-	-	**3**	**3**	-	-	-	-

SECTION 11D: Level of Contribution of the COs to POs and PSOs			
Number	**Programme Outcomes**	**Proficiency Assessed by**	**Contribution Level (from 1 to 3)**
PO 1			
PO 2			
PO 3			
PO6			
PO8			
PO9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	CIE/Quiz/AAT	**3**
PO 11			
PSO 1			
PSO 3			

1.1 SECTION 12: Course Content	
WEEK- I	CALL LAB: Speech Sounds with Active Listening
	ICS LAB: Introducing self and introducing others and feedback:
	a. Common mispronunciations b. Errors committed in self-introduction and introducing others
WEEK- 2	CALL LAB: Listening to Distinguish Speech Sounds (minimal pairs) – Testing Exercises.
	ICS LAB: Ice Breaking Activity
	a. Difficulty in familiarizing with the sounds of English language, errors in using different kinds of sounds, vowels and consonants. b. Supports a positive social climate; decreases in off task behaviors; improved social skills; improves student enjoyment; and raises participation levels.
WEEK- 3	CALL LAB: Listening for General Information Followed by Multiple Questions.
	ICS LAB: Role Play Activity
	a. Listening actively to understand the information to respond. b. Take on different roles and act out situations like ordering food in a restaurant, asking for directions, or even having a phone conversation.
WEEK- 4	CALL LAB: Listening Comprehension Activity
	ICS LAB: Social Etiquettes
	a. Enhancing their language skills, academic performance, and social interactions. b. Positive social interactions, enhancing communication skills, and contributing to overall personal and academic success.
WEEK- 5	CALL LAB: Neutralization of Mother Tongue Influence (MTI).
	CS LAB: Describing Objects, Situations, Places, People and Events

	a. Influence of Mother tongue in spoken communication. b. Strengthen the art of writing and spoken language.
WEEK- 6	CALL LAB: Techniques for Effective Listening.
	ICS LAB: Story Telling
	a. Actively engaging with the speaker to understand their message fully. b. Enhancing their language skills, creativity, and overall learning experience
WEEK- 7	CALL LAB: Identifying the Literal and Implied Meaning.
	ICS LAB: Non-Verbal Communication.
	a. Listening for evaluation – Write summary – Listening for evaluation – Listening comprehension exercises. b. Attention of non-verbal ques.
WEEK- 8	CALL LAB: Structure of syllables
	ICS LAB: JAM Sessions using public address system.
	a. Practicing consonant clusters b. Practicing different methods of dividing the syllables c. Participating in just a minute session
WEEK- 9	CALL LAB: Past tense and plural markers
	ICS LAB: Oral Presentations
	a. Addition of suffixes to verbs. b. Confidence and fluency in delivering different oral presentations
WEEK- 10	CALL LAB: Minimal pairs
	ICS LAB: Debates
	a. Difficulties in understanding and remembering various homonyms, homophones and homographs. b. Problems in understanding the difference between debates and discussions, participating and contributing.
WEEK- 11	CALL LAB: Intonation
	ICS LAB: Group discussion
	a. Inability in focused listening, understanding the accent, vocabulary and discourse markers in connected speech. b. Lack of confidence in participating and contributing to Group discussions.
WEEK- 12	CALL LAB: Demonstration on how to write leaflets, messages and notices.
	ICS LAB: Techniques and methods to write summaries and reviews of videos
	a. Inadequacy and inappropriacy in writing leaflets, messages and notices. b. Lack of proficiency in writing summaries and reviews of videos.
WEEK- 13	CALL LAB: Pronunciation practice.
	ICS LAB: Information transfer.
	a. Influence of mother tongue in using English language. b. Problems in interpreting data from diagram to text and text to diagram.
WEEK- 14	CALL LAB: Open Ended Experiments-Phonetics Practice.
	ICS LAB: Picture Extempore

	a. Persistent problems in identifying the phonetic symbols, remembering and using them. b. Execution while describing picture.
WEEK- 15	CALL LAB: Open Ended experiments-Text to Speech.
	ICS LAB: Writing slogan related to the image.
	a. Difficulties in writing text to Speech. b. Lack of fluency in writing slogans related to the images.

SECTION 13: Tentative Schedule of Instructions

Week Number	Topics	Duration (Hours)
1	1.1 Introduction to pronunciation and Introducing self and introducing others and feedback	3
2	1.1 Introduction to phonetics, listening to English sounds, Vowel and Consonant sounds and describing a person or place or a thing using relevant adjectives – feedback	3
3	3.1 Structure of syllables and JAM Sessions using public address system	3
4	4.1 Word accent and stress shifts and asking for directions and giving directions	3
5	5.1 Past tense and plural markers and Role plays on fixed expressions in various situations	3
6	6.1 Weak forms and strong forms and Extempore-Picture	3
7	7.1 Intonation and Interpretation of Proverbs and Idioms	3
8	8.1 Neutralization of Mother Tongue Influence (MTI) and Etiquette	3
9	9.1 Common errors in pronunciation practice through tongue twisters and Oral Presentations	3
10	10.1 Minimal pairs and Debates	3
11	11.1 Listening comprehension and Group discussion	3
12	12.1 Demonstration on how to write leaflets, messages and notices and Techniques and methods to write summaries and reviews of videos	3
13	13.1 Revision of Experiments	3
14	14.1 Revision of experiments	3
15	15.1Experiments behind the syllabus	3
16	16.1Continuous Internal examinations	3
	Total	**48**

SECTION 14: Specific Goals for the Course

The following table shows the knowledge and skills covered by the unit outcomes:

Knowledge	Skills
Learners should understand: • The role of pronunciation in clear communication including mastering phonetic sounds. • How to neutralize the influence of their other tongue on English pronunciation, improving clarity and overall communication skills. • The listening comprehension skills through group discussions, helping t hem to understand different	**Learners can:** • Learners can describe people, places, and things effectively by applying their understanding of phonetics and word formation. • Learners can neutralize their mother tongue influence (MTI) and speak English with greater clarity, reducing misunderstandings in communication.

perspective and communicate more effectively in collaborative settings. • The idiomatic expressions and proverbs, improving their cultural and contextual understand of language use in professional communication. • The weak and strong form in natural speech to ensure smooth communication, improving both fluency and listening comprehension. • To develop the ability to communicate confidently in real situations through role plays, group discussions and debates	• Learners can participate in role plays and group discussions with confidence, adapting their communication style to suit different real-life situations. • Learners can interpret and apply idiomatic expressions and proverbs in conversation, demonstrating cultural awareness and improving language flexibility. • Learners can use syllable structure and word stress correctly, improving their spoken communication when speaking in front of an audience or using a public address system • Learners can participate in role plays and group discussions with confidence, adapting their communication style to suit different real-life situations

Administrative Information

SECTION 15: History of changes		
Regulations	**Description of change**	**BOS Date**
R 16	**From R15 JNTUH, Hyderabad to R16 IARE regulations with change in V module** • **No change in syllabus**	24.07.2016
R 18	**Changes from R16 to R18 regulation** **Module – IV:** compressors cascade testing is introduced	16.07.2018
UG 20	**Changes from R18 to UG 20 regulation** **Module -V:** Performance characteristics, turbine blade cooling is added.	17.11.2020
BT 23	**Incorporated the following additions in BT 23 regulations** **Week – I** • Cultural variations in introductions • Effective pauses in Speech **Week- II** • Examples of vowels in different languages • Common consonant clusters in English **Week -III** • Structure of simple and complex syllables. **Week-IV** • How word accent affects the intelligibility and fluency **Week-V** • Importance of correct usage of past tense and plural forms in communication **Week-VI** The role of weak and strong forms in English pronunciation and fluency Use weak forms in casual description, and switch to strong forms when	24.08.2023

	emphasising something important. **Week-VII** • The science of pitch in English • Intonation in expressing emotions and attitudes **Week-VIII** • Functions of intonation • Common Pitfalls which lead to dull or confusing communication **Week-IX** • Sound Confusion and Substitution: Overgeneralization or Fossilized Mistakes • Include rhetorical questions to engage the audience and Pause for dramatic effect or clarity **Week-X** • Techniques for Practicing Minimal Pairs • Errors in debate and debate phrases and expressions **Week-XI** • Effective Activities for Listening Practice • Useful Language for Group Discussions **Week-XII** Use rhetorical questions and Include graphics or icons Tips for Summarizing and Structure of a Review	

Course Outline Approvals	
Course Coordinator Name: Dr.K.Bhaskar Signature: Date:	**Head of the Department** Name: Dr.Jetty Wilson Signature: Date:
Dean of Outcome Based Teaching and Learning Name: Dr. Srinivasulu Signature: Date:	**Dean of Academics** Name: Dr. G. Chandrasekhar Signature: Date:

Check List		
Section	**Description**	**Please tick (✓)**
1	General Information about the Course	✓
2	Notional Study Time	✓
3	A. Course Outcomes	✓
	B. Cognitive Levels	✓
4	Content and Context of the Course	✓

5	Complex Engineering Problem Solving	✓
6	A. Assessment Methods – Direct	✓
	B. Assessment Methods – Indirect	✓
7	Content Delivery / Instructional Methodologies	✓
8	Engineering Competencies (ECs) Focused	✓
9	Employability Skills	✓
10	Relevance to Sustainability goals	✓
11	A. Mapping between COs and POs / PSOs	✓
	B. Indicators of Attainment with COs to POs and PSOs	✓
	C. Course Articulation Matrix of COs to POs	✓
	D. Level of Contribution of the COs to POs and PSOs	✓
12	Syllabus	✓
13	Tentative Schedule of Instructions	✓
14	Specific Goals for the Course	✓
15	History of Changes	✓

Signature of Course Coordinator **HOD**
Dr.K.Bhaskar, Assistant Professor

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**Object Oriented Programming Laboratory**
Course Code	ACSE03
Course Start	First Semester
Course Type	Core
Regulation	IARE - BT 25
Prerequisite Courses	-
Department	ECE
Number of Credits	1 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Laboratory
Course Coordinator's Name	Ms Ajitha G
Prior Learning Assessment and Recognition (PLAR)	Students interested in PLAR pathways for open learning can register one semester prior to the start of semester. Students will receive the necessary contact information one semester in advance.
Open Learning Faculty Member Information	Open Learning Faculty (OLF) is available to assist students. Students will receive the necessary contact information at the start of the course.
Course Webpage	https://akanksha.iare.ac.in/index?route=course/details&course_id=1682
Course Description	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.
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.
Text and Reference Books	**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.

Learning and Teaching Strategies	Online material will provide the foundation of the learning resources, requiring the students to log in and engage regularly throughout the sixteen weeks of the course. There will be a mix of suggested readings, discussions and video content containing embedded digital content and undertake the assessment tasks.

DELIVERY / INSTRUCTIONAL METHODOLOGIES:							
✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

SECTION 2: Teaching Learning Scheme

At least 42 lecture hours of scheduled laboratories activities (TLA) will be delivered in person,

Notional Study Time:48 Hours(Laboratory Exercises)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA 1	Lectures	-	-	-
TLA 2	Tutorials	-	-	-
TLA 3	Case Study	-	-	-
TLA 4	Problem Solving	-	-	-
TLA 5	Demonstration	-	-	-
TLA 6	Scheduled revision sessions	-	-	-
TLA 7	Guided independent study: Directed viewing of video materials / PPTs	-	-	-
TLA 8	Independent private study	-	-	-
TLA 9	Laboratory Exercises	14	03	42
TLA 10	Homework assignments / Programming assignments	-	-	-
TLA 11	Placement / work based learning or Specific practical training	-	-	-
TLA 12	Presentation / Seminar Preparation	-	-	-
TLA 13	Course Project / Preparation for Complex Problem Solving	-	-	-
TLA 14	Technical visit	-	-	-
TLA 15	Field activities	-	-	-
			Total study hours	**42**
			Expected total study hours	**42**

SECTION 3A: Course Outcomes

After successfully completing this course, the student will be able to:

Outcome Number	Course Outcomes	Learning Domain
CO1	**Develop** non-trivial programs in an modern programming language.	Apply
CO2	**Apply** the principles of selection and iteration.	Apply
CO3	**Appreciate** uses of modular programming concepts for handling complex problems..	Analyse

CO4	**Recognise** and apply principle features of object-oriented design such as abstraction and encapsulation.	Apply
CO5	**Design** classes with a view of flexibility and reusability.	Apply
CO6	**Code, test and evaluate** small usecases to conform to a specification.	Analyse

SECTION 3B: Cognitive Levels

Blooms Taxonomy Level	Cognitive Level in Percentage (%)
Remember	0
Understand	0
Apply	66.66
Analyse	33.33
Evaluate	0
Create	0

SECTION 4: Object Oriented Programming Laboratory.	
CO1	**Develop non-trivial programs in an modern programming language.**
	1. Getting Started Exercises 2. Exercises on Number Systems (for Science/Engineering Students)
CO2	**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
CO3	**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
CO4	**Recognise and apply principle features of object-oriented design such as abstraction and encapsulation.**
	1. Exercises on Classes and Objects
CO5	**Design classes with a view of flexibility and reusability.**
	1. Exercises on Inheritance
CO6	**Code, test and evaluate small usecases to conform to a specification.**
	1. Exercises on Polymorphism, Abstract Classes and Interfaces

SECTION 5: Complex Engineering Problem Solving- NA

.

SECTION 6A: Assessment Methods – Direct

Item	Evaluation Components	Week in / out	Marks
1	Day to day evaluation	Every week	20
2	Internal examination and Viva-voce	10 +10	20
3	Semester end examination (External)	Week – 17	60

Total Marks	**100**
Department's Late Submission Policy: 1. 1 – 24 hours: 25% of the mark will be deducted 2. > 24 hours: Not accepted	
SECTION 6B: Assessment Methods –Indirect	
Course End Survey (End Semester OBE Feedback)	✓

SECTION 8: Engineering Competencies (ECs) Focused: NA
Please tick (✓) relevant engineering competency profile covered

EC Number	Attributes	Profiles	(✓)
EC1	Depth of knowledge required (CP)	Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill-founded, illogical, erroneous, unreliable or unrealistic requirements applicable to the engineering discipline	✓
EC2	Depth of analysis required (CP)	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	✓
EC3	Design and development of solutions (CA)	Support sustainable development solutions by ensuring functional requirements, minimize environmental impact and optimize resource utilization throughout the life cycle, while balancing performance and cost effectiveness.	✓
EC4	Range of conflicting requirements (CP)	Competently addresses complex engineering problems which involve uncertainty, ambiguity, imprecise information and wide-ranging or conflicting technical, engineering and other issues.	-
EC5	Infrequently encountered issues (CP)	Conceptualizes alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.	-
EC6	Protection of society (CA)	Identifies, quantifies, mitigates and manages technical, health, environmental, safety, economic and other contextual risks associated to seek achievable sustainable outcomes with engineering application in the designated engineering discipline.	-
EC7	Range of resources (CA)	Involve the coordination of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies) in the timely delivery of outcomes	-
EC8	Extent of stakeholder involvement (CP)	Design and develop solution to complex engineering problem considering a very perspective and taking account of stakeholder views with widely varying needs.	✓
EC9	Extent of applicable codes, legal and regulatory (CP)	Meet all level, legal, regulatory, relevant standards and codes of practice, protect public health and safety in the course of all engineering activities.	✓
EC10	Interdependence (CP)	High level problems including many component parts or sub-problems, partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then re-combines to form a whole, with the integrity and performance of the overall system as the top consideration.	✓
EC11	Continuing professional development (CPD) and lifelong learning (CA)	Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.	✓
EC12	Judgement (CA)	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Require	-

		judgement in decision making in the course of all complex engineering activities.	

SECTION 9: 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.

This Lab provides students with opportunities to develop strong programming, debugging, and problem-solving skills using object-oriented principles. It prepares them for careers in software development, IT services, and advanced technology fields.

Employability Skills:

- Helps students break down complex problems into smaller, manageable parts.
- Encourages the use of Java's object-oriented principles (encapsulation, inheritance, polymorphism) to design efficient solutions.
- Builds the ability to translate real-world scenarios into code, making learning practical and industry-oriented.
- Strengthens logical reasoning and structured thinking, which are vital for academic projects and professional software development.

Project Management:

- Trains students to identify syntax, logic, and runtime errors systematically.
- Improves the skill of interpreting error messages and applying corrective measures effectively.
- Provides hands-on practice with debugging tools, which are widely used in the software industry.
- Develops a problem-fixing mindset, essential for delivering error-free and reliable code.
- Makes students more industry-ready, as debugging is a critical part of every real-world software project.

SECTION 10: Relevance to Sustainability goals

Brief description about the course and its correlation with Sustainability Development Goal (SDGs).

SDG Goals		Correlation with SDG
4		**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.
7		**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:** 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:** Supports the development of efficient algorithms and systems crucial for advancing technological infrastructure and innovation.
11		**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.

SECTION 11A: Mapping between COs and POs / PSOs

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	✓	-	-	-	✓	-	-	-	✓	-	-	-	-	✓
CO2	✓	✓	-	-	✓	-	-	-	✓	-	-	-	-	-
CO3	✓	✓	-	-	✓	-	-	-	✓	-	-	✓	-	-
CO4	-	✓	✓	-	✓	-	-	-	✓	-	-	✓	-	-
CO5	-	✓	✓	-	✓	-	-	-	✓	-	-	✓	✓	-
CO6	-	✓	-	-	✓	-	-	-	✓	-	-	✓	✓	-

Outcomes		WKS and Indicators of attainment and Justification for mapping (students will be able to)																																						IAs Count
COs	POs	WK 1	WK 2								WK 3			WK 4			WK 5						WK 6			WK 7				WK 8							WK 9						
		a	a	b	c	D	e	f	g	h	a	b	c	a	b	c	a	b	c	d	e	f	a	b	c	a	b	c	d	a	b	c	d	e	f	g	a	b	c	d	e	f	
CO 1	PO 1		•		•		•	•		•		•																														7
	PO 5			•	•		•	•		•																																6
	PO 9			•		•	•	•		•														•																		6
CO2	PO 1		•	•	•		•	•		•		•																														8
	PO 2		•	•	•		•	•		•		•	•	•	•																											12
	PO 5																•	•	•	•		•																					5
	PO 9			•	•		•	•		•																																6
CO3	PO 1			•	•		•	•		•		•	•	•	•																											10
	PO 2			•	•		•	•		•														•	•																		8
	PO 5			•	•		•	•																•	•																		7
	PO 9																																				•	•		•	•	•	5
CO4	PO 2		•	•	•		•	•		•		•			•																											9
	PO 3																•	•	•	•																							4
	PO 5			•	•		•	•		•														•	•																		8
	PO 9																																				•	•		•	•	•	5
CO 5	PO 2	•	•	•	•		•	•			•	•	•	•	•																											13

	PO 3																•	•	•	•		•																					**5**
	PO 5		•	•	•	•	•	•		•														•																			**8**
	PO 9																																				•	•	•	•	•	•	**6**
CO 6	**PO 2**	•	•	•	•	•	•	•		•	•	•	•	•	•																												**13**
	PO 5		•	•	•	•	•	•		•														•																			**8**
	PO 9																																				•	•	•	•	•	•	**6**

SECTION 11B: Indicators of Attainment with COs to POs and PSOs

Course Outcomes	**Percentage of Indicators of Attainments (IA) with POs and PSOs**														
	PO												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**		**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	46.6	-	-	-	66.6	-	-	-	-	85	-	-	-	-	66
CO2	57.5	75	-	-	55.5	-	-	-	-	85	-	-	-	-	-
CO3	66.7	50	-	-	77.7	-	-	-	-	71	-	-	68	-	-
CO4	-	56.3	66.7	-	88.8	-	-	-	-	71	-	-	73	-	-
CO5	-	81	71	-	88.8	-	-	-	-	85	-	-	73	45.5	-
CO6	-	81	-	-	88.8	-	-	-	-	85	-	-	45	45.5	-

SECTION 11C: Course Articulation Matrix of COs to POs

0 No Contribution (0-5%)	**1** Low (≥5 - <40%)	**2** Moderate (≥40 - <60%)	**3** High (≥60%)

Course Outcomes	**Program Outcomes (POs)**											**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	2	-	-	-	3	-	-	-	3	-	-	-	-	3
CO2	2	3	-	-	2	-	-	-	3	-	-	-	-	-
CO3	3	2	-	-	3	-	-	-	3	-	-	3	-	-
CO4	-	3	3	-	3	-	-	-	3	-	-	3	-	-
CO5	-	3	3	-	3	-	-	-	3	-	-	3	2	-
CO6	-	3	-	-	3	-	-	-	3	-	-	2	2	-
Total	~~7~~	18	~~6~~	-	17	-	-	3	18	-	-	11	4	3
Maximum value	**2.33**	**3**	**3**	**0**	**2.83**	**0**	**0**	3	**3**	**0**	**0**	**2.75**	**2**	**3**

SECTION 11D: Level of Contribution of the COs to POs and PSOs

Number	**Programme Outcomes**	**Proficiency Assessed by**	**Contribution Level (from 1 to 3)**
PO 1	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**.	Laboratory experiments, internal and external lab examinations	3
PO 2	Identify, formulate, review research literature and analyse **complex engineering problems** reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).	Laboratory experiments, internal and external lab examinations	3
PO 3	Design creative solutions for **complex engineering problems** and design / develop systems / components/ processes to meet identified needs with consideration	Laboratory experiments, internal	3

	for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)	and external lab examinations	
PO 5	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve **complex engineering problems**. (WK2 and WK6).	Laboratory experiments, internal and external lab examinations	**3**
PO 9	Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences (Adopted: WK-1 & WK-9)	Laboratory experiments, internal and external lab examinations	**3**
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	Laboratory experiments, internal and external lab examinations	**3**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	Laboratory experiments, internal and external lab examinations	**2**
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.	Laboratory experiments, internal and external lab examinations	**3**

a. SECTION 12: Course Content	
WEEK- I	**GETTING STARTED EXERCISES**
	1.1 HelloWorld 1.2 CheckPassFail 1.3 CheckOddEven 1.4 PrintNumberInWord 1.5 PrintDayInWord.
WEEK- 2	**EXERCISES ON NUMBER SYSTEMS**
	2.1 Decimal (used by human beings for input and output) 2.2 Binary (used by computer for storage and processing) 2.3 Hexadecimal (shorthand or compact form for binary)
WEEK- 3	**EXERCISES ON DECISION AND LOOP**
	3.1 SumAverageRunningInt 3.2 Product1ToN 3.3 HarmonicSum 3.4 ComputePI 3.5 CozaLozaWoza 3.6 Fibonacci 3.7 ExtractDigits
WEEK- 4	**EXERCISES ON INPUT, DECISION AND LOOP**
	4.1 Add2Integer

	4.2 SumProductMinMax3 4.3 CircleComputation 4.4 Swap2Integers 4.5 IncomeTaxCalculator 4.6 IncomeTaxCalculatorWithSentinel 4.7 PensionContributionCalculatorWithSentinel 4.8 SalesTaxCalculator 4.9 ReverseInt 4.10 SumOfDigitsInt 4.11 InputValidation 4.12 AverageWithInputValidation
WEEK- 5	**EXERCISES ON NESTED-LOOPS(PATTERNS)**
	5.1 SquarePattern 5.2 SquarePattern 5.3 MultiplicationTable 5.4 TriangularPattern 5.5 BoxPattern 5.6 HillPattern 5.7 NumberPattern
WEEK- 6	**MAGIC(SPECIAL) NUMBERS**
	6.1 AmicableNumbers 6.2 ArmstrongNumber 6.3 CapricornNumber 6.4 CircularPrime 6.5 HappyNumber 6.6 AutomorphicNumber 6.7 DisariumNumber 6.8 Magic Number 6.9 NeonNumber 6.10 PalindromicNumber 6.11 PerfectNumber 6.12 SpecialNumber 6.13 SpyNumber 6.14 UglyNumber
WEEK- 7	**EXERCISES ON STRING AND CHAR OPERATIONS**
	7.1 ReverseString 7.2 CountVowelsDigits 7.3 PhoneKeyPad 7.4 Caesar's Code 7.5 Decipher Caesar's Code 7.6 Exchange Cipher 7.7 TestPalindromicWord 7.8 CheckBinStr 7.9 CheckHexStr 7.10 Bin2Dec 7.11 Hex2Dec 7.12 Oct2Dec
WEEK- 8	**EXERCISES ON ARRAYS**
	8.1 PrintArray

	8.2 PrintArrayInStars 8.3 GradesStatistics 8.4 Hex2Bin 8.5 Dec2Hex
WEEK- 9	**EXERCISES ON METHODS**
	9.1 exponent() 9.2 isOdd() 9.3 hasEight() 9.4 print() 9.5 arrayToString() 9.6 contains() 9.7 search() 9.8 equals() 9.9 copyOf() 9.10 swap() 9.11 reverse() 9.12 GradesStatistics 9.13 GradesHistogram
WEEK-10	**EXERCISES ON COMMAND-LINE ARGUMENTS, RECURSION**
	10.1 Arithmetic (Command-Line Arguments) 10.2 FactorialRecursive 10.3 Fibonacci (Recursive) 10.4 Length of a Running Number Sequence (Recursive) 10.5 GCD (Recursive)
WEEK-11	**MORE (DIFFICULT) EXERCISES**
	11.1 Matrices (2D Arrays) 11.2 PrintAnimalPattern (Special Characters and Escape Sequences) 11.3 Print Patterns (nested-loop) 11.4 Print Triangles (nested-loop) 11.5 Trigonometric Series 11.6 Exponential Series
WEEK-12	**EXERCISES ON CLASSES**
	12.1 The Rectangle Class 12.2 The Employee Class 12.3 The InvoiceItem Class 12.4 The Account Class 12.5 The Date Class
WEEK-13	**EXERCISES ON INHERITANCE**
	13.1 The Rectangle Class 13.2 The Employee Class 13.3 The InvoiceItem Class 13.4 The Account Class 13.5 The Date Class 13.6 The Circle and Cylinder Classes 13.7 Superclass Person and its subclasses
WEEK-14	**EXERCISES ON POLYMORPHISM, ABSTRACT CLASSES AND INTERFACES**
	14.1 Abstract Superclass Shape and Its Concrete Subclasses 14.2 GeometricObject Interface and its Implementation Classes Circle and Rectangle

	14.3 Movable Interface and its Implementation MovablePoint Class 14.4 Movable Interface and Classes MovablePoint and MovableCircle 14.5 Interfaces Resizable and GeometricObject 14.6 Abstract Superclass Animal and its Implementation Subclasses

SECTION 13: Tentative Schedule of Instructions

Week Number	Topics	Duration (Hours)
1	Getting Started Exercises	3
2	Exercises on Number Systems	3
3	Exercises on Decision and Loop	3
4	Exercises on Input, Decision and Loop	3
5	Exercises on Nested-Loops(Patterns)	3
6	Magic(Special) Numbers	3
7	Exercises on String and Char Operations	3
8	Exercises on Arrays	3
9	Exercises on Methods	3
10	Exercises on Command-Line Arguments, Recursion	3
11	More (Difficult) Exercises	3
12	Exercises on Classes	3
13	Exercises on Inheritance	3
14	Exercises on Polymorphism, Abstract Classes and Interfaces	3
	Total	**42**

SECTION 14: Specific Goals for the Course

The following table shows the knowledge and skills covered by the unit outcomes:

Knowledge	Skills
Learners should understand: • Fundamentals of object-oriented programming (OOP) using Java. • Data types, variables, and operators in Java. • Conditional statements and loops for decision-making and iteration. • Methods, classes, and objects as the building blocks of Java programs. • Principles of inheritance, polymorphism, encapsulation, and abstraction. • Common data structures like arrays and array lists..	**Learners can:** • Write clean, readable, and well-commented Java code. • Use conditional statements (if/else, switch) and loops (for, while, do-while) effectively. • Implement functions and recursion to break down complex problems into manageable sub-problems. • Develop robust programs for applications such as calculators, inventory systems, and text analyzers. • Debug and troubleshoot Java code using standard tools and techniques. • Optimize code for efficiency and performance.

EXPERIMENTS FOR ENHANCED LEARNING (EEL): NA

S.No	Design Oriented Experiments
1	Develop a program for an Online Shopping Cart using classes and interfaces. Include features like adding items, billing, and discounts.
2	Design a Banking Application that supports deposit, withdrawal, and balance inquiry with proper exception handling.
3	Implement a Student Information System that stores details of students using ArrayList/Collections, and allows searching and sorting.
4	Write a program to implement a Library Management System using OOP concepts (classes, inheritance, polymorphism).

Administrative Information

SECTION 15: History of changes		
Regulations	**Description of change**	**BOS Date**
R16	**As per JNTUH syllabus**	24.07.2016
R18	**No change in syllabus from R16**	
UG 20	**Changes from R18 to UG 20 regulation** **Incorporated the following additions** Exercises on VENDING MACHINE CONTROLLER Exercises on RAM design Exercises on Gray-Encoded Counter	01.11.2020
BT 23	Same as UG 20	21.08.2023

Approvals	
Course Coordinator Name: Signature: Date:	**Head of the Department** Name: Signature: Date:
Dean of Outcome Based Teaching and Learning Name: Dr. Ch.Srinivasulu Signature: Date:	**Dean of Academics** Name: Dr. G. Chandrasekhar Signature: Date:

Check List		
Section	**Description**	**Please tick (✓)**
1	General Information about the Course	✓
2	Notional Study Time	✓
3	A. Course Outcomes	✓
	B. Cognitive Levels	✓
4	Content and Context of the Course	✓

5	Complex Engineering Problem Solving	✓
6	A. Assessment Methods – Direct	✓
	B. Assessment Methods – Indirect	✓
7	Content Delivery / Instructional Methodologies	✓
8	Engineering Competencies (ECs) Focused	✓
9	Employability Skills	✓
10	Relevance to Sustainability goals	✓
11	A. Mapping between COs and POs / PSOs	✓
	B. Indicators of Attainment with COs to POs and PSOs	✓
	C. Course Articulation Matrix of COs to POs	✓
	D. Level of Contribution of the COs to POs and PSOs	✓
12	Syllabus	✓
13	Tentative Schedule of Instructions	✓
14	Specific Goals for the Course	✓
15	History of Changes	✓

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

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**ENGINEERING PHYSICS LABORATORY**
Course Code	AHSE05
Course Start	FIRST SEMESTER
Course Type	Core
Regulation	IARE - BT 25
Prerequisite Courses	1. Intermediate Physics
Department	CSE(DS),CSE(AIML),Civil, EEE, ECE, Mechanical Engineering
Number of Credits	1 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Theory and laboratory
Course Coordinator's Name	**Dr. N V Surya Sharma** **Nv.surya@iare.ac.in**
Prior Learning Assessment and Recognition (PLAR)	Students interested in PLAR pathways for open learning can register one semester prior to the start of semester. Students will receive the necessary contact information one semester in advance.
Open Learning Faculty Member Information	Open Learning Faculty (OLF) is available to assist students. Students will receive the necessary contact information at the start of the course.
Course Webpage	https://akanksha.iare.ac.in/index?route=course/details&course_id=1242
Course Description	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.
CourseObjectives	**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
Text and Reference Books	**Text Books** 1. 1. C. L. Arora, "Practical Physics", S. Chand Co., New Delhi, 3rd Edition, 2012. 2. 2. Vijay Kumar, Dr. T. Radha krishna, "Practical Physics for Engineering Students", S M Enterprises, 2nd Edition, 2014. 3. Dr. Rizwana, "Engineering Physics Manual", Spectrum Techno Press, 2018 Page 4 **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"
Learning and Teaching Strategies	Online material will provide the foundation of the learning resources, requiring the students to log in and engage regularly throughout the sixteen weeks of the course. There will be a mix of suggested readings, discussions and video content containing

	embedded digital content and undertake the assessment tasks.

DELIVERY / INSTRUCTIONAL METHODOLOGIES:							
✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

SECTION 2: Teaching Learning Scheme

At least 48 lecture hours of scheduled laboratories activities (TLA) will be delivered in person,

Notional Study Time:48 Hours(Laboratory Exercises)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA 1	Lectures	-	-	-
TLA 2	Tutorials	-	-	-
TLA 3	Case Study	-	-	-
TLA 4	Problem Solving	-	-	-
TLA 5	Demonstration	-	-	-
TLA 6	Scheduled revision sessions	-	-	-
TLA 7	Guided independent study: Directed viewing of video materials / PPTs	-	-	-
TLA 8	Independent private study	-	-	-
TLA 9	Laboratory Exercises	14	02	28
TLA 10	Homework assignments / Programming assignments	-	-	-
TLA 11	Placement / work based learning or Specific practical training	-	-	-
TLA 12	Presentation / Seminar Preparation	-	-	-
TLA 13	Course Project / Preparation for Complex Problem Solving	-	-	-
TLA 14	Technical visit	-	-	-
TLA 15	Field activities	-	-	-
			Total study hours	**28**
			Expected total study hours	**28**

SECTION 3A: Course Outcomes

After successfully completing this course, the student will be able to:

Outcome Number	Course Outcomes	Learning Domain
CO1	**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	Understand
CO2	**Illustrate** principle, working and application of wave propagation and compare the results of frequency with theoretical harmonics and overtones	Analyze
CO3	**Investigate** the energy losses, curie temperature and properties associated with a given Ferro magnetic materia	Analyze
CO4	**Examine** launching of light through optical fiber from the concept of light gathering capacity of numerical aperture and determine the divergence of Laser beam	Apply

CO5	**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	Analyze
CO6	**Analyse** the variation of magnetic field induction produced at various points along the axis of current carrying coil.	Analyze

SECTION 3B: Cognitive Levels	
BloomsTaxonomyLevel	**CognitiveLevel in Percentage (%)**
Remember	0
Understand	17
Apply	17
Analyse	66
Evaluate	0
Create	0

SECTION 4: Engineering Physics laboratory	
CO1	**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 (Lorentz Force) 3. Energy gap of a Semiconductor diode 4. Resistivity -Four probe Method
CO2	**Illustrate principle, working and application of wave propagation and compare the results of frequency with theoretical harmonics and overtones**
	1. Melde's Experiment
CO3	**Investigate the energy losses, curie temperature and properties associated with a given Ferro magnetic material.**
	1. B-H Curve With CRO 2. Magnetic Materials
CO4	**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
CO5	**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
CO6	**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

SECTION 5: Complex Engineering Problem Solving- NA
.

SECTION 6A: Assessment Methods – Direct			
Item	**Evaluation Components**	**Week in / out**	**Marks**

1	Day to day evaluation	Every week	20
2	Internal examination and Viva-voce	10 +10	20
3	Semester end examination (External)	Week – 17	60
		Total Marks	**100**

Department's Late Submission Policy:

1. 1 – 24 hours: 25% of the mark will be deducted
2. > 24 hours: Not accepted

SECTION 6B: Assessment Methods –Indirect	
Course End Survey (End Semester OBE Feedback)	✓

SECTION 8: Engineering Competencies (ECs) Focused: NA

Please tick (✓) relevant engineering competency profile covered

EC Number	Attributes	Profiles	(✓)
EC1	Depth of knowledge required (CP)	Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill-founded, illogical, erroneous, unreliable or unrealistic requirements applicable to the engineering discipline	-
EC2	Depth of analysis required (CP)	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	-
EC3	Design and development of solutions (CA)	Support sustainable development solutions by ensuring functional requirements, minimize environmental impact and optimize resource utilization throughout the life cycle, while balancing performance and cost effectiveness.	-
EC4	Range of conflicting requirements (CP)	Competently addresses complex engineering problems which involve uncertainty, ambiguity, imprecise information and wide-ranging or conflicting technical, engineering and other issues.	-
EC5	Infrequently encountered issues (CP)	Conceptualizes alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.	-
EC6	Protection of society (CA)	Identifies, quantifies, mitigates and manages technical, health, environmental, safety, economic and other contextual risks associated to seek achievable sustainable outcomes with engineering application in the designated engineering discipline.	✓
EC7	Range of resources (CA)	Involve the coordination of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies) in the timely delivery of outcomes	-
EC8	Extent of stakeholder involvement (CP)	Design and develop solution to complex engineering problem considering a very perspective and taking account of stakeholder views with widely varying needs.	-
EC9	Extent of applicable codes, legal and regulatory (CP)	Meet all level, legal, regulatory, relevant standards and codes of practice, protect public health and safety in the course of all engineering activities.	-
EC10	Interdependence (CP)	High level problems including many component parts or sub-problems, partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then re-combines to form a whole, with the integrity and performance of the overall system as the top consideration.	-
EC11	Continuing professional development (CPD) and lifelong	Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.	-

	learning (CA)		
EC12	Judgement (CA)	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Require judgement in decision making in the course of all complex engineering activities.	-

SECTION 9: Employability Skills

Example: Project based skills

The study of Applied Physics Laboratory equips students with a range of practical, hands-on skills that are highly valued in the industry. These skills are particularly important in the design, testing, and optimization of Physics systems and technologies.

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

SECTION 10: Relevance to Sustainability goals

Brief description about the course and its correlationwith Sustainability Development Goal (SDGs).

SDG Goals		Correlation with SDG
4		**Quality Education**: In order to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all, foundation is very much important. Physics laboratory comes under basic science course felicitating students to gain and ascertain basic knowledge which will help them to envisage to their higher education

SECTION 11A: Mapping between COs and POs / PSOs

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	✓	✓	-	✓	-	-	-	-	-	-	-	-	-	-
CO2	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO3	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO4	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO5	✓	✓	-	✓	-	-	-	-	-	-	-	-	-	-
CO6	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-

Outcomes		WKS and Indicators of attainment and Justificationformapping(studentswillbeableto)																																			IAs Count
COs	POs	WK 1	WK 2								WK 3			WK 4			WK 5						WK 6			WK 7				WK 8							WK 9						
		A	a	b	c	D	e	f	g	h	a	b	c	a	b	c	a	b	c	d	e	f	a	b	c	a	b	c	d	a	b	c	d	e	f	g	a	b	c	d	e	f	
CO 1	PO 1	•	•	•	•	•	•	•				•	•	•	•																											11
	PO 2	•	•	•	•	•	•	•				•	•	•	•																											11
	PO 11																													•	•		•	•	•							4
	PSO 1	•	•	•	•	•	•	•				•	•	•	•																											11
CO2	PO 1	•	•	•	•	•	•	•				•	•	•	•																											11
	PO 2	•	•	•	•	•	•	•				•	•	•	•																											11

	PO 11																													•	•		•	•	•								4
	PSO 1	•	•	•	•	•	•	•				•	•	•	•																													11
CO3	PO 1	•	•	•	•	•	•	•				•	•	•	•																													11
	PO 2	•	•	•	•	•	•	•				•	•	•	•																													11
	PO 11																													•	•			•	•	•							4
	PSO 1	•	•	•	•	•	•	•				•	•	•	•																													11
CO4	PO 1	•	•	•	•	•	•					•	•	•	•																													11
	PO 2	•	•	•	•	•	•					•	•	•	•																													11
	PO 11																													•	•			•	•	•							4
	PSO 1	•	•	•	•	•	•	•				•	•	•	•																													11
CO 5	PO 1	•	•	•	•	•	•					•	•	•	•																													11
	PO 2	•	•	•	•	•	•					•	•	•	•																													11
	PO 11																													•	•			•	•	•							4
	PSO 1	•	•	•			•					•	•	•																														11
CO 6	PO 1	•	•	•	•	•	•					•	•	•	•																													11
	PO 2	•	•	•	•	•	•					•	•	•	•																													11
	PO 11																													•	•			•	•	•							4
	PSO 1	•	•	•	•	•	•					•	•	•	•																													11

SECTION 11B: Indicators of Attainment with COs to POs and PSOs

Course Outcomes	Percentage of Indicators of Attainments (IA) with POs and PSOs														
	PO												PSO		
	1	2	3	4	5	6	7		8	9	10	11	1	2	3
CO1	66	40	-	18	-	-	-		-	-	-	-	-	-	-
CO2	66	40	-	-	-	-	-		-	-	-	-	-	-	-
CO3	66	40	-	-	-	-	-		-	-	-	-	-	-	-
CO4	66	40	-	-	-	-	-		-	-	-	-	-	-	-
CO5	66	40	-	18	-	-	-		-	-	-	-	-	-	-
CO6	66	40	-	-	-	-	-		-	-	-	-	-	-	-

SECTION 11C: Course Articulation Matrix of COs to POs

0 No Contribution (0-5%)	1 Low (≥5 - <40%)	2 Moderate (≥40 - <60%)	3 High (≥60%)
-			

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	4	-	2	-	-	-	-	-	-	-	-	-	-
CO2	1	4	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	4	-	-	-	-	-	-	-	-	-	-	-	-
CO4	2	4	-	-	-	-	-	-	-	-	-	-	-	-
CO5	1	2	-	2	-	-	-	-	-	-	-	-	-	-

CO6	2	4	-	-	-	-	-	-	-	-	-	-	-	-
~~**Total**~~	~~11~~	~~22~~	~~-~~	~~4~~	~~-~~	~~-~~	~~-~~	~~-~~	~~-~~	~~-~~	~~-~~	~~-~~	~~-~~	~~-~~
Maximum value	3	4	-	2	-	-	-	-	-	-	-	-	-	-

SECTION 11D: Level of Contribution of the COs to POs and PSOs

Number	Programme Outcomes	Proficiency Assessed by	Contribution Level (from 1 to 3)
PO 1	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**.	Laboratory experiments, internal and external lab examinations	**3**
PO 2	Identify, formulate, review research literature and analyse **complex engineering problems** reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).	Laboratory experiments, internal and external lab examinations	**2**
PO 4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	Laboratory experiments, internal and external lab examinations	**1**
PSO 1	Design, Develop, Fabricate and Commission the Electrical Systems involved in Power generation, Transmission, Distribution and Utilization.	-	**-**
PSO 2	Focus on the Components of Electrical Drives with its Converter Topologies for Energy Conversion, Management and Auditing in Specific applications of Industry and Sustainable Rural Development.	-	**-**
PSO 3	Gain the Hands-On Competency Skills in PLC Automation, Process Controllers, HMI and other Computing Tools necessary for entry level position to meet the Requirements of the Employer.	-	**-**

a. SECTION 12: Course Content

WEEK- I	**ERRORS AND MEASUREMENT**
	When a number represents a physical measurement, it is never exact because of the limitations of the instrument used or the way it was employed etc. It is essential, therefore, that each experimental result be presented in a way that indicates its reliability. The accuracy of result is important, for example, the calibration of the measuring instruments or systematic errors on the part of whoever is taking the data.
WEEK- 2	**HALL EFFECT (LORENTZ FORCE)**
	Study the phenomenon of Hall effect and determine the charge carrier density and Hall coefficient of a given sample. Determine whether the give semiconductor is p - type or n - type using the principle of hall effect
WEEK- 3	**ENERGY GAP OF SEMICONDUCTOR**
	Determination of energy gap of a given semiconductor diode by measuring the variation of current as a function of temperature.

WEEK- 4	**RESISTIVITY – FOUR PROBE METHOD**
	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
WEEK- 5	**MELDE's EXPERIMENT**
	Determination of frequency of a given tuning fork in longitudinal wave propagation and transverse mode of wave propagation by understanding the theoretical harmonics and overtones
WEEK- 6	**B-H CURVE WITH CRO**
	Evaluate the energy loss per unit volume of a given magnetic material per cycle by tracing the hysteresis loop (B-H curve) and observing the hysteresis loss of ferro magnetic materials.
WEEK- 7	**MAGNETIC MATERIAL**
	Determine the curie temperature (Tc) and relative permeability of a ferromagnetic materials.
WEEK- 8	**OPTICAL FIBER**
	Evaluation of numerical aperture and acceptance angle of a given optical fiber.
WEEK- 9	**LASER DIVERGENCE**
	Determination of the beam divergence of the given laser beam.
WEEK- 10	**SOLAR CELL**
	Studying the characteristics of solar cell at different intensities and determination of maximum workable power.
WEEK- 11	**LIGHT EMITTING DIODE**
	Studying V-I characteristics of LED in forward bias for different LEDs and measure the threshold voltage and forward resistance
WEEK- 12	**BIASSING DIODE**
	To draw the V-I Characterstics of PN Diode in Forward and reverse bias
WEEK- 13	**PLANCK'S CONSTANT**
	Determination of Planck's constant by measuring threshold voltage of given LED.
WEEK- 14	**STEWART GEE'S APPARATUS**
	Study the magnetic field along the axis of current carrying coil – Stewart and Gee's method

SECTION 13: Tentative Schedule of Instructions

Week Number	Topics	Duration (Hours)
1	When a number represents a physical measurement, it is never exact because of the limitations of the instrument used or the way it was employed etc. It is essential, therefore, that each experimental result be presented in a way that indicates its reliability. The accuracy of result is important, for example, the calibration of the measuring instruments or systematic errors on the part of whoever is taking the data.	2
2	Study the phenomenon of Hall effect and determine the charge carrier density and Hall coefficient of a given sample. Determine whether the give semiconductor is p - type or n - type using the principle of hall effect	2
3	Determination of energy gap of a given semiconductor diode by measuring the variation of current as a function of temperature.	2
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	2

	method	
5	Determination of frequency of a given tuning fork in longitudinal wave propagation and transverse mode of wave propagation by understanding the theoretical harmonics and overtones	2
6	Evaluate the energy loss per unit volume of a given magnetic material per cycle by tracing the hysteresis loop (B-H curve) and observing the hysteresis loss of ferro magnetic materials.	2
7	Determine the curie temperature (Tc) and relative permeability of a ferromagnetic materials.	2
8	Evaluation of numerical aperture and acceptance angle of a given optical fiber.	2
9	Determination of the beam divergence of the given laser beam.	2
10	Studying the characteristics of solar cell at different intensities and determination of maximum workable power.	2
11	Studying V-I characteristics of LED in forward bias for different LEDs and measure the threshold voltage and forward resistance	2
12	To draw the V-I Characterstics of PN Diode in Forward and reverse bias	2
13	Determination of Planck's constant by measuring threshold voltage of given LED.	2
14	Study the magnetic field along the axis of current carrying coil – Stewart and Gee's method	2
	Total	**28**

SECTION 14: Specific Goals for the Course	
The following table shows the knowledge and skills covered by the unit outcomes:	
Knowledge	**Skills**
Learners should understand: • Fundamentals of Semiconductors and its properties and applications • Characteristics of Laser and working principles • Properties of Nanomaterials • Properties of stationary waves	**Learners can:** • Find the type of semiconductor whether it is p-type or n-type semiconductor. • Find the divergence of Laser beam and diffraction • Find the resistivity of nanomaterials by using four probe method • Find the frequency of tuning fork by using Melde's experiment.

EXPERIMENTS FOR ENHANCED LEARNING (EEL): NA

S.No	Design Oriented Experiments
1	Fabry Perot interferometer using Laser
2	Photo diode by using Reverse bias
3	Quantum Anomalous Hall effect

Administrative Information

SECTION 15: History of changes		
Regulations	**Description of change**	**BOS Date**
R 16	**From R15 JNTUH, Hyderabad to R16 IARE regulations with change in V module** • **No change in syllabus**	24.07.2016

R 18	**Changes from R16 to R18 regulation** **Module – IV:** compressors cascade testing is introduced	16.07.2018
UG 20	**Changes from R18 to UG 20 regulation** **Module -V:** Performance characteristics, turbine blade cooling is added.	17.11.2020
BT 23	**Incorporated the following additions in BT 23 regulations** **Module – I** • Take off Thrust Specific Fuel Consumption, Aircraft Range, • Endurance Factor Specific Impulse. is added **Module - II** • Cooling, Material, Aircraft Fuels, Emissions and Pollutants. **Module -III** • Classification of Thrust Reverser Systems in nozzle. **Module IV** • Performance characteristics of centrifugal and axial flow compressors-single stage, multistage compressor, • Stall and Surge, Surge Control Methods • Multi spool compressor, variable vanes, air bleed.	21.08.2023

Course Outline Approvals	
Course Coordinator Name: Dr. NV Surya Sharma Signature: Date:	**Head of the Department** Name: Dr. Rizwana Signature: Date:
Dean of Outcome Based Teaching and Learning Name: Dr. Srinivasulu Signature: Date:	**Dean of Academics** Name: Dr. G. Chandrasekhar Signature: Date:

Check List		
Section	**Description**	**Please tick (✓)**
1	General Information about the Course	✓
2	Notional Study Time	✓
3	A. Course Outcomes	✓
	B. Cognitive Levels	✓
4	Content and Context of the Course	✓
5	Complex Engineering Problem Solving	✓
6	A. Assessment Methods – Direct	✓
	B. Assessment Methods – Indirect	✓
7	Content Delivery / Instructional Methodologies	✓
8	Engineering Competencies (ECs) Focused	✓
9	Employability Skills	✓
10	Relevance to Sustainability goals	✓
11	A. Mapping between COs and POs / PSOs	✓
	B. Indicators of Attainment with COs to POs and PSOs	✓

	C. Course Articulation Matrix of COs to POs	✓
	D. Level of Contribution of the COs to POs and PSOs	✓
12	Syllabus	✓
13	Tentative Schedule of Instructions	✓
14	Specific Goals for the Course	✓
15	History of Changes	✓

Signature of Course Coordinator, **HOD**

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

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**ENGINEERING WORKSHOP**
Course Code	AMEE02
Course Start	First & Second Semester
Course Type	Foundation
Regulation	IARE - BT 25
Prerequisite Courses	1.There is no prerequisite required to this course
Department	ECE
Number of Credits	2 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Laboratory
Course Coordinator's Name	**Dr.B.Vijyakrishna, Assistant** Professor of Mechanical Engineering IARE10662 **b.vijayakrishna@iare.ac.in**
Prior Learning Assessment and Recognition (PLAR)	Students interested in PLAR pathways for open learning can register one semester prior to the start of semester. Students will receive the necessary contact information one semester in advance.
Open Learning Faculty Member Information	Open Learning Faculty (OLF) is available to assist students. Students will receive the necessary contact information at the start of the course.
Course Webpage	https://akanksha.iare.ac.in/index?route=course/details&course_id=337
Course Description	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 principles of contemporary trends in manufacturing processes, such as CNC machining and 3D printing, as well as gain practical experience in carpentry, fitting, and welding. Skills learned in the course enable the students to learn about the design process in digital manufacturing used in various industrial applications.
Course Objectives	**The students will try to learn:** a) The basics and hands-on practice of carpentry, fitting, and welding. b) The impart knowledge and skill to use tools, equipment, measuring instruments, and modern techniques. c) The concepts apply to the manufacturing processes of casting, moulding and forging. d) The basic machining operations by CNC lathe, CNC milling, and 3D printing machine.
Text and Reference Books	**Text Books** 1. Hajra Choudhury S.K., Hajra Choudhury A.K. and NirjharRoy S.K., "Elements of Workshop Technology", Media promoters and publishers private limited, Mumbai, 4th Edition ,2022. 2. Kalpakjian S, Steven S. Schmid, "Manufacturing Engineering and Technology", Pearson Education India Edition, 7th Edition, 2021. 3. Gowri P. Hariharan, A. Suresh Babu," Manufacturing Technology – I", Pearson Education, 3rd Edition, 2022.

	Reference Books 1. Gowri P. Hariharan, A. Suresh Babu, "Manufacturing Technology – I", Pearson Education, 6th Edition, 2021. 2. Roy A. Lindberg, "Processes and Materials of Manufacture", Prentice Hall India, 4th Edition, 2022. 3. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw-Hill House, 2023.
Learning Resources	**Course full stack** is made available in IARE learning management portal – Akansha, which includes course outline description, lab manual, tutorial question bank, Model question papers (2 sets), power point presentations (PPTs) .
Supplemental Materials	**Readings, Videos, and Links** 1. **https://youtu.be/D_xEl0ZVxII?si=iJWR-AJAl-TWHBS9** 2. **https://youtu.be/adDPkllsGVA?si=vIMuT4sYJ3-7dktR** 3. **https://youtu.be/prEKFzfTE2M?si=1oYOGAnHllo1hbUD** 4. **https://youtu.be/13rlMu1HRzA?si=Cok_mSJoKU8ZTQHc**
Learning and Teaching Strategies	The online material will serve as the foundation of the learning resources, requiring students to log in and actively participate throughout the fourteen-week course. It will include a blend of suggested readings, discussions, and video content with embedded digital resources, along with assessment tasks to be completed.

SECTION 2: Teaching Learning Scheme

At least 48 lecture hours of scheduled teaching and learning activities (TLA) will be delivered in person, with the remaining hours for scheduled and self-scheduled teaching and learning activities delivered either in person or online.

Notional Study Time: 90 Hours (Lecture hours: 15, Tutorial hours: 30, Scheduled revision session hours: 2, Guided independent study hours: 15, Homework / Programming assignment hours: 10, Course project / Preparation for complex problem-solving hours: 15)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA 1	Lectures			
TLA 2	Tutorials	15	01	15
TLA 3	Case Study			
TLA 4	Problem Solving			
TLA 5	Demonstration			
TLA 6	Scheduled revision sessions			
TLA 7	Guided independent study: Directed viewing of video materials / PPTs			
TLA 8	Independent private study			
TLA 9	Laboratory Exercises	30	01	30
TLA 10	Homework assignments / Programming assignments			
TLA 11	Placement / work based learning or Specific practical training			
TLA 12	Presentation / Seminar Preparation			
TLA 13	Course Project / Preparation for Complex Problem Solving			
TLA 14	Technical visit			
TLA 15	Field activities	0	0	0
			Total study hours	**45**
			Expected total study hours	**45**

SECTION 3A: Course Outcomes		
After successfully completing this course, the student will be able to:		
Outcome Number	**Course Outcomes**	**Learning Domain**
CO1	Select appropriate tools, work material and measuring instruments useful for carpentry, fitting and welding.	Apply
CO2	Use flat sheets for sheet metal and intricate shapes made from mild steel for Black smithy.	Apply
CO3	Choose appropriate components and tools to prepare pipe fitting and joints of specific shapes and sizes.	Apply
CO4	Experiment with the moulding techniques for producing cast components in complex shapes using different patterns.	Apply
CO5	Execute hard soldering techniques to join similar and dissimilar materials used in industries.	Apply
CO6	Demonstrate appropriate equipment and methods for various machining processes used in CNC machines and 3D printing for manufacturing industries.	Understand

SECTION 3B: Cognitive Levels	
Blooms Taxonomy Level	**Cognitive Level in Percentage (%)**
Remember	0
Understand	**16**
Apply	**84**
Analyse	**0**
Evaluate	0
Create	0

SECTION 4: Content and Context of Engineering Workshop	
CO1	**Select appropriate tools, work material and measuring instruments useful for carpentry, fitting, and welding.**
	This outcome focuses on enabling students to identify and choose the correct tools, materials, and measuring instruments required for performing basic workshop processes. In carpentry, students learn to select tools such as saws, chisels, planes, hammers, and marking instruments along with suitable wood materials to prepare accurate joints and components. In fitting, they develop the skill of choosing files, hacksaws, hammers, and precision measuring tools like Vernier callipers, micrometers, and surface plates for working with metals such as mild steel. In welding, students become familiar with selecting appropriate welding machines (arc, gas, MIG/TIG), electrodes, filler rods, clamps, protective gear, and the correct workpiece material depending on the application. Across all these processes, the ability to select and use measuring instruments correctly ensures accuracy, safety, and quality in manufacturing tasks. This outcome lies at the "Apply" level of Bloom's Taxonomy, as it involves practical application of knowledge to real workshop situations, preparing students for advanced manufacturing practices.
CO2	**Use flat sheets for sheet metal and intricate shapes made from mild steel for Black smithy.**
	This outcome emphasizes the practical skills required to work with flat sheets in sheet metal processes and to shape mild steel components through blacksmithy techniques. In sheet metal work, students learn to handle flat sheets and perform operations such as cutting, bending, folding, notching, and forming to create simple and functional components like trays, funnels, and boxes. In blacksmithy, they gain experience in heating mild steel to the appropriate temperature and shaping it into intricate forms using hammers, anvils, tongs, and swages to produce parts such as hooks, chisels, and rings. Through these tasks, students develop hands-on expertise in material handling, shaping techniques, and process accuracy. This outcome lies at the "Apply" level of Bloom's Taxonomy, as it requires the application of knowledge and skill to manipulate raw materials into desired shapes, preparing students for real-world manufacturing and fabrication practices.

CO3	**Choose appropriate components and tools to prepare pipe fitting and joints of specific shapes and sizes.**
	This outcome focuses on developing the ability to identify and select suitable components, materials, and tools required for pipe fitting operations. Students learn to work with different types of pipes such as PVC, GI, copper, or mild steel, and understand the use of components like elbows, tees, unions, reducers, and couplings to prepare pipe layouts of specific shapes and sizes. They also gain hands-on experience with tools such as pipe wrenches, threading dies, cutters, reamers, and measuring instruments to ensure accurate fitting and alignment. By practicing pipe assembly and joint preparation, students acquire essential skills for applications in plumbing, fluid transportation, and industrial piping systems. This outcome is aligned with the "Apply" level of Bloom's Taxonomy, as it requires students to practically select and use appropriate tools and components to complete functional pipe fitting tasks with accuracy and efficiency.
CO4	**Experiment with the moulding techniques for producing cast components in complex shapes using different patterns.**
	This outcome is aimed at building students' practical understanding of moulding processes used in casting. It involves experimenting with various moulding techniques such as green sand moulding, dry sand moulding, and CO_2 moulding to produce cast components of different geometries. Students learn to handle pattern materials like wood, metal, or plastic and use different types of patterns such as single-piece, split, or match-plate patterns to create mould cavities. Through hands-on practice, they gain experience in preparing mould boxes, ramming sand, placing cores, and ensuring proper gating and riser systems for defect-free castings. The ability to experiment with different moulding methods allows students to appreciate the relationship between pattern design, mould preparation, and the quality of the final casting. This outcome is positioned at the "Apply–Analyze" level of Bloom's Taxonomy, since students not only apply techniques but also test and analyze their effectiveness in producing complex shapes accurately.
CO5	**Execute hard soldering techniques to join similar and dissimilar materials used in industries.**
	This outcome focuses on developing students' practical skills in performing hard soldering or brazing operations to join metals. Students learn to select appropriate filler materials, fluxes, and heating methods for different metals such as copper, brass, aluminium, and mild steel. They gain hands-on experience in preparing joint surfaces, applying flux, heating the workpieces uniformly, and executing the soldering process to achieve strong and durable joints. The process also emphasizes safety practices, temperature control, and precision to prevent defects such as cracks, voids, or weak bonds. By executing hard soldering techniques, students acquire the competence to join similar and dissimilar metals effectively, which is widely applied in manufacturing, plumbing, HVAC, and automotive industries. This outcome is at the "Apply" level of Bloom's Taxonomy, as it involves practical application of knowledge and skills in real-world industrial processes.
CO6	**Demonstrate appropriate equipment and methods for various machining processes used in CNC machines and 3D printing for manufacturing industries.**
	This outcome emphasizes students' ability to understand and showcase the use of modern manufacturing equipment and techniques. Students learn to operate CNC machines for turning, milling, and drilling operations, understanding the role of tooling, programming, and process parameters in achieving precision components. Additionally, they explore 3D printing technologies, including FDM, SLA, and SLS, to create prototypes and complex geometries from digital models. Through demonstrations, students gain practical exposure to machine setup, operation, and safety measures, as well as the ability to select suitable methods and materials based on design requirements. This outcome aligns with the "Apply–Understand" level of Bloom's Taxonomy, as it requires students to apply their knowledge of equipment and processes while demonstrating an understanding of manufacturing principles in industrial applications.

SECTION 5: Complex Engineering Problem Solving
Design and fabricate a small mechanical assembly, such as a manually operated press or a pipe-supported platform, that integrates sheet metal components, mild steel elements, and pipe fittings. The assembly must withstand specified loads, include precise welded, soldered, and fitted joints, and incorporate bent or shaped components created using blacksmithy and sheet metal techniques. Additionally, analyze the system for forces, moments, centroid, and mass moment of inertia to ensure stability and functionality under operational conditions.

SECTION 6A: Assessment Methods – Direct			
Item	**Evaluation Components**	**Week in / out**	**Marks**
AAT: 1 - 1	Tech-Talk / Worksheets	Week – 1 / 14	
AAT: 1 - 2	Hack-a-thon	-	
AAT: 2 - 1	Complex Engineering Problem Solving	Week-14	
AAT: 2 - 2	Hack-a-thon	-	
CIE - 1	2 hours - Answer 4 out of 5 questions	Week - 7	40
CIE - 2	2 hours - Answer 4 out of 5 questions	Week - 14	
SEE	3 hours - Answer 1 from each module	Week - 15	60
		Total Marks	**100**
Department's Late Submission Policy: 1. 1 – 24 hours: 25% of the mark will be deducted 2. > 24 hours: Not accepted			
SECTION 6B: Assessment Methods –Indirect			
Course End Survey (End Semester OBE Feedback)			✓

SECTION 7: Content Delivery / Instructional Methodologies Please tick (✓) relevant engineering competency profile covered							
X	 Power Point Presentations	**X**	 Chalk and Talk	X	 MOOC	✓	 AAT

SECTION 8: Engineering Competencies (ECs) Focused Please tick (✓) relevant engineering competency profile covered			
EC Number	**Attributes**	**Profiles**	**(✓)**
EC1	Depth of knowledge required (CP)	Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill-founded, illogical, erroneous, unreliable or unrealistic requirements applicable to the engineering discipline	✓
EC2	Depth of analysis required (CP)	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	✓
EC3	Design and development of solutions (CA)	Support sustainable development solutions by ensuring functional requirements, minimize environmental impact and optimize resource utilization throughout the life cycle, while balancing performance and cost effectiveness.	✓
EC4	Range of conflicting requirements (CP)	Competently addresses complex engineering problems which involve uncertainty, ambiguity, imprecise information and wide-ranging or conflicting technical, engineering and other issues.	-
EC5	Infrequently encountered issues (CP)	Conceptualizes alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.	-
EC6	Protection of society (CA)	Identifies, quantifies, mitigates and manages technical, health, environmental, safety, economic and other contextual risks associated to seek achievable sustainable outcomes with engineering application in the designated engineering discipline.	-
EC7	Range of resources (CA)	Involve the coordination of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies) in the timely delivery of outcomes	-

EC8	Extent of stakeholder involvement (CP)	Design and develop solution to complex engineering problem considering a very perspective and taking account of stakeholder views with widely varying needs.	✓
EC9	Extent of applicable codes, legal and regulatory (CP)	Meet all level, legal, regulatory, relevant standards and codes of practice, protect public health and safety in the course of all engineering activities.	-
EC10	Interdependence (CP)	High level problems including many component parts or sub-problems, partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then re-combines to form a whole, with the integrity and performance of the overall system as the top consideration.	✓
EC11	Continuing professional development (CPD) and lifelong learning (CA)	Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.	✓
EC12	Judgement (CA)	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Require judgement in decision making in the course of all complex engineering activities.	-

SECTION 9: Employability Skills

Example: Communication skills / Programming skills / Project based skills

Communication Skills

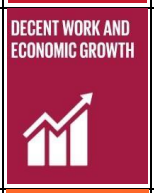
- Prepare clear and detailed technical reports documenting workshop experiments, material selection, and fabrication processes.
- Create assembly sketches, diagrams, and annotated drawings to convey design ideas effectively.
- Present project outcomes and practical demonstrations to peers and instructors, explaining design rationale and problem-solving steps.
- Develop team collaboration and discussion skills during group assignments or lab activities.

Programming / Computational Skills

- Use basic CAD software (like AutoCAD or SolidWorks) to model components, sheet metal parts, and assemblies before fabrication.
- Apply simulation tools to analyze forces, moments, and motion of mechanical systems.
- Use spreadsheet software or simple programming scripts (Python/Excel) for calculations related to centroids, area moments of inertia, and dynamic analysis.
- Explore CNC programming fundamentals (G-code) for machining simple components and 3D printing designs.

Project-Based / Practical Skills

- Plan and execute hands-on fabrication projects, integrating multiple workshop processes such as fitting, welding, soldering, and sheet metal forming.
- Apply engineering mechanics principles (statics, dynamics, work-energy, impulse-momentum) to design safe and functional assemblies.
- Perform material selection, tool selection, and joint design for project components.
- Test, measure, and evaluate prototype performance, ensuring alignment with design calculations and specifications.
- Develop problem-solving and critical thinking skills by troubleshooting fabrication issues and optimizing designs.

SECTION 10: Relevance to Sustainability goals Brief description about the course and its correlation with Sustainability Development Goal (SDGs).		
SDG Goals		**Correlation with SDG**
4		**Quality Education:** This subject will prepare students for modern technological challenges, improving educational tools, and promoting skills essential for global development.
8		**Decent Work and Economic Growth:** Prepares students for careers in technology-driven industries, boosting employability and fostering innovation in the digital economy.
9		**Industry, Innovation, and Infrastructure:** Supports the development of efficient algorithms and systems crucial for advancing technological infrastructure and innovation.
11		**Sustainable Cities and Communities:** Enables the creation of smart city technologies (e.g., optimized traffic systems, resource management) using graph and tree structures.
17		**Partnerships for the Goals:** Facilitates collaboration in data-driven research and global educational initiatives through scalable and efficient data processing.

SECTION 11A: Mapping between COs and POs / PSOs														
Course Outcomes	**Program Outcomes (POs)**											**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	-	-	-	✓	✓	-	-	-	-	-	-	-	-	✓
CO2	-	-	-	✓	✓	-	-	-	-	-	-	-	-	✓
CO3	-	-	-	✓	✓	-	-	-	-	-	-	-	-	✓
CO4	-	-	-	✓	✓	-	-	-	-	-	-	-	-	✓
CO5	-	-	-	✓	✓	-	-	-	-	-	-	-	-	✓
CO6	-	-	-	-	✓	-	-	✓	✓	-	-	✓	-	✓

Outcomes		WKS and Indicators of attainment and Justification for mapping (students will be able to)																																									IAs Count
COs	POs	WK 1	WK 2								WK 3			WK 4			WK 5						WK 6			WK 7				WK 8							WK 9						
		a	a	b	c	d	e	f	g	h	a	b	c	a	b	c	a	b	c	d	e	f	a	b	c	a	b	c	d	a	b	c	d	e	f	g	a	b	c	d	e	f	
CO 1	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																•	•	•			•																					4
	PO 11																													•	•	•			•	•							5
	PSO 1	•	•	•			•		•			•	•	•																													8
CO2	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																•	•	•			•																					4
	PO 4																													•	•	•			•	•							5
	PO 5		•	•	•	•	•		•														•	•	•																		9
	PO 11																													•	•	•			•	•							5
	PSO 1	•	•	•			•		•			•	•	•																													8
	PSO 3		•	•			•		•			•	•	•									•	•	•																		10
CO3	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																•	•	•			•																					4
	PO 4																													•	•	•			•	•							5
	PO 5		•	•	•	•	•		•														•	•	•																		9
	PO 11																													•	•	•			•	•							5
	PSO 1	•	•	•			•		•			•	•	•																													8
	PSO 2		•	•			•		•			•	•	•									•	•	•																		10
	PSO 3		•	•			•		•			•	•	•									•	•	•																		10
CO4	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																•	•	•			•																					4
	PO 4																													•	•	•			•	•							5
	PO 5		•	•	•	•	•		•														•	•	•																		9
	PO 11																													•	•	•			•	•							5
	PSO 1	•	•	•			•		•			•	•	•																													8
	PSO 2		•	•			•		•			•	•	•									•	•	•																		10
	PSO 3		•	•			•		•			•	•	•									•	•	•																		10
CO 5	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																•	•	•			•																					4
	PO 4																													•	•	•			•	•							5
	PO 5		•	•	•	•	•		•														•	•	•																		9

	PO 11																											•	•	•			•	•								5
	PSO 1	•	•	•		•		•			•	•	•																												8
	PSO 2		•	•		•		•			•	•	•								•	•	•																		10
	PSO 3		•	•		•		•			•	•	•								•	•	•																		10
CO 6	PO 1	•	•	•	•	•	•		•			•	•	•																											10
	PO 2	•	•	•	•	•	•		•			•	•	•																											10
	PO 3																•	•	•			•																			4
	PO 4																											•	•	•			•	•								5
	PO 5		•	•	•	•	•		•													•	•	•																	9
	PO 6	•													•	•	•			•					•	•															8
	PO 11																											•	•	•			•	•								5
	PSO 1	•	•	•		•		•			•	•	•																												8
	PSO 2		•	•		•		•			•	•	•																												10
	PSO 3		•	•		•		•			•	•	•																												10

SECTION 11B: Indicators of Attainment with COs to POs and PSOs															
Course Outcomes	Percentage of Indicators of Attainments (IA) with POs and PSOs														
	PO												PSO		
	1	2	3	4	5	6	7		8	9	10	11	1	2	3
CO1	-	-	-	71	82	-	-	-	-	-	-	-	-	-	67
CO2	-	-	-	71	82	-	-	-	-	-	-	-	-	-	67
CO3	-	-	-	71	82	-	-	-	-	-	-	-	-	-	67
CO4	-	-	-	71	82	-	-	-	-	-	-	-	-	-	67
CO5	-	-	-	71	82	-	-	-	-	-	-	-	-	-	67
CO6	-	-	-		82	-	-	-	82	82	-	-	90	-	67

SECTION 11C: Course Articulation Matrix of COs to POs			
0 No Contribution (0-5%)	1 Low (≥5 - <40%)	2 Moderate (≥40 - <60%)	3 High (≥60%)
-			

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	-	-	-	3	3	-	-	-	-	-	-	-	-	3
CO2	-	-	-	3	3	-	-	-	-	-	-	-	-	3
CO3	-	-	-	3	3	-	-	-	-	-	-	-	-	3
CO4	-	-	-	3	3	-	-	-	-	-	-	-	-	3
CO5	-	-	-	3	3	-	-	-	-	-	-	-	-	3
CO6	-	-	-		3	-	-	3	3	-	-	2	-	3
Total	-	-	-	15	18	-	-	3	3	-	-	2	-	18
Average	-	-	-	3	3	-	-	3	3	-	-	2	-	3

SECTION 11D: Level of Contribution of the COs to POs and PSOs			
Number	**Programme Outcomes**	**Proficiency Assessed by**	**Contribution Level (from 1 to 3)**
PO 1	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**.	CIE / SEE / AAT:1 – 2 Assignments / Open-ended problems	**3**
PO 2	Identify, formulate, review research literature and analyse **complex engineering problems** reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).	CIE / SEE / AAT:1 – 2 Hack-a-thon	**3**
PO 3	Design creative solutions for **complex engineering problems** and design / develop systems / components/ processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**3**
PO 4	Conduct investigations of **complex engineering problems** using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**3**
PO 5	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve **complex engineering problems**. (WK2 and WK6).	CIE / SEE / AAT:2 – 2 Hack-a-thon	**3**
PO 6	Analyze and evaluate societal and environmental aspects while solving **complex engineering problems** for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7)	CIE / SEE / AAT:2 – 2 Hack-a-thon	**3**
PO 11	Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**3**
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications..	AAT: 1 – 1 Tech-Talk	**2**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	AAT: 2 – 1 Complex Engineering Problem Solving	**3**
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.	AAT: 2 – 1 Complex Engineering Problem Solving	**3**

SECTION 12: Course Content	
WEEK - I	**INTRODUCTION TO CARPENTRY**
	Preparation of the cross-half lap joint
WEEK- II	**INTRODUCTION TO FITTING**
	Making of a square fitting using mild steel plates

WEEK - III	**INTRODUCTION TO WELDING**
	Creating the lap joint in accordance with the mild steel plates
WEEK - IV	**INTRODUCTION TO SHEET METAL**
	Create the rectangular tray
WEEK - V	**INTRODUCTION TO BLACK SMITHY**
	Construct the J-hook using the given mild steel rod
WEEK - VI	**INTRODUCTION TO PLUMBING**
	Form of PVC pipe fitting of T Joint through various components
WEEK - VII	**INTRODUCTION TO MOULDING**
	Create the bearing housing mould
WEEK - VIII	**INTRODUCTION TO CONCRETE MOULDING AND PLASTER OF PARIS**
	Preparation of concrete cube by moulding technique
WEEK - IX	**INTRODUCTION TO HARD SOLDERING**
	Soldering of two mild steel plates
WEEK - X	**DEMONSTRATION ON COMPUTER NUMERICALLY CONTROLLED (CNC)LATHE**
	Demonstration of the plain turning process on a CNC lathe
WEEK - XI	**DEMONSTRATION ON COMPUTER NUMERICALLY CONTROLLED (CNC)MILLING**
	Demonstration of plain milling (facing) on CNC milling
WEEK - XII	**DEMONSTRATION ON 3D PRINTING MACHINE**
	Demonstration of 3D printing machine
WEEK - XIII	**DEMONSTRATION ON 6- AXIS ROBOT**
	Demonstration of the 6 – axis aristo robot
WEEK - XIV	**DEMONSTRATION ON CYLINDRICAL GRINDING MACHINE**
	Demonstration of grinding process on a cylindrical grinding machine

SECTION 13: Tentative Schedule of Instructions

Week Number	Topics	Duration (Hours)
1	Preparation of the cross-half lap joint	3
2	Making of a square fitting using mild steel plates	3
3	Creating the lap joint in accordance with the mild steel plates	3
4	Create the rectangular tray	3
5	Construct the J-hook using the given mild steel rod	3
6	Form of PVC pipe fitting of T Joint through various components	3
7	Create the bearing housing mould	3
8	Preparation of concrete cube by moulding technique	3
9	Soldering of two mild steel plates	3
10	Demonstration of the plain turning process on a CNC lathe	3
11	Demonstration of plain milling (facing) on CNC milling	3
12	Demonstration of 3D printing machine	3
13	Demonstration of the 6 – axis aristo robot	3
14	Demonstration of grinding process on a cylindrical grinding machine	3
15	CIE Examination & SEE Examination	6
	Total	**48**

SECTION 14: Specific Goals for the Course	
The following table shows the knowledge and skills covered by the unit outcomes:	
Knowledge	**Skills**
Learners should understand: 1. Carpentry and Woodworking Basics • Properties of wood • Types of carpentry joints • Tools used in carpentry 2. Fitting Fundamentals • Properties of mild steel • Filing, marking, and measuring techniques • Fitting tolerances 3. Welding Basics • Principles of welding • Types of weld joints • Safety precautions in welding 4. Sheet Metal Work • Properties of sheet metals • Bending and forming processes • Use of sheet metal tools 5. Blacksmithy • Forging techniques • Heating and shaping mild steel • Use of anvil and hammer 6. Plumbing • Types of pipes and fittings • Plumbing tools • Joining and sealing methods 7. Moulding • Types of moulds and patterns • Sand moulding techniques • Applications in casting 8. Concrete Moulding & Plaster of Paris • Properties of concrete and POP • Curing methods • Applications in construction 9. Hard Soldering • Principles of soldering • Types of fluxes and filler materials • Heat application methods	**Learners can:** 1. Prepare a Cross-Half Lap Joint using wood and hand tools • Make a Square Fitting using mild steel plates • Create a Lap Joint with mild steel plates using welding • Fabricate a Rectangular Tray using sheet metal • Construct a J-Hook using a mild steel rod • Prepare a PVC T-Joint Fitting using plumbing components • Create a Bearing Housing Mould • Prepare a Concrete Cube by moulding • Perform Soldering of Two Mild Steel Plates

10. CNC Lathe • Basics of CNC programming • Turning operations • CNC safety procedures	• Observe Plain Turning Process on CNC Lathe
11. CNC Milling • CNC milling operations • Facing techniques • Milling cutter types	• Observe Plain Milling (Facing) on CNC Milling Machine
12. 3D Printing • Principles of additive manufacturing • Materials used in 3D printing • Applications in industries	• Observe a 3D Printing Demonstration
13. Robotics • Basics of industrial robots • 6-axis robot kinematics • Applications in automation	• Observe 6-Axis Aristo Robot Demonstration
14. Grinding • Grinding principles • Cylindrical grinding techniques • Surface finishing	• Observe Cylindrical Grinding Process

Administrative Information

SECTION 15: History of changes		
Regulations	**Description of change**	**BOS Date**
R 18	Traditional syllabus with Machine shop, Carpentry, Fitting, Welding, Blacksmithy, Tinsmithy, Electrical, Moulding, Plastic/Blow moulding.	16.07.2018
UG 20	Removed Machine Shop, CNC, Plastic/Blow moulding, Focus shifted to Carpentry, Fitting, Blacksmithy, Tinsmithy, Electrical.	17.11.2020
BT 23	Introduced Modern Manufacturing & Robotics, added 3D Printing, CNC, Laser engraving, 6-Axis Robot, FANUC Simulator.	21.08.2023
BT 25	Streamlined to a balanced syllabus combining essential hands-on skills with modern technology demonstrations, making it more practical, efficient, and easier for students to grasp both traditional and modern workshop practices	02.09.2025

Course Outline Approvals	
Course Coordinator Name: Signature: Date:	**Head of the Department** Name: Signature: Date:
Dean of Outcome Based Teaching and Learning Name: Signature: Date:	**Dean of Academics** Name: Signature: Date:

Check List		
Section	**Description**	**Please tick (✓)**
1	General Information about the Course	
2	Notional Study Time	
3	A. Course Outcomes	
	B. Cognitive Levels	
4	Content and Context of the Course	
5	Complex Engineering Problem Solving	
6	A. Assessment Methods – Direct	
	B. Assessment Methods – Indirect	
7	Content Delivery / Instructional Methodologies	
8	Engineering Competencies (ECs) Focused	
9	Employability Skills	
10	Relevance to Sustainability goals	
11	A. Mapping between COs and POs / PSOs	
	B. Indicators of Attainment with COs to POs and PSOs	
	C. Course Articulation Matrix of COs to POs	
	D. Level of Contribution of the COs to POs and PSOs	
12	Syllabus	
13	Tentative Schedule of Instructions	
14	Specific Goals for the Course	
15	History of Changes	

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

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**Engineering Chemistry**
Course Code	AHSE03
Course Start	II Semester
Course Type	Foundation
Regulation	IARE - BT 25
Prerequisite Courses	Basic principles of chemistry
Department	Electronics and Communication Engineering
Number of Credits	3 Credits
Academic Year	2025-2026
Method(s) of Instruction	Theory
Course Administrator	**Dr. VNSR Venkateswararao,** Associate Professor Department of Chemistry IARE10682 vnsr.venkateswararao@iare.ac.in
Course Coordinator's Name	**Dr. C Mahender,** Assistant Professor Department of Chemistry IARE11131 c.mahender@iare.ac.in
Prior Learning Assessment and Recognition (PLAR)	Students interested in PLAR pathways for open learning can register one semester prior to the start of semester. Students will receive the necessary contact information one semester in advance.
Open Learning Faculty Member Information	Open Learning Faculty (OLF) is available to assist students. Students will receive the necessary contact information at the start of the course.
Course Webpage	https://akanksha.iare.ac.in/index?route=course/details&course_id=155
Course Description	The course focuses on the fundamental concepts of chemistry and then builds an interface with their industrial applications. It deals with the water purification processes, electrochemical principles in batteries, corrosion of metallic structures and preventive methods to control corrosion in metals, engineering materials such as plastics, fibers and elastomers, biodegradable polymers, renewable and non-renewable energy resources, nanomaterials, lubricants, biosensors and spectroscopic techniques leading to diverse applications across various fields, It cultivates the students to identify chemistry in each piece of finely engineered products used in industries.
Course Objectives	**The students will try to learn:** a. The different parameters to remove causes of hardness of water and their reactions towards complexometric method. b. The concepts of electrochemical principles and causes of corrosion in the new developments and breakthroughs efficiently in engineering and technology. c. The fundamental knowledge of conventional and non conventional energy sources and their applications in engineering.

	d. The different types of materials with respect to mechanisms and its significance in industrial applications.
Text and Reference Books	**Text Books** 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 Chemistry s. 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.
Learning Resources	**Course full stack** is made available in IARE learning management portal – Akansha, which includes lecture notes, tutorial question bank, definition and terminology, tech-talk topics, assignments, Model question papers (2 sets), power point presentations (PPTs) and ELRV lecture recordings at: 1.https://www.youtube.com/playlist?list=PLzkMouYverAL7JCnxG4A1auJeWFYzK2zr
Supplemental Materials	**Reading, videos and links** 1. Engineering chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S.Krishnan.http://www.cdeep.iitb.ac.in/webpage_data/nptel/Core%20Science/Engineering%20Chemistry%201/About-Faculty.html 2. https://books.google.co.in/books?id=R1JtyILNIsAC&pg=PR3&source=gbs_selected_pages&cad=3#v=onepage&q&f=false 3. https://books.google.co.in/books?id=eQTLCgAAQBAJ&pg=SA1PA53&source=gbs_selected_pages&cad=3#v=onepage&q&f=false
Learning and Teaching Strategies	Online material will provide the foundation of the learning resources, requiring the students to log in and engage regularly throughout the sixteen weeks of the course. There will be a mix of suggested readings, discussions and video content containing embedded digital content and undertake the assessment tasks.

SECTION 2: Teaching Learning Scheme

At least 48 lecture hours of scheduled teaching and learning activities (TLA) will be delivered in person, with the remaining hours for scheduled and self-scheduled teaching and learning activities delivered either in person or online.

Notional Study Time: 90 Hours (Lecture hours: 48, Tutorial hours: 8, Scheduled revision session hours: 2, Guided independent study hours: 15, Homework / Programming assignment hours: 10, Course project / Preparation for complex problem solving hours: 15)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA 1	Lectures	48	01	48
TLA 2	Tutorials	00	0	00
TLA 3	Case Study			
TLA 4	Problem Solving	10	01	10
TLA 5	Demonstration			
TLA 6	Scheduled revision sessions	02	01	02
TLA 7	Guided independent study: Directed viewing of video materials / PPTs			5

TLA 8	Independent private study			
TLA 9	Laboratory Exercises	0	0	0
TLA 10	Homework assignments / Programming assignments			5
TLA 11	Placement / work based learning or Specific practical training	0	0	0
TLA 12	Presentation / Seminar Preparation	5	1	5
TLA 13	Course Project / Preparation for Complex Problem Solving			0
TLA 14	Technical visit			
TLA 15	Field activities	0	0	0
			Total study hours	**75**
			Expected total study hours	**75**

SECTION 3A: Course Outcomes		
After successfully completing this course, the student will be able to:		
Outcome Number	**Course Outcomes**	**Learning Domain**
CO1	**Explain** the water quality characteristics for its usage in domestic and industrial purposes.	Understand
CO2	**Identify** complexometry for calculation of hardness of water to avoid industrial problems.	Apply
CO3	**Outline** the principles of electrochemical systems to control the corrosion in metals.	Understand
CO4	**Summarize** the applications of polymers based on their degradability and properties.	Understand
CO5	**Choose** the appropriate fuel based on their calorific value for energy efficient processes.	Apply
CO6	**Make use** of knowledge on advanced materials for technological improvements in various sectors.	Apply

SECTION 3B: Cognitive Levels	
Blooms Taxonomy Level	**Cognitive Level in Percentage (%)**
Remember	0
Understand	**50**
Apply	**50**
Analyse	0
Evaluate	0
Create	0

SECTION 4: Content and Context of Engineering Chemistry	
CO1	**Explain the water quality characteristics for its usage in domestic and industrial purposes.**
	The basic properties of water for its usage in domestic and industrial purposes can be justified by considering how water's unique characteristics influence its applications in various fields. Water is often called the "universal solvent" due to its ability to dissolve many substances, making it essential for a wide range of uses. Exploring the key properties of water and explain why they are critical for both domestic and industrial purposes.
CO2	**Identify complexometry for calculation of hardness of water to avoid industrial problems.**
	complexometric titration using EDTA is a justified and efficient method for calculating the hardness of water, which plays a crucial role in avoiding industrial problems such as scale formation, corrosion, and operational inefficiencies. This method provides Accurate measurement of hardness, allowing for targeted water treatment. Prevention of scale formation and equipment damage, extending the life of

	industrial systems.Optimized treatment processes, reducing chemical and maintenance costs. Therefore, complexometry is an essential tool in industrial water management, ensuring that water hardness is controlled to prevent detrimental effects on both operations and equipment, ultimately promoting cost-efficiency, system longevity, and regulatory compliance.
CO3	**Outline the principles of electrochemical systems to control the corrosion in metals.**
	Applying electrochemical systems to control corrosion lies in the fact that corrosion is inherently an electrochemical phenomenon.Understanding how electrons move and react in metal-environment interfaces allows us to develop effective control strategies, whether through cathodic protection, coatings, inhibitors, or alloying. Each method leverages an electrochemical principle to either prevent or slow down the reactions that lead to metal degradation.
CO4	**Summarize the applications of polymers based on their degradability and properties..**
	The extending applications of polymers based on their degradability and properties is justified by the diverse and impactful ways polymers are utilized across various industries. Biodegradable polymers offer sustainable alternatives for applications like packaging, agriculture, and medical devices, while non-degradable polymers remain essential for industries requiring durability and long-term performance. Photodegradable polymers provide a middle ground, breaking down upon exposure to sunlight, thus addressing the plastic waste issue in outdoor and single-use products. By understanding the specific needs of an application and selecting polymers accordingly, industries can benefit from improved performance, reduced environmental impact, and compliance with evolving sustainability goals.
CO5	**Choose the appropriate fuel based on their calorific value for energy efficient processes.**
	The selection of the appropriate fuel based on its calorific value is a key factor in ensuring energy-efficient processes. High-calorific-value fuels provide more energy per unit, resulting in reduced fuel consumption, lower operational costs, and reduced environmental impact. By carefully selecting fuels based on their calorific value, industries can maximize energy output, optimize fuel usage, minimize emissions, and improve the efficiency of their operations. However, this choice must also be balanced with other factors like fuel availability, cost, environmental considerations, and process-specific requirements. Ultimately, understanding and applying the concept of calorific value allows industries to make informed decisions that lead to more sustainable and energy-efficient processes.
CO6	**Make use of the knowledge on advanced materials for technological improvements in various sectors.**
	predicting the knowledge on the viability of advanced materials for technological improvements is justified by the fact that these materials offer unique properties that directly align with the needs of various sectors. Their ability to improve performance, reduce costs, and address environmental concerns makes them invaluable for the development of cutting-edge technologies in aerospace, energy, healthcare, electronics, and automotive industries. The continued research and development in advanced materials are critical for driving technological advancements, and understanding their viability allows industries to choose the most suitable materials for their specific requirements. This strategic selection can lead to more efficient, sustainable, and cost-effective solutions across multiple sectors.

SECTION 5: Complex Engineering Problem Solving

SECTION 6A: Assessment Methods – Direct			
Item	**Evaluation Components**	**Week in / out**	**Marks**
AAT: 1 - 1	Tech-Talk	Week – 2 / 5	05
AAT: 1 - 2	Definitions and Terminology	Week – 4 / 7	05
AAT: 2 - 1	Concept Vedio	Week – 9 / 12	05
AAT: 2 - 2	Assignment	Week – 12 / 15	05

CIE - 1	2 hours - Answer 4 out of 5 questions	Week - 9	10
CIE - 2	2 hours - Answer 4 out of 5 questions	Week - 17	10
SEE	3 hours - Answer 1 from each module	Week - 18	60
		Total Marks	**100**

Department's Late Submission Policy:

1. 1 – 24 hours: 25% of the mark will be deducted
2. > 24 hours: Not accepted

SECTION 6B: Assessment Methods –Indirect	
Course End Survey (End Semester OBE Feedback)	✓

SECTION 7: Engineering Competencies (ECs) Focused

Please tick (✓) relevant engineering competency profile covered

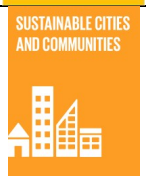
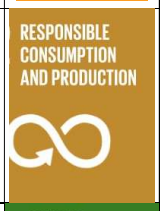
EC Number	Attributes	Profiles	(✓)
EC1	Depth of knowledge required (CP)	Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill-founded, illogical, erroneous, unreliable or unrealistic requirements applicable to the engineering discipline	✓
EC2	Depth of analysis required (CP)	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	-
EC3	Design and development of solutions (CA)	Support sustainable development solutions by ensuring functional requirements, minimize environmental impact and optimize resource utilization throughout the life cycle, while balancing performance and cost effectiveness.	✓
EC4	Range of conflicting requirements (CP)	Competently addresses complex engineering problems which involve uncertainty, ambiguity, imprecise information and wide-ranging or conflicting technical, engineering and other issues.	-
EC5	Infrequently encountered issues (CP)	Conceptualizes alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.	-
EC6	Protection of society (CA)	Identifies, quantifies, mitigates and manages technical, health, environmental, safety, economic and other contextual risks associated to seek achievable sustainable outcomes with engineering application in the designated engineering discipline.	✓
EC7	Range of resources (CA)	Involve the coordination of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies) in the timely delivery of outcomes	-
EC8	Extent of stakeholder involvement (CP)	Design and develop solution to complex engineering problem considering a very perspective and taking account of stakeholder views with widely varying needs.	-
EC9	Extent of applicable codes, legal and regulatory (CP)	Meet all level, legal, regulatory, relevant standards and codes of practice, protect public health and safety in the course of all engineering activities.	-
EC10	Interdependence (CP)	High level problems including many component parts or sub-problems, partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then re-combines to form a whole, with the integrity and performance of the overall system as the top consideration.	-
EC11	Continuing professional development (CPD) and lifelong learning (CA)	Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.	-
EC12	Judgement (CA)	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Require	-

		judgement in decision making in the course of all complex engineering activities.	

SECTION 8: 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.

SECTION 9: Relevance to Sustainability goals

Brief description about the course and its correlation with Sustainability Development Goal (SDGs).

SDG Goals		Correlation with SDG
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.
6		**Clean water and Sanitation:** Safe and readily available water is important for public health, domestic use, food production or recreational purpose. countries' economic growth and can contribute greatly to poverty reduction.
7		**Affordable and Clean Energy:** Affordable electricity is provided by clean energy sources such as solar, wind and hydropower**.**
11		**Sustainable Cities and Communities:** Renewable energy systems for sustainable cities.
12		**Responsible Composition and Production:** Renewable energy systems for sustainable cities
13		**Climate Action:** Non-renewable energy resources release harmful greenhouse gases into the atmosphere, creating the greenhouse effect which causes global warming.

15		**Life on Land:** The biodegradable plastics material focuses on creating a more sustainable and greener world with a smaller environmental imprint

SECTION 10A: Mapping between COs and POs / PSOs

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-
CO2	✓	✓	-	-	-	✓	-	-	-	-	-	-	-	-
CO3	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-
CO4	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-
CO5	✓	✓	-	-	-	✓	-	-	-	-	-	-	-	-
CO6	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-

Outcomes		WKS and Indicators of attainment and Justification for mapping (students will be able to)																																			IAs Count
COs	POs	WK 1	WK 2								WK 3			WK 4			WK 5						WK 6			WK 7				WK 8							WK 9						
		a	a	b	c	d	e	f	g	h	a	b	c	a	b	c	a	b	c	d	e	f	a	b	c	a	b	c	d	a	b	c	d	e	f	g	a	b	c	d	e	f	
CO1	PO 1	•			•	•	•	•			•	•	•	•	•	•																										11
	PO 6	•															•		•								•																04
CO2	PO 1	•	•	•	•	•	•	•			•	•	•	•	•	•																											13
	PO 2	•	•	•	•	•	•	•			•	•	•	•	•	•																											13
	PO 6	•															•		•								•																04
CO3	PO 1	•		•	•		•	•			•			•	•	•																											09
	PO 6	•															•		•		•					•	•	•																07
CO4	PO 1	•					•	•			•			•	•	•																											7
	PO 6	•															•		•		•						•	•																06
CO5	PO 1	•	•	•	•	•	•	•			•	•	•	•	•	•																											13
	PO 2	•	•	•	•	•	•	•			•	•	•	•	•	•																											13
	PO 6																•	•	•	•						•	•	•																07
CO6	PO 1	•		•	•	•	•	•			•	•	•	•	•	•																											12
	PO 6	•																	•		•						•	•																05

SECTION 10B: Indicators of Attainment with COs to POs and PSOs

Course Outcomes	Percentage of Indicators of Attainments (IA) with POs and PSOs														
	PO												PSO		
	1	2	3	4	5	6	7		8	9	10	11	1	2	3
CO1	73	-	-	-	-	36	-		-	-	-	-	-	-	-
CO2	87	87	-	-	-	36	-		-	-	-	-	-	-	-

CO3	60	-	-	-	-	64	-		-	-	-	-	-	-	-
CO4	47	-	-	-	-	54	-		-	-	-	-	-	-	-
CO5	87	87	-	-	-	64	-		-	-	-	-	-	-	-
CO6	80	-	-	-	-	45	-		-	-	-	-	-	-	-

SECTION 10C: Course Articulation Matrix of COs to POs

0 No Contribution (0-5%)	**1** Low (≥5 - <40%)	**2** Moderate (≥40 - <60%)	**3** High (≥60%)

Course Outcomes	**Program Outcomes (POs)**											**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	3	-	-	-	-	1	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	1	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	3	-	-	-	-	-	-	-	-
CO4	2	-	-	-	-	2	-	-	-	-	-	-	-	-
CO5	3	3	-	-	-	3	-	-	-	-	-	-	-	-
CO6	3	-	-	-	-	2	-	-	-	-	-	-	-	-
Total	17	6	-	-	-	12	-	-	-	-	-	-	-	-
Average	**3**	**3**	-	-	-	**2**	-	-	-	-	-	-	-	-

SECTION 10D: Level of Contribution of the COs to POs and PSOs

Number	**Programme Outcomes**	**Proficiency Assessed by**	**Contribution Level (from 1 to 3)**
PO 1	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**.	CIE / SEE / AAT: 1-1, 1-2,2-1,2-2 Tech-Talk / Assignment Definition and Terminology/Concept video	**3**
PO 2	Identify, formulate, review research literature and analyse **complex engineering problems** reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).	CIE / SEE / AAT: 1-1, 1-2,2-1,2-2 Tech-Talk / Assignment Definition and Terminology/Concept video	**3**
PO 3	Design creative solutions for **complex engineering problems** and design / develop systems / components/ processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)	-	**-**
PO 4	Conduct investigations of **complex engineering problems** using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)	-	**-**
PO 5	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve **complex engineering problems**. (WK2 and WK6).	-	**-**
PO 6	Analyze and evaluate societal and environmental aspects while solving **complex engineering problems** for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7)	CIE / SEE / AAT: 1-1, 1-2,2-1,2-2 Tech-Talk / Assignment Definition and Terminology/Concept video	**2**

PO 11	Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)	-	-
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.	-	-

SECTION 11: Course Content	
MODULE - I	**WATER AND ITS TREATMENT**
	Introduction: Hardness, types, degree of hardness and units ; estimation of temporary and permanent hardness of water by complexometric method, numerical problems; Potable water and its specifications (WHO), steps involved in treatment of potable water, disinfection of potable water by chlorination and breakpoint chlorination; Internal treatment of boiler feed water: Calgon conditioning, phosphate conditioning and colloidal conditioning; external treatment methods: Softening of water by ion-exchange processes; desalination of brackish water, reverse osmosis.
MODULE - II	**ELECTRO CHEMISTRY AND CORROSION**
	Introduction: Electrode potential, standard electrode potential, Nernst equation (no derivation); Electrochemical cells: Galvanic cell, cell representation, EMF of cell, numerical problems; Batteries: classification of batteries, construction, working and applications of Zinc-air and Li-ion battery; Corrosion: Definition, Causes and effects of corrosion; Theories of corrosion: Chemical and electrochemical theories of corrosion; Corrosion control methods: Cathodic protection methods, sacrificial anode and impressed current methods.
MODULE - III	**POLYMERS**
	Polymers: Classification of polymers; types of polymerization-addition and condensation polymerization; Plastics, elastomers and fibers: Preparation, properties and applications of PVC, Buna-S and Nylon 6,6; Differences between thermoplastics and thermosetting plastics; Conducting polymers: Definition, classification with examples, mechanism of conduction in trans poly acetylene and applications of conducting polymers; Biodegradable polymers: poly lactic acid and their applications.
MODULE - IV	**ENERGY SOURCES**
	Introduction and characteristics of good fuel; Fossil fuels: Introduction, classification, petroleum, refining of crude oil; Cracking: Definition, types of cracking, moving bed catalytic cracking. LPG and CNG composition and uses; Synthetic fuel: Fischer-Tropsch process; Alternative and non-conventional sources of energy: solar, wind and hydropower advantages and disadvantages; Calorific value: units, HCV and LCV and Dulongs formula, numerical problems.
MODULE - V	**ADVANCED FUNCTIONAL MATERIALS**
	Nanomaterials: Introduction, preparation of nanomaterials by sol-gel method, chemical reduction method and applications of nanomaterials. Biosensors: Definition, Amperometric glucose monitor sensor; IR spectroscopy in night vision-security; Pollution Under Control, CO sensor, Passive Infrared detection; Raman spectroscopy application, Tumour detection in medical applications; Lubricants: characteristics of a good lubricant; properties of lubricants: viscosity, flash and fire point, cloud and pour point.

SECTION 12: Tentative Schedule of Instructions

Week Number	Topics	Duration (Hours)
1	1.1 Hardness, types of hardness, degree of hardness and units. 1.2 Problems on temporary and permanent hardness in Degree French and ppm 1.3 Estimation of temporary and permanent hardness of water by complexometric method.	3
2	2.1 Problems on the temporary hardness and permanent hardness in terms of calcium carbonate equivalents by using EDTA method. 2.2 Potable water and its specifications, steps involved in treatment of potable water. 2.3 Disinfection of potable water by chlorination and breakpoint chlorination.	3
3	3.1 Internal treatment of boiler feed water, Calgon conditioning, phosphate conditioning and colloidal conditioning. 3.2 External treatment methods, Softening of water by ion-exchange processes. 3.3 Desalination of brackish water, reverse osmosis.	3
4	4.1 Electrode potential, standard electrode potential, Nernst equation (no derivation) 4.2 Electrochemical cells: Galvanic cell, cell representation, EMF of cell. 4.3 Problems on Nernst equation and EMF of cell.	3
5	5.1 Classification of batteries, construction, working and applications of Li-ion battery. 5.2 Construction, working and applications of and Li-ion battery. 5.3 Definition, Causes and effects of corrosion.	3
6	6.1 Chemical theories of corrosion. 6.2 Electrochemical theories of corrosion. 6.3 Cathodic protection methods, sacrificial anode and impressed current methods.	3
7	7.1 Polymers, Classification of polymers 7.2 Types of polymerization-addition and condensation polymerization. 7.3 Plastics, elastomers and fibers, Differences between thermoplastics and thermosetting plastics	3
8	8.1 Preparation, properties, and engineering applications of PVC 8.2 Preparation, properties, and engineering applications of Nylon 6,6. 8.3 Preparation, properties, and engineering applications of Buna-S rubber.	3
CONTINIUOUS INTERNAL EXAMINATION (CIE- I)		
9	9.1 Conducting polymers: Definition, classification with examples, mechanism of conduction in trans poly acetylene and applications of conducting polymers 9.2 Biodegradable polymers, poly lactic acid and their applications. 9.3 Classification and characteristics of good fuel	3
10	10.1 Petroleum, refining of crude oil 10.2 Cracking, definition, types of cracking, moving bed catalytic cracking 10.3 LPG and CNG composition and uses	3
11	11.1 Synthetic fuel, Fischer-Tropsch process 11.2 Alternative and non-conventional sources of energy: solar, advantages and disadvantages. 11.3 Alternative and non-conventional sources of energy: wind advantages and disadvantages.	3
12	12.1 Alternative and non-conventional sources of energy: Hydropower advantages and disadvantages. 12.2 Calorific value, units, HCV and LCV and Dulongs formula 12.3 Problems on the higher and lower calorific values of the fuel.	3
13	13.1 Problems on the gross and net calorific values of the fuel. 13.2 Problems on HCV and LCV. 13.3 Nanomaterials, preparation of nanoparticles by sol-gel method.	3
14	14.1 Preparation of nanoparticles by chemical reduction method. 14.2 Applications of nanomaterials. 14.3 Biosensors: Definition, Amperometric glucose monitor sensor.	3
15	15.1 IR spectroscopy in night vision-security, Pollution Under Control, 15.2 CO sensor, Passive Infrared detection. 15.3 Raman spectroscopy application, Tumour detection in medical applications.	3
16	16.1 Lubricants, characteristics of a good lubricant. 16.2 properties of lubricants, viscosity, flash and fire point. 16.3 cloud and pour point of lubricants.	3
	Total	**48**

SECTION 14: Specific Goals for the Course	
The following table shows the knowledge and skills covered by the unit outcomes:	
Knowledge	**Skills**
Learners should understand: • The different water treatment methods to use in industries and domestic purpose. • The operation of electrochemical cell to produce electrical energy from spontaneous redox reaction in a cell. • Corrosion process in metals in presence of environment. • Polymerization process to synthesize the polymers • Qualitative and quantitative analysis of fuel to prevent problems in industries. • Synthetic process of nanomaterials. • Chemical reactions in setting and hardnening of cement. • Importance of smart materials.	**Learners can:** • Use complexometry method to calculate the hardness of water • Use standard reduction potential data to determine the relative strength of oxidizing and reducing agents. • Use sacrificial anodes to control corrosion in metal structures. • Use polymers in various sectors based on their properties. • Dulong's formula to find the higher calorific value and lower calorific value of fuels • Properties of lubricants to avoid problems in industries. • Lubrication process to apply under different load, pressure and temperature.

Administrative Information

SECTION 15: History of changes		
Regulations	**Description of change**	**BOS Date**
R 16	From R15 JNTUH, Hyderabad to R16 IARE regulations with change in V module • 40% of syllabus changed	24.07.2016
R 18	Changes from R16 to R18 regulation • Credit weightage is reduced from 4 to 3. • 50% of syllabus changed	16.07.2018
UG 20	Changes from R18 to UG 20 regulation • 50% of syllabus changed, Change of course name	17.11.2020
BT 23	Incorporated the following additions in BT 23 regulations • 30% of syllabus changed	21.08.2023
BT 25	Incorporated the following additions in BT 25 regulations • 20% of syllabus changed	18.08.2025

Course Outline Approvals	
Course Coordinator Name: Dr. C Mahender Signature: Date:	**Head of the Department** Name: Dr.V Anitha Rani Signature: Date:
Course Outline Approvals: The course outline description approved by Outcome Based Teaching Learning (OBTL) committee on *date* in meetings *IARE - OBTL – COD /104/25*	
Dean of Outcome Based Teaching and Learning Name: Dr.Srinivasulu Signature: Date:	**Dean of Academics** Name: Dr.GVR Sheshagiri Rao Signature: Date:

Check List

Section	Description	Please tick (✓)
1	General Information about the Course	✓
2	Notional Study Time	✓
3	A. Course Outcomes	✓
	B. Cognitive Levels	✓
4	Content and Context of the Course	✓
5	Complex Engineering Problem Solving	-
6	A. Assessment Methods – Direct	✓
	B. Assessment Methods – Indirect	✓
7	Content Delivery / Instructional Methodologies	✓
8	Engineering Competencies (ECs) Focused	✓
9	Employability Skills	✓
10	Relevance to Sustainability goals	✓
11	A. Mapping between COs and POs / PSOs	✓
	B. Indicators of Attainment with COs to POs and PSOs	✓
	C. Course Articulation Matrix of COs to POs	✓
	D. Level of Contribution of the COs to POs and PSOs	✓
12	Syllabus	✓
13	Tentative Schedule of Instructions	✓
14	Specific Goals for the Course	✓
15	History of Changes	✓

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

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**Ordinary Differential equations and vector calculus**
Course Code	AHSE08
Course Start	Second Semester
Course Type	Core
Regulation	IARE - BT 25
Prerequisite Courses	Matrices and calculus (AHSE01)
Department	Electronics and Communication Engineering
Number of Credits	3 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Theory
Course Administrator	**Mr. G. Satyanarayana** Assistant Professor of Mathematics IARE10774 g.satyanarayana@iare.ac.in
Course Coordinator's Name	**Dr. Madhusudan Dolai,** Assistant Professor of Mathematics IARE11180 d.madhusudan@iare.ac.in
Prior Learning Assessment and Recognition (PLAR)	Students interested in PLAR pathways for open learning can register one semester prior to the start of semester. Students will receive the necessary contact information one semester in advance.
Open Learning Faculty Member Information	Open Learning Faculty (OLF) is available to assist students. Students will receive the necessary contact information at the start of the course.
Course Webpage	https://akanksha.iare.ac.in/index?route=course/details&course_id=1787
Course Description	This course provides a comprehensive introduction to two fundamental areas differential equations and vector calculus. Students will explore the theory, techniques, and applications of differential equations, focusing on ordinary differential equations. course teaches how to use this powerful integral tool to convert complex differential/integral equations (in the time domain) into simpler algebraic equations, making them easier to solve, especially for engineering/science problems in circuits, control systems Additionally, the course delves into vector calculus, which involves the study of vector fields and operations like gradient, divergence, and curl. Key topics include line integrals, surface integrals, Green's theorem, Stokes' theorem, and the Divergence theorem, all of which are essential for understanding the behaviour of fields in multidimensional spaces. Throughout the course, students will develop both analytical and computational skills to solve problems and interpret results. By the end of the course, students will have the knowledge to approach complex scientific and engineering problems that require differential equations and vector calculus techniques.

Course Objectives	**The students will try to learn:** a. The analytical methods for solving first and higher order differential equations with constant coefficients. b. The Laplace techniques for solving initial/boundary value and engineering/physics problems c. The physical quantities of vector valued functions involved in engineering field. d. The logic of vector theorems for finding line, surface and volume integrals.
Text and Reference Books	**Text Books** 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. N.P. Bali and Manish Goyal "A textbook of Engineering Mathematics" Laxmi Publications, Reprint,2008, 3. B.V. Ramana, "Higher Engineering Mathematics", McGraw Hill Education.
Learning Resources	**Course full stack** is made available in IARE learning management portal – Akansha, which includes lecture notes, tutorial question bank, definition and terminology, tech-talk topics, assignments, Model question papers (2 sets), complex engineering problem solving statements, power point presentations (PPTs) and ELRV lecture recordings at: • https://www.youtube.com/playlist?list=PLzkMouYverAJun1tS4k59J7jNLEDOw0vq • https://www.youtube.com/playlist?list=PLzkMouYverAKJBoz5syuBzg1tn6LecSKz
Supplemental Materials	**Readings, Videos, and Links** 1. https://onlinecourses.nptel.ac.in/noc23_ma88/preview 2. 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
Learning and Teaching Strategies	Online material will provide the foundation of the learning resources, requiring the students to log in and engage regularly throughout the sixteen weeks of the course. There will be a mix of suggested readings, discussions and video content containing embedded digital content and undertake the assessment tasks.

SECTION 2: Teaching Learning Scheme

At least 48 lecture hours of scheduled teaching and learning activities (TLA) will be delivered in person, with the remaining hours for scheduled and self-scheduled teaching and learning activities delivered either in person or online.

Notional Study Time: 90 Hours (Lecture hours: 48, Tutorial hours:16, Scheduled revision session hours: 2, Homework / Programming assignment hours: 10, Course project / Preparation for complex problem solving hours: 14)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA 1	Lectures	48	01	48

TLA 2	Tutorials	0	0	0
TLA 3	Case Study			
TLA 4	Problem Solving			14
TLA 5	Demonstration			
TLA 6	Scheduled revision sessions	02	01	02
TLA 7	Guided independent study: Directed viewing of video materials / PPTs			
TLA 8	Independent private study			
TLA 9	Laboratory Exercises	0	0	0
TLA 10	Homework assignments / Programming assignments			10
TLA 11	Placement / work based learning or Specific practical training	0	0	0
TLA 12	Presentation / Seminar Preparation			
TLA 13	Course Project / Preparation for Complex Problem Solving			
TLA 14	Technical visit			
TLA 15	Field activities	0	0	0
			Total study hours	**74**
			Expected total study hours	**74**

SECTION 3A: Course Outcomes

After successfully completing this course, the student will be able to:

Outcome Number	Course Outcomes	Learning Domain
CO1	**Utilize** the methods of differential equations for solving the orthogonal trajectories and Newton's law of cooling.	Apply
CO2	**Solve** the higher order linear differential equations with constant coefficients by using method of variation of parameters.	Apply
CO3	**Apply** Laplace Transforms to evaluate Integrals and to solve Ordinary Differential Equations.	Apply
CO4	**Apply** inverse Laplace transforms for finding initial value problems	Apply
CO5	**Interpret** the vector differential operators and their relationships for solving engineering problems.	Understand
CO6	**Apply** the integral transformations to surface, volume and line of different geometrical models in the domain of engineering.	Apply

SECTION 3B: Cognitive Levels

Blooms Taxonomy Level	Cognitive Level in Percentage (%)
Remember	0
Understand	16
Apply	84
Analyse	0
Evaluate	0
Create	0

SECTION 4: Content and Context of Ordinary Differential Equations and Vector Calculus	
CO1	**Utilize the methods of differential equations for solving the orthogonal trajectories and Newton's law of cooling.**
	Make the student to understand basics of ordinary differential equations. They should made know that the basics of ordinary differential equations of first order and first degree. Teach learners about some standard methods of solving ordinary differential equations of first order and first degree. They should understand the process of determining the orthogonal trajectories through differential equations. This course focuses on the analysis and solution of First-Order Ordinary Differential Equations (ODEs) with an emphasis on two important applications: Orthogonal Trajectories and Newton's Law of Cooling. The course will cover the process of determining the differential equation for a family of curves and the method for finding the orthogonal trajectories of this family. The course will also introduce Newton's Law of Cooling, which describes the rate of change of the temperature of an object in relation to the ambient temperature. The course will cover how this law can be modelled using first-order linear differential equations and will guide students through solving such equations.
CO2	**Solve the higher order linear differential equations with constant coefficients by using method of variation of parameters.**
	Make the student to understand about the foundational principles of first order differential equations to extends to equations involving higher derivatives. Teach learners how to solve linear ODEs, particularly with constant coefficients, and make them to understand the nature of solutions in both homogeneous and non-homogeneous cases. Learners should also know about the method of variation of parameters to find a particular solution to a nonhomogeneous linear differential equation, which is useful for higher-order ordinary differential equations.
CO3	**Apply Laplace Transforms to evaluate Integrals and to solve Ordinary Differential Equations.**
	Teach learners about the formulas and properties of Laplace transforms. Make the student to understand Differentiation and Integration of Laplace transforms. Teach learners about periodic functions with examples. Learners should know about applying Laplace transforms exploring their applications in physics, engineering, and applied mathematics.
CO4	**Apply inverse Laplace transforms for finding initial value problems**
	Learners should have basic knowledge of partial fraction decomposition techniques. Teach learner about the formulas of inverse Laplace transforms. Learner should Understand the statement of Convolution theorem and apply to the functions They should know that how to use the formulas and theorems of inverse Laplace transforms. Learner should Understand solving initial value problems by Laplace transform method. Learners should be made to learn the usage real-world applications of these formulas, techniques and theorems in physics, engineering ,and develop problem-solving skills for solving ordinary differential equations .
CO5	**Interpret the vector differential operators and their relationships for solving engineering problems.**
	Learners are required to know basic calculus, including differentiation and integration of single variable functions. Teach learners fundamental concepts of vector differentiation and calculus tools such as gradients, divergences, and curls. Learner should understand the how vector functions change along arbitrary directions.
CO6	**Apply the integral transformations to surface, volume and line of different geometrical models in the domain of engineering**
	Learner should have the basic knowledge of the vector differentiation. Teach learner fundamental topics such as line integral, surface integral and volume integral. Make the Learner to understand the essential theorems like Green's theorem, Stokes' theorem, and the Gauss divergence Theorem. Make the learner capable to compute line, surface, and volume integrals in various coordinate systems. And also Apply the knowledge of key vector theorems to solve real-world problems.

SECTION 5: Complex Engineering Problem Solving

Complex Problem Solving

There is one piece of assessed coursework, involving a mixture of theoretical work. We encourage the students to get the ability to solve complex engineering problems using advanced mathematics can give companies and countries a competitive edge in the global market, driving economic growth and innovation.

Complex engineering problems in mathematics involve highly intricate and multifaceted challenges that require advanced mathematical techniques, interdisciplinary knowledge, and innovative problem-solving strategies. These problems often arise in real-world applications and demand a deep understanding of mathematical modelling, optimization, numerical methods, and computational techniques.

Complex engineering problems in mathematics are at the core of modern technological advancements. They require a blend of theoretical knowledge and computational skills to develop innovative solutions for real-world challenges. With the rise of artificial intelligence and computational power, engineers and mathematicians continue to tackle increasingly sophisticated problems, pushing the boundaries of what is possible in science and engineering.

SECTION 6A: Assessment Methods – Direct

Item	Evaluation Components	Week in / out	Marks
AAT: 1 – 1	Tech-Talk	Week – 2 / 5	05
AAT: 1 – 2	Assignments/open-ended problems	Week – 4 / 7	05
AAT: 2 – 1	Complex Engineering Problem Solving	Week – 9 / 12	05
AAT: 2 – 2	Assignments/open-ended problems	Week – 12 / 15	05
CIE – 1	2 hours - Answer 4 out of 5 questions	Week – 9	10
CIE – 2	2 hours - Answer 4 out of 5 questions	Week – 17	10
SEE	3 hours - Answer 1 from each module	Week – 18	60
		Total Marks	**100**

Department's Late Submission Policy:

1. 1 – 24 hours: 25% of the mark will be deducted
2. > 24 hours: Not accepted

SECTION 6B: Assessment Methods –Indirect

Course End Survey (End Semester OBE Feedback)	✓

SECTION 7: Engineering Competencies (ECs) Focused

Please tick (✓) relevant engineering competency profile covered

EC Number	Attributes	Profiles	(✓)
EC1	Depth of knowledge required (CP)	Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill-founded, illogical, erroneous, unreliable or unrealistic requirements applicable to the engineering discipline	✓
EC2	Depth of analysis required (CP)	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	✓
EC3	Design and development of solutions (CA)	Support sustainable development solutions by ensuring functional requirements, minimize environmental impact and optimize resource utilization throughout the life cycle, while balancing performance and cost effectiveness.	-

EC4	Range of conflicting requirements (CP)	Competently addresses complex engineering problems which involve uncertainty, ambiguity, imprecise information and wide-ranging or conflicting technical, engineering and other issues.	-
EC5	Infrequently encountered issues (CP)	Conceptualizes alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.	-
EC6	Protection of society (CA)	Identifies, quantifies, mitigates and manages technical, health, environmental, safety, economic and other contextual risks associated to seek achievable sustainable outcomes with engineering application in the designated engineering discipline.	-
EC7	Range of resources (CA)	Involve the coordination of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies) in the timely delivery of outcomes	-
EC8	Extent of stakeholder involvement (CP)	Design and develop solution to complex engineering problem considering a very perspective and taking account of stakeholder views with widely varying needs.	-
EC9	Extent of applicable codes, legal and regulatory (CP)	Meet all level, legal, regulatory, relevant standards and codes of practice, protect public health and safety in the course of all engineering activities.	-
EC10	Interdependence (CP)	High level problems including many component parts or sub-problems, partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then re-combines to form a whole, with the integrity and performance of the overall system as the top consideration.	-
EC11	Continuing professional development (CPD) and lifelong learning (CA)	Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.	-
EC12	Judgement (CA)	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Require judgement in decision making in the course of all complex engineering activities.	-

SECTION 8: Employability Skills

Example: Communication skills / Programming skills / Project based skills

There is one piece of assessed coursework, Studying Differential equations and vector calculus enhance the ability to model dynamic systems, and contribute to advancements in various fields. This expertise is particularly valuable in problem solving, analytical, and computational skills.

STEM (Science, Technology, Engineering, and Mathematics) careers, where analytical and technical skills are in high demand.

Employability Skills:

- Problem-solving skills for designing efficient solutions.
- Logical and analytical thinking for Problem-solving.
- Proficiency in mathematical modelling.
- Computational and Numerical skills in data analysis and engineering design.
- Interdisciplinary knowledge in systems engineering and data science.
- Teamwork and consulting in. complex mathematical concepts
- Programming and Software Proficiency in engineering simulations.

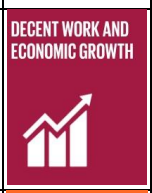
Project Management:

- Planning and organizing project timelines and tasks.
- Identifying resources and assign the roles effectively.
- Collaborating and communicating with team members.

- Identifying and mitigating project risks.
- Testing and validating system performance.

SECTION 9: Relevance to Sustainability goals

Brief description about the course and its correlation with Sustainability Development Goal (SDGs).

SDG Goals		Correlation with SDG
4		**Quality Education:** This subject equips students with problem-solving and analytical skills, fostering innovation and critical thinking. These mathematical tools are essential for training the next generation of scientists, engineers, and policymakers to tackle sustainability challenges.
8		**Decent Work and Economic Growth:**
9		**Industry, Innovation, and Infrastructure:**
11		**Sustainable Cities and Communities:**
17		**Partnerships for the Goals:**

SECTION 10A: Mapping between COs and POs / PSOs

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO2	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO3	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO5	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO6	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-

Outcomes		WKS and Indicators of attainment and Justification for mapping (students will be able to)																																									IAs Count
COs	POs	WK 1	WK 2								WK 3			WK 4			WK 5						WK 6			WK 7				WK 8							WK 9						
		a	A	b	c	d	e	f	g	h	a	b	c	a	b	c	a	b	c	D	e	f	a	b	c	a	b	c	d	a	b	c	D	e	f	g	a	b	c	d	e	f	
CO 1	PO 1	•	•	•		•	•	•			•	•		•																													9
	PO 2	•	•	•		•	•	•			•	•		•																													9
	PO 3																																										
	PO 11																																										
	PSO 1																																										
CO2	PO 1	•	•	•		•	•	•			•	•		•																													9
	PO 2	•	•	•		•	•	•			•	•		•																													9
	PO 3																																										
	PO 4																																										
	PO 5																																										
	PO 11																																										
	PSO 1																																										
	PSO 3																																										
CO3	PO 1	•	•	•		•	•	•			•	•		•																													9
	PO 2																																										
	PO 3																																										
	PO 4																																										
	PO 5																																										
	PO 11																																										
	PSO 1																																										
	PSO 2																																										
	PSO 3																																										
CO4	PO 1	•	•	•		•	•	•			•	•		•																													9
	PO 2	•	•	•		•	•	•			•	•		•																													9
	PO 3																																										
	PO 4																																										
	PO 5																																										
	PO 11																																										
	PSO 1																																										
	PSO 2																																										
	PSO 3																																										
CO 5	PO 1	•	•	•		•	•	•			•	•		•																													9
	PO 2	•	•	•		•	•	•			•	•		•																													9
	PO 3																																										
	PO 4																																										

	PO 5																																										
	PO 11																																										
	PSO 1																																										
	PSO 2																																										
	PSO 3																																										
CO 6	PO 1	•	•	•		•	•	•			•	•		•																													9
	PO 2	•	•	•		•	•	•			•	•		•																													9
	PO 3																																										
	PO 4																																										
	PO 5																																										
	PO 6																																										
	PO 11																																										
	PSO 1																																										
	PSO 2																																										
	PSO 3																																										

SECTION 10B: Indicators of Attainment with COs to POs and PSOs

Course Outcomes	Percentage of Indicators of Attainments (IA) with POs and PSOs														
	PO												PSO		
	1	2	3	4	5	6	7		8	9	10	11	1	2	3
CO1	60	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	60	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	60	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	60	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO6	60	60	-	-	-	-	-	-	-	-	-	-	-	-	-

SECTION 10C: Course Articulation Matrix of COs to Pos

0 No Contribution (0-5%)	**1** Low (≥5 - <40%)	**2** Moderate (≥40 - <60%)	**3** High (≥60%)

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO6	3	3	-	-	-	-	-	-	-	-	-	-	-	-
Total	18	15	-	-	-	-	-	-	-	-	-	-	-	-
Average	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

SECTION 10D: Level of Contribution of the COs to POs and PSOs			
Number	**Programme Outcomes**	**Proficiency Assessed by**	**Contribution Level (from 1 to 3)**
PO 1	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**.	CIE / SEE / AAT:1 – 2 Assignments / Open-ended problems	**3**
PO 2	Identify, formulate, review research literature and analyse **complex engineering problems** reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).	CIE / SEE / AAT:1 – 2	**3**
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	AAT: 1 – 1 Tech-Talk	
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	AAT: 2 – 1 Complex Engineering Problem Solving	
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.	AAT: 2 – 1	

SECTION 11: Course Content	
MODULE – I	**FIRSTORDERAND FIRST DEGREE ODE**
	Exact differential equations, Equations reducible to exact differential equations, linear and Bernoulli's equations, Applications: Orthogonal Trajectories (Cartesian Coordinates) Newton's law of cooling, law of natural growth and decay.
MODULE – II	**ORDINARY DIFFERENTIAL EQUATIONS OF HIGHER ORDER**
	Second order linear differential equations with constant coefficients: non-homogeneous terms of the type e^{ax}, sinax , cosax , polynomials in x, $e^{ax}V(x)$ and xV(x),, method of variation of parameters
MODULE – III	**LAPLACE TRANSFORMS**
	Laplace transforms: Laplace transform of standard functions, first shifting theorem, Laplace transforms of functions multiplied by 't' and divided by 't', Laplace transforms of derivatives and integrals of function, evaluation of integrals by Laplace transforms, Laplace transform of periodic functions. Inverse Laplace transform by different methods, Convolution theorem (without proof). Applications: solving initial value problems by Laplace transform method
MODULE – IV	**VECTOR DIFFERNTIATION**
	Scalar and vector point functions; definitions of gradient, divergent and curl , directional derivative; vector identities solenoidal and irrotational vector point functions; scalar potential function.
MODULE – V	**VECTOR INTEGRATION**
	Line integral, surface integral and volume integral, Green's theorem in a plane, Stoke's theorem and Gauss divergence theorem without proofs.

SECTION 12: Tentative Schedule of Instructions		
Week Number	**Topics**	**Duration (Hours)**
1	1.1 Introduction to ordinary Differential equations 1.2 Variable Separable, homogenous and non-homogenous differential equations 1.3 Exact differential equations	3
2	2.1 Non- Exact Differential equations (Method-1) 2.2 Non-Exact Differential equations (Method-2) 2.3 Non-Exact Differential equations (Method-3)	3
3	3.1 Non-Exact Differential equations (Method-4) 3.2 Non-Exact Differential equations (Method-5) 3.3 Linear differential equations of first order	3
4	4.1 Bernoulli's Equation 4.2 Applications of ODE, Orthogonal trajectories 4.3 Applications of ODE, Newton's law of cooling 4.4 Applications of ODE, natural growth and decay	3
5	5.1 Linear Differential Equations of Second and Higher Order with Constant Coefficients 5.2 Non-Homogeneous term of the type f (X) = e^{ax}	3
6	6.1 Non-Homogeneous term of the type f (X) = Sinax 6.2 Non-Homogeneous term of the type f (X) = Cosax 6.3 Non-Homogeneous term of the type f (X) = X^n	3
7	7.1 Non-Homogeneous term of the type f (X) = X^n 7.2 Determine particular non-homogeneous term of the type f (X) = e^{ax} V(x) 7.3 Determine particular non-homogeneous term of the type f (X) = x V(x) 7.4 Solving second order linear differential equations using method of variation of parameters	3
8	8.1 Laplace transform of standard functions, first shifting theorem 8.2 Laplace transforms of functions multiplied by 't' and divided by 't' 8.3 Laplace transforms of derivatives and integrals of function, 8.4 evaluation of integrals by Laplace transforms, Laplace transform of periodic functions.	3
CONTINIUOUS INTERNAL EXAMINATION (CIE- II)		
9	9.1 Inverse Laplace transform by different methods 9.2 Convolution theorem (without proof) 9.3 solving initial value problems by Laplace transform method	3
10	10.1 In Scalar and Vector Point Function (Definitions of Gradient, divergent, curl 10.2 Problems on Gradient of vector point functions 10.3 Problems on divergence of vector point functions	3
11	11.1 Problems on divergence and curl 11.2 Problems on directional derivative 11.3 Vector identities	3
12	12.1 Problems on directional derivative 12.2 Solenoidal and irrotational vectors 12.3. Problems on Solenoidal and irrotational vectors	3
13	13.1 Introduction to Line integral 13.2 Problems on line integral 13.3 Surface Integral	3
14	14.1 Problems on surface integral 14.2 Volume integral 14.3 Problems on Volume integral	3
15	15.1 Green's theorem 15.2 Calculating areas by using Green's theorem 15.3 Stoke's theorem	3
16	16.1 Problems on Stoke's theorem 16.2 Gauss divergence theorem 16.3 Gauss divergence theorem	3

Total	**48**

SECTION 14: Specific Goals for the Course	
The following table shows the knowledge and skills covered by the unit outcomes:	
Knowledge	**Skills**
Learners should understand: • different types of first order first degree DE • various analytical methods to get solution • the physical or practical significance of the solutions obtained. • Translating real-world problems into mathematical models using higher-order ODEs. • the behaviour of systems • Solution Techniques • Economic models and financial derivatives. • How to solve differential equations easily with help of Laplace transforms. • How a system behaves over time from the poles of the Laplace transform • How to model the flow of vehicles on roads and networks. • How to analyse forces, motion, and energy in systems. • How identify conservative vector fields, and derive potential functions, which simplify calculations in physics and engineering.	**Learners can:** • Determine the DE for a family of curves • Determine the method for finding orthogonal trajectories of the family. • able to model Newtons law of cooling using first order linear ODE and can solve them • Enhancing your ability to approach and solve problems systematically. • Evaluate different methods to solve differential equations. • Can existing research on differential equations • Develop new methods or applying existing methods to new problems. • able to translate real-world phenomena into mathematical equations. • able to convert complex dynamic problems into solvable forms, • able to solve problems in electromagnetism, fluid dynamics, and continuum mechanics. • able to model physical phenomena using vector calculus, which is essential for simulations and predictions in various scientific domains.

Administrative Information

SECTION 15: History of changes		
Regulations	**Description of change**	**BOS Date**
R 16	From R15 JNTUH, Hyderabad to R16 IARE regulations with change in module-V • **Module - V:**	24.07.2016
R 18	Changes from R16 to R18 regulation • **Module I:** Root finding techniques, by bisection, False and Newton-Raphson method are introduced • **Module – II:** Finite difference, forward, back ward and central differences and interpolation of unequal intervals by Lagrane interpolation are introduced • Module-III: Numerical Analysis is introduced	16.07.2018
UG 20	Changes from R18 to UG 20 regulation • Vector Calculus: Gradient, curl, divergence and directional derivative are introduced in vector differentiation and in Green's theorem, Stoke's theorem and Gauss divergence theorem are introduced.	17.11.2020
BT 23	Incorporated the following additions in BT 23 regulations • Credit weightage is reduced from 4 to 3. • **Module – I:** Exact, Non-exact, Linear and Bernoulli's differential equations are introduced with applications orthogonal trajectories and Newton's law of cooling in First order first degree ODE • **Module – II:** Second and higher order ODE with constant coefficients with variation parameters method are introduced.	21.08.2023
BT25	Incorporated the following additions in BT 23 regulations	

	Module-I: Law of natural growth and decay **Module –III:** Laplace transforms: Laplace transform of standard functions, first shifting theorem, Laplace transforms of functions multiplied by 't' and divided by 't', Laplace transforms of derivatives and integrals of function, evaluation of integrals by Laplace transforms, Laplace transform of periodic functions. Inverse Laplace transform by different methods, Convolution theorem (without proof). Applications: solving initial value problems by Laplace transform method	

Course Outline Approvals	
Course Coordinator Name: Dr. Madhusudan Dolai Signature: Date:	**Head of the Department** Name: Dr. P. Srilatha Signature: Date:
Course Outline Approvals: The course outline description approved by Outcome Based Teaching Learning (OBTL) committee on *date* in meetings *IARE - OBTL – COD /104/25*	
Dean of Outcome Based Teaching and Learning Name: Dr. Ch. Srinivasulu Signature: Date:	**Dean of Academics** Name: Dr. G. Sheshagiri Rao Signature: Date:

Check List		
Section	**Description**	**Please tick (✓)**
1	General Information about the Course	
2	Notional Study Time	
3	A. Course Outcomes	
	B. Cognitive Levels	
4	Content and Context of the Course	
5	Complex Engineering Problem Solving	
6	A. Assessment Methods – Direct	
	B. Assessment Methods – Indirect	
7	Content Delivery / Instructional Methodologies	
8	Engineering Competencies (ECs) Focused	
9	Employability Skills	
10	Relevance to Sustainability goals	
11	A. Mapping between COs and POs / PSOs	
	B. Indicators of Attainment with COs to POs and PSOs	
	C. Course Articulation Matrix of COs to Pos	
	D. Level of Contribution of the COs to POs and PSOs	
12	Syllabus	
13	Tentative Schedule of Instructions	
14	Specific Goals for the Course	
15	History of Changes	

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**NETWORK ANALYSIS AND SYNTHESIS**
Course Code	**AEEE04**
Course Start	Second Semester
Course Type	Core
Regulation	IARE - BT 25
Prerequisite Courses	Matrices and Calculus and Electrical Circuits
Department	Electronics and Communication Engineering
Number of Credits	3 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Theory
Course Administrator	**Dr. Damodhar Reddy** Professor of Electrical and Electronics Engineering IARE11115 dr.damodharreddy@iare.ac.in
Course Coordinator's Name	**Mr.T. Ravi Babu** Assistant Professor of Electrical and Electronics Engineering IARE10732 travibabu@iare.ac.in
Prior Learning Assessment and Recognition (PLAR)	Students interested in PLAR pathways for open learning can register one semester prior to the start of semester. Students will receive the necessary contact information one semester in advance.
Open Learning Faculty Member Information	Open Learning Faculty (OLF) is available to assist students. Students will receive the necessary contact information at the start of the course.
Course Webpage	https://www.iare.ac.in/sites/default/files/BT25/AEEE04.pdf
Course Description	This course covers transient and steady-state analysis of RL, RC, and RLC circuits in both series and parallel configurations. It introduces Laplace transform techniques for circuit analysis and applications. The course also covers two-port network parameters and their interconnections. Additionally, it explores filter design concepts, including low-pass, high-pass, band-pass, and band-stop filters, and attenuators and network synthesis.
Course Objectives	**The students will try to learn:** a. The RL, RC, and RLC circuits under different excitations using integro-differential and Laplace transform approaches b. The two-port electrical networks and apply network topology concepts like tie-set and cut-set matrices for circuit analysis c. The various filter and attenuator configurations for frequency-selective and signal conditioning applications. d. The electrical networks using driving-point functions, positive real functions, and classical synthesis methods such as Foster and Causer forms.

Text and Reference Books	**Text Books** 1. Van Valkenburg M.E, "Network Analysis", Prentice Hall of India, 3rd Edition, 2000 2. William Hayt H, Kimmerly Jack E. and Steven Durbin M, "Engineering Circuit Analysis", McGraw Hill,6th Edition, 2002**.** 3. Ravish R Singh, "Network Analysis and Synthesis", McGraw Hill, 2nd Edition, 2019. **Reference Books** 1. A Sudhakar, Shyammohan S Palli, "Circuits and Networks: Analysis and Synthesis", McGraw Hill, 5th Edition, 2017. 2. Chakravarthy A., "Circuit Theory", Dhanpat Rai & Co., First Edition, 1999. 3. James W.Nilsson, Susan A.Riedel, "Electric Circuits", Pearson, 11th Edition, 2020. 4. B. Subramanyam, "Electric Circuit Analysis", Dreamtech Press & Wiley, 2021.
Learning Resources	https://www.iare.ac.in/sites/default/files/BT25/AEEE04.pdf
Supplemental Materials	**Readings, Videos, and Links** 1. NPTEL :: NOC : Basic Electrical Circuits, IIT Madras https://nptel.ac.in/courses/117106108 2. https://www.youtube.com/watch?v=25Ycc8Md8Cc#:~:text=Watch%20the%20full%20video%20to,unacademy.com/...
Learning and Teaching Strategies	Online material will provide the foundation of the learning resources, requiring the students to log in and engage regularly throughout the sixteen weeks of the course. There will be a mix of suggested readings, discussions and video content containing embedded digital content and undertake the assessment tasks.

SECTION 2: Teaching Learning Scheme

At least 48 lecture hours of scheduled teaching and learning activities (TLA) will be delivered in person, with the remaining hours for scheduled and self-scheduled teaching and learning activities delivered either in person or online.

Notional Study Time: 90 Hours (Lecture hours: 48, Tutorial hours: 8, Scheduled revision session hours: 2, Guided independent study hours: 15, Homework / Programming assignment hours: 10, Course project / Preparation for complex problem-solving hours: 15)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA1	Lectures	48	01	48
TLA 2	Tutorials	08	01	08
TLA 3	Case Study			
TLA 4	Problem Solving			
TLA 5	Demonstration			
TLA 6	Scheduled revision sessions	02	01	02
TLA 7	Guided independent study: Directed viewing of video materials / PPTs			15
TLA 8	Independent private study			
TLA 9	Laboratory Exercises	0	0	0
TLA 10	Homework assignments / Programming assignments			10
TLA 11	Placement / work based learning or Specific practical training	0	0	0
TLA 12	Presentation / Seminar Preparation			

TLA 13	Course Project / Preparation for Complex Problem Solving			15
TLA 14	Technical visit			
TLA 15	Field activities	0	0	0
			Total study hours	**90**
			Expected total study hours	**90**

SECTION 3A: Course Outcomes		
After successfully completing this course, the student will be able to:		
Outcome Number	**Course Outcomes**	**Learning Domain**
CO1	**Observe the response of transient and steady state analysis of RL, RC and RLC circuits (Series and Parallel).**	Understand
CO2	**Examine the behaviour of circuits using Laplace transforms**	Analyze
CO3	**Synthesize and manipulate abstruse network topology constructs to derive and interpret tie-set and cut-set matrices for intricate electrical networks.**	Create
CO4	**Design and critically evaluate multifaceted constant-K and M-derived filter architectures across diverse frequency spectra, employing advanced network synthesis principles.**	Create
CO5	**Apply different types of attenuators and equalizers to control signal strength and improve sound or signal quality in networks.**	Apply
CO6	**Learn to analyze and design different network types using impedance, admittance, poles, and zeros, and apply methods to create LC, RC, and RL circuits.**	Create

SECTION 3B: Cognitive Levels	
BloomsTaxonomyLevel	**Cognitive Level in Percentage (%)**
Remember	00
Understand	17
Apply	17
Analyze	16
Evaluate	00
Create	50

SECTION 4: Content and Context of Electrical Circuits	
CO1	**Observe the response of transient and steady state analysis of RL, RC and RLC circuits (Series and Parallel).**
	This topic covers the importance of initial conditions in resistors, inductors, and capacitors for accurate transient analysis. The transient response of series RL, RC, and RLC circuits is studied using the integro-differential method for both DC and sinusoidal excitations. Similarly, parallel RL, RC, and RLC circuits are analyzed to understand current and voltage evolution over time. The integro-differential approach provides a systematic method to solve circuit equations considering energy storage elements. Emphasis is placed on predicting circuit behavior during switching and response to varying inputs. Initial conditions in R, L, and C elements are critical for accurate prediction of transient behavior in electrical circuits. Understanding transient responses helps in designing and controlling circuits during switching events. The integro-differential approach provides a mathematical framework to analyze both series and parallel RLC networks under DC and sinusoidal excitations. This analysis is essential for evaluating voltage and current evolution over time in practical circuits. The concepts are applied in power systems, communication circuits, and electronic devices to ensure stability and proper performance.

CO2	**Examine the behaviour of circuits using Laplace transforms**
	This topic introduces Laplace transforms of standard inputs such as step, ramp, exponential, and impulse functions. The transient response of series RL, RC, and RLC circuits is analyzed using the Laplace transform method for both DC and sinusoidal excitations. Similarly, parallel RL, RC, and RLC circuits are studied to determine voltage and current responses. The Laplace transform approach provides a systematic and efficient method to solve integro-differential circuit equations. Emphasis is placed on predicting circuit behavior and response to various input signals in practical applications. Laplace transforms provide a powerful mathematical tool for analyzing circuit responses to various input signals. By transforming differential equations into algebraic equations, the transient behavior of series and parallel RL, RC, and RLC circuits can be studied efficiently. This approach applies to both DC and sinusoidal excitations, simplifying the calculation of voltage and current responses. Understanding these responses is essential for designing stable and reliable electrical networks. These concepts are widely used in power systems, signal processing, and control engineering applications.
CO3	**Synthesize and manipulate abstruse network topology constructs to derive and interpret tie-set and cut-set matrices for intricate electrical networks.**
	The topic introduces two-port network parameters including open-circuit impedance (Z), short-circuit admittance (Y), transmission (ABCD), and hybrid (h) parameters along with their inter-relationships. Methods for analyzing series, parallel, and cascade connections of two-port networks are discussed. Fundamentals of network topology using graph theory are presented. Key topological elements such as graphs, trees, chords, and branches are defined. The formulation of tie-set and cut-set matrices for systematic network analysis is explained. Numerical problems on tie-set and cut-set matrices are solved to reinforce understanding. These topics form the foundation for systematic analysis and modelling of electrical networks used in communication, control, and power systems. Two-port network parameters enable simplified representation of complex circuits for interconnection and performance evaluation. Inter-relationships among parameters allow flexibility in analysis under different boundary conditions. Network topology concepts provide a graph-theoretic approach to handle large and intricate networks efficiently. Tie-set and cut-set matrices support computer-aided circuit analysis using KVL and KCL. Practical problem-solving strengthens readiness for advanced network synthesis and system design applications.
CO4	**Design and critically evaluate multifaceted constant-K and M-derived filter architectures across diverse frequency spectra, employing advanced network synthesis principles.**
	The topic covers the classification of filters into low-pass, high-pass, band-pass, and band-stop types. It introduces basic filter networks and their role in controlling signal frequency components. Constant-K filters are discussed with design and characteristics of low-pass, high-pass, band-pass, and band-stop configurations. M-derived filters are explained, highlighting improvements over constant-K filters in impedance matching and cut off sharpness. Both T and π configurations of low-pass and high-pass M-derived filters are covered. Practical examples and design equations are included for analyzing and constructing filter circuits. Filters are essential in electrical and communication systems for controlling and shaping signal frequencies. Understanding filter classification helps in selecting the right type for signal processing applications. Constant-K and M-derived filters form the basis of analog filter design, providing predictable frequency response. Low-pass, high-pass, band-pass, and band-stop filters are applied to allow or reject specific frequency bands. T and π configurations of M-derived filters improve termination matching and selectivity. This topic equips students with the skills to design, analyze, and implement practical filter networks for various applications.
CO5	**Apply different types of attenuators and equalizers to control signal strength and improve sound or signal quality in networks.**
	The topic covers attenuators and their types including T, π, L, Bridge-T, and lattice configurations. Asymmetrical attenuators for unequal input/output impedances are introduced. Equalizers are discussed to improve signal fidelity and compensate for frequency-dependent losses. Types of equalizers include series, shunt, constant resistance, Bridge-T attenuation, Bridge-T phase, Lattice attenuation, and Lattice phase equalizers. Design principles, characteristics, and applications of attenuators and equalizers in signal conditioning and network performance improvement are included. Attenuators and equalizers are used in communication and signal processing systems to control signal amplitude and improve quality. Different attenuator configurations—T, π, L, Bridge-T, and lattice—allow precise reduction of signal strength while maintaining impedance matching. Asymmetrical attenuators are applied when source and load impedances differ. Equalizers compensate for frequency-dependent distortion or loss, ensuring flat amplitude and linear phase

	response. Understanding these devices enables effective design of networks for signal conditioning and transmission fidelity.
CO6	**Learn to analyze and design different network types using impedance, admittance, poles, and zeros, and apply methods to create LC, RC, and RL circuits.**
	This topic focuses on the analysis and design of electrical networks using fundamental parameters like impedance, admittance, poles, and zeros. Students learn to characterize network behavior in the frequency domain. Methods for designing LC, RC, and RL circuits are introduced for practical implementation. Techniques for applying these methods to realize desired network functions are covered. Emphasis is placed on systematic synthesis and evaluation of circuits for signal processing and control applications. Understanding network analysis and design is essential for predicting and controlling circuit behavior in electrical and electronic systems. Impedance, admittance, poles, and zeros provide a mathematical framework for frequency response analysis. LC, RC, and RL circuits form the building blocks of analog networks in filters, amplifiers, and signal processing. Applying synthesis methods allows students to realize desired network functions practically. This knowledge is critical for designing efficient, reliable, and optimized electrical networks.

SECTION 5: Complex Engineering Problem Solving

This course equips engineers to analyse, design, and optimize electrical networks across DC and AC systems, addressing both transient and steady-state behaviour. It covers transient analysis of RL, RC, and RLC circuits using integro-differential and Laplace transform methods to predict current, voltage, and energy storage under DC and sinusoidal excitations. Students learn two-port network parameters, series/parallel/cascade connections, and network topology concepts including graphs, trees, tie-set and cut-set matrices for systematic analysis of complex circuits. The course develops skills in filters, attenuators, and equalizers, enabling frequency response shaping, signal level control, and phase/amplitude correction in communication and signal processing systems. Emphasis is placed on network synthesis, including driving-point and transfer functions, poles, zeros, positive real functions, and realization of LC, RC, and RL networks using Foster and Cauer methods. Students apply KVL, KCL, impedance/admittance analysis, and energy storage principles to solve practical problems in power electronics, communication, and control circuits. The modules enable optimization, fault analysis, and performance evaluation in large-scale and intricate electrical networks. Overall, the course bridges theory and practical engineering applications, preparing students for advanced circuit design, analysis, and implementation in modern electrical systems.

SECTION 6A: Assessment Methods – Direct

Item	Evaluation Components	Week in / out	Marks
AAT: 1	Tech-Talk	Week – 2 / 5	05
AAT: 1	Assignments	Week – 4 / 7	05
AAT: 2	Complex Engineering Problem Solving	Week – 9 / 15	10
CIE - 1	2 hours - Answer 4 out of 5 questions	Week - 9	10
CIE - 2	2 hours - Answer 4 out of 5 questions	Week - 17	10
SEE	3 hours - Answer 1 from each module	Week - 18	60
		Total Marks	**100**

Department's Late Submission Policy:

1. 1 – 24 hours: 25% of the mark will be deducted
2. > 24 hours: Not accepted

SECTION 6B: Assessment Methods –Indirect

Course End Survey (End Semester OBE Feedback)	✓

SECTION 7: Engineering Competencies (ECs) Focused

Please tick (✓) relevant engineering competency profile covered

EC Number	Attributes	Profiles	(✓)

EC1	Depth of knowledge required (CP)	Fundamental for all modules; covers transient analysis, Laplace transforms, two-port networks, filters, attenuators, and network synthesis based on circuit theory principle	✓
EC2	Depth of analysis required (CP)	Needed for transient and steady-state analysis, Laplace domain calculations, network parameters, and synthesis; requires abstraction and modelling	✓
EC3	Design and development of solutions (CA)	Applicable in network synthesis, filter and attenuator design, and circuit realization; less emphasized in purely analysis-focused modules	✓
EC4	Range of conflicting requirements (CP)	Relevant when designing networks, filters, and attenuators where multiple constraints exist (frequency, impedance, stability)	✓
EC5	Infrequently encountered issues (CP)	Relevant when applying advanced network theorems, tie-set/cut-set matrices, and solving complex network synthesis problems	✓
EC6	Protection of society (CA)	Not directly covered in this syllabus; more relevant to power systems, safety, or control courses	✘
EC7	Range of resources (CA)	Focus on theoretical, computational, and modelling skills; limited real-world resource handling	✘
EC8	Extent of stakeholder involvement (CP)	Not directly applicable at this level	✘
EC9	Extent of applicable codes, legal and regulatory (CP)	Not directly applicable here	✘
EC10	Interdependence (CP)	Strongly relevant; networks are partitioned into sub-elements (series, parallel, cascade, tie-sets, cut-sets) and combined for whole-system analysis	✓
EC11	Continuing professional development (CPD) and lifelong learning (CA)	Indirectly applicable; mastering circuit theory forms the foundation for advanced courses and lifelong skill development	✓
EC12	Judgement (CA)	Required in selecting theorems, solution methods, and handling incomplete or approximate data in circuit analysis and network synthesis	✓

SECTION 8: Employability Skills

Example: Communication skills / Programming skills / Project based skills

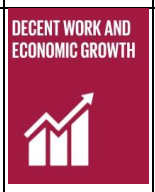
Employability skills are the transferable skills and personal attributes that make an individual suitable for employment in the field of Electrical Circuits and Network Analysis. They combine technical knowledge, problem-solving ability, and professional behaviour.

1. **Technical Skills**
   - Apply Kirchhoff's laws, mesh/nodal methods, and integro-differential approaches to analyze transient responses of RL, RC, and RLC circuits (series and parallel) for DC and sinusoidal excitations.
   - Use Laplace transforms techniques to solve transient responses and evaluate circuit behavior under step, ramp, exponential, and impulse inputs.
   - Analyze two-port network parameters (Z, Y, ABCD, and H) and interrelationships for series, parallel, and cascade network connections.
   - Derive and interpret tie-set and cut-set matrices for complex networks using graph theory, tree, chord, and incident matrices.
   - Design and evaluate filters (low-pass, high-pass, band-pass, band-stop) including constant-K and M-derived (T/π) networks, and apply attenuators/equalizers (T, π, L, Bridge-T, lattice) for amplitude and phase correction.
   - Perform network synthesis of LC, RC, and RL networks using driving-point and transfer functions, poles and zeros analysis, Foster and Causer methods, and Hurwitz polynomials.

2. **Communication Skills**
   - Present circuit analysis results clearly through phasor diagrams, transient response graphs, filter frequency response curves, and network matrices.
   - Write concise lab reports, technical documentation, and design calculation sheets for transient analysis, Laplace methods, and network synthesis.
   - Explain two-port network behaviour, filter/equalizer designs, and transient phenomena to peers, instructors, or industry supervisors.
3. **Teamwork and Collaboration**
   - Work collaboratively in labs and project teams to analyse transient responses, simulate circuits, and verify theoretical solutions.
   - Integrate knowledge of two-port networks, filters, and synthesis methods in multidisciplinary project tasks, supporting collective design and validation.
   - Participate in group simulations and experimental setups for balanced/unbalanced circuits and AC/DC network behaviour.
4. **Project and Time Management**
   - Manage small-scale circuit analysis, filter/equalizer design, and network synthesis projects within academic or industrial timelines.
   - Organize problem-solving approaches systematically using mesh, nodal, star-delta, tie-set/cut-set, and Laplace methods.
   - Prioritize tasks in experiments, simulations, and documentation to meet project goals, learning outcomes, and quality standards.

SECTION 9: Relevance to Sustainability goals

Brief description about the course and its correlationwith Sustainability Development Goal (SDGs).

SDG Goals		Correlation with SDG
4		**Quality Education:** Understanding transient behaviour of R, L, C elements enhances analytical and problem-solving skills. Laplace Transform techniques develop mathematical and analytical skills essential for engineering education. Teaches structured network modelling and system analysis, strengthening conceptual understanding. Understanding filter and attenuator design enhances practical skills in signal processing and electronics education. Develops advanced analytical and design skills in network synthesis, improving higher-order thinking in engineering education.
8		**Decent Work and Economic Growth:** Prepares students for careers in electronics, power systems, and renewable energy. Builds capabilities in designing industrial and communication systems, enhancing employability. Prepares students for careers in telecommunications, power distribution, and electronics. Enables career growth in communication, electronics, and instrumentation industries. Prepares students for careers in power system design, electronic networks, and instrumentation
9		**Industry, Innovation, and Infrastructure:** Enables modeling and design of reliable circuits essential for modern electrical infrastructure. Supports innovation in system modeling, simulation, and automated circuit design. Enables design of efficient networks and industrial systems. Supports innovation in signal processing, telecommunication networks, and industrial automation. Enables creation of reliable, innovative electrical and communication infrastructures.
11		**Sustainable Cities and Communities:** Knowledge of network topology supports smart grids, communication, and energy-efficient systems for urban development. Application in smart city solutions such as communication systems, noise reduction, and energy-efficient networks. Supports efficient design of energy and communication systems for urban sustainability
17		**Partnerships for the Goals:** Encourages collaboration in research and industry-academia partnerships through advanced system modeling and simulations.

SECTION 10A: Mapping between COs and POs / PSOs

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	✓	✓	-	✓	✓	-	✓	-	-	-	-	✓	✓	-
CO2	✓	✓	-	✓	✓	-	-	-	-	-	-	✓	✓	-
CO3	✓	✓	✓	-	✓		✓	-	✓	-	-	-	✓	✓
CO4	✓	✓	✓	-	✓	-	✓	-	✓	-	-	-	✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓	-	-	✓	-	✓	✓	✓
CO6	✓	✓	-	-	✓	-		-	-	✓	-	✓	✓	-

Outcomes		WKS and Indicators of attainment and Justificationformapping(studentswillbeableto)																																				IAs Count
COs	POs	WK 1	WK 2								WK 3			WK 4			WK 5						WK 6			WK 7				WK 8							WK 9						
		a	a	b	c	d	e	f	g	h	a	b	c	a	b	c	a	b	c	d	e	f	a	b	c	a	b	c	d	a	b	c	d	e	f	g	a	b	c	d	e	f	
CO 1	PO 1	•	•	•	•	•	•		•						•																												12
	PO 2	•	•	•	•	•	•		•			•	•		•																												13
	PO 4																•	•	•			•																					4
	PO 5																•	•	•			•																					4
	PO 7																•	•	•			•																					4
	PSO 1																													•	•	•			•	•							5
	PSO 2																													•	•	•			•	•							5
CO2	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 4																•	•	•			•																					4
	PO 5																													•	•	•			•	•							5
	PSO 1	•	•	•			•		•			•	•	•																													8
	PSO2	•	•	•			•		•			•	•	•																													8
CO3	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																•	•	•			•																					4
	PO 5																													•	•	•			•	•							5
	PO 7																													•	•	•			•	•							5
	PO 9																													•	•	•			•	•							5
	PSO 2																													•	•	•			•	•							5
	PSO 3																													•	•	•			•	•							5
CO4	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																													•	•	•			•	•							5

	PO 5		•	•	•	•	•		•													•	•	•															9
	PO 7		•	•	•	•	•		•													•	•	•															9
	PO 9		•	•	•	•	•		•													•	•	•															9
	PSO 2																											•	•	•			•	•						5
	PSO 3																											•	•	•			•	•						5
CO 5	PO 1	•	•	•	•	•	•		•			•	•	•																									10
	PO 2	•	•	•	•	•	•		•			•	•	•																									10
	PO 3																	•	•	•		•																	4
	PO 4																											•	•	•			•	•						5
	PO 5		•	•	•	•	•		•													•	•	•															9
	PO 6		•	•	•	•	•		•													•	•	•															9
	PO 7		•	•	•	•	•		•													•	•	•															9
	PO 10																											•	•	•			•	•						5
	PSO 1																											•	•	•			•	•						5
	PSO 2																											•	•	•			•	•						5
	PSO 3																											•	•	•			•	•						5
CO6	PO1	*	*	*	*	*	*																					•	•	•			•	•						10
	PO2	*			*	*	*	*					*	*	*													•	•	•			•	•						13
	PIO5	*										*	*															•	•	•			•	•						8
	PO7	*		*	*	*					*	*																•	•	•			•	•						10
	PSO2	*	*	*			*	*	*																			•	•	•			•	•						11
	PSO3	*	*				*			*																		•	•	•			•	•						8

SECTION 10B: Indicators of Attainment with COs to POs and PSOs														
Course Outcomes	Percentage of Indicators of Attainments (IA) with POs and PSOs													
	PO											PSO		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	80	72	-	72	66	-	66	-	-	66	-	71	71	-
CO2	66	66	-	66	71	-	-	-	-	-	-	53	53	-
CO3	66	66	66	-	66	-	72	-	72	-	-	-	71	71
CO4	66	66	81	-	81	-	81	-	72	-	-	-	53	53
CO5	66	66	66	71	90	-	-	-	-	71	71	71	71	71
CO6	66	66	-	-	71	-	72	-	-	-	-	-	53	53

SECTION 10C: Course Articulation Matrix of COs to POs														
0 No Contribution (0-5%)			1 Low (≥5 - <40%)				2 Moderate (≥40 - <60%)					3 High (≥60%)		
Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	3	-	3	3	-	3	-	-	3	-	3	3	-
CO2	3	3	3	3	3	-	-	-	3	3	-	2	2	2

CO3	3	3	3	-	3	-	3	-	3	-	-	-	3	3
CO4	3	3	3	-	3	-	3	-	3	-	-	-	2	2
CO5	3	3	3	3	3	-	-	-	-	3	3	3	3	3
CO6	3	3	-	-	3	-	3	-	-	-	-	-	2	2
Total	18	18	12	9	18	-	12	-	9	9	3	8	12	12
Average	**3**	**3**	**2**	**1.5**	3	**-**	**2**	**-**	**1.5**	**1.5**	**0.5**	**1.5**	**2**	**2**

SECTION 10D: Level of Contribution of the COs to POs and PSOs

Number	Programme Outcomes	Proficiency Assessed by	Contribution Level (from 1 to 3)
PO 1	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**.	CIE / SEE / AAT:1 – 2 Assignments / Open-ended problems	**3**
PO 2	Identify, formulate, review research literature and analyse **complex engineering problems** reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).	CIE / SEE / AAT:1 – 2 Hack-a-thon	**3**
PO 3	Design creative solutions for **complex engineering problems** and design / develop systems / components/ processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**2**
PO 4	Conduct investigations of **complex engineering problems** using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**1.5**
PO5	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**.	CIE / SEE / AAT:1 – 2 Assignments / Open-ended problems	**3**
PO6	Identify, formulate, review research literature and analyse **complex engineering problems** reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).	CIE / SEE / AAT:1 – 2 Hack-a-thon	**-**
PO7	Design creative solutions for **complex engineering problems** and design / develop systems / components/ processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**2**
PO9	Conduct investigations of **complex engineering problems** using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**-**
PO 10	Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**1.5**
PO 11	Design creative solutions for **complex engineering problems** and design / develop systems /	CIE / SEE / AAT:2 – 1	**0.5**

	components/ processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)	Complex Engineering Problem Solving	
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	AAT: 1 – 1 Tech-Talk	**1.5**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	AAT: 1 – 1 Tech-Talk	**2**
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.	AAT: 1 – 1 Tech-Talk	**2**

SECTION 11: Course Content

MODULE - I	**TRANSIENT ANALYSIS**
	Significance of Initial conditions of R, L and C elements. Transient response of series RL, RC and RLC circuits using integro-differential approach for DC and Sinusoidal excitations. Transient response of parallel RL, RC and RLC circuits using integro-differential approach for DC and Sinusoidal excitations.
MODULE - II	**ELECTRICAL CIRCUIT ANALYSIS USING LAPLACE TRANSFORMS**
	Laplace Transforms of step, ramp, exponential, impulse functions (inputs). Transient response of series RL, RC and RLC circuits using Laplace Transforms approach for DC and Sinusoidal excitations. Transient response of parallel RL, RC and RLC circuits using Laplace Transforms approach for DC and Sinusoidal excitations.
MODULE - III	**TWO PORT NETWORK PARAMETERS AND NETWORK TOPOLOGY**
	Two port network parameters: Open circuit impedance, short-circuit admittance, Transmission, Hybrid parameters & inter-relationships, Series, parallel and cascade connection of two port networks, Network Topology: Graph, tree, chord, Tie-set, cut-set, incident matrices, Problems on Tie-set and cut-set matrices.
MODULE - IV	**FILTERS AND ATTENUATORS**
	Filters: Classification of Filters, Filter Networks, Constant-K Filters-Low pass, high pass, Band pass, band-stop filters, M-derived Filters- T and π filters- Low pass, high pass. Attenuators: Types – T, π , L, Bridge T and lattice ,Asymmetrical Attenuators T, π , L Equalizers- Types- Series, Shunt, Constant resistance, bridge T attenuation, bridge T phase, Lattice attenuation, lattice Phase equalizers
MODULE - V	**NETWORK SYNTHESIS**
	Network Synthesis: Driving point impedance and admittance, transfer impedance and admittance, network functions of Ladder and non-ladder networks, Poles, Zeros analysis of network functions, Hurwitz polynomials, Positive Real Functions, synthesis of LC, RC and RL Functions by foster and causer methods.

SECTION 12: Tentative Schedule of Instructions

Week Number	Topics	Duration (Hours)
1	1.1 OBE of Network Analysis And Synthesis 1.2 **MODULE – I**:Transient Analysis: Significance of Initial conditions of R, L and C elements 1.3 Transient response of series RL, circuit using integro-differential approach for DC and Sinusoidal excitations 1.4 Problems	4

2	2. 1 Transient response of series RC, circuit using integro-differential approach for DC and Sinusoidal excitations 2.2 Problems. 2.3 Transient response of series RlC, circuit using integro-differential approach for DC and Sinusoidal excitations 2.4 Problems	4
3	3.1 Transient response of parallel RL circuit using integro-differential approach for DC and Sinusoidal excitations 3.2 Problems 3.3 Transient response of parallel RC circuit using integro-differential approach for DC and Sinusoidal excitations 3.4 Problems	4
4	4.1 Transient response of parallel RLC circuit using integro-differential approach for DC and Sinusoidal excitations 4.2 Problems. 4.3 **MODULE-II:** Electrical Circuit Analysis Using Laplace Transforms 4.4 Laplace Transforms of step, ramp, exponential, impulse functions (inputs).	4
5	5.1 Transient response of series RL, RC and RLC circuits using Laplace Transforms approach for DC and Sinusoidal excitations. 5.2 Transient response of parallel RL, RC circuits using Laplace Transforms approach for DC and Sinusoidal excitations. 5.3 Transient response of parallel RLC circuits using Laplace Transforms approach for DC and Sinusoidal excitations. 5.4 Problems	4
6	6.1. **MODULE-III:** Two Port Network Parameters And Network Topology: Two port network parameters: Open circuit impedance, short-circuit admittance 6.2 Transmission, Hybrid parameters & inter-relationships 6.3 Series, parallel and cascade connection of two port networks. 6.4 Problems	4
CONTINIUOUS INTERNAL EXAMINATION (CIE- I)		
7	7.1 Network Topology: Graph, tree, chord, Tie-set, cut-set, incident matrices 7.2 Problems on Tie-set and cut-set matrices. 7.3 **MODULE-IV:** Filters And Attenuators: Filters: Classification of Filters, Filter Networks 7.4 Constant-K Filters-Low pass, high pass, Band pass, band-stop filters	4
8	8.1 Problems 8.2 M-derived Filters- T and π filters- Low pass, high pass 8.3 Problems 8.4 Attenuators: Types – T, π , L	4
9	9.1 Bridge T and lattice 9.2 Asymmetrical Attenuators T, π 9.3 L Equalizers- Types- Series, Shunt, Constant resistance 9.4 bridge T attenuation	4
10	10.1 bridge T phase 10.2 Lattice attenuation, lattice Phase equalizers 10.3 Problems. 10.4 **MODULE-V:** Network Synthesis: Introduction	4
11	11.1 Driving point impedance and admittance 11.2 transfer impedance and admittance 11.3 network functions of Ladder and non-ladder networks 11.4 Poles, Zeros analysis of network functions	4
12	12.1 Hurwitz polynomials 12.2 Positive Real Functions 12.3 synthesis of LC, RC and RL Functions by foster method 12.4 synthesis of LC, RC and RL Functions by causer method and Problems	4
	Total	**48**

SECTION 14: Specific Goals for the Course	
The following table shows the knowledge and skills covered by the unit outcomes:	
Knowledge	**Skills**
Learners should understand: • Understand the significance of initial conditions of R, L, and C elements and the transient behavior of series and parallel RL, RC, and RLC circuits under DC and sinusoidal excitations using integro-differential equations. • Understand Laplace transform techniques and their application to analyze transient responses of series and parallel RL, RC, and RLC circuits for DC and sinusoidal excitations. • Understand two-port network parameters, their inter-relationships, and basic network topology concepts including graphs, trees, tie-sets, and cut-sets. • Understand the principles, classification, and characteristics of filter networks, attenuators, and equalizers including constant-K, m-derived, and lattice structures. • Understand network synthesis concepts including network functions, poles–zeros, Hurwitz polynomials, positive real functions, and Foster and Cauer synthesis methods for LC, RC, and RL networks.	**Learners can:** • Analyze and solve transient responses of series and parallel RL, RC, and RLC circuits for DC and sinusoidal inputs by applying initial conditions and integro-differential methods. • Apply Laplace transforms and inverse transforms to solve transient responses of series and parallel RL, RC, and RLC circuits for standard input functions. • Analyze two-port networks and network topologies by calculating parameters and forming tie-set and cut-set matrices for given circuits. • Design and analyze filters, attenuators, and equalizers to achieve specified attenuation, impedance, and frequency response characteristics. • Analyze and synthesize LC, RC, and RL networks by determining network functions, identifying poles and zeros, and realizing circuits using Foster and Cauer forms.

Administrative Information

SECTION 15: History of changes		
Regulations	**Description of change**	**BOS Date**
R 18	Changes from R16 to R18 regulation: Removed topic :the Resonance: Series and parallel resonance, concept of band width and Q factor	09.07.2018
UG 20	Changes from R18 to UG20 regulation: : added the content two port network and graph theory	17.11.2020
BT 23	No change	21.08.2023
BT 25	Changes from BT23 to BT25 regulation: Added the content Two port network parameters, Network Topology, Attenuators, Network Synthesis	26-08-2025

Course Outline Approvals	
Course Coordinator Name: Mr. T Ravi Babu Signature: Date: 28-01-2026	**Head of the Department** Name: Dr. Damodhar Reddy Signature: Date: 28-01-2026
Course Outline Approvals: The course outline description approved by Outcome Based Teaching Learning (OBTL) committee on *date* in meetings *IARE - OBTL – COD /10/4/25*	
Dean of Outcome Based Teaching and Learning Name: Dr. CH Srinivasulu Signature: Date: 28-01-2026	**Dean of Academics** Name: Dr. GVR Seshagiri Rao Signature: Date: 28-01-2026

Check List		
Section	**Description**	**Please tick (✓)**
1	General Information about the Course	✓
2	Notional Study Time	✓
3	A. Course Outcomes	✓
	B. Cognitive Levels	✓
4	Content and Context of the Course	✓
5	Complex Engineering Problem Solving	✓
6	A. Assessment Methods – Direct	✓
	B. Assessment Methods – Indirect	✓
7	Content Delivery / Instructional Methodologies	✓
8	Engineering Competencies (ECs) Focused	✓
9	Employability Skills	✓
10	Relevance to Sustainability goals	✓
11	A. Mapping between COs and POs / PSOs	✓
	B. Indicators of Attainment with COs to POs and PSOs	✓
	C. Course Articulation Matrix of COs to POs	✓
	D. Level of Contribution of the COs to POs and PSOs	✓
12	Syllabus	✓
13	Tentative Schedule of Instructions	✓
14	Specific Goals for the Course	✓
15	History of Changes	✓

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

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**Data Structures**
Course Code	ACSE05
Course Start	Second Semester
Course Type	Core
Regulation	IARE - BT 25
Prerequisite Courses	Object-Oriented Programming (ACSE01)
Department	Electronics and Communication Engineering
Number of Credits	3 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Theory and laboratory
Course Administrator	**Dr. Venu malagavelli** Professor of Civil Engineering IARE10607 **venu@iare.ac.in**
Course Coordinator's Name	**Dr. V. Kishen Ajay Kumar,** Associate Professor of Electronics and Communication Engineering IARE10817 **v.kishenajaykumar@iare.ac.in**
Prior Learning Assessment and Recognition (PLAR)	Students interested in PLAR pathways for open learning can register one semester prior to the start of semester. Students will receive the necessary contact information one semester in advance.
Open Learning Faculty Member Information	Open Learning Faculty (OLF) is available to assist students. Students will receive the necessary contact information at the start of the course.
Course Webpage	https://akanksha.iare.ac.in/index?route=course/details&course_id=1242
Course Description	This course introduces the fundamental concepts of data structures and explores the different implementations (array-based and linked representations) of these data structures. Topics include recursion, fundamental data structures (including stacks, queues, linked lists, hash tables, trees, and graphs), and algorithmic analysis. Includes analysing algorithms' running-time complexity and space requirements, searching and sorting techniques. Course includes laboratory component for lab-based exercises. Key notions of object-oriented programming with a view for efficiency, maintainability, and code-reuse, are emphasized. The Java programming language will be used to demonstrate the concepts discussed in lecture, and students will demonstrate these skills by solving real-world problems in the Java language.
Course Objectives	**The students will try to learn:** a. The concepts of data structures b. Implementation of various ADTs (abstract data types) such as lists, stack, queue, tree and graph structures

	c. Real life use of various data structures d. Methods to analyse, learn and compare different algorithms e. Applications, advantages and limitations of various data structures.
Text and Reference Books	**Text Books** 1. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, Data Structures and Algorithms in Java", 6th edition, John Wiley & Sons Inc., 2014, ISBN-13: 978-1118771334 2. Mark Allen Weise, "Data Structures and Algorithm Analysis in Java", 3rd edition, Pearson education, 2012, ISBN-13: 978-0273752110 **Reference Books** 1. S. Lipschutz, "Data Structures", Tata McGraw Hill Education, 1st edition, 2014, ISBN-13: 978-1259029967 2. D. Samanta, "Classic Data Structures", PHI Learning, 2nd edition, 2004, ISBN: 812033731X, 9788120337312.
Learning Resources	**Course full stack** is made available in IARE learning management portal – Akansha, which includes lecture notes, tutorial question bank, definition and terminology, tech-talk topics, assignments, Model question papers (2 sets), complex engineering problem solving statements, power point presentations (PPTs) and ELRV lecture recordings at: • https://www.youtube.com/watch?v=wtcPOIiOGeY&list=PLzkMouYverAJBXkAe4S6SEDdjKLbxo2du • https://www.youtube.com/playlist?list=PLzkMouYverAI9IvTTpixG2GL2jpT8HQsW
Supplemental Materials	**Readings, Videos, and Links** 1. https://ece.uwaterloo.ca/~dwharder/aads/Lecture_materials/ 2. https://ocw.mit.edu/courses/6-006-introduction-to-algorithms-spring-2020/pages/lecture-notes/ 3. https://www.cise.ufl.edu/~sahni/cop5536/presentations.htm 4. https://cds.iisc.ac.in/courses/ds286/ 5. https://www.cise.ufl.edu/~sahni/cop3530/powerpoint.htm
Learning and Teaching Strategies	Online material will provide the foundation of the learning resources, requiring the students to log in and engage regularly throughout the sixteen weeks of the course. There will be a mix of suggested readings, discussions and video content containing embedded digital content and undertake the assessment tasks.

SECTION 2: Teaching Learning Scheme

At least 48 lecture hours of scheduled teaching and learning activities (TLA) will be delivered in person, with the remaining hours for scheduled and self-scheduled teaching and learning activities delivered either in person or online.

Notional Study Time: 90 Hours (Lecture hours: 48, Tutorial hours: 8, Scheduled revision session hours: 2, Guided independent study hours: 15, Homework / Programming assignment hours: 10, Course project / Preparation for complex problem solving hours: 15)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA 1	Lectures	48	01	48
TLA 2	Tutorials	08	01	08
TLA 3	Case Study			
TLA 4	Problem Solving			
TLA 5	Demonstration			
TLA 6	Scheduled revision sessions	02	01	02

TLA 7	Guided independent study: Directed viewing of video materials / PPTs			15
TLA 8	Independent private study			
TLA 9	Laboratory Exercises	0	0	0
TLA 10	Homework assignments / Programming assignments			10
TLA 11	Placement / work based learning or Specific practical training	0	0	0
TLA 12	Presentation / Seminar Preparation			
TLA 13	Course Project / Preparation for Complex Problem Solving			15
TLA 14	Technical visit			
TLA 15	Field activities	0	0	0
			Total study hours	**90**
			Expected total study hours	**90**

SECTION 3A: Course Outcomes

After successfully completing this course, the student will be able to:

Outcome Number	Course Outcomes	Learning Domain
CO1	**Outline** common data structures and fundamental algorithms, and familiarise with the associated terminology.	Understand
CO2	**Illustrate** Abstract Data Types (ADT) in terms of their data structures (strings, stacks, queues, linked lists, hash tables, trees and graphs).	Understand
CO3	**Develop** programs to implement common algorithms for sorting and searching data.	Apply
CO4	**Make** use of linear data structures and nonlinear data structures solving real time applications.	Apply
CO5	**Describe** hashing techniques and collision resolution methods for efficiently accessing data with respect to performance.	Understand
CO6	**Compare** various types of data structures in terms of implementation, operations and performance.	Analyze

SECTION 3B: Cognitive Levels

Blooms Taxonomy Level	Cognitive Level in Percentage (%)
Remember	0
Understand	32
Apply	52
Analyse	16
Evaluate	0
Create	0

SECTION 4: Content and Context of Data Structures

CO1	**Outline common data structures and fundamental algorithms and familiarise with the associated terminology.**
	Make the student to understand data Structure vs files. They should made to know that data structure is often referred to data storage in main memory (RAM) and data storage representation in secondary storage is referred to as file structure or database. Teach learners about common formats used for data storage and transfer between systems. They should understand the structure of

	common file data formats such as JavaScript Object Notation (JSON), comma separated values (CSV) and extensible markup language (XML). Familiarise with the common data structures and with appropriate terminology for the most common data structures. Algorithms manipulate that data in these structures in various ways, such as searching for a data item and sorting a set of data elements.
CO2	**Illustrate Abstract Data Types (ADT) in terms of their data structures (strings, stacks, queues, linked lists, hashing, trees and graphs).**
	Teach learners how to create and manipulate language-specific built-in abstract structures for storing collections of values. These should include simple and multi-dimensional arrays, sets (unique values) and tuples (unchangeable values). Learners should also know how to use hash table (map) structures to store data as key/value pairs. For each of the above data structures, learners must know how to add, locate, remove and update data anywhere within the structure. Learners must know how to create both a singly and doubly linked list abstract data structure from first principles. They must also know how to add, locate, remove and update elements anywhere within the structure. Learners must know how to create a binary search tree abstract data structure from first principles. They should be able to traverse it and add, locate, remove and update elements at any point within it. Learners should know how to apply these abstract data structures by writing code containing stacks, queues, deques and heaps, using both linked lists and appropriate built-in structures. Learners should know how to add, locate, remove and update elements at any point within them.
CO3	**Develop programs to implement common algorithms for sorting and searching data.**
	Teach learners how recursion works and how recursive functions are structured. They should be capable of applying recursion to common problems. Examples might include factorial or Fibonacci sequence calculations, as well as string operations such as reversal and character counting. Learners must know how to sort collections of data, both in ascending and descending order, using a variety of different sorting algorithms. They must know how to code common sorting algorithms such as bubble sort, selection sort, merge sort, shell sort, radix sort and quicksort. They should understand how each works and demonstrate their application. Learners must know how to search through data. They should know how to perform linear searches of unsorted data. Learners should also know how to perform the more efficient binary searches on sorted data. They should do this using both iteration and recursion. They should also use binary tree structure searching capabilities. You should also make learners aware of the effects of sorting data before searching within it. You should teach learners how to find the largest and smallest values in a given list of values. Learners critically review their program code with a view to increasing its efficiency. This not only tells them how well the code is working, but also offers them insights into any improvements they should apply.
CO4	**Compare common algorithms for sorting and searching data.**
	Learners should know how linear searching becomes less efficient as the volume of data increases. They should also know that, while binary searching can solve the problem for large data sets, the additional overhead of initial sorting of data can reduce this. Although learners do not need to derive the time and space complexity of algorithms and data structures, they should understand what these terms mean and know the different time complexities of accessing, searching, inserting and deleting elements within arrays, stacks, queues, singly and doubly linked lists, hash tables, and binary trees. Learners should also know the different time complexities of the different sorting algorithms (bubble sort, selection sort, merge sort and quicksort). You can use common notation, such as Big O, to describe these. To consolidate their understanding, you should give learners a range of problems to solve that cover the range of algorithms and data structures taught during the course. You should also encourage learners to write multiple versions of their code using different algorithms and/or data structures and compare their efficiency.

	There are opportunities for learners to work in groups to discuss, analyse and formulate a solution to a given problem. Learners could then produce independent solutions and compare and contrast.
CO5	**Apply collision resolution techniques to resolve collisions within the hash table.**
	Learners are required to know **Hashing and usage of** hash functions to generate hash values. The hash value is used to create an index for the keys in the hash table. The hash function may return the same hash value for two or more keys. When two or more keys have the same hash value, a **collision** happens. To handle this collision, use **Collision Resolution Techniques (linear probing, quadratic probing and chaining)**. Make the students to know that, a hash table is a data structure that holds information in an associative manner. Data access becomes very speedy if we know the index of the needed data. As a result, regardless of data size, it becomes a data structure with incredibly fast insertion and search operations. Hash Tables are arrays that use the hash technique to generate an index from which an element can be entered or located. You should make the students understand the Hashing's irreversibility and constant time access properties that have made possible to find applications in a variety of domains. The following are some examples of hashing applications, including password security, password verification, tokenization, programming language data structures and compilers, blockchain, machine learning feature hashing, and many others! Learners should be made to learn the usage and working of the function called "hash function" to convert data of any arbitrary size to a fixed-size value and storing it in a data structure called "hash table" at the value produced by hash functions. Hash codes, digests, hash values, and hashes are all terms for the values returned by this function.
CO6	**Choose the appropriate data structure to solve real-world problems and to defend the selection.**
	Learners should develop the ability to choose appropriate data structures and algorithms based on application requirements, as these choices directly influence performance. For instance, a hash table is suitable for scenarios requiring fast data lookups, whereas a binary search tree may be more effective when maintaining data in sorted order. Likewise, while quick sort performs well in general cases, merge sort may be preferable in situations demanding stability and consistent performance. Learners will design and implement two different versions of a hash table interface: open addressing (including linear probing, quadratic probing, double hashing, and rehashing) and chaining. They will also analyze and evaluate the time complexity of fundamental hash table operations such as insertion, deletion, and search. Furthermore, a solid understanding of complexity analysis—both time and space complexity—is essential for assessing algorithm efficiency. Big-O notation (e.g., $O(n)$, $O(\log n)$, $O(n^2)$) will be used to express the worst-case performance of algorithms, enabling informed decisions when selecting optimal solutions

SECTION 5: Complex Engineering Problem Solving

Programs, complex problem solving and programming projects
There is one piece of assessed coursework, involving a mixture of theoretical work and programming. We encourage to use the data structures and algorithms in different languages — although they can use a single language, depending on the level of their ability.

Programming assignments are a mandatory part of the course. Homework programs will concentrate on implementing fundamental programming concepts and techniques. Projects will be large scale programs implementing the Abstract Data Types discussed in class. Programming Projects will be worth significantly more points than homework programs. All programs are individual assignments.

Programming exams/hack-a-thons will also be conducted. Student are required to complete these tasks during the class period with no assistance.

Data Structures and Algorithms for External Storage: Considering the differences in access characteristics between main memory and external storage devices such as disks, several algorithms for sorting files of externally stored data such as indexed files and B-trees, that are well suited for storing and retrieving information on secondary storage devices will be discussed.

SECTION 6A: Assessment Methods – Direct

Item	Evaluation Components	Week in / out	Marks
AAT: 1 - 1	Tech-Talk	Week – 2 / 5	05
AAT: 1 - 2	Hack-a-thon	Week – 4 / 7	05
AAT: 2 - 1	Complex Engineering Problem Solving	Week – 9 / 12	05
AAT: 2 - 2	Hack-a-thon	Week – 12 / 15	05
CIE - 1	2 hours - Answer 4 out of 5 questions	Week - 9	10
CIE - 2	2 hours - Answer 4 out of 5 questions	Week - 17	10
SEE	3 hours - Answer 1 from each module	Week - 18	60
		Total Marks	**100**

Department's Late Submission Policy:

1. 1 – 24 hours: 25% of the mark will be deducted
2. > 24 hours: Not accepted

SECTION 6B: Assessment Methods –Indirect	
Course End Survey (End Semester OBE Feedback)	✓

SECTION 7: Engineering Competencies (ECs) Focused

Please tick (✓) relevant engineering competency profile covered

EC Number	Attributes	Profiles	(✓)
EC1	Depth of knowledge required (CP)	Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill-founded, illogical, erroneous, unreliable or unrealistic requirements applicable to the engineering discipline	✓
EC2	Depth of analysis required (CP)	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	✓
EC3	Design and development of solutions (CA)	Support sustainable development solutions by ensuring functional requirements, minimize environmental impact and optimize resource utilization throughout the life cycle, while balancing performance and cost effectiveness.	✓
EC4	Range of conflicting requirements (CP)	Competently addresses complex engineering problems which involve uncertainty, ambiguity, imprecise information and wide-ranging or conflicting technical, engineering and other issues.	-
EC5	Infrequently encountered issues (CP)	Conceptualizes alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.	-
EC6	Protection of society (CA)	Identifies, quantifies, mitigates and manages technical, health, environmental, safety, economic and other contextual risks associated to seek achievable sustainable outcomes with engineering application in the designated engineering discipline.	-
EC7	Range of resources (CA)	Involve the coordination of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies) in the timely delivery of outcomes	-
EC8	Extent of stakeholder involvement (CP)	Design and develop solution to complex engineering problem considering a very perspective and taking account of stakeholder views with widely varying needs.	✓
EC9	Extent of applicable codes, legal and regulatory (CP)	Meet all level, legal, regulatory, relevant standards and codes of practice, protect public health and safety in the course of all engineering activities.	-

EC10	Interdependence (CP)	High level problems including many component parts or sub-problems, partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then re-combines to form a whole, with the integrity and performance of the overall system as the top consideration.	✓
EC11	Continuing professional development (CPD) and lifelong learning (CA)	Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.	✓
EC12	Judgement (CA)	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Require judgement in decision making in the course of all complex engineering activities.	-

SECTION 8: Employability Skills

Example: Communication skills / Programming skills / Project based skills

Studying Data Structures equips the students with a range of employability skills that are highly valued in industries.

Employability Skills:

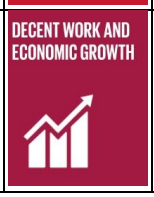
- Problem-solving skills for designing efficient solutions.
- Logical and analytical thinking for data organization.
- Proficiency in programming languages like C / C++ / Java / Python.
- Optimization skills for time and space complexity.
- Knowledge of scalable and robust system design.
- Teamwork and collaboration in software development.
- Adaptability to learn and apply advanced data structures.

Project Management:

- Planning and organizing project timelines and tasks.
- Allocating resources efficiently.
- Collaborating and communicating with team members.
- Identifying and mitigating project risks.
- Testing and validating system performance.

SECTION 9: Relevance to Sustainability goals

Brief description about the course and its correlation with Sustainability Development Goal (SDGs).

SDG Goals		Correlation with SDG
4		**Quality Education:** This subject will prepare students for modern technological challenges, improving educational tools, and promoting skills essential for global development.
8		**Decent Work and Economic Growth:** Prepares students for careers in technology-driven industries, boosting employability and fostering innovation in the digital economy.

9		**Industry, Innovation, and Infrastructure:** Supports the development of efficient algorithms and systems crucial for advancing technological infrastructure and innovation.
11		**Sustainable Cities and Communities:** Enables the creation of smart city technologies (e.g., optimized traffic systems, resource management) using graph and tree structures.
17		**Partnerships for the Goals:** Facilitates collaboration in data-driven research and global educational initiatives through scalable and efficient data processing.

SECTION 10A: Mapping between COs and POs / PSOs

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	✓	✓	✓	-	-	-	-	-	-	-	✓	✓	-	-
CO2	✓	✓	✓	✓	✓	-	-	-	-	-	✓	✓	-	✓
CO3	✓	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓
CO6	✓	✓	✓	✓	✓	✓	-	-	-	-	✓	✓	✓	✓

Outcomes		WKS and Indicators of attainment and Justification for mapping (students will be able to)																																						IAs Count
COs	POs	WK 1	WK 2								WK 3			WK 4			WK 5						WK 6			WK 7				WK 8						WK 9						
		a	a	b	c	d	e	f	g	h	a	b	c	a	b	c	a	b	c	d	e	f	a	b	c	a	b	c	d	a	b	c	d	e	f	g	a	b	c	d	e	f	
CO 1	PO 1	•	•	•	•	•	•		•			•	•	•																												10
	PO 2	•	•	•	•	•	•		•			•	•	•																												10
	PO 3																•	•	•			•																					4
	PO 11																													•	•	•			•	•							5
	PSO 1	•	•	•			•		•			•	•	•																												8
CO2	PO 1	•	•	•	•	•	•		•			•	•	•																												10
	PO 2	•	•	•	•	•	•		•			•	•	•																												10
	PO 3																•	•	•			•																					4
	PO 4																													•	•	•			•	•							5
	PO 5		•	•	•	•	•		•														•	•	•																	9
	PO 11																													•	•	•			•	•							5
	PSO 1	•	•	•			•		•			•	•	•																												8

	PSO 3		•	•			•		•			•	•	•									•	•	•																		10
CO3	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																•	•	•			•																					4
	PO 4																													•	•	•			•	•							5
	PO 5		•	•	•	•	•		•															•	•	•																		9
	PO 11																													•	•	•			•	•							5
	PSO 1	•	•	•			•		•			•	•	•																													8
	PSO 2		•	•			•		•			•	•	•									•	•	•																		10
	PSO 3		•	•			•		•			•	•	•									•	•	•																		10
CO4	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																•	•	•			•																					4
	PO 4																													•	•	•			•	•							5
	PO 5		•	•	•	•	•		•															•	•	•																		9
	PO 11																													•	•	•			•	•							5
	PSO 1	•	•	•			•		•			•	•	•																													8
	PSO 2		•	•			•		•			•	•	•									•	•	•																		10
	PSO 3		•	•			•		•			•	•	•									•	•	•																		10
CO 5	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																•	•	•			•																					4
	PO 4																													•	•	•			•	•							5
	PO 5		•	•	•	•	•		•															•	•	•																		9
	PO 11																													•	•	•			•	•							5
	PSO 1	•	•	•			•		•			•	•	•																													8
	PSO 2		•	•			•		•			•	•	•									•	•	•																		10
	PSO 3		•	•			•		•			•	•	•									•	•	•																		10
CO 6	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																•	•	•			•																					4
	PO 4																													•	•	•			•	•							5
	PO 5		•	•	•	•	•		•															•	•	•																		9
	PO 6	•															•	•	•			•				•	•		•														8
	PO 11																													•	•	•			•	•							5
	PSO 1	•	•	•			•		•			•	•	•																													8
	PSO 2		•	•			•		•			•	•	•									•	•	•																		10
	PSO 3		•	•			•		•			•	•	•									•	•	•																		10

SECTION 10B: Indicators of Attainment with COs to POs and PSOs															
Course Outcomes	**Percentage of Indicators of Attainments (IA) with POs and PSOs**														
	PO												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**		**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	67	67	67	-	-	-	-		-	-	-	71	53	-	-
CO2	67	67	67	71	82	-	-		-	-	-	71	53	-	90
CO3	67	67	67	71	82	-	-		-	-	-	71	53	90	90
CO4	67	67	67	71	82	-	-		-	-	-	71	53	90	90
CO5	67	67	67	71	82	-	-		-	-	-	71	53	90	90
CO6	67	67	67	71	82	80	-		-	-	-	71	53	90	90

SECTION 10C: Course Articulation Matrix of COs to POs														
0 No Contribution (0-5%)			**1** Low (≥5 - <40%)				**2** Moderate (≥40 - <60%)					**3** High (≥60%)		
Course Outcomes	**Program Outcomes (POs)**											**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	3	3	3	-	-	-	-	-	-	-	3	2	-	-
CO2	3	3	3	3	3	-	-	-	-	-	3	2	-	3
CO3	3	3	3	3	3	-	-	-	-	-	3	2	3	3
CO4	3	3	3	3	3	-	-	-	-	-	3	2	3	3
CO5	3	3	3	3	3	-	-	-	-	-	3	2	3	3
CO6	3	3	3	3	3	3	-	-	-	-	3	2	3	3
Total	18	18	18	15	15	3	-	-	-	-	18	12	12	15
Average	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**3**	**2**	**3**	**3**

SECTION 10D: Level of Contribution of the COs to POs and PSOs			
Number	**Programme Outcomes**	**Proficiency Assessed by**	**Contribution Level (from 1 to 3)**
PO 1	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**.	CIE / SEE / AAT:1 – 2 Assignments / Open-ended problems	3
PO 2	Identify, formulate, review research literature and analyse **complex engineering problems** reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).	CIE / SEE / AAT:1 – 2 Hack-a-thon	3
PO 3	Design creative solutions for **complex engineering problems** and design / develop systems / components/ processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	3
PO 4	Conduct investigations of **complex engineering problems** using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	3
PO 5	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing	CIE / SEE / AAT:2 – 2 Hack-a-thon	3

	their limitations to solve **complex engineering problems**. (WK2 and WK6).		
PO 6	Analyze and evaluate societal and environmental aspects while solving **complex engineering problems** for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7)	CIE / SEE / AAT:2 – 2 Hack-a-thon	**3**
PO 11	Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**3**
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	AAT: 1 – 1 Tech-Talk	**2**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs	AAT: 2 – 1 Complex Engineering Problem Solving	**3**
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..	AAT: 2 – 1 Complex Engineering Problem Solving	**3**

SECTION 11: Course Content	
MODULE - I	**INTRODUCTION TO DATA STRUCTURES, SEARCHING AND SORTING**
	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**
	Stacks: Stack ADT, definition and operations, Implementations of stacks using array, applications of stacks, Arithmetic expression conversion and evaluation; Queues: Primitive operations; Implementation of queues using Arrays, applications of linear queue, circular queue and double ended queue (deque).
MODULE - III	**LINKED LISTS**
	Linked lists: Introduction, singly linked list, representation of a linked list in memory, operations on a single linked list; Applications of linked lists: Polynomial representation and sparse matrix manipulation. Types of linked lists: Circular linked lists, doubly linked lists; Linked list representation and operations of Stack, linked list representation and operations of queue.
MODULE - IV	**NON-LINEAR DATA STRUCTURES**
	Trees: Basic concept, binary tree, binary tree representation, array and linked representations, binary tree traversal, binary tree variants, 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**

	Binary search trees: Binary search trees, properties and operations; Balanced search trees: AVL trees; Introduction to M- Way search trees, B trees; Hashing and collision: Introduction, hash tables, hash functions, collisions, applications of hashing.

SECTION 12: Tentative Schedule of Instructions		
Week Number	**Topics**	**Duration (Hours)**
1	1.1 Introduction to data structures 1.2 Classification of data structures, operations on data structures 1.3 Recursive algorithms and performance analysis	3
2	2.1 Searching techniques: linear search, binary search 2.2 Uniform binary search, interpolation search 2.3 Fibonacci search	3
3	3.1 Sorting techniques: bubble sort, selection sort 3.2 Insertion sort 3.3 Quick sort, comparison between sorting techniques	3
4	4.1 Merge sort 4.2 Radix sort 4.3 Shell sort and comparison between sorting techniques	3
5	5.1 Stack ADT, definition and operations 5.2 Implementations of stacks using arrays 5.3 Applications of stacks	3
6	6.1 Arithmetic expression conversion and evaluation 6.2 Queues: primitive operations, applications of queue 6.3 Implementation of queues using arrays	3
7	7.1 Circular queue – operations and its implementation 7.2 Double ended queue (deque) – operations and its implementation 7.3 Linked lists: introduction, operations, advantages and disadvantages	3
8	8.1 Singly linked list, operations on a single linked list 8.2 Applications of linked lists - polynomial representation 8.3 Sparse matrix manipulation	3
CONTINIUOUS INTERNAL EXAMINATION (CIE- I)		
9	9.1 Types of linked lists: circular linked lists 9.2 Doubly linked lists 9.3 Linked list representation and operations of stack and queue	3
10	10.1 Trees basics, binary tree representation, array and linked representations 10.2 Binary tree traversal, binary tree variants 10.3 Threaded binary trees, application of trees	3
11	11.1 Graphs: basic concept, graph terminology 11.2 Graph representations - adjacency matrix, adjacency lists 11.3 Graph implementation	3
12	12.1 Graph traversals – Breadth First Search (BFS) 12.2 Graph traversals – Depth First Search (DFS) 12.3 Applications of graph	3
13	13.1 Minimum spanning trees (MST) – Kruskals algorithm 13.2 Prim's algorithm, examples 13.3 Applications of MST	3
14	14.1 Binary search trees (BST) - properties and applications 14.2 Balanced search trees, operations 14.3 Implementation of BST	3
15	15.1 Introduction to AVL trees 15.2 Introduction to m-way search trees 15.3 B-trees, applications of B-trees	3

16	16.1 Hashing: introduction, hash tables, hash functions 16.2 Collisions – collision resolution techniques 16.3 Applications of hashing	3
	Total	**48**

SECTION 14: Specific Goals for the Course	
The following table shows the knowledge and skills covered by the unit outcomes:	
Knowledge	**Skills**
Learners should understand: • Built-in data structures • Abstract data structures Tthe implementation of static abstract data structures • The implementation of dynamic abstract data structures • How to compare different search algorithms • How to compare different sorting algorithms • How to construct tree and tree traversals • Graph representation and traversal (BFS and DFS) • Priority queue is an abstract data type that performs operations on data elements per their priority. • Hashing technique in data structures to map keys and values into a hash table.	**Learners can:** • Produce code to access, add, remove and update data within built-in collection structures • Produce code that creates singly linked list data structures from first principles • Produce code to access, add, remove, and update data in a singly linked list • Produce code that creates doubly linked list data structures from first principles • Produce code to access, add, remove, and update data in a doubly linked list • Produce code that uses binary search tree data structures from first principles • Produce code to access, add, remove, and update data by traversing a binary search tree • Produce code to implement stacks, queues, deques, and heap structures, using both the linked list and array or list structures • Produce recursive functions or methods to solve a variety of problems • Produce code that uses sorting algorithms • Produce code that uses searching algorithms • Produce code to locate the largest and smallest items in a collection of values • Select the best search algorithm based on time and space complexity • Select the best sort algorithm based on time and space complexity • Construct minimal spanning tree using Prims and Kruskal algorithms • Find the shortest path between source and destination using Dijkstra's algorithm • Basic operations on hash tables like, Search, Insert, update and remove.

Administrative Information

SECTION 15: History of changes		
Regulations	**Description of change**	**BOS Date**
R 16	From R15 JNTUH, Hyderabad to R16 IARE regulations with change in V module • **Module - V:** Pattern Matching and Tries is replaced with Binary Trees and Hashing	24.07.2016

	• Data Structures and algorithms are implemented using C programming language	
R 18	Changes from R16 to R18 regulation • Credit weightage is reduced from 4 to 3. • **Module I:** Performance analysis- time complexity and space complexity, Asymptotic Notation-Big O, Omega, and Theta notations are introduced • **Module – IV:** Minimum spanning trees – Prims and Kruskal algorithms are introduced • Data Structures and algorithms are implemented using C programming language.	16.07.2018
UG 20	Changes from R18 to UG 20 regulation • Data Structures and related algorithms are studied using object-oriented programming using Python.	17.11.2020
BT 23	Incorporated the following additions in BT 23 regulations • **Module – I:** Uniform Binary Search, Interpolation Search, Radix and Shell Sort • Data Structures and related algorithms are studied using object-oriented programming using Java.	21.08.2023

Course Outline Approvals	
Course Coordinator Name:Dr.V.Kishen Ajay Kumar Signature: Date:19-01-2026	**Head of the Department** Name:Dr.P.Munaswamy Signature: Date: 19-01-2026
Course Outline Approvals: The course outline description approved by Outcome Based Teaching Learning (OBTL) committee on *date* in meetings *IARE - OBTL – COD /104/25*	
Dean of Outcome Based Teaching and Learning Name: **Dr. Ch Srinivasulu** Signature: Date: 19-01-2026	**Dean of Academics** Name: **Dr. G Chandra Sekhar** Signature: Date: 19-01-2026

Check List		
Section	**Description**	**Please tick (✓)**
1	General Information about the Course	✓
2	Notional Study Time	✓
3	A. Course Outcomes	✓
	B. Cognitive Levels	✓
4	Content and Context of the Course	✓
5	Complex Engineering Problem Solving	✓
6	A. Assessment Methods – Direct	✓
	B. Assessment Methods – Indirect	✓
7	Content Delivery / Instructional Methodologies	✓
8	Engineering Competencies (ECs) Focused	✓
9	Employability Skills	✓
10	Relevance to Sustainability goals	✓
11	A. Mapping between COs and POs / PSOs	✓
	B. Indicators of Attainment with COs to POs and PSOs	✓

	C. Course Articulation Matrix of COs to POs	✓
	D. Level of Contribution of the COs to POs and PSOs	✓
12	Syllabus	✓
13	Tentative Schedule of Instructions	✓
14	Specific Goals for the Course	✓
15	History of Changes	✓

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

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**Essentials of Problem Solving**
Course Code	ACSE02
Course Start	First Semester
Course Type	Core
Regulation	IARE – BT25
Prerequisite Courses	Nil
Department	Electronics and Communication Engineering
Number of Credits	3 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Theory
Course Administrator	**Dr. M Madhusudhan Reddy** Assistant Professor of CE IARE10881 m.madhusudhanreddy@iare.ac.in
Course Coordinator's Name	**Dr. Sreelakshmi Doma** Assistant Professor of AI &ML IARE10869 d.sreelakshmi@iare.ac.in
Prior Learning Assessment and Recognition (PLAR)	Students interested in PLAR pathways for open learning can register one semester prior to the start of semester. Students will receive the necessary contact information one semester in advance.
Open Learning Faculty Member Information	Open Learning Faculty (OLF) is available to assist students. Students will receive the necessary contact information at the start of the course.
Course Webpage	https://akanksha.iare.ac.in/index?route=course/details&course_id=9
Course Description	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 designed computer programs in regard to their efficiency and suitability for real-life applications.
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 coloring and traversal algorithms for solving real-time problems. IV. The numerical methods to solve algebraic equations.

Text and Reference Books	**Text Books** 1. Karin R Saoub, *Graph Theory: An Introduction to Proofs, Algorithms, and Applications,* 1 st edition, Chapman and Hall, 2021. 2. S S Sastry, *Introductory Methods of Numerical Analysis*, 5th edition, 2012. **Reference Books** 1. Mahinder Kumar Jain, *Numerical Methods: For Scientific and Scientific Computation, New Age International Pvt. Ltd., 7 th edition,* 2019. 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, 2 nd edition,* 2019. 4. Jann Kiusalaas, *Numerical Methods in Engineering with Python, Cambridge University Press, 2 nd edition* 2010.
Learning Resources	**Course full stack** is made available in IARE learning management portal – Akansha, which includes lecture notes, tutorial question bank, definition and terminology, tech-talk topics, assignments, Model question papers (2 sets), complex engineering problem solving statements, power point presentations (PPTs) and ELRV lecture recordings at: https://www.youtube.com/watch?v=QMmA_BMDvIQ&list=PLzkMouYverALQmPhcIJpyJgK4ZBd0OQ8k
Supplemental Materials	**Readings, Videos, and Links** 1. https://akanksha.iare.ac.in/index?route=course/details&course_id=95 2. https://www.youtube.com/watch?v=QMmA_BMDvIQ&list=PLzkMouYverALQmPhcIJpyJgK4ZBd0OQ8k
Learningand Teaching Strategies	Online material will provide the foundation of the learning resources, requiring the students to log in and engage regularly throughout the sixteen weeks of the course. There will be a mix of suggested readings, discussions and video content containing embedded digital content and undertake the assessment tasks.

SECTION 2: Teaching Learning Scheme

At least 48 lecture hours of scheduled teaching and learning activities (TLA) will be delivered in person, with the remaining hours for scheduled and self-scheduled teaching and learning activities delivered either in person or online.

Notional Study Time: 90 Hours (Lecture hours: 48, Tutorial hours: 8, Scheduled revision session hours: 2, Guided independent study hours: 15, Homework / Programming assignment hours: 10, Course project / Preparation for complex problem-solving hours: 15)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA1	Lectures	48	01	48
TLA 2	Tutorials	08	01	08
TLA 3	Case Study			
TLA 4	Problem Solving			
TLA 5	Demonstration			
TLA 6	Scheduled revision sessions	02	01	02
TLA 7	Guided independent study: Directed viewing of video materials / PPTs			15
TLA 8	Independent private study			
TLA 9	Laboratory Exercises	0	0	0
TLA 10	Homework assignments / Programming assignments			10

TLA 11	Placement / work based learning or Specific practical training	0	0	0
TLA 12	Presentation / Seminar Preparation			
TLA 13	Course Project / Preparation for Complex Problem Solving			15
TLA 14	Technical visit			
TLA 15	Field activities	0	0	0
			Total study hours	**90**
			Expected total study hours	**90**

SECTION 3A: Course Outcomes

After successfully completing this course, the student will be able to:

Outcome Number	Course Outcomes	Learning Domain
CO1	Outline the graph terminologies, graph representation, and relate them to practical examples.	Understand
CO2	Build efficient graph routing algorithms for various optimization problems on graphs.	Understand
CO3	Use effective techniques from graph theory to solve problems in networking and telecommunication.	Understand
CO4	Interpret the fundamental concepts of polynomials, roots of equations and solve corresponding problems using computer programs.	Understand
CO5	Apply the knowledge of numerical methods to solve algebraic and transcendental equations arising in real-life situations.	Apply
CO6	Solve numerical integrals and ordinary differential equations to simulate discrete time algorithms.	Apply

SECTION 3B: Cognitive Levels

Blooms Taxonomy Level	Cognitive Level in Percentage (%)
Remember	0
Understand	67
Apply	33
Analyze	0
Evaluate	0
Create	0

SECTION 4: Content and Context of Elements of Electrical and Electronics Engineering	
CO1	**Outline the graph terminologies, graph representation, and relate them to practical examples.**
	Graph terminology is essential for understanding graph theory, which is widely used in computer science, mathematics, and optimization problems. Below are the key terms: **Basic Terms** Graph (G): A collection of vertices (nodes) and edges (links), represented as G=(V,E)G = (V, E)G=(V,E), where: VVV is the set of vertices (nodes). EEE is the set of edges (connections between nodes). Vertex (Node): A fundamental unit of a graph, usually represented as v∈Vv Edge (Link): A connection between two vertices, represented as e∈Ee Degree of a Vertex: The number of edges connected to a vertex. In-degree: Number of edges directed into a vertex (for directed graphs). Out-degree: Number of edges directed out of a vertex (for directed graphs). Types of Graphs Undirected Graph: A graph where edges have no direction (i.e., if there is an edge between A and B, it can be traversed in both directions). Directed Graph (Digraph): A graph where edges have directions, meaning traversal is only allowed in the given direction. Weighted Graph: A graph where each edge has an associated weight or cost. Simple Graph: A graph that has no loops (edges that connect a vertex to itself) and no multiple edges between the same pair of vertices. Multigraph: A graph that allows multiple edges between the same set of vertices. Complete Graph (K_n): A graph where every pair of vertices is connected by an edge. Bipartite Graph: A graph whose vertices can be divided into two disjoint sets such that all edges connect a vertex from one set to a vertex from the other set.
CO2	**Build efficient graph routing algorithms for various optimization problems on graphs.**
	Efficient graph routing algorithms are essential for solving various optimization problems such as shortest path, network flow, traveling salesman problem, and vehicle routing. Below are some key graph routing algorithms optimized for different use cases. **1. Shortest Path Algorithms** Used in navigation, robotics, and network routing. **A. Dijkstra's Algorithm (Single-Source Shortest Path)** Use Case: Finds the shortest path from a single source to all other nodes in a graph with non-negative edge weights. Optimized Implementation: Use a min-heap (priority queue) for better performance. **B. Bellman-Ford Algorithm (Handles Negative Weights)** Use Case: Works on graphs with negative weights and detects negative weight cycles. Time Complexity: O(VE). Optimized Implementation: Early termination if no updates in a full iteration. **C. Floyd-Warshall Algorithm (All-Pairs Shortest Path)** Use Case: Computes shortest paths between all pairs of nodes in dense graphs. Time Complexity: O(V3) Optimized Implementation: Use matrix exponentiation for special cases. Use bitwise operations for faster updates. **D. A Algorithm (Heuristic Shortest Path) *** Use Case: Best for real-world navigation (e.g., Google Maps). Time Complexity: O(E)O(E)O(E) in the best case. Optimized Implementation: Use an admissible heuristic (e.g., Euclidean distance for grids). Use jump point search (JPS) for grid-based graphs.
CO3	**Use effective techniques from graph theory to solve problems in networking and telecommunication.**

	Graph theory plays a crucial role in solving networking and telecommunication problems by optimizing network design, routing, traffic management, and fault tolerance. Below are some effective techniques and their applications. **1. Network Topology Design** Used in planning efficient and resilient network infrastructures. **A. Minimum Spanning Tree (MST) for Backbone Networks** • **Problem**: Find the most cost-effective way to connect all network nodes with minimal wiring costs. • **Solution**: Use **Prim's** or **Kruskal's** algorithm to construct an MST. • **Example Application**: o Designing **fiber-optic networks** and **wireless mesh networks**. **B. Graph Partitioning for Load Balancing** • **Problem**: Divide a large network into smaller sub-networks to optimize load distribution. • **Solution**: Use **spectral clustering** or **Kernighan–Lin algorithm**. • **Example Application**: o **Data center network segmentation** for better resource allocation. **2. Routing Optimization** Used in packet switching, congestion control, and efficient data transmission. **A. Shortest Path Routing (Dijkstra's Algorithm)** • **Problem**: Find the fastest route for packet delivery. • **Solution**: Use **Dijkstra's algorithm** for **single-source shortest paths**. • **Example Application**: o **OSPF (Open Shortest Path First)** routing protocol in IP networks. **B. Load-Balanced Routing (Edge-Disjoint Paths)** • **Problem**: Prevent congestion by distributing traffic across multiple paths. • **Solution**: Compute **edge-disjoint shortest paths** to spread traffic. • **Example Application**: o **Multipath TCP (MPTCP)** for load balancing across multiple network interfaces. ***C. Delay-Tolerant Routing (A Algorithm)**** • **Problem**: Find an optimal path in a dynamic network where delays exist. • **Solution**: Use *A algorithm** with heuristic estimates of network delay. • **Example Application**: o **Mobile Ad-hoc Networks (MANETs)** and **Vehicular Ad-hoc Networks (VANETs)**.
CO4	**Interpret the fundamental concepts of polynomials, roots of equations and solve corresponding problems using computer programs.**
	Polynomials and their roots play a crucial role in various fields of mathematics, engineering, and computer science. Let's break down the key concepts and solve related problems using computer programs. **. Fundamental Concepts** **A. Polynomials** A polynomial is an algebraic expression of the form: P(x)=anxn+an−1xn−1+⋯+a1x+a0P(x) = a_n x^n + a_{n-1} x^{n-1} + \dots + a_1 x + a_0P(x)=an xn+an−1xn−1+⋯+a1x+a0 where: • an,an−1,...,a0a_n, a_{n-1}, ..., a_0an,an−1,...,a0 are **coefficients**. • xxx is the **variable**. • nnn is the **degree** of the polynomial. **B. Roots of Equations** The **roots** (or solutions) of a polynomial equation P(x)=0P(x) = 0P(x)=0 are the values of xxx that satisfy the equation. *Types of Roots:* 1. **Real Roots**: Roots that are real numbers. 2. **Complex Roots**: Roots that involve imaginary numbers (e.g., i=−1i = \sqrt{-1}i=−1). **Multiplicity of Roots**: If a root r is repeated mmm times, it has a **multiplicity** of m.

CO5	**Apply the knowledge of numerical methods to solve algebraic and transcendental equations arising in real-life situations.**
	Many real-world problems involve algebraic or transcendental equations that cannot be solved analytically. Numerical methods provide approximate solutions using iterative techniques. **1. Types of Equations** **A. Algebraic Equations** Equations of the form: P(x)=anxn+an−1xn−1+⋯+a1x+a0=0P(x) = a_nx^n + a_{n-1}x^{n-1} + \dots + a_1x + a_0 = 0P(x)=anxn+an−1xn−1+⋯+a1x+a0=0 Examples: • **Quadratic equations** (x2−4x+4=0x^2 - 4x + 4 = 0x2−4x+4=0) • **Cubic equations** (x3−6x2+11x−6=0x^3 - 6x^2 + 11x - 6 = 0x3−6x2+11x−6=0) • **Higher-degree polynomials** **B. Transcendental Equations** Equations involving non-algebraic functions like **trigonometric, exponential, and logarithmic functions**: Since transcendental equations **do not have closed-form solutions**, we use **numerical methods** to approximate their roots.

CO6	**Solve numerical integrals and ordinary differential equations to simulate discrete time algorithms.**
	In real-world problems, numerical integration and solving ODEs are essential for simulating discrete-time algorithms in physics, engineering, and machine learning. **Numerical Integration and ODEs in Discrete-Time Simulations** Numerical methods are essential for solving complex mathematical problems that arise in physics, engineering, finance, and computer science. Two fundamental problems in this area are **numerical integration** (approximating the area under a curve) and solving **ordinary differential equations (ODEs)** (which describe dynamic systems). **1. Numerical Integration** Numerical integration is used when an integral cannot be solved analytically. Common methods include: • **Trapezoidal Rule**: Approximates the integral as a series of trapezoids. • **Simpson's Rule**: Uses quadratic polynomials for better accuracy. **2. Solving Ordinary Differential Equations (ODEs)** ODEs describe how variables change over time. Since most real-world ODEs lack simple solutions, numerical methods approximate them. • **Euler's Method**: A simple but less accurate method that updates the solution using the derivative. • **Runge-Kutta (RK4)**: A higher-order method that balances accuracy and efficiency. **3. Applications in Discrete-Time Algorithm Simulations** These methods are used in: • **Physics**: Simulating motion and electric circuits. • **Biology**: Modeling population dynamics (e.g., predator-prey models). • **Engineering**: Control systems and signal processing. • **Machine Learning**: Training neural networks and optimization.

SECTION 5: Complex Engineering Problem Solving

Here's a breakdown of the process and key skills involved:

1. Problem Definition

- **Clearly state the problem:** Identify the unknowns, constraints, and desired outcomes.
- **Understand the context:** What are the real-world implications of the problem?
- **Gather information:** Collect relevant data, specifications, and any existing solutions.

2. Problem Analysis

- **Simplify the problem:** Break down the complex problem into smaller, manageable parts.
- **Apply fundamental principles:** Use Ohm's Law, Kirchhoff's Laws, network theorems, and other relevant concepts to analyze the circuit or system.
- **Develop a model:** Create a simplified representation of the system using circuit diagrams, equations, or simulations.

3. Solution Design

- **Explore potential solutions:** Brainstorm different approaches to solve the problem.

- **Evaluate feasibility:** Consider practical constraints like cost, materials, and time.
- **Select the best solution:** Choose the most efficient and effective solution based on your analysis.

4. Implementation and Testing

- **Build a prototype:** If necessary, construct a physical circuit or system to test your design.
- **Simulate the design:** Use software tools to simulate the circuit and verify its performance.
- **Analyze results:** Compare the actual or simulated results with the desired outcomes.

5. Evaluation and Refinement

- **Assess the solution:** Does it meet the requirements and constraints?
- **Identify limitations:** What are the weaknesses or areas for improvement?
- **Refine the design:** Make necessary adjustments to optimize the solution.

Key Skills for Complex Problem Solving

- **Strong foundation in electrical principles:** A solid understanding of basic concepts is essential.
- **Analytical and problem-solving skills:** Ability to break down complex problems and apply appropriate techniques.
- **Mathematical and computational skills:** Proficiency in algebra, calculus, and using calculators or software for calculations.
- **Circuit analysis and design skills:** Knowledge of circuit components, their behavior, and how to analyze and design circuits.
- **Critical thinking and evaluation:** Ability to assess solutions, identify limitations, and refine designs.
- **Communication and teamwork skills:** Ability to effectively communicate ideas and collaborate with others.

Example Complex Engineering Problem

Design a power supply for a small electronic device that requires a stable 5V DC output from a 120V AC input. The device has a variable load current ranging from 0.1A to 1A.

Steps to Solve:

1. **Problem Definition:** Design a power supply with specific input/output requirements and load variations.
2. **Problem Analysis:** Analyze the AC input, determine the necessary rectification and filtering stages, and select appropriate components (transformer, diodes, capacitors, voltage regulator).
3. **Solution Design:** Choose a suitable rectifier circuit (bridge rectifier), calculate the transformer turns ratio, select appropriate filter capacitor, and choose a voltage regulator (e.g., LM7805).
4. **Implementation and Testing:** Build a prototype power supply, test it under different load conditions, and measure the output voltage and ripple.
5. **Evaluation and Refinement:** Analyze the results, adjust component values if necessary to achieve the desired output voltage and stability, and ensure it meets the load current requirements.

SECTION 6A: Assessment Methods – Direct

Item	Evaluation Components	Week in / out	Marks
AAT: 1 - 1	Tech-Talk	Week – 02 / 05	05
AAT: 1 - 2	Hack-a-thon	Week – 04 / 07	05
AAT: 2 - 1	Complex Engineering Problem Solving	Week – 09 / 12	05
AAT: 2 - 2	Hack-a-thon	Week – 12 / 15	05
CIE - 1	2 hours - Answer 4 out of 5 questions	Week - 09	10
CIE - 2	2 hours - Answer 4 out of 5 questions	Week - 17	10
SEE	3 hours - Answer 1 from each module	Week - 18	60
		Total Marks	**100**

Department's Late Submission Policy:

1. 1 – 24 hours: 25% of the mark will be deducted
2. > 24 hours: Not accepted

SECTION 6B: Assessment Methods –Indirect

Course End Survey (End Semester OBE Feedback)	✓

SECTION 7: Engineering Competencies (ECs) Focused Please tick (✓) relevant engineering competency profile covered			
EC Number	**Attributes**	**Profiles**	**(✓)**
EC1	Depth of knowledge required (CP)	Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill- founded, illogical, erroneous, unreliable or unrealistic requirements applicable to the engineering discipline	✓
EC2	Depth of analysis required (CP)	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	✓
EC3	Design and development of solutions (CA)	Support sustainable development solutions by ensuring functional requirements, minimize environmental impact and optimize resource utilization throughout the life cycle, while balancing performance and cost effectiveness.	✓
EC4	Range of conflicting requirements (CP)	Competently addresses complex engineering problems which involve uncertainty, ambiguity, imprecise information and wide-ranging or conflicting technical, engineering and other issues.	-
EC5	Infrequently encountered issues (CP)	Conceptualizes alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.	-
EC6	Protection of society (CA)	Identifies, quantifies, mitigates and manages technical, health, environmental, safety, economic and other contextual risks associated to seek achievable sustainable outcomes with engineering application in the designated engineering discipline.	-
EC7	Range of resources (CA)	Involve the coordination of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies) in the timely delivery of outcomes	-
EC8	Extent of stakeholder involvement (CP)	Design and develop solution to complex engineering problem considering a very perspective and taking account of stakeholder views with widely varying needs.	✓
EC9	Extent of applicable codes, legal and regulatory (CP)	Meet all level, legal, regulatory, relevant standards and codes of practice, protect public health and safety in the course of all engineering activities.	-
EC10	Interdependence (CP)	High level problems including many component parts or sub-problems, partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then re-combines to form a whole, with the integrity and performance of the overall system as the top consideration.	✓
EC11	Continuing professional development (CPD) and-lifelong learning (CA)	Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.	✓
EC12	Judgement (CA)	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Require judgement in decision making in the course of all complex engineering activities.	-

SECTION 8: Employability Skills
Example: Communication skills / Programming skills / Project based skills
Studying Data Structures equips the students with a range of employability skills that are highly valued in industries. **Employability Skills:**

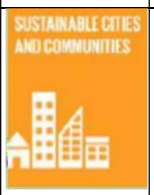
- Problem-solving skills for designing efficient solutions.
- Logical and analytical thinking for data organization.
- Proficiency in programming languages like C / C++ / Java / Python.
- Optimization skills for time and space complexity.
- Knowledge of scalable and robust system design.
- Teamwork and collaboration in software development.
- Adaptability to learn and apply advanced data structures.

Project Management:

- Planning and organizing project timelines and tasks.
- Allocating resources efficiently.
- Collaborating and communicating with team members.
- Identifying and mitigating project risks.
- Testing and validating system performance.

SECTION 9: Relevance to Sustainability goals

Brief description about the course and its correlationwith Sustainability Development Goal (SDGs).

SDG Goals		Correlation with SDG
4		**Quality Education:** This subject will prepare students for modern technological challenges, improving educational tools, and promoting skills essential for global development.
8		**Decent Work and Economic Growth:** Prepares students for careers in technology-driven industries, boosting employability and fostering innovation in the digital economy.
9		**Industry, Innovation, and Infrastructure:** Supports the development of efficient algorithms and systems crucial for advancing technological infrastructure and innovation.
11		**Sustainable Cities and Communities:** Enables the creation of smart city technologies (e.g., optimized traffic systems, resource management) using graph and tree structures.
17		**Partnerships for the Goals:** Facilitates collaboration in data-driven research and global educational initiatives through scalable and efficient data processing.

SECTION 10A: Mapping between COs and POs / PSOs														
Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	✓	✓		-	-	-	-	-	-	-			-	-
CO2	✓	✓				-	-	-	-	-			-	
CO3	✓	✓				-	-	-	-	-				
CO4	✓	✓				-	-	-	-	-				
CO5	✓	✓				-	-	-	-	-				
CO6	✓	✓					-	-	-	-				

Outcomes		WKS and Indicators of attainment and Justification for mapping(students will be able to)																																											IAs Coun
COs	POs	WK 1	WK 2								WK 3			WK 4			WK 5						WK 6			WK 7				WK 8							WK 9															
		a	a	b	c	d	e	f	g	h	a	b	c	a	b	c	a	b	c	d	e	f	a	b	c	a	b	c	d	a	b	c	d	e	f	g	a	b	c	d	e	f									
CO 1	PO 1	.	.	.	.	.	.		.			.	.	.																																					10
	PO 2	.	.	.	.	.	.		.			.	.	.																																					10
	PO 3																.	.	.			.																													4
	PO 11																														.	.	.			.	.													5
	PSO 1	.	.	.			.		.			.	.	.																																					8
CO2	PO 1	.	.	.	.	.	.		.			.	.	.																																					10
	PO 2	.	.	.	.	.	.		.			.	.	.																																					10
	PO 3																.	.	.			.																													4
	PO 4																														.	.	.			.	.													5
	PO 5		.	.	.	.	.		.														.	.	.																									9
	PO 11																														.	.	.			.	.													5
	PSO	.	.	.			.		.			.	.	.																																					8
	PSO 3		.	.			.		.			.	.	.									.	.	.																									10
CO3	PO 1	.	.	.	.	.	.		.			.	.	.																																					10
	PO 2	.	.	.	.	.	.		.			.	.	.																																					10
	PO 3																.	.	.			.																													4
	PO 4																														.	.	.			.	.													5
	PO 5		.	.	.	.	.		.														.	.	.																									9
	PO 11																														.	.	.			.	.													5
	PSO 1	.	.	.			.		.			.	.	.																																					8
	PSO 2		.	.			.		.			.	.	.									.	.	.																									10
	PSO		.	.			.		.			.	.	.									.	.	.																									10
CO4	PO 1	.	.	.	.	.	.		.			.	.	.																																					10
	PO 2	.	.	.	.	.	.		.			.	.	.																																					10
	PO 3																.	.	.			.																													4

	PO 4																										.	.	.			.	.						5
	PO 5		.	.	.	.	.		.													.	.	.														9
	PO 11																										.	.	.			.	.						5
	PSO 1	.	.	.			.		.			.	.	.																								8
	PSO 2		.	.			.		.			.	.	.								.	.	.														10
	PSO 3		.	.			.		.			.	.	.								.	.	.														10
CO 5	PO 1	.	.	.	.	.	.		.			.	.	.																								10
	PO 2	.	.	.	.	.	.		.			.	.	.																								10
	PO 3															.	.	.			.																	4
	PO 4																										.	.	.			.	.						5
	PO 5		.	.	.	.	.		.													.	.	.														9
	PO 11																										.	.	.			.	.						5
	PSO 1	.	.	.			.		.			.	.	.																								8
	PSO 2		.	.			.		.			.	.	.								.	.	.														10
	PSO 3		.	.			.		.			.	.	.								.	.	.														10
CO 6	PO 1	.	.	.	.	.	.		.			.	.	.																								10
	PO 2	.	.	.	.	.	.		.			.	.	.																								10
	PO 3															.	.	.			.																	4
	PO 4																										.	.	.			.	.						5
	PO 5		.	.	.	.	.		.													.	.	.														9
	PO 6	.														.	.	.			.					.	.		.										8
	PO 11																										.	.	.			.	.						5
	PSO 1	.	.	.			.		.			.	.	.																								8
	PSO 2		.	.			.		.			.	.	.								.	.	.														10
	PSO 3		.	.			.		.			.	.	.								.	.	.														10

SECTION 10B: Indicators of Attainment with COs to POs and PSOs														
Course Outcomes	Percentage of Indicators of Attainments (IA) with POs and PSOs													
	PO											PSO		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	100	40												
CO2	100	40												
CO3	100	40												
CO4	66.6	30												
CO5	66.6	40												
CO6	66.6	40												

SECTION 10C: Course Articulation Matrix of COs to POs														
0 No Contribution (0-5%)			**1** Low (≥5 - <40%)				**2** Moderate (≥40 - <60%)					**3** High (≥60%)		
Course Outcomes	**Program Outcomes (POs)**											**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	3	1												
CO2	3	1												
CO3	3	1												
CO4	3	1												
CO5	3	1												
CO6	3	1												
Total	18	6												
Average	**3**	**1**												

SECTION 10D: Level of Contribution of the COs to POs and PSOs			
Number	**Programme Outcomes**	**Proficiency Assessed by**	**Contribution Level (from 1 to 3)**
PO 1	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**.	CIE / SEE / AAT:1 – 2 Assignments / Open-ended problems	**3**
PO 2	Identify, formulate, review research literature and analyse **complex engineering problems** reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).	CIE / SEE / AAT:1 – 2 Tech talk	**3**
PO 3	Design creative solutions for **complex engineering problems** and design / develop systems / components/ processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**3**
PO 4	Conduct investigations of **complex engineering problems** using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**3**

PO 5	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve **complex engineering problems**. (WK2 and WK6).	CIE / SEE / AAT:2 – 2 Assignments	**3**
PO 6	Analyze and evaluate societal and environmental aspects while solving **complex engineering problems** for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7)	CIE / SEE / AAT:2 – 2 Assignments	**3**
PO 11	Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**3**
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	AAT: 1 – 1 Tech-Talk	**2**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	AAT: 2 – 1 Complex Engineering Problem Solving	**3**
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.	AAT: 2 – 1 Complex Engineering Problem Solving	**3**

SECTION 11: Course Content

MODULE - I	**GRAPH THEORY**
	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**
	Eulerian circuit: 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**
	Four color theorem, vertex coloring, edge coloring, coloring variations, first-fit coloring algorithm. Graph traversal: depth-first search, bread-first search and its applications; Minimum spanning trees: Kruskal's and Prim's algorithm, union-find structure.
MODULE - IV	**ALGEBRAIC AND TRANSCENDENTAL 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**

	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).

SECTION12		
	Tentative Schedule of Instructions	
Week Number	**Topics**	**Duration (Hours)**
1	1.1 Introduction to Graph Terminology 1.2 Basic definitions of graph circuits 1.3 Basics of digraphs 1.4 Basics of weighted graphs 1.5 Complete graphs	5
2	2.1 Graph complements 2.2 Bipartite graphs 2.3 Graph combinations 2.4 Isomorphisms 2.5 Matrix representations of graphs	5
3	3.1 Incidence and adjacency matrices 3.2 Degree sequence. 3.3 **Mock Test – I** 3.4 Eulerian circuit 3.5 Konigsberg bridge problem	5
4	4.1 Touring a graph 4.2 Eulerian graphs 4.3 Hamiltonian cycles 4.4 he traveling salesman problem 4.5 Shortest paths: Dijkstra's algorithm	5
5	5.1 Walks using matrices Representation of alternating quantities 5.2 Four color theorem, 5.3 Vertex coloring, 5.4 Edge coloring, coloring variations, first-fit coloring algorithm. **5.5. Mock Test -II**	5 e **15** of **18**
6	6.1 Touring a graph 6.2 Eulerian graphs 6.3 Hamiltonian cycles 6.4 The traveling salesman problem 6.5 Shortest paths: Dijkstra's algorithm	5
7	7.1 Revision of Incidence and adjacency matrices 7.2 Degree sequence. 7.3 **Mock Test – III** 7.4 Eulerian circuit 7.5 Konigsberg bridge problem	5
8	8.1 Hamiltonian cycles 8.2 The traveling salesman problem 8.3 Shortest paths: Dijkstra's algorithm 8.4 Eulerian circuit 8.5 Konigsberg bridge problem	5
CONTINIUOUS INTERNAL EXAMINATION (CIE- I)		

9	9.1 Revision 9.2 Graph traversal Problems 9.3 Depth-first search, 9.4 Bread-first search and its applications; 9.5 Working Operation of P-N Junction diode 9.6 V-I characteristics of P-N Junction diode 9.7 **Mock Test-IV**	5
10	10.1 Minimum spanning trees 10.2 Problems 10.3 Kruskal's and Prim's algorithm 10.4 Problems 10.5 Problems	5
11	11.1 Problems 11.2 Kruskal's and Prim's algorithm 11.3 Kruskal's and Prim's algorithm 11.4 Depth-first search Problems 11.5 Breadth -first search Problems	5
12	12.1 Algebraic equations 12.2 Method of false position 12.3 Bisection method 12.4 Iteration method 12.5 Problems	5
13	13.1 Newton-Raphson method 13.2 Secant method 13.3 Ramanujan's Method 13.4 Muller's method (Approximation up to 2 decimals only) 13.5 Problems	5
14	14.1 Trapezoidal rule, 14.2 Simpson's 1/3 rule, 14.3 Simpson's 3/8 rule, CC configurations 14.4 Problems 14.5 Problems	5
15	15.1 Runge-Kutta's second order method of solving ordinary differential equations (Approximation up to 2 decimals only). 15.2 Problems 15.3 Solution by Taylor's series 15.4 Problems 15.5 **Mock Test-V**	5
16	16.1 Euler's method of solving an ordinary differential equation numerically 16.2 Numerical problems 16.3 **Mock Test-VI** 16.4 Revision ofTaylor'sseries 16.5 Problems	5
	Total	**80**

SECTION 13: Specific Goals for the Course	
The following table shows the knowledge and skills covered by the unit outcomes:	
Knowledge	**Skills**
Learners should understand: · Concepts in electrical technology · abstract electrical modules · the implementation of circuit laws · how to compare different circuit parameters · how to compare ac and dc models · how to construct machines · semiconductor device analysis · BJT characteristics analysis · Small signal models for transistors	**Learners can:** · make complex problems · develop network models · make use in circuit solving methods · implement in designing circuits · gains knowledge on supply systems · grab principles and application knowledge about machines · learn diode and transistor characteristics · learn various configurations · develop hybrid parameters · solve numerical models · implement in laboratory course · make use of theorems

Administrative Information

SECTION 14: History of changes		
Regulations	**Description of change**	**BOS Date**
R 16	From R15 JNTUH, Hyderabad to R16 IARE regulations with change in **Module I** Graph terminology, digraphs, weighted graphs, complete graphs, graph complements, bipartite graphs, graph combinations, isomorphisms, matrix representations of graphs, incidence and adjacency matrices, degree sequence.	24.07.2016
R 18	Changes from R16 to R18 regulation · Credit weightage is reduced from 4 to 3. · **Module – IV:** Algebraic equations, method of false position, bisection method, iteration method, Newton-Raphson method, Secant method, Ramanujan's Method (Approximation up to 2 decimals only).	16.07.2018
UG 20	Changes from R18 to UG 20 regulation · **MODULE-IV:** ALGEBRAIC AND TRANSCENDENTAL 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).	17.11.2020
BT 23	Changes from UG 20 to BT 23 regulation **MODULE-V**: 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).	21.08.2023
BT 25	Changes from BT 23 to BT 25 regulation In this regulation the course contains only theory no laboratory sessions. As the course introduce in I semester keeping in point of students benefit.	

Course Outline Approvals	
Course Coordinator Name: Dr. Sreelakshmi Doma Signature: Date:	**Head of the Department** Name: Dr. P Munaswamy Signature: Date:
Course Outline Approvals: The course outline description approved by Outcome Based Teaching Learning (OBTL) committee on *date* in meetings *IARE - OBTL – COD /104/25*	
Dean of Outcome Based Teaching and Learning Name: Dr. CH. Srinivasulu Signature: Date:	**Dean of Academics** Name: Dr. GVR Seshagiri Rao Signature: Date:

Check List		
Section	**Description**	**Please tick (✓)**
1	General Information about the Course	
2	Notional Study Time	
3	A. Course Outcomes	
	B. Cognitive Levels	
4	Content and Context of the Course	
5	Complex Engineering Problem Solving	
6	A. Assessment Methods – Direct	
	B. Assessment Methods – Indirect	
7	Content Delivery / Instructional Methodologies	
8	Engineering Competencies (ECs) Focused	
9	Employability Skills	
10	Relevance to Sustainability goals	
11	A. Mapping between COs and POs / PSOs	
	B. Indicators of Attainment with COs to POs and PSOs	
	C. Course Articulation Matrix of COs to POs	
	D. Level of Contribution of the COs to POs and PSOs	
12	Syllabus	
13	Tentative Schedule of Instructions	
14	Specific Goals for the Course	
15	History of Changes	

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

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**ENGINEERING CHEMISTRY LABORATORY**
Course Code	AHSE06
Course Start	II Semester
Course Type	Foundation
Regulation	IARE - BT 25
Prerequisite Courses	Basic principles of chemistry
Department	ELECTRONICS AND COMMUNICATION ENGINEERING
Number of Credits	1Credit hours
Academic Year	2025-26
Method(s) of Instruction	Theory and laboratory
Course Coordinator's Name	**Dr. C Mahender,** Assistant Professor Department of Chemistry IARE11131 c.mahender@iare.ac.in
Course Webpage	https://www.iare.ac.in/sites/default/files/BT25/AHSE06.pdf
Course Description	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. These practical approaches give the awareness to chemical methods and perform testing of materials in various industries.
Course Objectives	**The students will try to learn:** a. The quantitative analysis to know the strength of unknown solutions by instrumental methods. b. The troubles of hard water and its estimation by analytical techniques. c. The applications of appropriate lubricant for finely tuned machinery. d. The basic knowledge on quantity of light absorbed by the materials.
Text and Reference Books	**Text Books** 1. Vogel's text book of practical organic chemistry 5th edition **2.** Inorganic Quantitative analysis by A.I. Vogel, ELBS Publications **Reference Books** 1. Lab manual for Engineering chemistry by B. Ramadevi and P. Aparna, S Chand Publications, NewDelhi (2022) 2. College Practical Chemistry by V.K. Ahluwalia , Narosa Publications Ltd. New Delhi (2007).
Learning and Teaching Strategies	Online material will provide the foundation of the learning resources, requiring the students to log in and engage regularly throughout the sixteen weeks of the course. There will be a mix of suggested readings, discussions and video content containing embedded digital content and undertake the assessment tasks.

DELIVERY / INSTRUCTIONAL METHODOLOGIES:							
✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

SECTION 2: Teaching Learning Scheme

At least 48 lecture hours of scheduled laboratories activities (TLA) will be delivered in person,

Notional Study Time:48 Hours(Laboratory Exercises)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA 1	Lectures	-	-	-
TLA 2	Tutorials	-	-	-
TLA 3	Case Study	-	-	-
TLA 4	Problem Solving	-	-	-
TLA 5	Demonstration	-	-	-
TLA 6	Scheduled revision sessions	-	-	-
TLA 7	Guided independent study: Directed viewing of video materials / PPTs	-	-	-
TLA 8	Independent private study	-	-	-
TLA 9	Laboratory Exercises	12	03	36
TLA 10	Homework assignments / Programming assignments	-	-	-
TLA 11	Placement / work based learning or Specific practical training	-	-	-
TLA 12	Presentation / Seminar Preparation	-	-	-
TLA 13	Course Project / Preparation for Complex Problem Solving	-	-	-
TLA 14	Technical visit	-	-	-
TLA 15	Field activities	-	-	-
			Total study hours	**36**
			Expected total study hours	**36**

SECTION 3A: Course Outcomes

After successfully completing this course, the student will be able to:

Outcome Number	Course Outcomes	Learning Domain
CO1	**Use** analytical techniques like conductometry and pH metry to recognize the electrical properties of solutions	Apply
CO2	**Utilize** the potentiometer to characterize and measure the electrical potential of an analyte.	Apply
CO3	**Implement** the principles of water analysis for domestic and industrial applications.	Apply
CO4	**Synthesize** the polymeric materials from monomers with polymerization process.	Understand
CO5	**Select** different types of lubricants to know its properties for the proper lubrication of machinery in industries.	Apply
CO6	**Identify** the absorption tendency of solids or liquids by using colorimetry	Understand

SECTION 3B: Cognitive Levels

Blooms Taxonomy Level	Cognitive Level in Percentage (%)
Remember	0
Understand	33.33
Apply	66.66
Analyse	0
Evaluate	0
Create	0

SECTION 4: Engineering Chemistry laboratory	
CO1	**Use analytical techniques like conductometry and pH metry to recognize the electrical properties of solutions.**
	• Enables students to understand common methods for measuring the conductance and pH of solutions in a laboratory. • Understand the determining the purity of water, measuring the ion concentration in electrolyte solutions. • Prepare students to apply their knowledge to recognize the importance of pH monitoring in industries like water treatment, pharmaceuticals, and food production.
CO2	**Utilize the potentiometer to characterize and measure the electrical potential of an analyte.**
	• Helps students understand the concept of potentiometer and observe how strong acids have lower EMF values due to complete ionization, while weak acids have higher EMF values because of partial ionization. • Builds skills to analyze differences between strong acids and weak acids. • Learn the proper procedure for calibrating a potentiometer using KCl solutions and handling the electrode carefully to avoid contamination and damage. • Builds skills to analyze measuring the EMF of batteries, studying redox reactions, determining the concentration of ions in a solution using electrochemical cells. • These methods are simple and effective for students to gain practical knowledge about the properties of electrolyte solutions and electrochemical cells.
CO3	**Implement the principles of water analysis for domestic and industrial applications.**
	• Understand why water analysis is essential for ensuring safe drinking water for domestic use. • Learn how water quality impacts industrial processes, such as manufacturing, food production, and energy generation. • Recognize the environmental significance of monitoring and maintaining clean water sources. • Assess industrial water quality to prevent corrosion, scaling, or biological growth in machinery. • Understand the role of water quality monitoring in environmental protection and regulatory compliance. • Develop problem-solving skills for proposing solutions to water contamination issues.
CO4	**Synthesize the polymeric materials from monomers with polymerization process.**
	• Understand the process of polymerization, the chemical reaction in which monomers link together to form polymers. • Analyze how the structure and functional groups in monomers influence the physical, chemical, and mechanical properties of the resulting polymer. • Gain hands-on experience in synthesizing monomers and learn how catalysts, temperature, and pressure affect polymerization. • Explore how polymer properties are tailored for various applications like packaging, textiles, biomedical devices, and automotive parts. • Develop problem-solving skills to design polymers with specific characteristics for practical use. • Understand the environmental impact of polymers and explore sustainable alternatives like biodegradable polymers.
CO5	**Select different types of lubricants to know its properties for the proper lubrication of machinery in industries.**

	• Learn that lubricants reduce friction and wear between moving parts in machinery. • Understand how lubricants prevent corrosion, remove heat, and act as a sealant in engines and other equipment. • Students will explore how the properties of lubricants determine their suitability for specific industrial applications. • Identify and differentiate between mineral oils, synthetic oils, and greases. • Learn how to select the appropriate lubricant for machinery used in sectors like automotive Manufacturing, Aerospace and Food Processing using food-grade lubricants. • Understand maintenance practices, including proper storage, application, and disposal of lubricants.
CO6	**Identify the absorption tendency of solids or liquids by using colorimetry.**
	• Understand how to calibrate instruments using standard solutions. • Generate and analyze absorption spectra to determine unknown concentrations. • Plot calibration curves and apply them to calculate the concentration of a sample. • Develop skills in experimental design, including proper sample preparation and dilution. • Learn how colorimetry and spectroscopy are used to determine the concentration of various substances include Metal ions in water samples, pharmaceuticals and biological molecules, • food and beverage colorants and environmental pollutants

SECTION 5: Complex Engineering Problem Solving- NA

.

SECTION 6A: Assessment Methods – Direct

Item	Evaluation Components	Week in / out	Marks
1	Day to day evaluation	Every week	20
2	Internal examination and Viva-voce	10 +10	20
3	Semester end examination (External)	Week – 17	60
		Total Marks	**100**

Department's Late Submission Policy:

1. 1 – 24 hours: 25% of the mark will be deducted
2. > 24 hours: Not accepted

SECTION 6B: Assessment Methods –Indirect

Course End Survey (End Semester OBE Feedback)	✓

SECTION 8: Engineering Competencies (ECs) Focused: NA

Please tick (✓) relevant engineering competency profile covered

EC Number	Attributes	Profiles	(✓)
EC1	Depth of knowledge required (CP)	Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill-founded, illogical, erroneous, unreliable or unrealistic requirements applicable to the engineering discipline	-
EC2	Depth of analysis required (CP)	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	-
EC3	Design and development of	Support sustainable development solutions by ensuring functional requirements, minimize environmental impact and optimize	-

	solutions (CA)	resource utilization throughout the life cycle, while balancing performance and cost effectiveness.	
EC4	Range of conflicting requirements (CP)	Competently addresses complex engineering problems which involve uncertainty, ambiguity, imprecise information and wide-ranging or conflicting technical, engineering and other issues.	-
EC5	Infrequently encountered issues (CP)	Conceptualizes alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.	-
EC6	Protection of society (CA)	Identifies, quantifies, mitigates and manages technical, health, environmental, safety, economic and other contextual risks associated to seek achievable sustainable outcomes with engineering application in the designated engineering discipline.	-
EC7	Range of resources (CA)	Involve the coordination of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies) in the timely delivery of outcomes	-
EC8	Extent of stakeholder involvement (CP)	Design and develop solution to complex engineering problem considering a very perspective and taking account of stakeholder views with widely varying needs.	-
EC9	Extent of applicable codes, legal and regulatory (CP)	Meet all level, legal, regulatory, relevant standards and codes of practice, protect public health and safety in the course of all engineering activities.	-
EC10	Interdependence (CP)	High level problems including many component parts or sub-problems, partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then re-combines to form a whole, with the integrity and performance of the overall system as the top consideration.	-
EC11	Continuing professional development (CPD) and lifelong learning (CA)	Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.	-
EC12	Judgement (CA)	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Require judgement in decision making in the course of all complex engineering activities.	-

SECTION 9: Employability Skills

Example: Communication skills / Programming skills / Project based skills

- **Project based skills:** Awareness on instrumental methods of analysis and real-time applications through properties of materials.
- The study of Engineering Chemistry Laboratory equips students with a range of practical knowledge and hands-on experience in applying chemical principles to solve engineering problems.
- Learn how chemical properties influence the behaviour of materials used in engineering applications.
- Explore the application of chemistry in various industries includes fuel analysis,polymer synthesis, water treatment in engineering applications
- Students will have a strong foundation in chemical analysis, problem-solving, and practical applications of chemistry in engineering fields.

SECTION 10: Relevance to Sustainability goals

Brief description about the course and its correlation with Sustainability Development Goal (SDGs).

SDG Goals		Correlation with SDG
4		**Quality Education:** Enhancement in the additional skills for the students with analytical tools.

6		**Clean Water and Sanitation:** Ensures the availability to clean water through hard water analysis and its removal with chemical methodology.
14		**Life Below Water:** Knowledge gained on the colorimetry provides awareness to students on the effect of metals from industrial effluents on living organisms in water bodies.

SECTION 11A: Mapping between COs and POs / PSOs

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO2	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO3	✓	✓	-	-	-	✓	-	-	-	-	-	-	-	-
CO4	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO6	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-

Outcomes		WKS and Indicators of attainment and Justificationformapping(studentswillbeableto)																																				IAs Count
COs	POs	WK 1	WK 2								WK 3			WK 4			WK 5						WK 6			WK 7				WK 8							WK 9						
		A	a	b	c	d	e	f	g	h	a	b	c	a	b	c	a	b	c	d	e	f	a	b	c	a	b	c	d	a	b	c	d	e	f	g	a	b	c	d	e	f	
CO 1	PO 1	•	•	•	•	•	•	•			•		•	•																												10
	PO 2	•	•	•	•		•				•	•	•	•	•																											10
CO2	PO 1	•	•	•	•	•	•	•			•		•	•																												10
	PO 2	•	•	•	•		•				•	•	•	•	•																											10
CO3	PO 1	•		•	•	•	•				•	•	•	•	•																											10
	PO 2	•	•	•	•		•				•	•	•	•	•																											10
	PO 6	•															•		•		•					•	•		•													7
CO4	PO 1	•	•	•	•	•	•	•			•		•	•																												10
CO 5	PO 1	•	•	•	•	•	•	•			•		•	•	•																											11
	PO 2	•	•	•	•		•				•	•	•	•	•																											10
CO 6	PO 1	•	•	•	•	•	•					•	•	•	•																											11
	PO 2	•	•	•	•		•	•			•	•	•	•	•																											11

SECTION 11B: Indicators of Attainment with COs to POs and PSOs

Course Outcomes	Percentage of Indicators of Attainments (IA) with POs and PSOs														
	PO												PSO		
	1	2	3	4	5	6	7		8	9	10	11	1	2	3
CO1	67	67	-	-	-	-	-		-	-	-	-	-	-	-
CO2	67	67	-	-	-	-	-		-	-	-	-	-	-	-
CO3	67	67	-	-	-	64	-		-	-	-	-	-	-	-
CO4	67	-	-	-	-	-	-		-	-	-	-	-	-	-
CO5	73	67	-	-	-	-	-		-	-	-	-	-	-	-
CO6	73	73	-	-	-	-	-		-	-	-	-	-	-	-

SECTION 11C: Course Articulation Matrix of COs to POs

0 No Contribution (0-5%)	1 Low (≥5 - <40%)	2 Moderate (≥40 - <60%)	3 High (≥60%)
-			

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	3	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO6	3	3	-	-	-	-	-	-	-	-	-	-	-	-
Total	18	15	-	-	-	3	-	-	-	-	-	-	-	-
Max. Value	**3**	**3**				**3**								

SECTION 11D: Level of Contribution of the COs to POs and PSOs

Number	Programme Outcomes	Proficiency Assessed by	Contribution Level (from 1 to 3)
PO 1	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**.	CIE / SEE	**3**
PO 2	Identify, formulate, review research literature and analyse **complex engineering problems** reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).	CIE / SEE	**3**
PO6	Analyze and evaluate societal and environmental aspects while solving **complex engineering problems** for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7)	CIE / SEE	**3**

2.1 SECTION 12: Course Content

WEEK- 1	INTRODUCTION TO CHEMISTRY LABORATORY

	1.1 Safety Guidelines to chemistry lab
WEEK- 2	**MEASUREMENT OF STRENGTH OF ACID SOLUTIONS BY CONDUCTOMETRY**
	2.1 Estimation of the concentration of strong acid using conductometer
WEEK- 3	**MEASUREMENT OF STRENGTH OF MIXTURE OF ACIDIC SOLUTIONS BY CONDUCTOMETRY**
	3.1 Estimation of concentration of strong and weak acid in an acid mixture using conductometer
WEEK- 4	**MEASUREMENT OF ELECTROMOTIVE FOR SOLUTIONS BY POTENTIOMETRY**
	4.1 Estimation of iron content of the given solution by $K_2Cr_2O_7$ using potentiometer
WEEK- 5	**MEASUREMENT OF ELECTROMOTIVE FOR SOLUTIONS BY POTENTIOMETRY**
	5.1 Estimation of concentration of hydrochloric acid using potentiometer
WEEK- 6	**MEASUREMENT OF STRENGTH OF ACIDIC SOLUTIONS BY pH METRY**
	6.1 Determination of strength of given hydrochloric acid using pH meter
WEEK- 7	**MEASUREMENT OF TOTAL DISSOLVED SOLIDS IN WATER**
	7.1 Measurement of total dissolved solids (TDS) in different water samples
WEEK- 8	**COMPLEXOMETRY METHOD**
	8.1 Estimate the total hardness of water by EDTA
WEEK- 9	**PRECIPITATION METHOD**
	9.1 Determination of chloride content in water by Argentometry.
WEEK- 10	**PREPARATION OF POLYMER**
	10.1 Preparation of Thiokol rubber by using sodium polysulphide.
WEEK- 11	**VISCOSITY OF LUBRICANT**
	11.1 Determine the viscosity of the lubricants using Ostwald's viscometer
WEEK- 12	**PROPERTIES OF LUBRICANTS**
	12.1 Determine the flash and fire points of lubricants
WEEK- 13	**CLOUD AND POUR POINT OF LUBRICANTS**
	13.1 Determination of cloud and pout point of lubricants
WEEK- 14	**COLORIMETRY**
	14.1 Estimate the metal ion concentration using colorimeter

SECTION 13: Tentative Schedule of Instructions

Week Number	Topics	Duration (Hours)
1	1.1 Estimation of concentration of strong acid using conductometer	3
2	2.1 Estimation of concentration of strong and weak acid in an acid mixture using conductometer	3
3	3.1 Estimation of concentration hydrochloric acid for measurement of electromotive force solutions using potentiometer	3
4	4.1 Determine the Ph of the unknown solution by Ph metry	3

5	5.1 Measurement of Total Dissolved Solids (TDS) in different water samples	3
6	6.1 Determination of chloride content of water by Argentometry	3
7	7.1 Measurement of Alkalinity of different water samples	3
8	8.1 Estimate the Total Hardness of water using EDTA	3
9	9.1 Synthesize Thiokol rubber using sodium polysulphide with 1,2-Dichloroethane.	3
10	10.1 Determine the Viscosity of the Lubricants using Ostwald's Viscometer.	3
11	11.1 Determine the Flash and Fire Points of Lubricants	3
12	12.1 Estimate the Metal Ion Concentration using Colorimeter	3
	Total	**36**

SECTION 14: Specific Goals for the Course

The following table shows the knowledge and skills covered by the unit outcomes:

Knowledge	Skills
Learners should understand: • To handle laboratory equipment and instruments safely and efficiently. • To collect accurate and reliable data using appropriate techniques and instrumentation. • Understand and follow laboratory safety protocols to ensure a safe working environment. • The environmental impact of chemical processes and the role of sustainable practices in engineering. • Experimental troubleshooting, including identifying and correcting errors in experimental procedures.	**Learners can:** • Master basic laboratory techniques such as titration, filtration, distillation, and synthesis of chemicals • Utilize modern techniques such as spectroscopy, chromatography, and electrochemical analysis. • Develop awareness of ethical issues related to laboratory practices, including integrity in data reporting and research. • Investigate the chemical processes involved in energy production, corrosion, and waste management. • Develop critical thinking and problem-solving skills by interpreting complex experimental results and suggesting improvements.

Administrative Information

SECTION 15: History of changes

Regulations	Description of change	BOS Date
R 16	From R15 JNTUH, Hyderabad to R16 IARE regulations • 30% of syllabus changed	24.07.2016
R 18	Changes from R16 to R18 regulation • 40% of syllabus changed	16.07.2018
UG 20	• No Laboratory	-
BT 23	Changes from R18 regulation to BT 23 regulations 50% of syllabus changed	21.08.2023
BT25	Changes from BT 23 regulation to BT 25 syllabus 20% of syllabus changed	18.08.2025

Course Outline Approvals	
Course Coordinator Name: Dr VNSR Venkateswara Rao Signature: Date:	**Head of the Department** Name: Dr. V Anitha Rani Signature: Date:
Dean of Outcome Based Teaching and Learning Name: Dr. Srinivasulu Signature: Date:	**Dean of Academics** Name: Dr. GVR Sheshagiri Rao Signature: Date:

Check List		
Section	**Description**	**Please tick (✓)**
1	General Information about the Course	
2	Notional Study Time	
3	A. Course Outcomes	
	B. Cognitive Levels	
4	Content and Context of the Course	
5	Complex Engineering Problem Solving	
6	A. Assessment Methods – Direct	
	B. Assessment Methods – Indirect	
7	Content Delivery / Instructional Methodologies	
8	Engineering Competencies (ECs) Focused	
9	Employability Skills	
10	Relevance to Sustainability goals	
11	A. Mapping between COs and POs / PSOs	
	B. Indicators of Attainment with COs to POs and PSOs	
	C. Course Articulation Matrix of COs to POs	
	D. Level of Contribution of the COs to POs and PSOs	
12	Syllabus	
13	Tentative Schedule of Instructions	
14	Specific Goals for the Course	
15	History of Changes	

Signature of Course Coordinator **HOD, CE**
Dr. VNSR Venkateswara Rao, Associate Professor

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

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**NETWORK ANALYSIS AND SYNTHESIS LABORATORY**
Course Code	AEEE05
Course Start	II Semester
Course Type	Non-Core
Regulation	IARE - BT 25
Prerequisite Courses	Electrical Circuits, Linear Algebra and Calculus
Department	ECE
Number of Credits	1Credit hours
Academic Year	2025-26
Method(s) of Instruction	Theory and laboratory
Course Coordinator's Name	**Mr. T RAVI BABU,** Assistant Professor Department of EEE IARE10732 **travibabu@iare.ac.in**
Course Webpage	https://www.iare.ac.in/sites/default/files/BT25/AEEE05.pdf
Course Description	The Network Analysis and Synthesis Laboratory provide hands-on experience in analyzing, designing, and testing electrical networks. Students learn to apply fundamental circuit theories, network theorems, and synthesis techniques to real-time electrical and electronic circuits. It is designed to give hands-on experience on virtual instrumentation through digital simulation techniques. These techniques enable the students in examining characteristics of DC and AC circuits, filters, solution of differential equation, generation of three phase and complex wave forms using MATLAB.
Course Objectives	**The students will try to learn:** a. The RL, RC, and RLC circuits under different excitations using integro-differential and Laplace transform approaches. b. The two-port electrical networks and apply network topology concepts like tie-set and cut-set matrices for circuit analysis c. The various filter and attenuator configurations for frequency-selective and signal conditioning applications d. The electrical networks using driving-point functions, positive real functions, and classical synthesis methods such as Foster and Causer forms.
Text and Reference Books	**Text Books** 1. A Chakrabarthy, "Circuit Theory", Dhanpat Rai Publications, 6th edition, 2006. 2. A Sudhakar, Shyammohan S Palli, "Circuits and Networks", Tata McGraw Hill, 4th edition, 2010 **Reference Books** 1. William Hayt, Jack E Kemmerly S.M. Durbin, "Engineering Circuit Analysis", Tata McGraw Hill, 7th edition, 2010. 2. K S Suresh Kumar, "Electric Circuit Analysis", Pearson Education, 1st edition, 2013.

	3. Rudrapratap, “Getting started with MATLAB: A Quick Introduction for Scientists and Engineers”, Oxford University Press, 1st edition, 19994.
Learning and Teaching Strategies	Online material will provide the foundation of the learning resources, requiring the students to log in and engage regularly throughout the sixteen weeks of the course. There will be a mix of suggested readings, discussions and video content containing embedded digital content and undertake the assessment tasks.

DELIVERY / INSTRUCTIONAL METHODOLOGIES:							
✓	Demo Video	✓	Lab Worksheets	✓	Viva Questions	✓	Probing further Questions

SECTION 2: Teaching Learning Scheme

At least 48 lecture hours of scheduled laboratories activities (TLA) will be delivered in person,

Notional Study Time:48 Hours(Laboratory Exercises)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA 1	Lectures	-	-	-
TLA 2	Tutorials	-	-	-
TLA 3	Case Study	-	-	-
TLA 4	Problem Solving	-	-	-
TLA 5	Demonstration	-	-	-
TLA 6	Scheduled revision sessions	-	-	-
TLA 7	Guided independent study: Directed viewing of video materials / PPTs	-	-	-
TLA 8	Independent private study	-	-	-
TLA 9	Laboratory Exercises	12	03	36
TLA 10	Homework assignments / Programming assignments	-	-	-
TLA 11	Placement / work based learning or Specific practical training	-	-	-
TLA 12	Presentation / Seminar Preparation	-	-	-
TLA 13	Course Project / Preparation for Complex Problem Solving	-	-	-
TLA 14	Technical visit	-	-	-
TLA 15	Field activities	-	-	-
			Total study hours	**36**
			Expected total study hours	**36**

SECTION 3A: Course Outcomes

After successfully completing this course, the student will be able to:

Outcome Number	Course Outcomes	Learning Domain

CO1	**Simulate and analyze electrical circuits to verify resonance phenomena, network theorems, and power measurement techniques.**	Analyse
CO2	**Evaluate time and frequency domain responses of RL, RC, and filter circuits using circuit simulation tools.**	Evaluate
CO3	**Determine and interpret two-port network parameters for diverse interconnection configurations.**	Analyse
CO4	**Measure active, reactive, and three-phase power in balanced star and delta connected systems.**	Apply
CO5	**Analyze coupling effects in magnetically coupled circuits through coefficient, self, and mutual inductance calculations.**	Analyse
CO6	**Validate classical theorems and compensation principles for optimizing circuit performance.**	Evaluate

SECTION 3B: Cognitive Levels

Blooms Taxonomy Level	Cognitive Level in Percentage (%)
Remember	0
Understand	0
Apply	16.66
Analyse	50
Evaluate	33.33
Create	0

SECTION 4: Engineering Chemistry laboratory	
CO1	**Simulate and analyze electrical circuits to verify resonance phenomena, network theorems, and power measurement techniques.**
	• Helps students understand resonance behavior in RLC circuits by observing impedance, current, and power factor variations using simulation tools. • Enables verification of classical network theorems by comparing analytical results with simulated circuit responses. • Builds skills to analyze and interpret circuit performance under different configurations and operating conditions. • Develops practical competence in measuring and validating active, reactive, and apparent power in single-phase and three-phase systems using simulation techniques.
CO2	**Evaluate time and frequency domain responses of RL, RC, and filter circuits using circuit simulation tools.**
	• Helps students understand transient and steady-state behavior of RL, RC, and filter circuits through time-domain simulations. • Enables evaluation of frequency-domain characteristics such as gain, phase, cutoff frequency, and bandwidth of filter circuits. • Builds skills to compare simulated responses with theoretical expectations for different circuit parameters and inputs. • Develops the ability to interpret simulation waveforms, Bode plots, and response curves for performance assessment of electrical circuits.
CO3	**Determine and interpret two-port network parameters for diverse interconnection configurations.**
	• Helps students understand different two-port network parameters (Z, Y, h, and ABCD) and their physical significance. • Enables determination of two-port parameters through analytical methods and circuit simulation for various network configurations. • Builds skills to interpret the effect of series, parallel, and cascaded interconnections on two-port network behaviour. • Develops the ability to convert between different parameter sets and analyze their suitability for

	specific applications. • Enhances problem-solving skills by correlating theoretical concepts with simulated results for practical network analysis.
CO4	**Measure active, reactive, and three-phase power in balanced star and delta connected systems.**
	• Helps students understand the concepts of active, reactive, and apparent power in three-phase electrical systems. • Enables measurement of power in balanced star and delta connected loads using appropriate power measurement techniques. • Builds skills to apply the two-wattmeter method for determining total power and power factor in three-phase systems. • Develops the ability to analyse the relationship between line and phase voltages and currents in star and delta configurations. • Enhances practical competence in interpreting power measurements and validating theoretical calculations with measured results.
CO5	**Analyze coupling effects in magnetically coupled circuits through coefficient, self, and mutual inductance calculations**
	• Helps students understand the principles of magnetic coupling and the role of mutual and self-inductance in electrical circuits. • Enables calculation of the coefficient of coupling (k) and its impact on energy transfer between inductively coupled circuits. • Builds skills to compute self-inductance and mutual inductance for various circuit configurations. • Develops the ability to analyze the effect of coupling on voltage, current, and resonance in coupled circuits. • Enhances practical competence in designing and interpreting transformer models and coupled inductor circuits. • Provides hands-on experience in using simulation and analytical methods to study coupling effects and optimize circuit performance.
CO6	**Validate classical theorems and compensation principles for optimizing circuit performance.**
	• Helps students understand the fundamentals of classical network theorems (Thevenin, Norton, Superposition, Maximum Power Transfer, Tellegen) and compensation principles. • Enables verification of these theorems and principles through calculations, experiments, and simulations in practical circuits. • Builds skills to analyze and interpret circuit behavior under different configurations and load conditions. • Develops the ability to apply compensation techniques to optimize voltage, current, and power performance in electrical networks. • Enhances practical competence in comparing theoretical predictions with measured or simulated results to validate circuit performance.

SECTION 5: Complex Engineering Problem Solving- NA

.

SECTION 6A: Assessment Methods – Direct

Item	Evaluation Components	Week in / out	Marks
1	Day to day evaluation	Every week	20
2	Internal examination and Viva-voce	10 +10	20
3	Semester end examination (External)	Week – 17	60
		Total Marks	**100**

Department's Late Submission Policy: 1. 1 – 24 hours: 25% of the mark will be deducted 2. > 24 hours: Not accepted	
SECTION 6B: Assessment Methods –Indirect	
Course End Survey (End Semester OBE Feedback)	✓

SECTION 8: Engineering Competencies (ECs) Focused: NA

Please tick (✓) relevant engineering competency profile covered

EC Number	Attributes	Profiles	(✓)
EC1	Depth of knowledge required (CP)	Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill-founded, illogical, erroneous, unreliable or unrealistic requirements applicable to the engineering discipline	✓
EC2	Depth of analysis required (CP)	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	✓
EC3	Design and development of solutions (CA)	Support sustainable development solutions by ensuring functional requirements, minimize environmental impact and optimize resource utilization throughout the life cycle, while balancing performance and cost effectiveness.	✓
EC4	Range of conflicting requirements (CP)	Competently addresses complex engineering problems which involve uncertainty, ambiguity, imprecise information and wide-ranging or conflicting technical, engineering and other issues.	-
EC5	Infrequently encountered issues (CP)	Conceptualizes alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.	-
EC6	Protection of society (CA)	Identifies, quantifies, mitigates and manages technical, health, environmental, safety, economic and other contextual risks associated to seek achievable sustainable outcomes with engineering application in the designated engineering discipline.	✓
EC7	Range of resources (CA)	Involve the coordination of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies) in the timely delivery of outcomes	-
EC8	Extent of stakeholder involvement (CP)	Design and develop solution to complex engineering problem considering a very perspective and taking account of stakeholder views with widely varying needs.	-
EC9	Extent of applicable codes, legal and regulatory (CP)	Meet all level, legal, regulatory, relevant standards and codes of practice, protect public health and safety in the course of all engineering activities.	-
EC10	Interdependence (CP)	High level problems including many component parts or sub-problems, partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then re-combines to form a whole, with the integrity and performance of the overall system as the top consideration.	✓
EC11	Continuing professional development (CPD) and lifelong learning (CA)	Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.	-
EC12	Judgement (CA)	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Require judgement in decision making in the course of all complex engineering activities.	-

SECTION 9: Employability Skills

Example: Communication skills / Programming skills / Project based skills

- **Communication Skills:**
  Technical Documentation: Students prepare structured laboratory records and simulation reports clearly explaining resonance, filter characteristics, two-port parameters, and power measurement results using standard electrical engineering terminology.
  Result Interpretation & Explanation:
  Ability to orally and in writing interpret frequency response plots, transient responses, wattmeter readings, and parameter values, and justify observed deviations from theoretical results.
  Presentation of Simulated Results:
  Communicate circuit behavior effectively through labeled waveforms, phasor diagrams, frequency response curves, and tabulated results obtained from simulation software.
  Collaborative Discussion:
  Engage in group discussions to explain circuit configurations, assumptions, and theorem verification outcomes, enhancing peer-to-peer technical communication.
- **Project based skills:**
  Circuit Modeling Using Simulation Software:
  Develop and simulate RL, RC, RLC, filter, two-port, and three-phase circuits using tools such as MATLAB/Simulink, LTSPICE, MULTISIM, OR PSPICE.
  Parameter Extraction and Analysis:
  Use simulation outputs to compute resonance frequency, bandwidth, quality factor, time constant, steady-state error, Z/Y/ABCD/h-parameters, and power quantities.
  Frequency and Time Domain Analysis:
  Perform frequency sweeps and transient simulations to analyze low-pass, high-pass, band-pass, and band-stop filters and non-sinusoidal input responses.
  Validation of Theoretical Concepts:
  Verify network theorems (Superposition, Thevenin, Norton, Maximum Power Transfer) and magnetic coupling parameters by comparing simulated results with analytical calculations.
- **Project based skills:**
  Systematic Problem Solving:
  Design complete simulation-based experiments starting from circuit selection, parameter calculation, simulation execution, and result validation.
  Mini-Project Development:
  Integrate multiple concepts (resonance, filters, power measurement, coupled circuits) into mini-projects such as filter design, power analysis of three-phase systems, or resonance studies.
  Optimization and Design Insight:
  Analyze how variation of circuit parameters affects resonance, power transfer, frequency response, and coupling efficiency, fostering design-oriented thinking.
  Industry-Relevant Application Exposure:
  Relate laboratory experiments to real-world applications such as power systems, communication filters, transformers, and signal conditioning circuits.

SECTION 10: Relevance to Sustainability goals

Brief description about the course and its correlationwith Sustainability Development Goal (SDGs).

SDG Goals		Correlation with SDG
4		**Quality Education:** Enhancement in the additional skills for the students with analytical tools.

7		**Affordable and Clean Energy:** Experiments on three-phase power measurement, reactive power analysis, power factor, maximum power transfer, and filter design directly support efficient generation, transmission, and utilization of electrical energy, contributing to clean and affordable energy systems.
9		**Industry, Innovation and Infrastructure:** The syllabus emphasizes design, simulation, and validation of electrical networks and filters, mirroring industry practices in power systems, electronics, and communication infrastructure, and encourages innovation through circuit optimization.
12		**Responsible Consumption and Production:** Analysis of power loss minimization, efficient power transfer, reactive power management, and filter optimization promotes responsible use of electrical resources and reduction of energy wastage in electrical systems.
13		**Climate Action:** By improving energy efficiency, power quality, and reactive power control, the laboratory indirectly supports reduction of carbon emissions and promotes sustainable electrical practices aligned with climate action goals.

SECTION 11A: Mapping between COs and POs / PSOs

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	✓	✓	✓	✓	✓	✓	✓	-	✓	✓	-	✓	✓	✓
CO2	✓	✓	✓	✓	✓	-	✓	-	-	✓	-	✓	✓	✓
CO3	✓	✓	✓	✓	✓	-	-	-	-	✓	-	✓	✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓	-	-	✓	-	✓	✓	-
CO5	✓	✓	✓	✓	✓		✓	-	-	✓	-	✓	✓	-
CO6	✓	✓	✓	✓	✓	✓	✓	-	-	✓	-	✓	✓	✓

Outcomes		WKS and Indicators of attainment and Justificationformapping(studentswillbeableto)																																									IAs Count
COs	POs	WK 1	WK 2								WK 3			WK 4			WK 5						WK 6			WK 7				WK 8							WK 9						
		A	a	b	c	d	e	f	g	h	a	b	c	a	b	c	a	b	c	d	e	f	a	b	c	a	b	c	d	a	b	c	d	e	f	g	a	b	c	d	e	f	
CO 1	PO 1	•	•	•	•	•	•	•			•		•	•																													10
	PO 2	•	•	•	•	•	•	•			•		•	•																													8
	PO 3	•	•	•	•	•	•	•			•		•	•																													11

	PO 4	•	•	•	•	•	•	•			•		•	•																													10
	PO 5	•	•	•	•		•				•	•	•	•	•																												10
	PO 6	•	•	•	•		•					•	•	•	•																												8
	PO 7	•	•	•	•		•					•	•	•	•																												9
	PO 9	•	•	•	•		•					•	•	•	•																												10
	PO 10	•	•	•	•		•					•	•	•	•																												11
	PSO 1	•	•	•	•		•					•	•	•	•																												10
	PSO 2	•	•	•	•		•					•	•	•	•																												9
	PSO 3	•	•	•	•		•					•	•	•	•																												10
CO2	PO 1	•	•	•	•	•	•	•			•		•	•																													10
	PO 2	•	•	•	•		•				•	•	•	•	•																												10
	PO 3	•	•	•	•		•					•	•	•	•																												8
	PO 4	•	•	•	•		•					•	•	•	•																												10
	PO 5	•	•	•	•		•					•	•	•	•																												12
	PO 7	•	•	•	•		•					•	•	•	•																												9
	PO 10	•	•	•	•		•					•	•	•	•																												8
	PSO 1	•	•	•	•		•					•	•	•	•																												7
	PSO 2	•	•	•	•		•					•	•	•	•																												8
	PSO 3	•	•	•	•		•					•	•	•	•																												9
CO3	PO 1	•		•	•	•	•				•	•	•	•	•																												10
	PO 2	•	•	•	•		•				•	•	•	•	•																												10
	PO 3	•															•		•		•					•	•		•														7
	PO 4																																										8
	PO 5			*	*	*		*		*	*	*					*	*		*		*																					10
	PO 10	*		*	*	*			*	*			*	*	*																												9
	PSO 1	*			*	*	*	*	*	*				*	*	*				*																							11
	PSO 2	*			*	*		*	*	*	*		*	*			*																										10
	PSO 3	*			*	*	*		*	*	*				*																												8
CO4	PO 1	•	•	•	•	•	•	•			•		•	•																													10
	PO 2	•	•	•	•	•	•	•			•		•	•																													9
	PO 3	•	•	•	•	•	•	•			•		•	•																													8
	PO 4	•	•	•	•	•	•	•			•		•	•																													9
	PO 5	•	•	•	•	•	•	•			•		•	•																													10
	PO 6	•	•	•	•	•	•	•			•		•	•																													11
	PO 7	•	•	•	•	•	•	•			•		•	•																													12
	PO 10	•	•	•	•	•	•	•			•		•	•																													9
	PSO 1	•	•	•	•	•	•	•			•		•	•																													8
	PSO2	•	•	•	•	•	•	•			•		•	•																													10

CO 5	PO 1	•	•	•	•	•	•	•			•		•	•	•																												11
	PO 2	•	•	•	•		•				•	•	•	•	•																												10
	PO 3	•	•	•	•		•				•	•	•	•	•																												9
	PO 4	•	•	•	•		•				•	•	•	•	•																												8
	PO 5	•	•	•	•		•				•	•	•	•	•																												10
	PO 7	•	•	•	•		•				•	•	•	•	•																												8
	PO 10	•	•	•	•		•				•	•	•	•	•																												9
	PSO 1	•	•	•	•		•				•	•	•	•	•																												7
	PSO 2	•	•	•	•		•				•	•	•	•	•																												9
CO 6	PO 1	•	•	•	•	•	•					•	•	•	•																												11
	PO 2	•	•	•	•		•	•			•	•	•	•	•																												11
	PO 3	•	•	•	•		•	•			•	•	•	•	•																												9
	PO 4	•	•	•	•		•	•			•	•	•	•	•																												8
	PO 5	•	•	•	•		•	•			•	•	•	•	•																												9
	PO 6	•	•	•	•		•	•			•	•	•	•	•																												10
	PO 7	•	•	•	•		•	•			•	•	•	•	•																												11
	PO 10	•	•	•	•		•	•			•	•	•	•	•																												12
	PSO 1	•	•	•	•		•	•			•	•	•	•	•																												9
	PSO 2	•	•	•	•		•	•			•	•	•	•	•																												8
	PSO 3	•	•	•	•		•	•			•	•	•	•	•																												8

SECTION 11B: Indicators of Attainment with COs to POs and PSOs														
Course Outcomes	**Percentage of Indicators of Attainments (IA) with POs and PSOs**													
	PO											**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	67	67	55	56	65	35	30	-	30	55	-	65	55	35
CO2	67	67	56	58	65	-	35	-	-	56	-	67	56	30
CO3	67	67	55	58	45	-	-	-	-	58	-	67	54	30
CO4	67	55	55	52	55	55	50	-	-	55	-	65	55	-
CO5	73	67	58	45	53	-	35	-	-	54	-	73	54	-
CO6	73	73	58	45	51	30	-	-	-	56	-	73	58	32

SECTION 11C: Course Articulation Matrix of COs to POs

0 No Contribution (0-5%)	1 Low (≥5 - <40%)	2 Moderate (≥40 - <60%)	3 High (≥60%)
-			

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	3	2	2	3	1	1	-	1	2	-	3	2	1
CO2	3	3	2	2	3	-	1	-	-	2	-	3	2	1
CO3	3	3	2	2	2	-	-	-	-	2	-	3	2	1
CO4	3	2	2	2	2	2	2	-	-	2	-	3	2	-
CO5	3	3	2	2	2	-	1	-	-	2	-	3	2	-
CO6	3	3	2	2	3	1	1	-	-	2	-	3	2	1
Total	18	15	12	12	15	4	6	-	-	12	-	18	12	4
Max. Value	3	2.8	2	2	2.8	0.6	1	-	0.1	2	-	3	2	0.6

SECTION 11D: Level of Contribution of the COs to POs and PSOs

Number	Programme Outcomes	Proficiency Assessed by	Contribution Level (from 1 to 3)
PO 1	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**	CIE / SEE	**3**
PO 2	Identify, formulate, review research literature and analyse **complex engineering problems** reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).	CIE / SEE	**2.8**
PO 3	Design creative solutions for **complex engineering problems** and design / develop systems / components/ processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)	CIE / SEE	**2**
PO 4	Conduct investigations of **complex engineering problems** using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)	CIE / SEE	**2**
PO 5	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**.	CIE / SEE	**2.8**
PO6	Identify, formulate, review research literature and analyse **complex engineering problems** reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).	CIE / SEE	**0.6**
PO 7	Individual and Collaborative Team Work Role in and Diversity of Team(WK9)	CIE / SEE	**1**
PO 9	Communication: Level of Communication According to Type of Activities Performed. (WK1,WK9)	CIE / SEE	**0.1**

PO 10	Project Management and Finance: Level of Management Required for Differing Types of Activity(WK2,WK5)	CIE / SEE	**2**
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	CIE / SEE	**3**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	CIE / SEE	**2**
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.)	CIE / SEE	**0.6**

3.1 SECTION 12: Course Content	
WEEK- 1	**VERIFICATION OF SERIES AND PARALLEL RESONANCE USING ANY CIRCUIT SIMULATION SOFTWARE.**
	Verification of series and parallel resonance using any circuit simulation software
WEEK- 2	**TIME RESPONSE OF FIRST ORDER RL AND RC CIRCUIT FOR PERIODIC NON – SINUSOIDAL INPUTS**
	Determination of time response of first order RL and RC circuit for periodic non – sinusoidal inputs – time constant and steady-state error using any circuit simulation software
WEEK- 3	**TWO PORT NETWORK PARAMETERS – Z, Y, TRANSMISSION AND HYBRID PARAMETERS**
	Determination of two port network parameters – Z, Y, transmission and hybrid parameters.
WEEK- 4	**THREE PHASE POWER IN BALANCED STAR CONNECTED LOAD USING TWO WATTMETER METHOD**
	Measurement of 3-phase power in balanced star connected load using two-wattmeter method.
WEEK- 5	**CO-EFFICIENT OF COUPLING, SELF AND MUTUAL INDUCTANCE IN MAGNETIC COUPLED CIRCUITS**
	Determination of co-efficient of coupling, self and mutual inductance in magnetic coupled circuits.
WEEK- 6	**FREQUENCY DOMAIN ANALYSIS OF LOW-PASS FILTER AND HIGH-PASS FILTERS**
	Analysis of low-pass filter and high-pass filters in frequency domain using circuit simulation software
WEEK- 7	**SUPERPOSITION AND MAXIMUM POWER TRANSFER THEOREMS**
	Verification of superposition and maximum power transfer theorems using circuit simulation software
WEEK- 8	**THEVENIN'S AND NORTON'S THEOREMS**
	Verification of thevenin's and norton's theorems using circuit simulation software
WEEK- 9	**ACTIVE POWER FOR STAR AND DELTA CONNECTED BALANCED LOADS**
	Measurement of active power for delta connected balanced loads.
WEEK- 10	**REACTIVE POWER FOR STAR AND DELTA CONNECTED BALANCED LOADS**
	Measurement of reactive power for star and delta connected balanced loads
WEEK- 11	**FREQUENCY DOMAIN ANALYSIS OF BAND-PASS FILTERS.**
	Analysis of band-pass filter in frequency domain using circuit simulation software

WEEK- 12	**FREQUENCY DOMAIN ANALYSIS OF BAND-STOP FILTERS**
	Analysis of band-stop filter in frequency domain using circuit simulation software
WEEK- 13	**TIME RESPONSE OF FIRST ORDER RL, RC CIRCUIT FOR PERIODIC NON SINUSOIDAL INPUTS**
	Determination of time response of first order RL, RC circuit for periodic non – sinusoidal inputs – time constant and steady state error
WEEK- 14	**COMPENSATION THEOREM**
	Verification of compensation theorem using circuit simulation software

SECTION 13: Tentative Schedule of Instructions

Week Number	Topics	Duration (Hours)
1	1.1 Verification of Series Resonance using any circuit simulation software. 1.2 Verification of Parallel Resonance using any circuit simulation software.	3
2	2.1 Time Response Of First Order RL Circuit For Periodic Non – Sinusoidal Inputs 2.2 Time Response Of First Order RC Circuit For Periodic Non – Sinusoidal Inputs	3
3	3.1 Two Port Network Parameters – Z Parameters 3.2 Two Port Network Parameters – Y Parameters 3.3 Two Port Network Parameters – Transmission Parameters 3.4 Two Port Network Parameters – Hybrid Parameters	3
4	4.1 Phase Power In Balanced Star Connected Load Using Two-Wattmeter Method	3
5	5.1 Co-Efficient Of Coupling, Self-Inductance In Magnetic Coupled Circuits 5.2 Co-Efficient Of Coupling, Mutual Inductance In Magnetic Coupled Circuits	3
6	6.1 Frequency Domain Analysis of Low-Pass Filter. 6.2 Frequency Domain Analysis of High-Pass Filters	3
7	7.1 Superposition Theorem 7.2 Maximum Power Transfer Theorem	3
8	8.1 Thevenin's Theorem 8.2 Thevenin's Theorem	3
9	9.1 Active Power For Star and Delta Connected Balanced Loads	3
10	10.1 Reactive Power For Star and Delta Connected Balanced Loads	3
11	11.1 Frequency Domain Analysis Of Band-Pass Filters	3
12	12.1 Frequency Domain Analysis Of Band-Stop Filters	3
13	13.1 Time Response of First Order RL Circuit For Periodic Non – Sinusoidal Inputs 13.1 Time Response of First Order RC Circuit For Periodic Non – Sinusoidal Inputs	3
14	14.1 Compensation Theorem	3
	Total	**42**

SECTION 14: Specific Goals for the Course	
The following table shows the knowledge and skills covered by the unit outcomes:	
Knowledge	**Skills**
Learners should understand: • Understanding of basic circuit elements (R, L, C), Ohm's law, Kirchhoff's laws, phasor representation, impedance, admittance, and resonance concepts in AC circuits. • Knowledge of first-order RL and RC circuits, time constant, natural and forced response, steady-state error, and response to non-sinusoidal periodic inputs. • Conceptual and analytical understanding of superposition, Thevenin's, Norton's, maximum power transfer, compensation theorem, and two-port network parameters (Z, Y, h, ABCD). • Understanding of self-inductance, mutual inductance, coefficient of coupling, dot convention, and energy transfer in coupled coils. • Knowledge of balanced star and delta connections, line and phase quantities, active and reactive power, power factor, and two-wattmeter method. • Understanding of frequency response, bandwidth, cut-off frequencies, resonance, and characteristics of low-pass, high-pass, band-pass, and band-stop filters, along with proficiency in circuit simulation software (MATLAB/Simulink, LTspice, Multisim, PSIM, etc.). .	**Learners can:** • Ability to model electrical circuits accurately and perform simulations using tools such as MATLAB/Simulink, LTspice, Multisim, or PSIM for time- and frequency-domain analysis. • Skill in calculating resonance conditions, time constants, steady-state responses, power, impedance, and two-port parameters using analytical methods and validating them through simulation results. • Ability to analyze and interpret transient waveforms, steady-state behavior, frequency response plots, bandwidth, cut-off frequencies, and resonance characteristics. • Proficiency in measuring and evaluating active and reactive power in single-phase and three-phase balanced star and delta systems, including the two-wattmeter method. • Skill in applying and verifying network theorems (Superposition, Thevenin's, Norton's, Maximum Power Transfer, Compensation theorem) to simplify complex circuits and validate results via simulation. • Ability to document simulation procedures, tabulate results, compare theoretical and simulated values, analyze deviations, and present conclusions clearly in laboratory records and reports.

Administrative Information

SECTION 15: History of changes		
Regulations	**Description of change**	**BOS Date**
R 16	From R15 JNTUH, Hyderabad to R16 IARE regulations • 30% of syllabus changed	24.07.2016
R 18	Changes from R16 to R18 regulation • 40% of syllabus changed	16.07.2018
UG 20	• No Laboratory	-
BT 23	Changes from R18 regulation to BT 23 regulations 50% of syllabus changed	21.08.2023
BT25	Changes from BT 23 regulation to BT 25 syllabus 50% of syllabus changed	18.08.2025

Course Outline Approvals

Course Coordinator Name: Mr T Ravi Babu Signature: Date:27-01-2026	**Head of the Department** Name: Dr. Damodhar Reddy Signature: Date: 27-01-2026
Dean of Outcome Based Teaching and Learning Name: Dr. CH Srinivasulu Signature: Date: 27-01-2026	**Dean of Academics** Name: Dr. GVR Sheshagiri Rao Signature: Date: 27-01-2026

Check List		
Section	**Description**	**Please tick (✓)**
1	General Information about the Course	✓
2	Notional Study Time	
3	A. Course Outcomes	✓
	B. Cognitive Levels	✓
4	Content and Context of the Course	✓
5	Complex Engineering Problem Solving	
6	A. Assessment Methods – Direct	✓
	B. Assessment Methods – Indirect	✓
7	Content Delivery / Instructional Methodologies	✓
8	Engineering Competencies (ECs) Focused	✓
9	Employability Skills	✓
10	Relevance to Sustainability goals	
11	A. Mapping between COs and POs / PSOs	✓
	B. Indicators of Attainment with COs to POs and PSOs	✓
	C. Course Articulation Matrix of COs to POs	✓
	D. Level of Contribution of the COs to POs and PSOs	✓
12	Syllabus	✓
13	Tentative Schedule of Instructions	✓
14	Specific Goals for the Course	✓
15	History of Changes	✓

Signature of Course Coordinator **HOD, EEE**
Mr. T RAVI BABU, Assistant Professor

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

CSE (ARTIFICIAL INTELLIGENCE & MACHINE LEARNING)

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**PROGRAMMING FOR PROBLEM SOLVING**
Course Code	ACSE07
Course Start	II- Semester
Course Type	Core
Regulation	IARE - BT 25
Prerequisite Courses	----
Department	ECE
Number of Credits	1.0 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Laboratory
Course Coordinator's Name	**Dr. M Madhusudhan Reddy** Assistant Professor of CE IARE10881 m.madhusudhanreddy@iare.ac.in
Prior Learning Assessment and Recognition (PLAR)	Students interested in PLAR pathways for open learning can register one semester prior to the start of semester. Students will receive the necessary contact information one semester in advance.
Open Learning Faculty Member Information	Open Learning Faculty (OLF) is available to assist students. Students will receive the necessary contact information at the start of the course.
Course Webpage	https://akanksha.iare.ac.in/index?route=course/details&course_id=
Course Description	This laboratory course will facilitate the students to designed with the fundamental programming skills and problem-solving strategies necessary to tackle a wide range of computational challenges. Through hands-on programming exercises and projects, students will learn how to write code, analyze problems and develop solutions using various programming languages and tools. The course will cover fundamental programming concepts and gradually progress to more advanced topics.
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.
Text and Reference Books	**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. Yashavant Kanetkar, Aditya Kanetkar, "Let Us Python", BPB Publications, 2 nd Edition, 2019. 2. Martin C. Brown, "Python: The Complete Reference", Mc. Graw Hill, Indian Edition, 2018. 3. Paul Barry, "Head First Python: A Brain-Friendly Guide", O'Reilly, 2nd Edition, 2016 4. Taneja Sheetal, Kumar Naveen, "Python Programming – A Modular Approach", Pearson, 1st Edition, 2017. 5. R Nageswar Rao, "Core Python Programming", Dreamtech Press, 2018.
Learning and Teaching Strategies	Online material will provide the foundation of the learning resources, requiring the students to log in and engage regularly throughout the sixteen weeks of the course. There will be a mix of suggested readings, discussions.

SECTION 2: Teaching Learning Scheme

At least 48 lecture hours of scheduled laboratories activities (TLA) will be delivered in person,

Notional Study Time: 48 Hours (Laboratory Exercises)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA 1	Lectures	-	-	-
TLA 2	Tutorials	-	-	-
TLA 3	Case Study	-	-	-
TLA 4	Problem Solving	-	-	-
TLA 5	Demonstration	1	3	3
TLA 6	Scheduled revision sessions	1	3	3
TLA 7	Guided independent study: Directed viewing of video materials / PPTs	-	-	-
TLA 8	Independent private study	-	-	-
TLA 9	Laboratory Exercises	14	03	42
TLA 10	Homework assignments / Programming assignments	-	-	-
TLA 11	Placement / work based learning or Specific practical training	-	-	-
TLA 12	Presentation / Seminar Preparation	-	-	-
TLA 13	Course Project / Preparation for Complex Problem Solving	-	-	-
TLA 14	Technical visit	-	-	-
TLA 15	Field activities	-	-	-
			Total study hours	**48**
			Expected total study hours	**48**

SECTION 3A: Course Outcomes		
After successfully completing this course, the student will be able to:		
Outcome Number	**Course Outcomes**	**Learning Domain**
CO1	Adapt programming concepts, syntax, and data structures through hands on coding exercises	Understand
CO2	Develop the ability to solve a variety of programming problems and algorithms using python	Create
CO3	Implement complex and custom data structures to solve real-world problems.	Apply
CO4	Demonstrate proficiency in implementing graph algorithms to solve variety of problems and scenarios	Apply
CO5	Develop critical thinking skills to solve the various real-world applications using graph theory	Create
CO6	Learn the importance of numerical methods and apply them to tackle a wide range of computational problems.	Understand

SECTION 3B: Cognitive Levels	
Blooms Taxonomy Level	**Cognitive Level in Percentage (%)**
Remember	0
Understand	33.33
Apply	33.33
Analyse	0
Evaluate	0
Create	33.33

SECTION 4: PROGRAMMING FOR PROBLEM SOLVING	
CO1	Adapt programming concepts, syntax, and data structures through hands on coding exercises
	• This course outcome aims to **design, implement, and test basic Python programs** by applying core programming concepts such as variables, data types, operators, control structures, functions, and input/output operations. • Learners will gain **hands-on experience in solving real-world computational problems** such as calculating distances and areas, computing mathematical values without relying on built-in libraries, generating random numbers, performing numerical and string-based operations, and handling edge cases effectively. • This strong foundation will **prepare learners for advanced programming and software development tasks** by strengthening their logical thinking and coding proficiency. • Learners will be able to **construct and apply core Python programming concepts** to develop small-scale real-world applications, simulate logical conditions, manipulate numeric and textual data, and analyze patterns using effective coding practices. • They will apply **algorithmic thinking** to simulate scenarios, analyze datasets, manipulate strings and time-based data, and generate pattern-based outputs using conditional and iterative constructs in Python. • Learners will be able to **construct and implement nested loop logic** to generate formatted output patterns, **analyze sorting and searching techniques** using lists and tuples, and **design programs to simulate real-life systems** such as ticket booking, banking transactions, and inventory management. • Learners will **simulate financial and computational operations** by applying arithmetic and logical operations, **validate user inputs**, and **handle exceptional conditions** such as invalid data, division by zero, and boundary cases using appropriate exception-handling mechanisms.

CO2	Develop the ability to solve a variety of programming problems and algorithms using python.
	• This course outcome aims to **design, implement, and apply user-defined functions in Python** to promote code modularity, readability, and reusability. Learners will **construct reusable logic blocks** for mathematical computations, string processing, date and time operations, and data validation, while **analyzing inputs, validating data, and evaluating outputs** to develop structured and maintainable Python programs. • Learners will **construct recursive and iterative functions** to **solve computational and combinatorial problems** using reusable logic. They will **design utility functions** to **check and classify numbers** (such as prime, palindrome, or Armstrong numbers) and **apply these functions** in different mathematical and real-world problem contexts. • Learners will **implement modular Python functions** to **determine zodiac signs based on birth dates** and return meaningful interpretations. They will **create functions to calculate the number of days in a given month**, incorporating **leap year logic**. By calling reusable date-validation functions, learners can **analyze input date components and verify correctness**. With appropriate formatting, learners will **develop functions to compute age differences between two dates** and **return results in terms of years, months, and days**. • Learners will **implement polymorphic behaviour using object-oriented features in Python**, such as inheritance and method overriding, to **demonstrate different object behaviors**. They will **reuse base class methods across derived classes**, thereby reinforcing the principles of abstraction, extensibility, and efficient algorithmic design.
CO3	Implement complex and custom data structures to solve real-world problems.
	• This course outcome aims to **design and implement advanced string processing and pattern recognition solutions using Python**. • Learners will **identify and apply key string and data structure operations** such as substring search, character frequency analysis, balanced parentheses checking, and token extraction. They will **implement efficient algorithms** to match and extract patterns from strings, lists, and dictionaries, **compare multiple approaches**, and **evaluate performance** on large datasets. • Learners will **rearrange characters, words, or data elements** based on strict alphabetical, numerical, or logical constraints using **sorting algorithms, custom comparator functions, and Python collections**, thereby reinforcing structured data manipulation skills. • Learners will **understand fundamental computing concepts** such as pattern matching, syntax rules, structured data formats (e.g., regular expressions, CSV, JSON). They will **apply mathematical and procedural rules** to perform string validation, data normalization, and logical pattern generation, while developing **awareness of system limitations and boundaries** such as input constraints, protocol formats, and data validation failures.
CO4	Demonstrate proficiency in implementing graph algorithms to solve variety of problems and scenarios.
	• This course outcome aims **to design and implement graph-based solutions using Python,** employing **appropriate data structures such as adjacency lists, adjacency matrices, and edge lists** to model real-world systems. • Learners will apply graph **traversal techniques such as Breadth-First Search (BFS) and Depth-First Search (DFS)** to analyze connectivity, reachability, and traversal paths in both directed and undirected graphs, and **construct modular Python programs** that simulate real-world scenarios such as social networks, transportation systems, and communication networks. • Learners will **demonstrate different graph representations and structures**, including weighted, unweighted, cyclic, acyclic, and disconnected graphs, to **promote algorithmic efficiency and manage complexity** in large problem spaces. • Learners will **apply graph algorithms** such as shortest path computation, cycle detection, and spanning tree construction to **evaluate optimal routes, detect redundancies, and analyze dependencies**, thereby solving optimization and decision-making problems. • Learners will **design reusable and extensible graph modules** using Python functions and classes, enabling **dynamic behaviour and scalability** in applications such as route planning, task scheduling, and network reliability analysis.

CO5	**Develop critical thinking skills to solve the various real-world applications using graph theory**
	• This course outcome aims to develop a **deep understanding of graph-based problem-solving techniques** and the ability to **model real-world applications using graph theory concepts** such as vertices, edges, paths, cycles, and connectivity. Learners will analyze how graph structures can represent complex systems including transportation networks, social networks, and communication systems. • Learners will **identify different classes of graph problems** such as connectivity analysis, shortest path problems, cycle detection, and network optimization. They will **analyze problem constraints**, select appropriate graph representations, and **differentiate between directed and undirected, weighted and unweighted graphs** based on application requirements. • Learners will **apply critical thinking to design efficient graph algorithms** using Python by implementing BFS, DFS, and shortest-path techniques. They will **evaluate algorithmic efficiency**, identify bottlenecks, and optimize solutions for large-scale graphs. • Learners will **formulate graph-based solutions** to real-world decision-making problems such as route planning, resource allocation, dependency resolution, and scheduling. They will **interpret outputs**, validate correctness, and **draw meaningful conclusions** from graph traversal and optimization results. Learners will **integrate graph theory concepts with Python programming constructs** to develop modular, reusable, and scalable applications, thereby strengthening analytical reasoning and real-world problem-solving skills.
CO6	**Learn the importance of numerical methods and apply them to tackle a wide range of computational problems**.
	• This course outcome aims to develop an **in-depth understanding of numerical methods** and their significance in solving mathematical and engineering problems where analytical solutions are difficult or impossible to obtain. • Learners will **analyze numerical techniques** such as root-finding methods, numerical integration, and approximation techniques, and **implement these methods using Python** to solve computational problems efficiently and accurately. • Learners will **evaluate the accuracy, stability, and convergence behavior** of numerical algorithms by comparing approximate solutions with exact or reference values and by analyzing error propagation. • Learners will **apply numerical methods to real-world problems** such as solving nonlinear equations, estimating integrals, and modelling scientific and engineering systems using iterative computational techniques. • Learners will **develop Python programs** that integrate numerical algorithms with proper input validation, iterative control structures, and result visualization, thereby enhancing their ability to solve complex computational problems systematically.

SECTION 5: Complex Engineering Problem Solving- Applicable

SECTION 6A: Assessment Methods – Direct			
Item	**Evaluation Components**	**Week in / out**	**Marks**
1	Day to day evaluation	Every week	20
2	Internal examination and Viva-voce	10 +10	20
3	Semester end examination (External)	Week – 17	60
		Total Marks	**100**
Department's Late Submission Policy: 1. 1 – 24 hours: 25% of the mark will be deducted 2. > 24 hours: Not accepted			
SECTION 6B: Assessment Methods –Indirect			
Course End Survey (End Semester OBE Feedback)			✓

SECTION 8: Engineering Competencies (ECs) Focused: NA
Please tick (✓) relevant engineering competency profile covered

EC Number	Attributes	Profiles	(✓)
EC1	Depth of knowledge required (CP)	Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill- founded, illogical, erroneous, unreliable or unrealistic requirements applicable to the engineering discipline	✓
EC2	Depth of analysis required (CP)	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	✓
EC3	Design and development of solutions (CA)	Support sustainable development solutions by ensuring functional requirements, minimize environmental impact and optimize resource utilization throughout the life cycle, while balancing performance and cost effectiveness.	✓
EC4	Range of conflicting requirements (CP)	Competently addresses complex engineering problems which involve uncertainty, ambiguity, imprecise information and wide-ranging or conflicting technical, engineering and other issues.	✓
EC5	Infrequently encountered issues (CP)	Conceptualizes alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.	✓
EC6	Protection of society (CA)	Identifies, quantifies, mitigates and manages technical, health, environmental, safety, economic and other contextual risks associated to seek achievable sustainable outcomes with engineering application in the designated engineering discipline.	-
EC7	Range of resources (CA)	Involve the coordination of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies) in the timely delivery of outcomes	-
EC8	Extent of stakeholder involvement (CP)	Design and develop solution to complex engineering problem considering a very perspective and taking account of stakeholder views with widely varying needs.	-
EC9	Extent of applicable codes, legal and regulatory (CP)	Meet all level, legal, regulatory, relevant standards and codes of practice, protect public health and safety in the course of all engineering activities.	-
EC10	Interdependence (CP)	High level problems including many component parts or sub-problems, partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then re-combines to form a whole, with the integrity and	✓

		performance of the overall system as the top consideration.	
EC11	Continuing professional development (CPD) and lifelong learning (CA)	Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.	✓
EC12	Judgement (CA)	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Require judgement in decision making in the course of all complex engineering activities.	-

SECTION 9: Employability Skills

Example: Communication skills / Programming skills / Project based skills

The study of programming with objects Laboratory equips students with a range of practical, hands-on skills that are highly valued in the industry. These skills are particularly important in the design, testing, and optimization of real time applications.

Employability Skills:

- Technical Proficiency: Develop strong coding skills in C#, enabling students to write clean, efficient, and maintainable code that meets industry standards.
- Problem-Solving Abilities: Enhance analytical and logical thinking skills to effectively tackle complex programming challenges and develop innovative solutions.
- Collaboration and Teamwork: Work collaboratively on projects and assignments, fostering communication and teamwork skills essential for software development teams

Project Management Skills:

- Planning and Organizing: Ability to design and manage laboratory experiments, ensuring efficient use of resources and time.
- Resource Allocation: Proficient in managing laboratory materials, equipment, and personnel to ensure successful experiment execution.
- Collaboration and Communication: Clear communication of experimental goals, procedures, and results across various teams and stakeholders.
- Risk Identification and Mitigation: Identifying potential risks in experimental setups and taking proactive measures to mitigate safety hazards and inaccuracies.
- Testing and Validation: Conducting rigorous testing and validation to ensure they meet safety, reliability, and performance standards.

SECTION 10: Relevance to Sustainability goals

Brief description about the course and its correlation with Sustainability Development Goal (SDGs).

SDG Goals		Correlation with SDG
4		Quality Education: Students can gain a deeper understanding of how technology addresses global challenges, promoting quality education by enhancing their critical thinking and problem-solving skills in the context of sustainable development.
8		Skill Development for Employment: Learning C# equips students with in-demand programming skills, enhancing their employability and contributing to economic growth by preparing them for careers in the tech industry.
9		Fostering Innovation: Proficiency in C# enables students to develop innovative software solutions, supporting the growth of technology-driven industries and contributing to the advancement of infrastructure.

11		Building Smart Solutions: Python programming skills can be used to develop applications that support smart city initiatives, such as efficient public transportation systems and smart energy management, promoting more sustainable urban living.
17		Promoting Ethical Technology Use: Learning to develop secure and reliable software helps create trustworthy digital systems, which can contribute to stronger institutions and promote justice through technology.
18		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.

SECTION 11A: Mapping between COs and POs / PSOs

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	✓	-	-	-	✓	-	-	-	-	-	-	✓	-	-
CO2	✓	-	✓	-	✓	-	-	-	-	-	-	✓	✓	-
CO3	✓	-	-	✓	✓	-	-	-	-	-	-	✓	-	-
CO4	✓	-	✓	-	-	-	✓	-	-	-	-	✓	✓	-
CO5	-	✓	-	✓	-	-	-	✓	-	-	-	✓	✓	-
CO6	✓	-	✓	-	-	-	✓	-	-	-	-	✓	✓	-

Outcomes		WKS and Indicators of attainment and Justification for mapping (students will be able to)																																						IAs Count
Cos	Pos	WK 1	WK 2								WK 3			WK 4			WK 5						WK 6			WK 7				WK 8							WK 9						
		A	a	b	c	d	e	f	g	h	a	b	c	a	b	c	a	b	c	d	e	f	a	b	c	a	b	c	d	a	b	c	d	e	f	g	a	b	c	d	e	f	
CO 1	PO 1	•	•	•	•	•	•	•				•	•	•																												10
	PO 5						•	•	•	•														•	•																		6
	PSO 1	•	•	•	•	•	•	•				•	•	•																												10
CO 2	PO 1	•	•	•	•	•	•	•				•	•	•																												10
	PO 3	•	•	•	•	•	•	•				•	•	•				•	•	•																						13
	PO 5						•	•	•	•														•	•																		06
	PSO 1	•	•	•	•	•	•	•				•	•	•																												10
	PSO 2	•	•	•	•	•	•	•				•	•	•																												10
CO 3	PO 1	•	•	•	•	•	•	•				•	•	•																												10
	PO 4	•	•	•	•	•	•	•				•	•	•																												10
	PO 5						•	•	•	•														•	•																		06
	PSO 1	•	•	•	•	•	•	•				•	•	•																												10

CO 4	PO 1	•	•	•	•	•	•	•			•	•	•																											10
	PO 3	•	•	•	•	•	•	•			•	•	•																											10
	PO 7	•	•	•	•	•	•	•			•	•	•																											10
	PSO 1	•	•	•	•	•	•	•			•	•	•																											10
	PSO 2	•	•	•	•	•	•	•			•	•	•																											10
CO 5	PO 2	•	•	•	•	•	•	•			•	•	•																											10
	PO 4					•	•	•	•													•	•																	06
	PO 8																																•	•		•				03
	PSO 1	•	•	•	•	•	•	•			•	•	•																											10
	PSO 2	•	•	•	•	•	•	•			•	•	•																											10
CO 6	PO 1	•	•	•	•	•	•	•			•	•	•																											10
	PO 3															•	•	•		•																				04
	PO 7					•	•	•	•													•	•																	06
	PSO 1	•	•	•	•	•	•	•			•	•	•																											10
	PSO 2	•	•	•	•	•	•	•			•	•	•																											10

SECTION 11B: Indicators of Attainment with COs to POs and PSOs														
Course Outcomes	Percentage of Indicators of Attainments (IA) with POs and PSOs													
	PO											PSO		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	66.67	-	-	-	54.54	-	-	-	-	-	-	66.67	-	-
CO2	66.67	-	64.00	-	54.54	-	-	-	-	-	-	66.67	66.67	-
CO3	66.67	-	-	66.67	54.54	-	-	-	-	-	-	66.67	-	-
CO4	66.67	-	66.67	66.67	-	-	-	-	-	-	-	66.67	66.67	-
CO5	-	66.67	-	54.54	-	-	-	50.00	-	-	-	66.67	66.67	-
CO6	66.67	-	66.67	-	-	-	-	-	-	-	-	66.67	66.67	-

SECTION 11C: Course Articulation Matrix of COs to Pos														
0 No Contribution (0-5%)			1 Low (≥5 - <40%)				2 Moderate (≥40 - <60%)					3 High (≥60%)		
Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	-	-	-	2	-	-	-	-	-	-	3	-	-
O2	3	-	3	-	2	-	-	-	-	-	-	3	3	-
CO3	3	-	-	3	2	-	-	-	-	-	-	3	-	-
CO4	3	-	3	3	-	-	-	-	-	-	-	3	3	-
CO5	-	3	-	2	-	-	-	2	-	-	-	3	3	-
CO6	3	-	-	-	-	-	-	-	-	-	-	3	3	-
Total	15	3	6	8	6	-	-	2	-	-	-	18	12	-
Average	**3**	**1**	**2**	**3**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**3**	**3**	**-**

SECTION 11D: Level of Contribution of the COs to POs and PSOs				
Number	**Programme Outcomes**		**Proficiency Assessed by**	**Contribution Level (from 1 to 3)**
PO 1	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**.		CIE / SEE / AAT:1 – 2 Assignments / Open-ended problems	**3**
PO 2	Identify, formulate, review research literature and analyse **complex engineering problems** reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).		CIE / SEE / AAT:1 – 2 Hack-a-thon	**3**
PO 11	Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to newand emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)		CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**3**
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications		AAT: 1 – 1 Tech-Talk	**3**

SECTION 12: Course Content	
WEEK- I	**Getting Started Exercises**
	Bookstore Catalog, Where Are You From? , What's Your Favorite Song? , Quiz Grading System, Exam Grading System, Acronym Generator, Name Numerology Value Calculator, Sentence Word Counter, Average Word Length Calculator, Future Value Calculator
WEEK- 2	**Exercises on List I**
	Art Gallery Inventory Checker, Shoe Store, Currency Exchange Office, Getting a New Bike , Ordering a T-shirt Online, Alan Turing, Four Seasons, Word Search, Spelling Competition, Bookstore
WEEK- 3	**Exercises on List II**
	Two Sum, Contains Duplicate, Roman to Integer, Plus One, Majority Element, Richest Customer Wealth, Fizz Buzz, Number of Steps to Reduce a Number to Zero, Running Sum of 1D Array, Remove Element.
WEEK- 4	**Exercises on Tuple**
	Student Report Card, Grocery Inventory Tracker, Quiz Master Analyzer, Library Book Tracker Banking Transaction Log
WEEK- 5	**Exercises on Dictionary**
	Student Information, New T-shirts in the Store, Colosseum, at a Pet Clinic, Juices, Olympic Games, Teaching Python, Furniture Store, Shifting List Elements, Numbers in a Triangle
WEEK- 6	**Exercises on Set**
	Count the Number of Vowels, Common Letters between Two English Words, Missing Letters Finder, City Travel Tracker, DNA Sequence Comparison, Panagram Detector, Shopping List Optimizer, Unique Words in Two Articles, College Course Enrollment, Lucky Draw Participants
	Exercises on Functions I

WEEK- 7	Sum of Natural Numbers and Their Cubes, compute nth Fibonacci Number, Next Guess for Square Root Approximation, Letter Grade from Score, Convert List of Number Strings to Numeric Values, Guess the Number Game, Playing with Numbers, Flipping Coins – Counting Heads and Tails, Comparator – Comparing Two Integers Using Boolean Operators, Digit Power Sum
WEEK- 8	**Exercises on Functions II**
	Power and Energy Calculator, Interest Analyzer, Statistician's Data Analyzer, Astronomer's Orbit Calculator, Farmer's Field Division, Banker's Loan Evaluator
WEEK- 9	**Exercise on Matrix Opreations**
	Add Two Matrices, Multiply Two Matrices, Transpose of a Matrix, Matrix Product, Find Maximum Element in Each Row of a Matrix.
WEEK- 10	**Exercises on Graph Representation**
	Build a graph, Number of Sink Nodes in a Directed Acyclic Graph (DAG), Represent a Graph using an Adjacency Matrix 10.4 Represent a Graph using an Adjacency List, Count the Number of Edges in an Undirected Graph
WEEK- 11	**Exercises on Graph Routing Algorithms**
	The Seven Bridges of Konigsberg, Hamiltonian Cycle Detection in a Graph, Count the Number of Hamiltonian Cycles in a Graph
WEEK- 12	**Exercises on Graph Path Algorithms**
	Travelling Salesman Problem, Shortest Paths from Source to all Vertices (Dijkstra's Algorithm) Shortest Cycle in an Undirected Unweighted Graph, Count Unique and all Possible Paths in a M x N Matrix.
WEEK- 13	**Exercises on Graph Coloring**
	Graph Coloring using Greedy Algorithm, Coloring a Cycle Graph, M-Coloring Problem, Edge Coloring of a Graph.
WEEK- 14	**Mini -Projects**
	Intelligent City Road Network Analysis, Social Network Influence and Connectivity Analyzer, Network Reliability and Failure Simulation, Online Shopping Cart and Billing System, Banking Operations Simulation System.

SECTION 13: Tentative Schedule of Instructions

Week Number	Topics	Duration (Hours)
1	Getting Started Exercises	3
2	List I	3
3	List II	3
4	Tuple	3
5	Dictionary	3
6	Set	3
7	Functions I	3
8	Functions II	3
9	Matrix Operations	3
10	Graph representation	3

11	Graph Routing Algorithms	3
12	Shortest Path Algorithms	3
13	Graph Coloring	3
14	Mini Projects	3
	Total	**42**

SECTION 14: Specific Goals for the Course

The following table shows the knowledge and skills covered by the unit outcomes:

Knowledge	Skills
• **Learners should understand:** • Basics of Python syntax, Python IDLE/IDE usage (IDLE, PyCharm, VS Code), script execution, debugging. • Variables, identifiers, keywords, indentation rules, and comments in Python. • Built-in data types: int, float, complex, string, boolean, list, tuple, set, dictionary. • Operators and expressions: arithmetic, relational, logical, assignment, membership, identity • Control flow constructs: if-else, for and while loops, break, continue, pass. • Functions: definition, parameters, return values, recursion, lambda functions. • String handling: indexing, slicing, methods, immutability, formatting, regular expressions (introductory). • Lists, tuples, sets, dictionaries: operations, methods, comprehensions. • File handling: text and binary files, file modes, with statement. • Exception handling: try-except, else, finally, custom exceptions. • Graph fundamentals: graphs, vertices, edges, degree, directed and undirected graphs. • Types of graphs: simple graphs, multigraphs, weighted graphs, complete graphs. • Graph traversal algorithms: Breadth-First Search (BFS), Depth-First Search (DFS) • Paths, cycles, connected and disconnected graphs. • Euler paths and circuits; Hamiltonian paths and cycles (introductory). • Shortest path concepts: weighted graphs, Dijkstra's algorithm (basic). • Spanning trees and minimum spanning trees (introductory idea). • Graph coloring concepts and applications. • Real-world applications of graphs: networks, routing, scheduling.	**Learners can:** • Write clean, readable, and efficient Python programs following PEP-8 coding standards. • Solve algorithmic and logical problems using Python. • Select and apply appropriate data structures for different problem domains. • Implement decision-making and branching using conditional statements. • Design efficient iterative and looping solutions. • Develop reusable and modular code using functions. • Perform text processing and pattern matching operations. • Apply list/dictionary comprehensions for concise and optimized code. • Read from and write to files for persistent data storage. • Identify, debug, and handle runtime errors effectively. • Represent graphs using Python data structures (adjacency list, adjacency matrix). • Construct and manipulate graphs programmatically. • Implement BFS and DFS using Python. • Determine connectivity and traversal paths in graphs. • Analyze and verify Eulerian and Hamiltonian properties using code. • Compute shortest paths using Python implementations. • Apply graph algorithms to solve optimization problems. • Implement simple graph coloring algorithms in Python. • Solve real-world problems using graph-based Python solutions. • Develop mini projects involving graph algorithms using Python.

• Integration of Python and Graph Theory in problem-solving contexts.	

EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Model a city road network as a weighted graph where intersections are nodes and roads are edges with distances. Implement Python programs to:Represent the graph using adjacency lists, Find shortest paths between locations using Dijkstra's algorithm, Identify disconnected areas and connectivity issues, Suggest optimal routes for emergency services
2	Design a Python application that models a social network as a graph. Users are vertices and relationships are edges. The system should: Determine connected components, identify influential users based on degree centrality, Perform BFS and DFS to explore connections, Detect isolated users or communities.
3	Simulate a computer network using graph structures. Nodes represent systems and edges represent communication links. The program should: Analyze network connectivity Simulate node or link failures, Determine critical nodes whose failure disconnects the network, Suggest improvements for fault tolerance.
4	E-commerce platforms depend on shopping cart systems to manage customer purchases. Design a Python application that allows users to add products to a cart, update quantities, remove items, and calculate the final bill including discounts and taxes. The system should store product details using dictionaries and generate an invoice saved to a file. Proper input validation and error handling must be incorporated to ensure reliability.
5	Banks rely on software systems to manage customer transactions securely and accurately. Develop a Python program that simulates core banking operations including account creation, deposits, withdrawals, and balance inquiry. Each transaction must be recorded and stored in a file for future reference. The program should enforce business rules such as minimum balance requirements and prevent invalid transactions through custom exceptions. The design should be modular, using functions and object-oriented programming principles.

SECTION 15: History of changes		
Regulations	**Description of change**	**BOS Date**
BT23	Introduced and approved by the committee	
BT23	Syllabus changed from BT23 regulation, introduced in depth knowledge on data structures like list, tuple, set and dictionaries, Functions	

Check List		
Section	**Description**	**Please tick (✓)**
1	General Information about the Course	
2	Notional Study Time	
3	A. Course Outcomes	
	B. Cognitive Levels	
4	Content and Context of the Course	
5	Complex Engineering Problem Solving	
6	A. Assessment Methods – Direct	
	B. Assessment Methods – Indirect	

7	Content Delivery / Instructional Methodologies	
8	Engineering Competencies (ECs) Focused	
9	Employability Skills	
10	Relevance to Sustainability goals	
11	A. Mapping between COs and POs / PSOs	
	B. Indicators of Attainment with COs to POs and PSOs	
	C. Course Articulation Matrix of COs to Pos	
	D. Level of Contribution of the COs to POs and PSOs	
12	Syllabus	
13	Tentative Schedule of Instructions	
14	Specific Goals for the Course	
15	History of Changes	

Course Outline Approvals	
Course Coordinator Name: Dr. D. Sreelakshmi Signature: Date:	**Head of the Department** Name: Dr. P Munaswamy Signature: Date:
Dean of Outcome Based Teaching and Learning Name: Dr. Srinivasulu Signature: Date:	**Dean of Academics** Name: Dr. GVR Seshagiri Rao Signature: Date:

Signature of Course Coordinator
Dr. D. Sreelakshmi, Assistant Professor

HOD, ECE

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

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**COMPUTER AIDED ENGINEERING GRAPHICS**
Course Code	AMEE03
Course Start	Second Semester
Course Type	Foundation
Regulation	IARE - BT 25
Prerequisite Courses	1.There is no prerequisite required to this course
Department	Electronics and Communication Engineering
Number of Credits	2 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Laboratory
Course Coordinator's Name	**Mr. K Arun Kumar,** Assistant Professor of Aeronautical Engineering IARE11018 **k.arunkumar@iare.ac.in**
Prior Learning Assessment and Recognition (PLAR)	Students interested in PLAR pathways for open learning can register one semester prior to the start of semester. Students will receive the necessary contact information one semester in advance.
Open Learning Faculty Member Information	Open Learning Faculty (OLF) is available to assist students. Students will receive the necessary contact information at the start of the course.
Course Webpage	https://akanksha.iare.ac.in/index?route=course/details&course_id=1685
Course Description	This course explains the Engineering Drawing as the technique that develops the ability to visualize any object with all physical and dimensional configurations. The AutoCAD software assists in preparation of drawings to carry out sophisticated design and analysis of machine components and structures. This is the foundation course for civil engineering, Electronics and Communication engineering and aeronautical engineering that are improving their technologies in the era of digital manufacturing and construction Course includes laboratory component for lab-based exercises. The primary purpose of a CAD lab is to facilitate the design process by providing resources and technology that allow for the development of detailed and accurate digital models.
Course Objectives	**The students will try to learn:** a. The illustration of different objects using technical drawings using concepts of engineering drawing. b. The standard principles of orthographic projection of objects for making technical drawings. c. The representation of draw sectional views and pictorial views of solids. d. The computer aided drafting skills for producing the 2D and 3D drawings
Text and Reference Books	**Text Books** 1. ENGINEERING GRAPHICS WITH AUTOCAD

	By D. M. KULKARNI, A. P. RASTOGI, A. K. SARKAR 2. 100 AutoCAD Exercises - Learn by Practicing Create CAD Drawings by Practicing with These Exercises By CADArtifex · 2017 **Reference Books** 1. S. Lipschutz, "Data Structures", Tata McGraw Hill Education, 1st edition, 2014, ISBN-13: 978-1259029967 2. D. Samanta, "Classic Data Structures", PHI Learning, 2nd edition, 2004, ISBN: 812033731X, 9788120337312.
Learning Resources	**Course full stack** is made available in IARE learning management portal – Akansha, which includes lecture notes, tutorial question bank, definition and terminology, tech-talk topics, assignments, Model question papers (2 sets), complex engineering problem solving statements, power point presentations (PPTs)
Supplemental Materials	**Readings, Videos, and Links** 1. https://onlinecourses.swayam2.ac.in/aic22_ts42/preview 2. https://www.youtube.com/watch?v=VtLXKU1PpRU 3. https://www.youtube.com/watch?v=2LumoE9KjoY 4. https://www.youtube.com/watch?v=MrYdZiyfbXU
Learning and Teaching Strategies	Online material will provide the foundation of the learning resources, requiring the students to log in and engage regularly throughout the sixteen weeks of the course. There will be a mix of suggested readings, discussions and video content containing embedded digital content and undertake the assessment tasks.

SECTION 2: Teaching Learning Scheme

At least 48 lecture hours of scheduled teaching and learning activities (TLA) will be delivered in person, with the remaining hours for scheduled and self-scheduled teaching and learning activities delivered either in person or online.

Notional Study Time: 90 Hours (Lecture hours: 15, Tutorial hours: 30, Scheduled revision session hours: 2, Guided independent study hours: 15, Homework / Programming assignment hours: 10, Course project / Preparation for complex problem solving hours: 15)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA 1	Lectures			
TLA 2	Tutorials	15	01	15
TLA 3	Case Study			
TLA 4	Problem Solving			
TLA 5	Demonstration			
TLA 6	Scheduled revision sessions			
TLA 7	Guided independent study: Directed viewing of video materials / PPTs			
TLA 8	Independent private study			
TLA 9	Laboratory Exercises	30	01	30
TLA 10	Homework assignments / Programming assignments			
TLA 11	Placement / work based learning or Specific practical training			
TLA 12	Presentation / Seminar Preparation			
TLA 13	Course Project / Preparation for Complex			

	Problem Solving			
TLA 14	Technical visit			
TLA 15	Field activities	0	0	0
			Total study hours	**45**
			Expected total study hours	**45**

SECTION 3A: Course Outcomes		
After successfully completing this course, the student will be able to:		
Outcome Number	**Course Outcomes**	**Learning Domain**
CO1	Demonstrate the use of draw, modify and dimension commands of AutoCAD for development of drawings used in design and analysis of structures	Understand
CO2	Explain the constructional procedure of scales, conic sections and special curves used in engineering practices	Understand
CO3	Utilize the principles of orthographic projection for projections of points, lines, planes and regular solids using first angle projections	Apply
CO4	Interpret the sectional views and true shape of the section for revealing interior features of an object veal interior features of an object	Analyse
CO5	Illustrate the development of surfaces for construction of storage vessels, chemical vessels, boilers, and chimneys in industrial applications	Apply
CO6	Make use of the concept of orthographic and isometric projections for converting isometric view to orthographic views and Vice-versa for engineering applications	Apply

SECTION 3B: Cognitive Levels	
Blooms Taxonomy Level	**Cognitive Level in Percentage (%)**
Remember	0
Understand	32
Apply	52
Analyse	16
Evaluate	0
Create	0

SECTION 4: Content and Context of Computer Aided Engineering Drawing	
CO1	**Demonstrate the use of draw, modify and dimension commands of AutoCAD for development of drawings used in design and analysis of structures**
	Understanding AutoCAD in Structural Design AutoCAD is a widely used Computer-Aided Design (CAD) software that allows engineers and designers to create precise 2D and 3D drawings. In structural engineering and design, AutoCAD helps in developing architectural plans, structural layouts, reinforcement detailing, and fabrication drawings. This Course Outcome (CO) aims to equip learners with the ability to use drawing, modification, and dimensioning tools in AutoCAD effectively to develop technical drawings for structural design and analysis.
CO2	**Explain the constructional procedure of scales, conic sections and special curves used in engineering practices.**
	Scales in Engineering Drawing Purpose of Scales: Used to represent large objects on a small sheet with correct proportions. Types of Scales: Plain Scale – Represents a single unit (e.g., meters and centimeters). Diagonal Scale – For more precise measurements, showing smaller divisions.

	Vernier Scale – Used in measuring instruments for higher accuracy. Comparative Scale – For comparing different units (e.g., feet and meters). Scale of Chords – Used in angle measurements. Construction Procedure: Determine the representative fraction (RF). Draw the main scale and divide it into equal parts. Add subdivisions if necessary for accuracy.
CO3	**Utilize the principles of orthographic projection for projections of points, lines, planes and regular solids using first angle projections**
	1. Understanding AutoCAD in Structural Design AutoCAD is a widely used Computer-Aided Design (CAD) software that allows engineers and designers to create precise 2D and 3D drawings. In structural engineering and design, AutoCAD helps in developing architectural plans, structural layouts, reinforcement detailing, and fabrication drawings. This Course Outcome (CO) aims to equip learners with the ability to use drawing, modification, and dimensioning tools in AutoCAD effectively to develop technical drawings for structural design and analysis.
CO4	**Interpret the sectional views and true shape of the section for revealing interior features of an object**
	Understanding Sectional Views in Engineering Drawing In engineering and technical drawing, sectional views are used to visually represent the interior features of an object that are not visible in standard orthographic projections. This Course Outcome (CO) focuses on the ability to: Interpret sectional views correctly. Identify the true shape of a section. Use sectional views to reveal hidden details of complex Electronics and Communication or structural.
CO5	**Illustrate the development of surfaces for construction of storage vessels, chemical vessels, boilers, and chimneys in industrial applications**
	Understanding Surface Development in Engineering Surface development refers to the process of unfolding a 3D object into a 2D layout to create a flat pattern for fabrication. This process is essential in sheet metal work, manufacturing, and industrial applications, where complex curved or cylindrical surfaces need to be cut and formed into precise shapes.
CO6	**Make use of the concept of orthographic and isometric projections for converting isometric view to orthographic views and Vice-versa for engineering applications**
	Understanding Projections in Engineering Drawing Engineering drawing is essential for visualizing, designing, and manufacturing Electronics and Communication and structural components. The two fundamental types of projections used in technical drawings are: Orthographic Projection – Represents multiple 2D views of an object from different angles. Isometric Projection – Represents a single 3D view of an object to show depth and perspective.

SECTION 5: Complex Engineering Problem Solving
AutoCAD is a powerful computer-aided design (CAD) software widely used for drafting, modeling, and engineering design When solving complex engineering problems AutoCAD helps in precise technical drawing, 3D modeling, and automation 2D Drafting & Detailing: Using line, polyline, trim, extend, mirror, fillet, and chamfer commands to create precise technical drawings. 3D Modeling & Surface Development Constructing solid models, extrusions, revolved shapes, and boolean operations for Electronics and Communication or architectural designs. Parametric Design Implementing constraints and dynamic blocks for adaptable models. Automation & Customization Using AutoLISP, Macros, and Scripts to solve repetitive or complex calculations automatically. Verifying & Optimizing the Design Use dimensioning, annotation, and layer management for clarity. Perform interference checking, clash detection, and mass properties analysis for 3D models. Generating Output for Manufacturing & Construction Export DXF/DWG files for CNC machining, laser cutting, or BIM integration.

Create professional layouts with title blocks, scaling, and plotting Gear Mechanism Design Civil & Structural Engineering Electrical Engineering Generate BOM (Bill of Materials) and Wiring Reports automatically.

SECTION 6A: Assessment Methods – Direct			
Item	**Evaluation Components**	**Week in / out**	**Marks**
AAT: 1 - 1	Tech-Talk / Worksheets	Week – 1 / 10	
AAT: 1 - 2	Hack-a-thon	Week – 4 / 7	
AAT: 2 - 1	Complex Engineering Problem Solving	Week – 9 / 12	
AAT: 2 - 2	Hack-a-thon	Week – 12 / 15	
CIE - 1	2 hours - Answer 4 out of 5 questions	Week - 9	40
CIE - 2	2 hours - Answer 4 out of 5 questions	Week - 17	
SEE	3 hours - Answer 1 from each module	Week - 18	60
		Total Marks	**100**
Department's Late Submission Policy: 1. 1 – 24 hours: 25% of the mark will be deducted 2. > 24 hours: Not accepted			
SECTION 6B: Assessment Methods –Indirect			
Course End Survey (End Semester OBE Feedback)			✓

SECTION 7: Content Delivery / Instructional Methodologies Please tick (✓) relevant engineering competency profile covered							
X	 Power Point Presentations	**X**	 Chalk and Talk	X	 MOOC	✓	 AAT

SECTION 8: Engineering Competencies (ECs) Focused Please tick (✓) relevant engineering competency profile covered			
EC Number	**Attributes**	**Profiles**	**(✓)**
EC1	Depth of knowledge required (CP)	Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill-founded, illogical, erroneous, unreliable or unrealistic requirements applicable to the engineering discipline	✓
EC2	Depth of analysis required (CP)	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	✓
EC3	Design and development of solutions (CA)	Support sustainable development solutions by ensuring functional requirements, minimize environmental impact and optimize resource utilization throughout the life cycle, while balancing performance and cost effectiveness.	✓
EC4	Range of conflicting requirements (CP)	Competently addresses complex engineering problems which involve uncertainty, ambiguity, imprecise information and wide-ranging or conflicting technical, engineering and other issues.	-
EC5	Infrequently encountered issues (CP)	Conceptualizes alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.	-
EC6	Protection of	Identifies, quantifies, mitigates and manages technical, health,	-

	society (CA)	environmental, safety, economic and other contextual risks associated to seek achievable sustainable outcomes with engineering application in the designated engineering discipline.	
EC7	Range of resources (CA)	Involve the coordination of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies) in the timely delivery of outcomes	-
EC8	Extent of stakeholder involvement (CP)	Design and develop solution to complex engineering problem considering a very perspective and taking account of stakeholder views with widely varying needs.	✓
EC9	Extent of applicable codes, legal and regulatory (CP)	Meet all level, legal, regulatory, relevant standards and codes of practice, protect public health and safety in the course of all engineering activities.	-
EC10	Interdependence (CP)	High level problems including many component parts or sub-problems, partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then re-combines to form a whole, with the integrity and performance of the overall system as the top consideration.	✓
EC11	Continuing professional development (CPD) and lifelong learning (CA)	Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.	✓
EC12	Judgement (CA)	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Require judgement in decision making in the course of all complex engineering activities.	-

SECTION 9: Employability Skills

Example: Communication skills / Programming skills / Project based skills

Employability Skills:

Mastering AutoCAD at the academic level enhances students' employability by developing technical expertise, problem-solving abilities, and industry-relevant skills. These skills are highly valued across engineering, architecture, manufacturing, and construction sectors. The key employability skills gained through learning AutoCAD include:

1. Technical Proficiency

- 2D & 3D Drafting Skills– Ability to create precise engineering drawings, blueprints, and schematics.
- Computer-Aided Design (CAD) Knowledge– Understanding of AutoCAD tools, layers, dimensioning, scaling, and layouts
- Industry-Specific Applications – Skills applicable to Electronics and Communication , civil, electrical, and architectural design.

2. **Problem-Solving & Analytical Skills**

Error Detection & Correction – Identifying and fixing drawing errors, misalignments, and incorrect dimensions.

Geometric & Spatial Visualization – Ability to interpret and modify complex 3D models.

Design Optimization – Creating efficient and cost-effective designs by modifying and improving drawings.

3. **Creativity & Innovation**

Conceptual Design– Developing innovative product and structural designs using CAD tools.

Rendering & Visualization – Enhancing presentation quality using 3D modeling and visualization techniques.

4. **Communication & Collaboration**

Technical Drawing Interpretation– Ability to read and interpret blueprints, section views, and assembly drawings.

Teamwork & Project Coordination– Working collaboratively in multi-disciplinary teams on CAD-based projects.
Documentation & Presentation – Effectively communicating design concepts through drawings, annotations, and reports.

5. **Time Management & Productivity**
Efficient Drafting Techniques – Using shortcuts, templates, and automation to improve productivity.
Project Management Skills – Handling multiple design projects and meeting deadlines.

6**. Adaptability to Industry Trends**
Integration with Advanced Tools – Learning to work with BIM (Building Information Modeling), CAM (Computer-Aided Manufacturing), and simulation software.
Understanding Industry Standards – Following ISO, ANSI, ASME, and other drafting standards.

Conclusion

Proficiency in AutoCAD prepares students for real-world design challenges, making them highly employable in industries like engineering, architecture, construction, and manufacturing. It enhances technical expertise, problem-solving, teamwork, and innovation, ensuring a strong foundation for career success.
Studying Data Structures equips the students with a range of employability skills that are highly valued in industries.

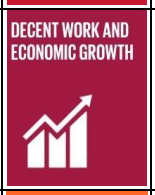
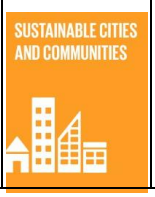
Project Management:

Project Management Skills Gained After Completing AutoCAD Training

- Planning & Organization
- Technical Problem-Solving
- Collaboration & Teamwork
- Quality Control & Compliance
- Project Execution & Delivery

SECTION 10: Relevance to Sustainability goals

Brief description about the course and its correlation with Sustainability Development Goal (SDGs).

SDG Goals		Correlation with SDG
4		**Quality Education:** This subject will prepare students for modern technological challenges, improving educational tools, and promoting skills essential for global development.
8		**Decent Work and Economic Growth:** Prepares students for careers in technology-driven industries, boosting employability and fostering innovation in the digital economy.
9		**Industry, Innovation, and Infrastructure:** Supports the development of efficient algorithms and systems crucial for advancing technological infrastructure and innovation.
11		**Sustainable Cities and Communities:** Enables the creation of smart city technologies (e.g., optimized traffic systems, resource management) using graph and tree structures.

17		**Partnerships for the Goals:** Facilitates collaboration in data-driven research and global educational initiatives through scalable and efficient data processing.

SECTION 11A: Mapping between COs and POs / PSOs

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	✓	✓	✓	-	-	-	-	-	-	-	✓	✓	-	-
CO2	✓	✓	✓	✓	✓	-	-	-	-	-	✓	✓	-	✓
CO3	✓	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓
CO4	✓	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓
CO6	✓	✓	✓	✓	✓	✓	-	-	-	-	✓	✓	✓	✓

Outcomes		WKS and Indicators of attainment and Justification for mapping (students will be able to)																																					IAs Count
COs	POs	WK 1	WK 2								WK 3			WK 4			WK 5						WK 6			WK 7				WK 8							WK 9						
		a	a	b	c	d	e	f	g	h	a	b	c	a	b	c	a	b	c	d	e	f	a	b	c	a	b	c	d	a	b	c	d	e	f	g	a	b	c	d	e	f	
CO 1	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																•	•	•			•																					4
	PO 11																													•	•	•			•	•							5
	PSO 1	•	•	•			•		•			•	•	•																													8
CO2	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																•	•	•			•																					4
	PO 4																													•	•	•			•	•							5
	PO 5		•	•	•	•	•		•														•	•	•																	9
	PO 11																													•	•	•			•	•							5
	PSO 1	•	•	•			•		•			•	•	•																													8
	PSO 3		•	•			•		•			•	•	•									•	•	•																	10
CO3	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																•	•	•			•																					4
	PO 4																													•	•	•			•	•							5
	PO 5		•	•	•	•	•		•														•	•	•																	9
	PO 11																													•	•	•			•	•							5
	PSO 1	•	•	•			•		•			•	•	•																													8

	PSO 2		•	•			•		•			•	•	•								•	•	•																			10
	PSO 3		•	•			•		•			•	•	•								•	•	•																			10
CO4	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																•	•	•			•																					4
	PO 4																												•	•	•			•	•								5
	PO 5		•	•	•	•	•		•													•	•	•																			9
	PO 11																												•	•	•			•	•								5
	PSO 1	•	•	•			•		•			•	•	•																													8
	PSO 2		•	•			•		•			•	•	•								•	•	•																			10
	PSO 3		•	•			•		•			•	•	•								•	•	•																			10
CO 5	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																•	•	•			•																					4
	PO 4																												•	•	•			•	•								5
	PO 5		•	•	•	•	•		•													•	•	•																			9
	PO 11																												•	•	•			•	•								5
	PSO 1	•	•	•			•		•			•	•	•																													8
	PSO 2		•	•			•		•			•	•	•								•	•	•																			10
	PSO 3		•	•			•		•			•	•	•								•	•	•																			10
CO 6	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																•	•	•			•																					4
	PO 4																												•	•	•			•	•								5
	PO 5		•	•	•	•	•		•													•	•	•																			9
	PO 6	•															•	•	•			•								•	•		•										8
	PO 11																												•	•	•			•	•								5
	PSO 1	•	•	•			•		•			•	•	•																													8
	PSO 2		•	•			•		•			•	•	•																													10
	PSO 3		•	•			•		•			•	•	•																													10

SECTION 11B: Indicators of Attainment with COs to POs and PSOs															
Course Outcomes	Percentage of Indicators of Attainments (IA) with POs and PSOs														
	PO												PSO		
	1	2	3	4	5	6	7		8	9	10	11	1	2	3
CO1	67	67	67	-	-	-	-		-	-	-	71	53	-	-
CO2	67	67	67	71	82	-	-		-	-	-	71	53	-	90
CO3	67	67	67	71	82	-	-		-	-	-	71	53	90	90
CO4	67	67	67	71	82	-	-		-	-	-	71	53	90	90

CO5	67	67	67	71	82	-	-		-	-	-	71	53	90	90
CO6	67	67	67	71	82	80	-		-	-	-	71	53	90	90

SECTION 11C: Course Articulation Matrix of COs to POs

0 No Contribution (0-5%)	**1** Low (≥5 - <40%)	**2** Moderate (≥40 - <60%)	**3** High (≥60%)
-			

Course Outcomes	**Program Outcomes (POs)**											**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	3	3	3	-	-	-	-	-	-	-	3	2	-	-
CO2	3	3	3	3	3	-	-	-	-	-	3	2	-	3
CO3	3	3	3	3	3	-	-	-	-	-	3	2	3	3
CO4	3	3	3	3	3	-	-	-	-	-	3	2	3	3
CO5	3	3	3	3	3	-	-	-	-	-	3	2	3	3
CO6	3	3	3	3	3	3	-	-	-	-	3	2	3	3
Total	18	18	18	15	15	3	-	-	-	-	18	12	12	15
Average	3	3	3	3	3	3	-	-	-	-	3	2	3	3

SECTION 11D: Level of Contribution of the COs to POs and PSOs

Number	**Programme Outcomes**	**Proficiency Assessed by**	**Contribution Level (from 1 to 3)**
PO 1	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**.	CIE / SEE / AAT:1 – 2 Assignments / Open-ended problems	**3**
PO 2	Identify, formulate, review research literature and analyse **complex engineering problems** reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).	CIE / SEE / AAT:1 – 2 Hack-a-thon	**3**
PO 3	Design creative solutions for **complex engineering problems** and design / develop systems / components/ processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**3**
PO 4	Conduct investigations of **complex engineering problems** using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)	CIE / SEE / AAT:2 – 1 Complex Engineering Problem Solving	**3**
PO 5	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve **complex engineering problems**. (WK2 and WK6).	CIE / SEE / AAT:2 – 2 Hack-a-thon	**3**
PO 6	Analyze and evaluate societal and environmental aspects while solving **complex engineering problems** for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7)	CIE / SEE / AAT:2 – 2 Hack-a-thon	**3**
PO 11	Recognize the need for, and have the preparation and ability for i) independent and life-long learning	CIE / SEE / AAT:2 – 1 Complex Engineering	**3**

	ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)	Problem Solving	
PSO 1	Build Embedded software and Digital Circuit Development platform for Robotics, Embe systems and Signal Processing Applications	AAT: 1 – 1 Tech-Talk	**2**
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Vir Instrumentation and System on Chip (SOC) designs.	AAT: 2 – 1 Complex Engineering Problem Solving	**3**
PSO 3	Make use of High Frequency Structure Simulator (HFSS) for modeling and evaluating Patch and Smart Antennas for Wired and Wireless Communication Applications.	AAT: 2 – 1 Complex Engineering Problem Solving	**3**

SECTION 12: Course Content	
MODULE - I	**INTRODUCTION TO ENGINEERING GRAPHICS**
	Principles of engineering graphics and their significance, scales, plain & diagonal, conic sections including the rectangular hyperbola, general method, cycloid, epicycloid and hypocycloid, introduction to computer aided drafting, views, commands.
MODULE - II	**ORTHOGRAPHIC PROJECTION**
	Principles of orthographic projections, conventions, projections of points and lines, projections of plane regular geometric figures. Computer aided orthographic projections, points, lines and planes.
MODULE - III	**PROJECTIONS OF REGULAR SOLIDS**
	Projections of regular solids, auxiliary views, sections or sectional views of right regular solids, prism. Cylinder, pyramid, cone, computer aided projections of solids, sectional views.
MODULE - IV	**DEVELOPMENT OF SURFACES**
	Development of surfaces of right regular solids, prism, cylinder, pyramid and cone, development of surfaces using computer aided drafting.
MODULE - V	**ISOMETRIC PROJECTIONS**
	principles of isometric projection, isometric scale, isometric views, conventions, isometric views of lines, plane figures, simple and compound solids, isometric projection of objects having non-isometric lines. Isometric projection of spherical parts, conversion of isometric views to orthographic views and viceversa, conventions, conversion of orthographic projection into isometric view using computer aided drafting

SECTION 13: Tentative Schedule of Instructions		
Week Number	**Topics**	**Duration (Hours)**
1	Introduction to AUTOCAD	3
2	Introduction to Engineering Drawing	3
3	Exercises on Geometrical Constructions	3
4	Exercises on Conic Sections	3
5	Principles of orthographic projections, conventions	3
6	Projections of points and lines	3
7	Projections of planes	3

8	Projections of regular solids	3
9	Exercises on prism, cylinder, pyramid, cone	3
10	Exercise on Development of surfaces 1Prisms	3
11	Exercise on Isometric projection of Planes	3
12	Exercise on Isometric projection of Solids	3
13	Demonstration of Ortho to Isometric and Isometric to Ortho	3
	Total	**39**

SECTION 14: Specific Goals for the Course

The following table shows the knowledge and skills covered by the unit outcomes:

Knowledge	Skills
Learners should understand: 1. Technical Drawing and Drafting Skills 2D Drafting & Annotation – Creating accurate plans, elevations, sections, and layouts. 3D Modeling & Visualization – Designing 3D objects, rendering, and material application. Geometric & Dimensioning Techniques – Using layers, scales, and constraints for precise drawings. 2. AutoCAD Tools & Commands Drawing Commands – Mastery of Line, Circle, Arc, Polyline, Rectangle, and other basic tools. Modify Commands – Editing drawings with Move, Copy, Rotate, Trim, Extend, Mirror, and Scale. Annotation & Text – Adding dimensions, labels, tables, and notes for professional documentation. Layer Management – Organizing drawings using layers, colors, and line weights. 3. Efficient Workflow & Productivity Features Block & Symbol Usage – Creating and using blocks, dynamic blocks, and external references (Xrefs). Templates & Standards – Working with predefined templates and CAD standards for industry applications. Shortcuts & Automation – Using macros, scripts, and command shortcuts to improve efficiency. 4. Project Execution & Industry Application Blueprint Reading & Interpretation – Understanding construction, Electronics and Communication , and electrical drawings. File Management & Exporting – Converting files into PDF, DXF, DWG, and other formats for sharing. Collaboration & Teamwork – Coordinating with architects, engineers, and designers on CAD projects. 5. Real-World Application & Career Readiness Industry-Specific Knowledge – Applying AutoCAD skills in civil, Electronics and Communication ,	**Learners can:** Skills Students Will Possess After Completing an AutoCAD Course Upon completing an AutoCAD course, students will develop a combination of technical, analytical, and professional skills that enhance their employability in fields like engineering, architecture, construction, manufacturing, and interior design. These skills include: 1. Technical Skills 2D Drafting & Detailing – Ability to create precise technical drawings, floor plans, and schematics. 3D Modeling & Visualization – Designing 3D objects, assemblies, and rendering visuals. Dimensioning & Scaling – Applying accurate measurements, tolerances, and proportions. Layer & Block Management – Organizing drawings using layers, blocks, and external references (Xrefs). Plotting & Printing – Exporting drawings in DWG, DXF, PDF formats with proper layouts. 2. Problem-Solving & Analytical Skills Error Identification & Correction – Detecting design flaws and fixing drawing inconsistencies. Optimization of Design – Modifying drawings to enhance efficiency and cost-effectiveness. Understanding Industry Standards – Following ISO, ANSI, ASME, and national drafting standards. 3. Productivity & Time Management Skills Efficient Use of AutoCAD Tools – Mastering shortcuts, scripts, and automation tools to improve speed. Template & Block Utilization – Reducing redundant work with predefined CAD blocks and templates. Project Workflow Management – Organizing design tasks, meeting deadlines, and handling revisions.

electrical, and architectural projects. Problem-Solving Skills – Identifying and resolving design errors, misalignments, and material inefficiencies. Project Documentation & Presentation – Creating professional technical reports and visual presentations. • built-in data structures • abstract data structures • the implementation of static abstract data structures • the implementation of dynamic abstract data structures • how to compare different search algorithms • how to compare different sorting algorithms • how to construct tree and tree traversals • graph representation and traversal (BFS and DFS) • priority queue is an abstract data type that performs operations on data elements per their priority. • hashing technique in data structures to map keys and values into a hash table.	4. Communication & Collaboration Skills Interpreting Technical Drawings – Understanding blueprints, engineering drawings, and schematics. Team Collaboration – Coordinating with architects, engineers, and designers on CAD projects. Presentation & Documentation – Creating technical reports, annotations, and visual presentations. 5. Career & Industry Readiness Skills Adaptability to Industry-Specific CAD Applications – Applying AutoCAD in Electronics and Communication , civil, electrical, and architectural domains. Software Integration Knowledge – Understanding interoperability with Revit, SolidWorks, CATIA, and BIM tools. Problem-Solving in Real-World Projects – Handling design challenges, optimizing layouts, and improving project efficiency.

Administrative Information

SECTION 15: History of changes		
Regulations	**Description of change**	**BOS Date**
R 18	From R18 JNTUH, Hyderabad to R16 IARE regulations with change in V module • **Module - V: Perspective projections** • Perspective projections: Perspective view of points, lines, plane figures and simple solids, vanishing point method and visual ray method	16.07.2018
UG 20	**Isometric and Orthographic Projections** Principles of Isometric projection–Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views	17.11.2020
BT 23	**Development of surfaces** Development of surfaces of right regular solids, prism, cylinder, pyramid and cone, development of surfaces using computer aided drafting	21.08.2023

Course Outline Approvals	
Course Coordinator Name: Signature: Date:	**Head of the Department** Name: Signature: Date:
Dean of Outcome Based Teaching and Learning Name: Signature: Date:	**Dean of Academics** Name: Signature: Date:

Check List		
Section	**Description**	**Please tick (✓)**
1	General Information about the Course	
2	Notional Study Time	
3	A. Course Outcomes	
	B. Cognitive Levels	
4	Content and Context of the Course	
5	Complex Engineering Problem Solving	
6	A. Assessment Methods – Direct	
	B. Assessment Methods – Indirect	
7	Content Delivery / Instructional Methodologies	
8	Engineering Competencies (ECs) Focused	
9	Employability Skills	
10	Relevance to Sustainability goals	
11	A. Mapping between COs and POs / PSOs	
	B. Indicators of Attainment with COs to POs and PSOs	
	C. Course Articulation Matrix of COs to POs	
	D. Level of Contribution of the COs to POs and PSOs	
12	Syllabus	
13	Tentative Schedule of Instructions	
14	Specific Goals for the Course	
15	History of Changes	

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**Ordinary Differential equations and vector calculus**
Course Code	AHSE08
Course Start	Second Semester
Course Type	Core
Regulation	IARE - BT 25
Prerequisite Courses	Matrices and calculus (AHSE01)
Department	Electronics and communication Engineering
Number of Credits	3 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Theory
Course Administrator	**Dr. P. Srilatha** Associate Professor of Mathematics IARE10161 g.srinivas@iare.ac.in
Course Coordinator's Name	**Dr. P. Raja Kumari,** Asst. Professor of Mathematics IARE10955 p.rajakumari@iare.ac.in
Prior Learning Assessment and Recognition (PLAR)	Students interested in PLAR pathways for open learning can register one semester prior to the start of semester. Students will receive the necessary contact information one semester in advance.
Open Learning Faculty Member Information	Open Learning Faculty (OLF) is available to assist students. Students will receive the necessary contact information at the start of the course.
Course Webpage	https://akanksha.iare.ac.in/index?route=course/details&course_id=1787
Course Description	This course provides a comprehensive introduction to two fundamental areas differential equations and vector calculus. Students will explore the theory, techniques, and applications of differential equations, focusing on ordinary differential equations. The course covers methods for solving linear and nonlinear differential equations, as well as their use in modelling real-world phenomena across engineering, physics, and other fields. Additionally, the course delves into vector calculus, which involves the study of vector fields and operations like gradient, divergence, and curl. Key topics include line integrals, surface integrals, Green's theorem, Stokes' theorem, and the Divergence theorem, all of which are essential for understanding the behaviour of fields in multidimensional spaces. Throughout the course, students will develop both analytical and computational skills to solve problems and interpret results. By the end of the course, students will have the knowledge to approach complex scientific and engineering problems that require differential equations and vector calculus techniques.
Course Objectives	**The students will try to learn:**

	a. The analytical methods for solving first and higher order differential equations with constant coefficients. b. The analytical methods for formation and solving partial differential equations. c. The physical quantities of vector valued functions involved in engineering field. d. The logic of vector theorems for finding line, surface and volume integrals.
Text and Reference Books	**Text Books** 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. N.P. Bali and Manish Goyal "A textbook of Engineering Mathematics" Laxmi Publications, Reprint,2008, 3. B.V. Ramana, "Higher Engineering Mathematics", McGraw Hill Education.
Learning Resources	**Course full stack** is made available in IARE learning management portal – Akansha, which includes lecture notes, tutorial question bank, definition and terminology, tech-talk topics, assignments, Model question papers (2 sets), complex engineering problem solving statements, power point presentations (PPTs) and ELRV lecture recordings at: • https://www.youtube.com/playlist?list=PLzkMouYverAJun1tS4k59J7jNLEDOw0vq • https://www.youtube.com/playlist?list=PLzkMouYverAKJBoz5syuBzg1tn6LecSKz
Supplemental Materials	**Readings, Videos, and Links** 1. https://onlinecourses.nptel.ac.in/noc23_ma88/preview 2. 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
Learning and Teaching Strategies	Online material will provide the foundation of the learning resources, requiring the students to log in and engage regularly throughout the sixteen weeks of the course. There will be a mix of suggested readings, discussions and video content containing embedded digital content and undertake the assessment tasks.

SECTION 2: Teaching Learning Scheme

At least 48 lecture hours of scheduled teaching and learning activities (TLA) will be delivered in person, with the remaining hours for scheduled and self-scheduled teaching and learning activities delivered either in person or online.

Notional Study Time: 90 Hours (Lecture hours: 48, Tutorial hours:16, Scheduled revision session hours: 2, Homework / Programming assignment hours: 10, Course project / Preparation for complex problem solving hours: 14)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA 1	Lectures	48	01	48

TLA 2	Tutorials	16	01	16
TLA 3	Case Study			
TLA 4	Problem Solving			14
TLA 5	Demonstration			
TLA 6	Scheduled revision sessions	02	01	02
TLA 7	Guided independent study: Directed viewing of video materials / PPTs			
TLA 8	Independent private study			
TLA 9	Laboratory Exercises	0	0	0
TLA 10	Homework assignments / Programming assignments			10
TLA 11	Placement / work based learning or Specific practical training	0	0	0
TLA 12	Presentation / Seminar Preparation			
TLA 13	Course Project / Preparation for Complex Problem Solving			
TLA 14	Technical visit			
TLA 15	Field activities	0	0	0
			Total study hours	**90**
			Expected total study hours	**90**

SECTION 3A: Course Outcomes

After successfully completing this course, the student will be able to:

Outcome Number	Course Outcomes	Learning Domain
CO1	**Utilize** the methods of differential equations for solving the orthogonal trajectories and Newton's law of cooling.	Apply
CO2	**Solve** the higher order linear differential equations with constant coefficients by using method of variation of parameters.	Apply
CO3	Make use of analytical methods for PDE formation to solve boundary value problems	Apply
CO4	Identify various techniques of Lagrange's method for solving linear partial differential equations which occur in science and engineering.	Apply
CO5	**Interpret** the vector differential operators and their relationships for solving engineering problems.	Understand
CO6	**Apply** the integral transformations to surface, volume and line of different geometrical models in the domain of engineering.	Apply

SECTION 3B: Cognitive Levels

Blooms Taxonomy Level	Cognitive Level in Percentage (%)
Remember	0
Understand	16
Apply	84
Analyse	0
Evaluate	0
Create	0

SECTION 4: Content and Context of Data Structures	
CO1	**Utilize the methods of differential equations for solving the orthogonal trajectories and Newton's law of cooling.**
	Make the student to understand basics of ordinary differential equations. They should made know that the basics of ordinary differential equations of first order and first degree. Teach learners about some standard methods of solving ordinary differential equations of first order and first degree. They should understand the process of determining the orthogonal trajectories through differential equations. This course focuses on the analysis and solution of First-Order Ordinary Differential Equations (ODEs) with an emphasis on two important applications: Orthogonal Trajectories and Newton's Law of Cooling. The course will cover the process of determining the differential equation for a family of curves and the method for finding the orthogonal trajectories of this family. The course will also introduce Newton's Law of Cooling, which describes the rate of change of the temperature of an object in relation to the ambient temperature. The course will cover how this law can be modelled using first-order linear differential equations and will guide students through solving such equations.
CO2	**Solve the higher order linear differential equations with constant coefficients by using method of variation of parameters.**
	Make the student to understand about the foundational principles of first order differential equations to extends to equations involving higher derivatives. Teach learners how to solve linear ODEs, particularly with constant coefficients, and make them to understand the nature of solutions in both homogeneous and non-homogeneous cases. Learners should also know about the method of variation of parameters to find a particular solution to a nonhomogeneous linear differential equation, which is useful for higher-order ordinary differential equations.
CO3	**Make use of analytical methods for PDE formation to solve boundary value problems.**
	Teach learners about the definition and classification of partial differential equations. Make the student to understand the differences between ordinary and partial differential equations. Teach learners mathematical principles and techniques used to derive PDE by eliminating arbitrary constants through differentiation and eliminating arbitrary function by partial differentiation. Learners should know about formation of PDE exploring their applications in physics, engineering, and applied mathematics.
CO4	**Identify various techniques of Lagrange's method for solving linear partial differential equations which occur in science and engineering.**
	Learners should have basic knowledge of ordinary and partial differential equations. Teach learner in-depth study of two fundamental techniques for solving partial differential equations (PDEs)the Grouping Method and the Method of Multipliers. Learner should Understand the principles behind the Grouping Method and its applications in simplifying PDEs They should know that how to choose the set of multipliers to solve the partial differential equation. Learners should be made to learn the usage real-world applications of these methods in physics, engineering, and optimization and develop problem-solving skills to tackle PDEs analytically using these techniques.
CO5	**Interpret the vector differential operators and their relationships for solving engineering problems.**
	Learners are required to know basic calculus, including differentiation and integration of single variable functions. Teach learners fundamental concepts of vector differentiation and calculus tools such as gradients, divergences, and curls. Learner should understand the how vector functions change along arbitrary directions.
CO6	**Apply the integral transformations to surface, volume and line of different geometrical models in the domain of engineering**
	Learner should have the basic knowledge of the vector differentiation. Teach learner fundamental topics such as line integral, surface integral and volume integral. Make the Learner to understand the essential theorems like Green's theorem, Stokes' theorem, and the Gauss divergence Theorem. Make the learner capable to compute line, surface, and volume integrals in various coordinate systems. And also Apply the knowledge of key vector theorems to solve real-world problems.

SECTION 5: Complex Engineering Problem Solving

Complex Problem Solving

There is one piece of assessed coursework, involving a mixture of theoretical work. We encourage the students to get the ability to solve complex engineering problems using advanced mathematics can give companies and countries a competitive edge in the global market, driving economic growth and innovation.

Complex engineering problems in mathematics involve highly intricate and multifaceted challenges that require advanced mathematical techniques, interdisciplinary knowledge, and innovative problem-solving strategies. These problems often arise in real-world applications and demand a deep understanding of mathematical modelling, optimization, numerical methods, and computational techniques.

Complex engineering problems in mathematics are at the core of modern technological advancements. They require a blend of theoretical knowledge and computational skills to develop innovative solutions for real-world challenges. With the rise of artificial intelligence and computational power, engineers and mathematicians continue to tackle increasingly sophisticated problems, pushing the boundaries of what is possible in science and engineering.

SECTION 6A: Assessment Methods – Direct

Item	Evaluation Components	Week in / out	Marks
AAT: 1 – 1	Tech-Talk	Week – 2 / 5	05
AAT: 1 – 2	Assignments/open-ended problems	Week – 4 / 7	05
AAT: 2 – 1	Complex Engineering Problem Solving	Week – 9 / 12	05
AAT: 2 - 2	Assignments/open-ended problems	Week – 12 / 15	05
CIE – 1	2 hours - Answer 4 out of 5 questions	Week – 9	10
CIE – 2	2 hours - Answer 4 out of 5 questions	Week – 17	10
SEE	3 hours - Answer 1 from each module	Week – 18	60
		Total Marks	**100**

Department's Late Submission Policy:

1. 1 – 24 hours: 25% of the mark will be deducted
2. > 24 hours: Not accepted

SECTION 6B: Assessment Methods –Indirect

Course End Survey (End Semester OBE Feedback)	✓

SECTION 7: Engineering Competencies (ECs) Focused

Please tick (✓) relevant engineering competency profile covered

EC Number	Attributes	Profiles	(✓)
EC1	Depth of knowledge required (CP)	Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information that may be ill-founded, illogical, erroneous, unreliable or unrealistic requirements applicable to the engineering discipline	✓
EC2	Depth of analysis required (CP)	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	✓
EC3	Design and development of solutions (CA)	Support sustainable development solutions by ensuring functional requirements, minimize environmental impact and optimize resource utilization throughout the life cycle, while balancing performance and cost effectiveness.	-

EC4	Range of conflicting requirements (CP)	Competently addresses complex engineering problems which involve uncertainty, ambiguity, imprecise information and wide-ranging or conflicting technical, engineering and other issues.	-
EC5	Infrequently encountered issues (CP)	Conceptualizes alternative engineering approaches and evaluates potential outcomes against appropriate criteria to justify an optimal solution choice.	-
EC6	Protection of society (CA)	Identifies, quantifies, mitigates and manages technical, health, environmental, safety, economic and other contextual risks associated to seek achievable sustainable outcomes with engineering application in the designated engineering discipline.	-
EC7	Range of resources (CA)	Involve the coordination of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies) in the timely delivery of outcomes	-
EC8	Extent of stakeholder involvement (CP)	Design and develop solution to complex engineering problem considering a very perspective and taking account of stakeholder views with widely varying needs.	-
EC9	Extent of applicable codes, legal and regulatory (CP)	Meet all level, legal, regulatory, relevant standards and codes of practice, protect public health and safety in the course of all engineering activities.	-
EC10	Interdependence (CP)	High level problems including many component parts or sub-problems, partitions problems, processes or systems into manageable elements for the purposes of analysis, modelling or design and then re-combines to form a whole, with the integrity and performance of the overall system as the top consideration.	-
EC11	Continuing professional development (CPD) and lifelong learning (CA)	Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.	-
EC12	Judgement (CA)	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Require judgement in decision making in the course of all complex engineering activities.	-

SECTION 8: Employability Skills

Example: Communication skills / Programming skills / Project based skills

There is one piece of assessed coursework, Studying Differential equations and vector calculus enhance the ability to model dynamic systems, and contribute to advancements in various fields. This expertise is particularly valuable in problem solving, analytical, and computational skills.

STEM (Science, Technology, Engineering, and Mathematics) careers, where analytical and technical skills are in high demand.

Employability Skills:

- Problem-solving skills for designing efficient solutions.
- Logical and analytical thinking for Problem-solving.
- Proficiency in mathematical modelling.
- Computational and Numerical skills in data analysis and engineering design.
- Interdisciplinary knowledge in systems engineering and data science.
- Teamwork and consulting in. complex mathematical concepts
- Programming and Software Proficiency in engineering simulations.

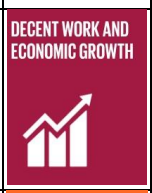
Project Management:

- Planning and organizing project timelines and tasks.
- Identifying resources and assign the roles effectively.
- Collaborating and communicating with team members.

- Identifying and mitigating project risks.
- Testing and validating system performance.

SECTION 9: Relevance to Sustainability goals

Brief description about the course and its correlation with Sustainability Development Goal (SDGs).

SDG Goals		Correlation with SDG
4		**Quality Education:** This subject equips students with problem-solving and analytical skills, fostering innovation and critical thinking. These mathematical tools are essential for training the next generation of scientists, engineers, and policymakers to tackle sustainability challenges.
8		**Decent Work and Economic Growth:**
9		**Industry, Innovation, and Infrastructure:**
11		**Sustainable Cities and Communities:**
17		**Partnerships for the Goals:**

SECTION 10A: Mapping between COs and POs / PSOs

Course Outcomes	Program Outcomes (POs)											Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO2	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO4	✓	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	✓	-	-	-	-	-	-	-	-	-	-	-	-
CO6	✓	-	-	-	-	-	-	-	-	-	-	-	-	-

...

Outcomes		WKS and Indicators of attainment and Justification for mapping (students will be able to)																																								IAs Count
COs	POs	WK 1	WK 2								WK 3			WK 4			WK 5						WK 6			WK 7				WK 8							WK 9						
		a	A	b	c	d	e	f	g	h	a	b	c	a	b	c	a	b	c	d	e	f	a	b	c	a	b	c	d	a	b	c	D	e	f	g	a	b	c	d	e	f	
CO 1	PO 1	•	•	•		•	•	•			•	•		•																													9
	PO 2	•	•	•		•	•	•			•	•		•																													9
	PO 3																																										
	PO 11																																										
	PSO 1																																										
CO2	PO 1	•	•	•		•	•	•			•	•		•																													9
	PO 2	•	•	•		•	•	•			•	•		•																													9
	PO 3																																										
	PO 4																																										
	PO 5																																										
	PO 11																																										
	PSO 1																																										
	PSO 3																																										
CO3	PO 1																																										
	PO 2	•	•	•		•	•	•			•	•		•																													9
	PO 3																																										
	PO 4																																										
	PO 5																																										
	PO 11																																										
	PSO 1																																										
	PSO 2																																										
	PSO 3																																										
CO4	PO 1	•	•	•		•	•	•			•	•		•																													9
	PO 2																																										
	PO 3																																										
	PO 4																																										
	PO 5																																										
	PO 11																																										
	PSO 1																																										
	PSO 2																																										
	PSO 3																																										
CO 5	PO 1																																										
	PO 2	•	•	•		•	•	•			•	•		•																													9
	PO 3																																										

	PO 4																																												
	PO 5																																												
	PO 11																																												
	PSO 1																																												
	PSO 2																																												
	PSO 3																																												
CO 6	**PO 1**	•	•	•		•	•	•			•	•		•																													**9**
	PO 2																																												
	PO 3																																												
	PO 4																																												
	PO 5																																												
	PO 6																																												
	PO 11																																												
	PSO 1																																												
	PSO 2																																												
	PSO 3																																												

SECTION 10B: Indicators of Attainment with COs to POs and PSOs

Course Outcomes	**Percentage of Indicators of Attainments (IA) with POs and PSOs**														
	PO												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**		**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	60	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	60	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	60	-	-	-	-	-	-	-	-	-	-	-	-	-
CO6	60	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SECTION 10C: Course Articulation Matrix of COs to Pos

0 No Contribution (0-5%)	**1** Low (≥5 - <40%)	**2** Moderate (≥40 - <60%)	**3** High (≥60%)

Course Outcomes	**Program Outcomes (POs)**										**Program Specific Outcomes (PSOs)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO6	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	12	12	-	-	-	-	-	-	-	-	-	-	-	-
Average	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

SECTION 10D: Level of Contribution of the COs to POs and PSOs			
Number	**Programme Outcomes**	**Proficiency Assessed by**	**Contribution Level (from 1 to 3)**
PO 1	Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**.	CIE / SEE / AAT:1 – 2 Assignments / Open-ended problems	**3**
PO 2	Identify, formulate, review research literature and analyse **complex engineering problems** reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).	CIE / SEE / AAT:1 – 2	**3**
PSO 1	Build Embedded Software and Digital Circuit Development platform for Robotics, Embedded Systems and Signal Processing Applications.	AAT: 1 – 1 Tech-Talk	
PSO 2	Focus on the Application Specific Integrated Circuit (ASIC) Prototype designs, Virtual Instrumentation and System on Chip (SOC) designs.	AAT: 2 – 1 Complex Engineering Problem Solving	
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.	AAT: 2 – 1	

SECTION 11: Course Content	
MODULE – I	**FIRSTORDERAND FIRST DEGREE ODE**
	Exact differential equations, Equations reducible to exact differential equations, linear and Bernoulli's equations, Applications: Orthogonal Trajectories (Cartesian Coordinates) Newton's law of cooling, law of natural growth and decay.
MODULE – II	**ORDINARY DIFFERENTIAL EQUATIONS OF HIGHER ORDER**
	Second order linear differential equations with constant coefficients: non-homogeneous terms of the type e^{ax}, sinax , cosax , polynomials in x, $e^{ax}V(x)$ and xV(x),, method of variation of parameters
MODULE – III	**LAPLACE TRANSFORMS**
	Laplace transforms: Laplace transform of standard functions, first shifting theorem, Laplace transforms of functions multiplied by 't' and divided by 't', Laplace transforms of derivatives and integrals of function, evaluation of integrals by Laplace transforms, Laplace transform of periodic functions. Inverse Laplace transform by different methods, Convolution theorem (without proof). Applications: solving initial value problems by Laplace transform method
MODULE – IV	**VECTOR DIFFERNTIATION**
	Scalar and vector point functions; definitions of gradient, divergent and curl , directional derivative; vector identities solenoidal and irrotational vector point functions; scalar potential function.
MODULE – V	**VECTOR INTEGRATION**
	Line integral, surface integral and volume integral, Green's theorem in a plane, Stoke's theorem and Gauss divergence theorem without proofs.

SECTION 12: Tentative Schedule of Instructions		
Week Number	**Topics**	**Duration (Hours)**
1	1.1 Introduction to ordinary Differential equations 1.2 Variable Separable, homogenous and non-homogenous differential equations 1.3 Exact differential equations	3
2	2.1 Non- Exact Differential equations (Method-1) 2.2 Non-Exact Differential equations (Method-2) 2.3 Non-Exact Differential equations (Method-3)	3
3	3.1 Non-Exact Differential equations (Method-4) 3.2 Non-Exact Differential equations (Method-5) 3.3 Linear differential equations of first order	3
4	4.1 Bernoulli's Equation 4.2 Applications of ODE, Orthogonal trajectories 4.3 Applications of ODE, Newton's law of cooling	3
5	5.1 Linear Differential Equations of Second and Higher Order with Constant Coefficients 5.2 Non-Homogeneous term of the type f (X) = e^{ax}	3
6	6.1 Non-Homogeneous term of the type f (X) = Sinax 6.2 Non-Homogeneous term of the type f (X) = Cosax 6.3 Non-Homogeneous term of the type f (X) = X^n	3
7	7.1 Non-Homogeneous term of the type f (X) = X^n 7.2 Determine particular non-homogeneous term of the type f (X) = e^{ax} V(x) 7.3 Determine particular non-homogeneous term of the type f (X) = x V(x) 7.4 Solving second order linear differential equations using method of variation of parameters	3
8	8.1 Laplace transform of standard functions, first shifting theorem 8.2 Laplace transforms of functions multiplied by 't' and divided by 't' 8.3 Laplace transforms of derivatives and integrals of function, 8.4 evaluation of integrals by Laplace transforms, Laplace transform of periodic functions.	3
CONTINIUOUS INTERNAL EXAMINATION (CIE- II)		
9	9.1 Inverse Laplace transform by different methods 9.2 Convolution theorem (without proof) 9.3 solving initial value problems by Laplace transform method	3
10	10.1 In Scalar and Vector Point Function (Definitions of Gradient, divergent, curl 10.2 Problems on Gradient of vector point functions 10.3 Problems on divergence of vector point functions	3
11	11.1 Problems on divergence and curl 11.2 Problems on directional derivative 11.3 Vector identities	3
12	12.1 Problems on directional derivative 12.2 Solenoidal and irrotational vectors 12.3. Problems on Solenoidal and irrotational vectors	3
13	13.1 Introduction to Line integral 13.2 Problems on line integral 13.3 Surface Integral	3
14	14.1 Problems on surface integral 14.2 Volume integral 14.3 Problems on Volume integral	3
15	15.1 Green's theorem 15.2 Calculating areas by using Green's theorem 15.3 Stoke's theorem	3
16	16.1 Problems on Stoke's theorem 16.2 Gauss divergence theorem 16.3 Gauss divergence theorem	3
	Total	**48**

SECTION 14: Specific Goals for the Course	
The following table shows the knowledge and skills covered by the unit outcomes:	
Knowledge	**Skills**
Learners should understand: • different types of first order first degree DE • various analytical methods to get solution • the physical or practical significance of the solutions obtained. • Translating real-world problems into mathematical models using higher-order ODEs. • the behaviour of systems • Solution Techniques • Economic models and financial derivatives. • Motion in video sequences with help of PDEs. • How to simulate and predict climate change and weather patterns using PDE • How to reconstruct images from raw data using PDE. • How to model the flow of vehicles on roads and networks. • How to analyze forces, motion, and energy in systems. • How identify conservative vector fields, and derive potential functions, which simplify calculations in physics and engineering.	**Learners can:** • Determine the DE for a family of curves • Determine the method for finding orthogonal trajectories of the family. • able to model Newtons law of cooling using first order linear ODE and can solve them • Enhancing your ability to approach and solve problems systematically. • Evaluate different methods to solve differential equations. • Can existing research on differential equations • Develop new methods or applying existing methods to new problems. • able to translate real-world phenomena into mathematical equations. • able to writing code to solve PDEs numerically using software like MATLAB, Python, or COMSOL. • able to solve problems in electromagnetism, fluid dynamics, and continuum mechanics. • able to model physical phenomena using vector calculus, which is essential for simulations and predictions in various scientific domains.

Administrative Information

SECTION 15: History of changes		
Regulations	**Description of change**	**BOS Date**
R 16	From R15 JNTUH, Hyderabad to R16 IARE regulations with change in V module • **Module - V:** •	24.07.2016
R 18	Changes from R16 to R18 regulation • **Module I:** Root finding techniques, by bisection, False and Newton-Raphson method are introduced • **Module – II:** Finite difference, forward, back ward and central differences and interpolation of unequal intervals by Lagrane interpolation are introduced • Module-III: Numerical Analysis is introduced	16.07.2018
UG 20	Changes from R18 to UG 20 regulation • Vector Calculus: Gradient, curl, divergence and directional derivative are introduced in vector differentiation and in Green's theorem, Stoke's theorem and Gauss divergence theorem are introduced.	17.11.2020
BT 23	Incorporated the following additions in BT 23 regulations • Credit weightage is reduced from 4 to 3. • **Module – I:** Exact, Non-exact, Linear and Bernoulli's differential equations are introduced with applications orthogonal trajectories and Newton's law of cooling in First order first degree ODE • **Module – II:** Second and higher order ODE with constant coefficients with variation parameters method are introduced.	21.08.2023

BT25	Incorporated the following additions in BT 23 regulations • **Module – I:** **Module –III:** Laplace transforms: Laplace transform of standard functions, first shifting theorem, Laplace transforms of functions multiplied by 't' and divided by 't', Laplace transforms of derivatives and integrals of function, evaluation of integrals by Laplace transforms, Laplace transform of periodic functions. Inverse Laplace transform by different methods, Convolution theorem (without proof). Applications: solving initial value problems by Laplace transform method	

Course Outline Approvals	
Course Coordinator Name: Dr. P. Raja Kumari Signature: Date:	**Head of the Department** Name: Dr. P. Srilatha Signature: Date:
Course Outline Approvals: The course outline description approved by Outcome Based Teaching Learning (OBTL) committee on *date* in meetings *IARE - OBTL – COD /104/25*	
Dean of Outcome Based Teaching and Learning Name: Dr. Ch. Srinivasulu Signature: Date:	**Dean of Academics** Name: Dr. G. Chandrasekhar Signature: Date:

Check List		
Section	**Description**	**Please tick (✓)**
1	General Information about the Course	
2	Notional Study Time	
3	A. Course Outcomes	
	B. Cognitive Levels	
4	Content and Context of the Course	
5	Complex Engineering Problem Solving	
6	A. Assessment Methods – Direct	
	B. Assessment Methods – Indirect	
7	Content Delivery / Instructional Methodologies	
8	Engineering Competencies (ECs) Focused	
9	Employability Skills	
10	Relevance to Sustainability goals	
11	A. Mapping between COs and POs / PSOs	
	B. Indicators of Attainment with COs to POs and PSOs	
	C. Course Articulation Matrix of COs to POs	
	D. Level of Contribution of the COs to POs and PSOs	
12	Syllabus	
13	Tentative Schedule of Instructions	
14	Specific Goals for the Course	
15	History of Changes	