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	Aeronautical Engineering
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:

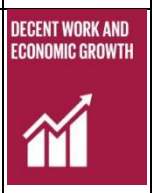
- Enhances analytical thinking for solving complex engineering and technical problems.
- Develops strong problem-solving skills applicable to real-world scenarios.
- Improves numerical computation abilities essential in data analysis and simulations.
- Builds skills in modelling complex systems for engineering 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 the prototype of UAVs and aero-foil models for testing by using low speed wind tunnel towards research in the area of experimental aerodynamics...	-	**-**
PSO 2	Focus on formulation and evaluation of aircraft elastic bodies for characterization of aero elastic phenomena..	-	**-**
PSO 3	Focus on formulation and evaluation of aircraft elastic bodies for characterization of aero elastic phenomena.	-	**-**

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	

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**Engineering Physics**
Course Code	AHSE02
Course Start	First Semester
Course Type	Core
Regulation	IARE - BT 25
Prerequisite Courses	Intermediate
Department	Aeronautical Engineering
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 basics of quantum computing 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. 2. Thomas G. Wong, Introduction to Classical and Quantum Computing, Rooted Grove. **Reference Books** 3. H.J Callister, "A Textbook of Materials Science and Engineering", Wiley Eastern Edition,8th Edition, 2013. 4. Halliday, Resnick and Walker, "Fundamentals of Physics", John Wiley Sons,11th Edition,2018. 5. Charles Kittel, "Introduction to Solid State Physics", Wiley Eastern, 2019. 6. S.L. Gupta and V. Kumar, "Elementary Solid State Physics", Pragathi Prakashan, 2019. 7. 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	Review the basic principle, types, entanglement and the logic gates of quantum computers.	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	**Review the basic principle, types, entanglement and the logic gates of quantum computers.**
	Teach the students with a comprehensive understanding of quantum computing by exploring their fundamental principles, qubits, quantum computers and wide-ranging applications. Students will grasp the fundamentals of quantum computing, starting with quantum bits or qubits. These are the centerpiece and most basic computational unit. Learners will get familiar with the basics of quantum computing, qubits, states, and their applications. They will grasp the fundamentals of quantum mechanics history, postulates, superposition, entanglement, and the EPR paradox. Students examine quantum gates, their transformations, controlled interactions, parametric flexibility, and circuit building. Grasp the fundamentals of simulating quantum computers, quantum states, gates, and operations. Learners will be able to solve complex problems currently intractable for classical computers, revolutionizing fields like drug discovery, materials science, and finance through methods like simulation and optimization. They also learn to apply principles of quantum mechanics, such as superposition and entanglement, to gain new computational capabilities and to develop advanced technologies like more efficient AI and machine learning models. Learners will use quantum phenomena like superposition (a qubit being in multiple states at once) and entanglement to perform computations in ways that are impossible for classical computers.

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	Assignments	Week – 9 / 12	05
AAT: 2 - 2	Concept Video	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	**QUANTUM COMPUTING**
	Introduction, linear algebra for quantum computation, Dirac's Bra and Ket notation and their properties, Hilbert space, Bloch's sphere, concept of quantum computer, classical bits, Qubits, multiple Qubit system, quantum computing system for information processing, evolution of quantum systems, quantum measurements, entanglement, quantum gates, challenges and advantages of quantum computing over classical computation,

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 12.2 Meissner effect 12.3 Effect of magnetic field	3
13	13.1 Type-I & type-II superconductors 13.2 BCS theory	3

	13.3 Applications of superconductors	
14	14.1 Introduction, linear algebra for quantum computation 14.2 Dirac's Bra and Ket notation and their properties 14.3 Hilbert space, Bloch's sphere	3
15	15.1 concept of quantum computer, classical bits 15.2 Qubits, multiple Qubit system 15.3 quantum computing system for information processing	3
16	16.1 evolution of quantum systems, quantum measurements, entanglement 16.2 quantum gates 16.3 challenges & advantages of quantum computing over classical computation	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. • Understand the quantum mechanical effects, such as superposition and quantum interference. • Apply the unique qualities of quantum mechanics to solve problems beyond the ability of even the most powerful classical computers.

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><td colspan="3">Branches: AE/ME/CE</td></tr>
<tr><td>JNTUH</td><td>R16</td><td>% of syllabus change</td></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><td colspan="3">Branches: ECE/EEE/CSE/IT</td></tr>
<tr><td>JNTUH</td><td>R16</td><td>% of syllabus change</td></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><td colspan="3">Branches: AE/ME/CE</td></tr>
<tr><td>R16</td><td>R18</td><td>% of syllabus change</td></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><td colspan="3">Branches: ECE/EEE</td></tr>
<tr><td>R16</td><td>R18</td><td>% of syllabus change</td></tr>
<tr><td>Engineering Physics</td><td>Waves and Optics</td><td>65% of syllabus changed
(Change of course name)</td></tr>
<tr><td colspan="3">Branches: CSE/IT</td></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><td colspan="3">Branches: AE/ME/CE/ECE/EEE</td></tr>
<tr><td>R18</td><td>UG20</td><td>% of syllabus change</td></tr>
<tr><td>Waves and Optics</td><td>Engineering Physics</td><td>10% of syllabus changed
(Change of course name)</td></tr>
<tr><td colspan="3">Branches: CSE/IT/CSE(AI&ML)/CSE(CS)/CSE(DS)/CSIT</td></tr>
<tr><td>R18</td><td>UG20</td><td>% of syllabus change</td></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><td colspan="3">Branches: AE/ME/CE/ECE/EEE/IT/CSE(AI&ML)</td></tr>
<tr><td>UG 20</td><td>BT 23</td><td>% of syllabus change</td></tr>
<tr><td>Engineering Physics</td><td>Applied Physics</td><td>70% of syllabus changed
(Change of course name)</td></tr>
<tr><td colspan="3">Branches: CSE/CSE(DS)</td></tr>
<tr><td>UG 20</td><td>BT 23</td><td>% of syllabus change</td></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	Aeronautical Engineering
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

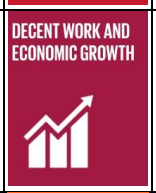
- **Benefit**: Communication skills enable students to build and maintain professional relationships.
- **Relevance to Industries**: Networking is critical for career growth, partnerships, and opportunities in any field.

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 the prototype of UAVs and aero-foil models for testing by using low speed wind tunnel towards research in the area of experimental aerodynamics.	AAT: 1 – 1 Tech-Talk	**2**
PSO 2	Focus on formulation and evaluation of aircraft elastic bodies for characterization of aero elastic phenomena.	AAT: 2 – 1 Complex Engineering Problem Solving	**3**
PSO 3	Make use of multi physics, computational fluid dynamics and flight simulation tools for building career paths towards innovative startups, employability and higher studies.	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	✓

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**ENGINEERING MECHANICS**
Course Code	AMEE01
Course Start	First Semester
Course Type	Foundation
Regulation	IARE - BT 25
Prerequisite Courses	Linear Algebra and Calculus
Department	Aeronautical Engineering
Number of Credits	3 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Theory
Course Administrator	**Dr. C Labesh Kumar** Assistant Professor of Mechanical Engineering IARE10100 **c.labeshkumar@iare.ac.in**
Course Coordinator	**Dr. D.Govardhan** Professor of Mechanical Engineering IARE10086 **d.govardhan@iare.ac.in**
Prior Learning Assessment and Recognition (PLAR)	No
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=33
Course Description	Engineering Mechanics is a branch of Physics that deals with the study of the system of forces acting on a particle which is at rest or in motion. The course emphasizes thorough understanding of theories and principles related to static and dynamic equilibrium of rigid bodies to acquire the analytical capability required for solving engineering problems and is one of the foundation courses that forms the basis of many of the traditional branches of engineering such as aerospace, civil and mechanical engineering.
Course Objectives	**The students will try to learn:** a. The application of mathematics and science principles to represent the free body diagrams in the area of rigid body mechanics b. The conditions of static and dynamic equilibrium of bodies subjected to a particular force system for solving the field problems. c. The effects of force and motion while carrying out the innovative design functions of engineering
Text and Reference Books	**Text Books** 1. Irving H. Shames (2006), —Engineering Mechanics‖, Prentice Hall, 4th Edition, 2013 2. S. Bhavikatti, —A Text Book of Engineering Mechanics‖, New Age International, 1st Edition, 2012

	3. R. C. Hibbler (2006), —Engineering Mechanics: Principles of Statics and Dynamics‖, Pearson Press, 5th Edition, 2021 **Reference Books** 1. F. P. Beer and E. R. Johnston (2011), —Vector Mechanics for Engineers‖, Vol I - Statics, Vol II, – Dynamics, Tata McGraw Hill , 9th Edition,2013 2. A.K. Tayal, —Engineering Mechanics‖, Uma Publications, 14th Edition, 2013 3. R. K. Bansal —Engineering Mechanics‖, Laxmi Publication, 8th Edition, 2013 4. Basudeb Bhattacharya, —Engineering Mechanics‖, Oxford University Press, 2nd Edition, 2014
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=PLzkMouYverAKB0aKoYKi6LZqdSKCV2KSB • https://www.youtube.com/playlist?list=PLzkMouYverAIS2u_lXRZex1L2m8EySjmQ
Supplemental Materials	**Readings, Videos, and Links** 1. https://ocw.mit.edu/courses/1-050-engineering-mechanics-i-fall-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.

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			
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			
TLA 10	Homework assignments / Programming assignments			10
TLA 11	Placement / work based learning or Specific practical training			

TLA 12	Presentation / Seminar Preparation			
TLA 13	Course Project / Preparation for Complex Problem Solving			15
TLA 14	Technical visit			
TLA 15	Field activities			
			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 unknown forces by free body diagrams to a given equilibrium force system through laws of mechanics.	Apply
CO2	**Calculate** the system of forces acting on wedge and screw jack by using the laws of static and dynamic frictions.	Apply
CO3	**Use** the concepts of centroid in stability problems for evaluation of area moment of inertia.	Apply
CO4	**Identify** the mass moment of inertia of symmetrical and non-symmetrical section by using the concepts of centre of gravity.	Understand
CO5	**Solve** the position, velocity, acceleration and the characteristics of a body in dynamic equilibrium for various types of motion using appropriate mathematical tools.	Apply
CO6	**Develop** governing equation from first principles by using work - energy and impulse - momentum in dynamic equilibrium condition.	Analyze

SECTION 3B: Cognitive Levels

Blooms Taxonomy Level	Cognitive Level in Percentage (%)
Remember	0
Understand	16
Apply	64
Analyse	16
Evaluate	0
Create	0

SECTION 4: Content and Context of Data Structures

CO1	**Deduce the unknown forces by free body diagrams to a given equilibrium force system through mechanics laws and derived laws.**
	The students will develop the ability to analyze and solve problems related to forces acting on objects or systems in equilibrium. By employing the principles of engineering mechanics, they will learn to deduce unknown forces using free body diagrams (FBDs). A free body diagram is a powerful tool that visually represents all external forces, moments, and reactions acting on a body, simplifying the analysis of complex systems. Students will apply fundamental mechanics laws, such as Newton's laws of motion, and derived principles, including equilibrium equations and the conditions for static and dynamic stability. Through systematic approaches, they will identify and isolate individual components or systems, represent the acting forces accurately, and solve for unknown quantities using mathematical techniques. This outcome emphasizes critical problem-solving skills, including decomposing forces into components, resolving concurrent and non-concurrent force systems, and applying the conditions of equilibrium to achieve practical solutions. Mastery of these skills will enable students to tackle real-

	world engineering problems, such as designing stable structures, ensuring the safety of mechanical systems, and analyzing force interactions in machinery. By the end of this course, students will be equipped to confidently deduce unknown forces and contribute to engineering design and analysis effectively.
CO2	**Interpret the static and dynamic friction laws for the equilibrium state of a wedge, ladder and screw jack.**
	Learner will focus on understanding and applying the principles of static and dynamic friction to analyze equilibrium state in various mechanical systems, including wedges, ladders, and screw jacks. Friction plays a critical role in maintaining equilibrium, and students will explore the laws governing frictional forces to interpret their effects on different systems. Students will first learn the foundational concepts of static and dynamic friction, such as the coefficient of friction, angle of repose, and limiting friction. They will then apply these concepts to real-world applications, examining how friction influences the stability and motion of engineering systems. For example, they will analyze the equilibrium of wedges used in lifting or splitting tasks, evaluate the safety and stability of ladders under various loading conditions, and determine the mechanical advantage and frictional losses in screw jacks. Through theoretical learning and practical problem-solving, students will gain insights into how friction can be harnessed or mitigated in engineering designs. By the end of this course, they will be able to interpret the frictional forces acting on different systems, calculate equilibrium conditions accurately, and propose solutions to optimize performance and safety in mechanical and structural applications.
CO3	**Identify the centroid and centre of gravity for the simple and composite plane sections from the first principles.**
	Students will develop a foundational understanding of centroids and centers of gravity for various plane sections, both simple and composite. These concepts are fundamental in engineering mechanics as they describe the geometric center of an area or the balance point of a body, which is essential in structural and mechanical designs. Students will begin by learning the first principles, including the definition and mathematical formulation of centroids and center of gravity. They will explore the methods for locating the centroid of simple shapes such as rectangles, triangles, and circles, and extend their knowledge to composite plane sections composed of multiple shapes. By applying the principle of moments and integrating over an area, students will deduce the exact location of the centroid. In addition, they will analyze the concept of the center of gravity, emphasizing its role in determining the stability and balance of objects under gravitational forces. Students will solve problems involving real-world scenarios, such as calculating centroids for structural beams and machine components or determining the center of gravity for irregular objects. By the end of this course, students will be proficient in identifying centroids and centers of gravity, equipping them with analytical skills essential for designing safe and efficient engineering systems.
CO4	**Calculate moment of inertia and mass moment of inertia of a circular plate, cylinder, cone and sphere from the first principles.**
	Students will be equipped with the ability to calculate the moment of inertia and mass moment of inertia of fundamental geometric shapes, such as circular plates, cylinders, cones, and spheres, using first principles. The moment of inertia is a critical property in mechanics, representing an object's resistance to angular motion about a specific axis, while the mass moment of inertia relates to its rotational dynamics. They will begin by understanding the fundamental definitions and mathematical formulations of moment of inertia and mass moment of inertia. They will apply integral calculus to derive expressions for these quantities, starting from basic principles. Through systematic problem-solving, they will calculate the moment of inertia of a circular plate and extend the analysis to three-dimensional objects like cylinders, cones, and spheres, considering uniform mass distributions. This emphasizes the practical application of the calculations in engineering scenarios, such as analyzing the rotational behavior of machine components, designing structural elements, and optimizing systems for stability and efficiency. By mastering these concepts, students will gain a deeper understanding of the physical significance of inertia and its role in dynamic and static systems. This knowledge forms the foundation for more advanced studies in mechanics, machine design, and

	structural analysis.
CO5	**Apply D'Alembert's principle to a dynamic equilibrium system by introducing the inertia force for knowing the acceleration and forces involved in the system.**
	Learner will focus on the application of D'Alembert's principle to analyze dynamic systems in equilibrium. D'Alembert's principle is a powerful tool in engineering mechanics that simplifies the study of dynamic systems by introducing an inertia force, allowing dynamic problems to be treated as equivalent static equilibrium problems. Students will begin by understanding the fundamentals of D'Alembert's principle, which states that the sum of all external forces and the inertia force acting on a body in motion is zero. By incorporating the inertia force, students will transform complex dynamic systems into simpler equilibrium systems, enabling easier analysis of accelerations and forces. Through practical examples, students will apply the principle to solve problems involving linear and angular motion, such as analyzing the dynamics of moving vehicles, rotating machinery, and oscillatory systems. They will calculate unknown forces and accelerations by systematically applying the equations of motion in conjunction with the inertia force. By mastering this concept, students will gain valuable skills in understanding and solving real-world engineering problems involving dynamic forces and accelerations. This knowledge is crucial for designing and analyzing systems like engines, mechanisms, and structures subjected to dynamic loading, ensuring optimal performance and safety.
CO6	**Determine the governing equation for momentum and vibrational phenomenon of mechanical system by using energy principles for obtaining co efficient and circular frequency.**
	Learner will emphasize the application of energy principles to derive governing equations for momentum and vibrational phenomena in mechanical systems. Understanding these principles is essential for analyzing and designing systems subjected to dynamic forces and oscillatory motions. They will explore the concepts of work, energy, and power, with a focus on their relationships in mechanical systems. They will learn to apply energy conservation and virtual work principles to formulate the governing equations for momentum and vibration. Through systematic derivations, students will calculate key parameters such as coefficients (e.g., damping or stiffness constants) and circular frequency, which describe the system's dynamic behavior. The course will involve analyzing practical systems, such as oscillating masses, springs, and dampers, to determine their vibrational characteristics. Students will gain insights into free and forced vibrations, resonance conditions, and energy dissipation in damping systems. Additionally, they will study the momentum principles to address impact forces and motion changes in dynamic systems. By mastering these concepts, students will acquire the analytical skills needed to solve complex problems in mechanical vibrations and dynamics. This knowledge is essential for the design, optimization, and performance analysis of engineering systems such as machinery, vehicles, and structures subjected to dynamic loading.

SECTION 5: Complex Engineering Problem Solving

Engineering Mechanics: Principles, Problem Solving, and Applications
There is one piece of assessed coursework, involving a mixture of theoretical analysis and applied problem-solving. Students are encouraged to apply fundamental principles across different engineering contexts—although they may focus on specific problem domains, depending on their level of understanding.
Problem-solving assignments are a mandatory part of the course. Homework problems will focus on applying key mechanics concepts and analytical techniques. Projects will involve large-scale problem-solving exercises, incorporating topics such as force equilibrium, kinematics and dynamics. Engineering projects will be worth significantly more points than homework problems. All work must be completed individually.
Examinations and in-class problem-solving sessions will also be conducted. Students are required to complete these tasks during the class period with no external assistance.

SECTION 6A: Assessment Methods – Direct

Item	Evaluation Components	Week in / out	Marks

AAT: 1 - 1	Tech-Talk	Week – 2 / 5	05
AAT: 1 - 2	Definition & Terminology	Week – 4 / 7	05
AAT: 2 - 1	Complex Engineering Problem Solving	Week – 9 / 12	05
AAT: 2 - 2	Definition & 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:

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

Employability Skills:

- Problem-solving skills for analyzing and designing mechanical systems.
- Logical and analytical thinking for evaluating forces, motion, and equilibrium.
- Proficiency in engineering tools and simulation software.
- Optimization skills for efficient structural and mechanical design.
- Knowledge of real-world applications in manufacturing, construction, and automation.
- Teamwork and collaboration in multidisciplinary engineering projects.
- Adaptability to learn and apply advanced engineering concepts.

Project Management:

- Planning and organizing project timelines and tasks.
- Allocating resources efficiently for engineering solutions.
- Collaborating and communicating with team members.
- Identifying and mitigating structural and mechanical failures.
- Testing and validating system performance through simulations and experiments.

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:** An Engineering Mechanics course provides students with a strong foundation in science, mathematics, and problem-solving skills, enhancing their overall educational experience and empowering them to address real-world challenges.
9		**Industry, Innovation, and Infrastructure:** Understanding Engineering Mechanics principles is crucial for developing and maintaining sustainable infrastructure and technological innovations. Students equipped with these skills can contribute to designing safer, more durable, and environmentally friendly infrastructure projects.
11		**Sustainable Cities and Communities:** Engineering Mechanics underpins the construction and maintenance of urban infrastructure. Students learn to design structures that can withstand environmental challenges and contribute to the safety and sustainability of urban spaces.

SECTION 10A: Mapping between COs and POs / PSOs

Course	Program Outcomes (POs)	Program Specific

Outcomes												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
CO2	PO 2	•	•	•	•	•	•		•			•	•	•																													10
CO3	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 4																													•	•	•		•	•								5
CO4	PO 1	•	•	•	•	•	•		•			•	•	•																													10
CO 5	PO 1	•	•	•	•	•	•		•			•	•	•																													10
CO 6	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 4																													•	•	•		•	•								5
	PSO 1	•	•	•			•		•			•	•	•																													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	67	63	-	-	-	-	-		-	-	-	-	-	-	-
CO2	-	63	-	-	-	-	-		-	-	-	-	-	-	-
CO3	-	63	-	71	-	-	-		-	-	-	-	-	-	-
CO4	67	-	-	-	-	-	-		-	-	-	-	-	-	-
CO5	67	-	-	-	-	-	-		-	-	-	-	-	-	-
CO6	-	63	-	71	-	-	-		-	-	-	-	100	-	-

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	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-

CO3	-	3	-	3	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO6	-	3	-	3	-	-	-	-	-	-	-	3	-	-
Total	**9**	**12**	**-**	**6**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**
Average	**3**	**3**	**-**	**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 Definition and Terminologies	**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**
PSO 1	Build the prototype of UAVs and aero-foil models for testing by using low speed wind tunnel towards research in the area of experimental aerodynamics.	CIE / SEE / AAT: 1 – 1 Definition and Terminologies	**3**

SECTION 11: Course Content	
MODULE - I	**INTRODUCTION TO ENGINEERING MECHANICS**
	2D Force Systems: Basic concepts, particle equilibrium; rigid body equilibrium; system of forces, coplanar concurrent forces, resultant, moment of forces and its application; couples and resultant of force system, equilibrium of system of forces, free body diagrams, equations of equilibrium of coplanar systems.
MODULE - II	**FRICTION, CENTROID AND CENTRE OF GRAVITY**
	Friction: Types of friction, limiting friction, laws of friction, static and dynamic friction; motion of bodies, wedge friction, screw jack. **Centroid and Centre of Gravity**: Centroid of lines, areas and volumes from first principle, centroid of composite sections; centre of gravity and its implications, theorems of Pappus–Guldinus.
MODULE - III	**AREA MOMENT OF INERTIA AND MASS MOMENT OF INERTIA**
	Area moment of inertia: Definition, moment of inertia of plane sections from first principles, theorems of moment of inertia, moment of inertia of standard sections and composite sections; product of inertia, parallel axis theorem, perpendicular axis theorem. **Mass Moment of Inertia:** Moment of inertia of masses, transfer formula for mass moment of inertia, mass moment of inertia of composite bodies.
MODULE - IV	**KINEMATICS OF RIGID BODIES AND IMPULSE – MOMENTUM METHOD**
	Review of particle dynamics, rectilinear motion; Plane curvilinear motion (rectangular path, and polar coordinates). Relative and constrained motion. Impulse-momentum (linear, angular); impact (Direct and oblique).

MODULE - V	KINETICS OF RIGID BODIES AND WORK – ENERGY PRINCIPLE
	Kinetics of rigid bodies, basic terms, D' Alembert's principle and its applications in plane motion and connected bodies; instantaneous centre of rotation in plane motion and simple problems; work-kinetic energy, power, potential energy. work energy principle and its application in plane motion of connected bodies.

SECTION 12: Tentative Schedule of Instructions		
Week Number	**Topics**	**Duration (Hours)**
1	1.1 Introduction to Engineering Mechanics, classification and laws of mechanics 1.2 Force and force characteristics, system of forces 1.3 Resultant, resultant of coplanar concurrent force system	3
2	2.1 Composition and resolution of forces, composition of concurrent forces by method of resolution 2.2 Free body diagram, supports and reactions 2.3 Equilibrium of bodies, equilibrant	3
3	3.1 Conditions of equilibrium 3.2 Moment, Varignon's theorem, couple 3.3 Resolution of force into force and a couple	3
4	4.1 Introduction to friction, laws of friction, important terms in friction, types of friction 4.2 Equilibrium of body due to friction on horizontal plane 4.3 Equilibrium of body due to friction on rough inclined plane	3
5	5.1 Effect of friction in connected bodies 5.2 Friction in wedge applications 5.3 Friction in screw applications	3
6	6.1 Screw jack, efficiency of a screw jack and condition for maximum efficiency 6.2 Over hauling and self-locking screws 6.3 Centre of gravity, centroid, difference between centre of gravity and centroid	3
7	7.1 Determination of centroid for simple sections 7.2 Determination of centroid for composite sections 7.3 Determination of centre of gravity of bodies, lines and arcs	3
8	8.1 Moment of inertia, radius of gyration, polar moment of inertia, theorems of moment of inertia 8.2 Moment of inertia from first principles 8.3 Moment of inertia of standard sections and composite sections	3
CONTINIUOUS INTERNAL EXAMINATION (CIE- I)		
9	9.1 Mass moment of inertia of composite bodies I section 9.2 Mass moment of inertia of composite bodies L section 9.3 Mass moment of inertia of composite bodies T section	3
10	10.1 Mass moment of inertia of composite bodies C section 10.2 Review of particle dynamics, rectilinear motion 10.3 Plane curvilinear motion (polar coordinates)	3
11	11.1 Curvilinear motion 11.2 Relative and constrained motion 11.3 Linear impulse and momentum	3
12	12.1 Conservation of momentum 12.2 Impact of elastic bodies 12.3 Impact and types of impact	3
13	13.1 Coefficient of restitution 13.2 Kinetics – introduction, important terms, Newtons laws of motion 13.3 Relation between force and mass	3
14	14.1 D'Alembert's principle 14.2 Application in plane motion 14.3 Motion of lift	3
15	15.1 Motion of body on inclined plane	3

	15.2 Inertia force and its application for connected bodies 15.3 Work, energy and power, units	
16	16.1 Work, energy equation for translation 16.2 Motion of body on inclined plane problem solving using work energy method 16.3 Work done by spring	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: • fundamental principles of force, equilibrium, and motion. • free-body diagrams and their application in problem-solving. • the concepts of statics and dynamics in mechanical systems. • the analysis of rigid body mechanics, including kinematics and kinetics. • the behavior of structures under different loading conditions. • the application of Newton's laws in engineering mechanics. • methods for solving static equilibrium problems in structures and machines. • the principles of work, energy, and power in mechanical systems. • the use of computational tools for solving engineering mechanics problems. • the importance of dimensional analysis and unit consistency in calculations.	**Learners can:** • analyze and solve problems involving forces, moments, and equilibrium. • construct and interpret free-body diagrams for mechanical systems. • apply Newton's laws to solve static and dynamic problems. • calculate reactions, internal forces, and moments in beams and trusses. • solve kinematics problems related to velocity, acceleration, and displacement. • solve kinetics problems involving work, energy, impulse, and momentum. • analyze motion using equations of motion for particles and rigid bodies. • determine center of mass and centroid for different structures. • apply principles of friction in engineering applications. • use vector analysis for solving force and motion problems. • solve problems involving rotational motion and angular momentum. • apply numerical and computational methods for engineering mechanics solutions. • select appropriate problem-solving methods based on complexity and constraints. • assess mechanical system stability and failure conditions.

Administrative Information

SECTION 15: History of changes		
Regulations	**Description of change**	**BOS Date**
R 16	From R15 JNTUH, Hyderabad to R16 IARE regulations **Module – I, II and III:** The syllabus for these modules are removed and replaced with the topics of dynamics. The course syllabus is prepared for only dynamics topics. **Module – I:** Kinematics of particles - rectilinear motion **Module – II:** Kinetics of particle **Module – III:** Impulse and momentum, virtual work	24.07.2016
R 18	Changes from R16 to R18 regulation • Syllabus topics for static mechanics is reintroduced. • **Module – II:** Truss elements analysis along with beams and its types	16.07.2018

	are introduced • **Module – III:** Virtual work and work energy method are introduced	
UG 20	Changes from R18 to UG 20 regulation • Credits has been reduced to 3 from 4 • **Module – I:** Spatial systems and 3D analysis were removed • **Module – II:** Truss elements analysis along with beams and its types were removed • **Module – IV:** Kinematics part was removed and work – energy method was included • **Module – V:** Impulse momentum method was added	17.11.2020
BT 23	Incorporated the following additions in BT 23 regulations • **Module – II:** Centroid and centre of gravity topics are added that are removed from Module - III • **Module – IV:** Kinematics part was included. Impulse momentum method was included from Module – V • **Module – V:** Kinetics and work – energy method part was included from Module – IV. Vibrations topic was removed	21.08.2023

Course Outline Approvals	
Course Coordinator Name: Signature: Date:	**Head of the Department** Name: 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	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	Aeronautical Engineering
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 the prototype of UAVs and aero-foil models for testing by using low speed wind tunnel towards research in the area of experimental aerodynamics.	AAT: 1 – 1 Tech-Talk	2
PSO 2	Focus on formulation and evaluation of aircraft elastic bodies for characterization of aero elastic phenomena.	AAT: 2 – 1 Complex Engineering Problem Solving	3

PSO 3	Make use of multi physics, computational fluid dynamics and flight simulation tools for building career paths towards innovative startups, employability and higher studies.	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
.

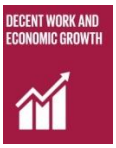
SECTION 6A: Assessment Methods – Direct			
Item	**Evaluation Components**	**Week in / out**	**Marks**
1	Day to day evaluation	Every week	20
2	Internal examination and Viva-voce	10 +10	20
3	Semester end examination (External)	Week – 17	60
		Total Marks	**100**
Department's Late Submission Policy: 1. 1 – 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	Aeronautical Engineering
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	uild the prototype of UAVs and aero-foil models for testing by using low speed wind tunnel towards research in the area of experimental aerodynamics.	Laboratory experiments, internal and external lab examinations	**3**
PSO 2	Focus on formulation and evaluation of aircraft elastic bodies for characterization of aero elastic phenomena.	Laboratory experiments, internal and external lab examinations	**2**
PSO 3	Make use of multi physics, computational fluid dynamics and flight simulation tools for building career paths towards innovative startups, employability and higher studies.	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	Aeronautical 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	Build the prototype of UAVs and aero-foil models for testing by using low speed wind tunnel towards research in the area of experimental aerodynamics.	-	**-**
PSO 2	Focus on formulation and evaluation of aircraft elastic bodies for characterization of aero elastic phenomena.	-	**-**
PSO 3	Make use of multi physics, computational fluid dynamics and flight simulation tools for building career paths towards innovative startups, employability and higher studies.	-	**-**

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 method	2

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**	16.07.2018

	Module – IV: compressors cascade testing is introduced	
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	Aeronautical Engineering
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

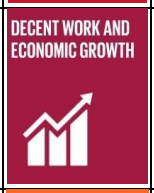
- Prepare clear and detailed technical reports documenting workshop experiments, material selection, and fabrication processes.
- Create assembly sketches, diagrams, and annotated drawings to convey design ideas effectively.
- Present project outcomes and practical demonstrations to peers and instructors, 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 the prototype of UAVs and aero-foil models for testing by using low speed wind tunnel towards research in the area of experimental aerodynamics.	AAT: 1 – 1 Tech-Talk	2
PSO 2	Focus on formulation and evaluation of aircraft elastic bodies for characterization of aero elastic phenomena..	AAT: 2 – 1 Complex Engineering Problem Solving	3
PSO 3	Make use of multi physics, computational fluid dynamics and flight simulation tools for building career paths towards innovative startups, employability and higher studies.	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	

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	Aeronautical Engineering
Number of Credits	3 Credits
Academic Year	2025-2026
Method(s) of Instruction	Theory
Course Administrator	**Dr. VNSR Venkateswararao,** AssociateProfessor Department of Chemistry IARE10682 vnsr.venkateswararao@iare.ac.in
Course Coordinator's Name	**Dr. S Anusha Kathyayani,** AssistantProfessor Department of Chemistry IARE11136 s.kathyayani@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.
CourseObjectives	**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. Thefundamental 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, 17thEdition, 2022. **Reference Books** 1. Shashi chawla& Engineering Chemistry", 1th Edition, 2017. 2. jayasree Reddy, "Engineering Chemistry", wiley Publications, 2023. 3. S.S Dara "Engineering Chemistrys. chand" 12th Edition, 2018. 4. Nitin K Puri "Nanomaterials Synthesis Properties And Applications", I K internationalpublishing 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 problemsolving hours: 15)

TLA Code	Teaching and Learning Activities	Number	Duration (Hours)	Total Workload
TLA1	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 characteristicsfor its usage in domestic and industrial purposes.	Understand
CO2	**Identify**complexometry for calculation of hardness of waterto 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 technologicalimprovements in various sectors.	Apply

SECTION 3B: Cognitive Levels

BloomsTaxonomyLevel	CognitiveLevel 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	**Identifycomplexometry 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 providesAccurate 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 technologicalimprovements 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

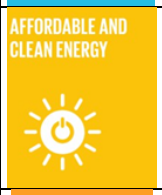
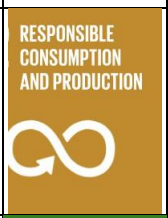
EC Number	Attributes	Profiles	(✓)
EC1	Depth of knowledge required (CP)	Ensures that all aspects of an engineering activity are soundly based on fundamental principles - by diagnosing, and taking appropriate action with data, calculations, results, proposals, processes, practices, and documented information 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 correlationwith 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 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**	
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 the prototype of UAVs and aero-foil models for testing by using low speed wind tunnel towards research in the area of experimental aerodynamics.	-	-
PSO 2	Focus on formulation and evaluation of aircraft elastic bodies for characterization of aero elastic phenomena.	-	-
PSO 3	Make use of multi physics, computational fluid dynamics and flight simulation tools for building career paths towards innovative startups, employability and higher studies.	-	-

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. 2.2Potable 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 onNernst 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. 5.3Definition, 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, polylactic 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. 14.2Applications of nanomaterials. 14.3Biosensors: Definition, Amperometric glucose monitor sensor.	3
15	15.1IR spectroscopy in night vision-security, Pollution Under Control, 15.2CO sensor, Passive Infrared detection. 15.3 Raman spectroscopy application, Tumour detection in medical applications.	3
16	16.1Lubricants, 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. S Anusha Kathyayani 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	Aeronautical Engineering
Number of Credits	3 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Theory
Course Administrator	**Dr. Madhusudan Dolai** Assistant Professor of Mathematics IARE11180 madhusudandolai@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=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/resources/#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	
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.

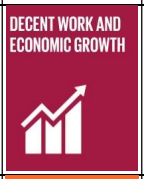
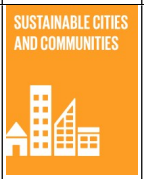
Employability Skills:

- 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																																							
	PSO3																																							

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	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	-	-	-	-	-	-	-	-	-	-	-	-
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 the prototype of UAVs and aero-foil models for testing by using low speed wind tunnel towards research in the area of experimental aerodynamics.	AAT: 1 – 1 Tech-Talk	
PSO 2	Focus on formulation and evaluation of aircraft elastic bodies for characterization of aero elastic phenomena.	AAT: 2 – 1 Complex Engineering Problem Solving	
PSO 3	Make use of multi physics, computational fluid dynamics and flight simulation tools for building career paths towards innovative startups, employability and higher studies.	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^n 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 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:** Law of natural growth and decay	02.09.2025

	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. 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. 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	✓

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**Thermodynamics**
Course Code	AMEE04
Course Start	Second Semester
Course Type	Core
Regulation	IARE - BT 25
Prerequisite Courses	Basic Physics, Engineering Mathematics
Department	Aeronautical Engineering
Number of Credits	3 Credit hours
Academic Year	2025 - 26
Method(s) of Instruction	Theory
Course Administrator	**Mr. V Phaninder Reddy** Assistant Professor of Aeronautical Engineering IARE10741 vphaninder@iare.ac.in
Course Coordinator's Name	**Dr. G Hima Bindu,** Assistant Professor of Mechanical Engineering IARE11099 **gade.himabindu@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=1324
Course Description	Fundamentals of classical thermodynamics: properties of pure substances, work and heat interactions, first and second laws of thermodynamics, entropy, power cycles, refrigeration cycles, and introduction to thermodynamic relations and property tables. Applications to engineering systems and problem solving.
Course Objectives	**The students will try to learn:** a. The fundamental knowledge on concepts of physics and chemistry for obtaining the axiomatic principles using thermodynamic co-ordinates. b. The thermodynamic disorder Ness in the real time physical systems like external/internal heat engines, heat pumps to get the measure of performance characteristics c. The performance characteristics of open and closed systems of thermodynamic cycles for effective delineation of real time applications. d. The thermodynamic cycles such as power and refrigerant cycles yields to alternative solutions to conserve the environment
Text and Reference Books	**Text Books** 1. P. K. Nag, "Engineering Thermodynamics", Tata McGraw Hill, 6 th edition, 2017. 2. Yunus Cengel, Michael A. Boles, "Thermodynamics-An Engineering Approach", Tata McGraw Hill, 8 th edition,2017. 3. D.S. Kumar., "Engineering Thermodynamics", S.K. Kataria and Sons, 2014.

	Reference Books 4.R.K. Rajput., "Engineering Thermodynamics", 4th edition, Laxmi Publications, 2016. 5.Mahesh M Rathore., "Thermal Engineering", Tata McGraw Hill Publishers, 2013. 6.Y. V. C. Rao, "An Introduction to Thermodynamics", Universities Press, 3 rd edition, 2013. 7. K. Ramakrishna, "Engineering Thermodynamics", Anuradha Publishers, 2 nd edition, 2011
Learning Resources	**Engineering Thermodynamics**
Supplemental Materials	**Readings, Videos, and Links** 1. https://archive.nptel.ac.in/courses/112/108/112108149/ 2. https://archive.nptel.ac.in/courses/112/105/112105271/ 3. https://link.springer.com/book/10.1007/978-981-15-3988-6 4. https://books.google.com.bz/books?id=-VgAZm6KWrwC&printsec=frontcover#v=onepage&q&f=false 5. https://books.google.co.in/books?id=bXHmDwAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#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	80	01	80
TLA 2	Tutorials	02	01	02
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			
TLA 8	Independent private study			
TLA 9	Laboratory Exercises			
TLA 10	Homework assignments / Programming assignments	02	01	02
TLA 11	Placement / work based learning or Specific practical training			
TLA 12	Presentation / Seminar Preparation			
TLA 13	Course Project / Preparation for Complex Problem Solving	04	01	04
TLA 14	Technical visit			
TLA 15	Field activities			
			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	**Recall** the basic concepts of thermodynamic properties and working principles of energy conversions in physical systems by laws of thermodynamics	Remember
CO2	**Summarize** the equivalence of two statements of second law of thermodynamics and the entropy concepts for typical engineering problems.	Understand
CO3	**Explain** the properties of pure substances and steam to emit relevant inlet and exit conditions of thermodynamic work bearing systems	Understand
CO4	**Apply** the significance of partial pressure and temperature to table the performance parameters of ideal gas mixtures	Apply
CO5	**Identify** the properties of air conditioning systems by practicing psychrometry chart and property tables	Apply
CO6	**Illustrate** the working of various air standard cycles and work out to get the performance characteristics.	Understand

SECTION 3B: Cognitive Levels	
Blooms Taxonomy Level	**Cognitive Level in Percentage (%)**
Remember	10
Understand	60
Apply	30
Analyse	0
Evaluate	0
Create	0

SECTION 4: Content and Context of Thermodynamics	
CO1	**Recall the basic concepts of thermodynamic properties and working principles of energy conversions in physical systems by laws of thermodynamics**
	1. Definitions: system, control volume, state, process, cycle, equilibrium. A system is a defined quantity of matter or space under study, while a control volume is a region where mass and energy can cross boundaries. The state defines the condition of a system by its properties; a process is a change of state; a cycle is a series of processes returning to the initial state; equilibrium implies no unbalanced driving forces within the system. **2. Pure substance: phase, critical point, triple point. Use of steam tables and property charts (P–v, T–s, h–s).** A pure substance has uniform chemical composition throughout. It may exist in one or more phases (solid, liquid, vapor). The critical point marks the end of distinct liquid–vapor phases, and the triple point is where all three phases coexist in equilibrium. Steam tables and property charts (P–v, T–s, h–s) are used to determine thermodynamic properties. **3. Ideal gas behavior and real gas corrections.** An ideal gas obeys the equation $PV = nRT$, assuming negligible molecular volume and no intermolecular forces. Real gases deviate from this behaviour at high pressures or low temperatures, requiring correction factors such as compressibility factor (Z) or use of van der Waals and other real gas equations.
CO2	**Summarize the equivalence of two statements of second law of thermodynamics and the entropy concepts for typical engineering problems**
	1. Energy forms, internal energy, enthalpy. Energy exists in various forms such as potential, kinetic, heat, and work. Internal energy (U) represents the microscopic energy stored within a system due to molecular motion and interactions. Enthalpy (H = U + PV) is a property useful for analyzing flow processes involving heat transfer and work at constant pressure. First law for closed systems (processes: isochoric, isobaric, isothermal, adiabatic).

	2. First law for control volumes — steady flow devices (nozzles, turbines, compressors, heat exchangers). The First Law of Thermodynamics states that energy can neither be created nor destroyed—only transformed. For a closed system undergoing a process, the heat added equals the change in internal energy plus the work done: $Q = \Delta U + W$. Common processes include isochoric (constant volume), isobaric (constant pressure), isothermal (constant temperature), and adiabatic (no heat exchange). **3. Conservation of mass.** For open systems or *control volumes* where mass crosses the boundary, the steady flow energy equation applies. This is used for analyzing *nozzles, turbines, compressors, pumps,* and *heat exchangers*, where energy exchange occurs continuously. **4. Conservation of Mass:** The law of conservation of mass states that mass can neither be created nor destroyed in any process. For steady-flow systems, the mass entering equals the mass leaving: $\dot{m}_{in} = \dot{m}_{out}$ ensuring continuity in all engineering flow systems.
CO3	**Explain the properties of pure substances and steam to emit relevant inlet and exit conditions of thermodynamic work bearing systems**
	1. Kelvin–Planck and Clausius Statements, Reversible and Irreversible Processes: The Kelvin–Planck statement says no engine can convert all heat from a single reservoir into work — some heat must be rejected. The Clausius statement says heat cannot flow spontaneously from a colder to a hotter body without external work. A reversible process can be reversed without leaving any change in the system or surroundings, while an irreversible process involves losses like friction, unrestrained expansion, or heat transfer through a finite temperature difference**.** **2. Carnot Cycle and Carnot Efficiency:** The Carnot cycle is an ideal reversible cycle consisting of two isothermal and two adiabatic processes, serving as a standard of comparison for all heat engines. Its efficiency depends only on the reservoir temperatures **3. Entropy Definition and Change:** Entropy (S) is a measure of energy dispersal or randomness in a system, defined as . For ideal gases, and for pure substances, it is found using property tables for different states and processes. **4. T–s Diagrams and Irreversibility:** The Temperature–Entropy (T–s) diagram graphically represents thermodynamic processes, showing heat transfer as the area under the curve. Reversible processes appear as smooth, well-defined paths, whereas irreversibility causes entropy generation, shifting the process path and reducing available work output.
CO4	**Apply the significance of partial pressure and temperature to table the performance parameters of ideal gas mixtures**
	1. Partial pressure p_i(Dalton's law: $p_i = y_i P$) is the driving variable for each component's contribution — it controls each species' density and entropy term $-R_i \ln p_i$. 2. **Temperature Tsets the thermal energy scale:** species internal energy and enthalpy scale with T(via c_v, c_p); it also appears in all ideal-gas state relations $pV = mR_iT$. Together they let you convert mole fractions $y_i$into mass-based properties and mixture thermodynamic performance numbers.
CO5	**Identify the properties of air conditioning systems by practicing psychrometry chart and property tables**
	Psychrometry is the study of moist air — a mixture of dry air and water vapor — and the changes in its properties during heating, cooling, humidification, or dehumidification processes. Understanding these properties is essential in **air-conditioning system design** to ensure comfort and energy efficiency. **In Practice** Use **psychrometric chart** to **visualize** processes and read properties directly. Use **property tables or software** for **accurate numerical calculations**. Record parameters like DBT, WBT, and RH at each stage of an HVAC cycle to evaluate performance.
CO6	**Illustrate the working of various air standard cycles and work out to get the performance characteristics**.
	Each air-standard cycle works, show the **PV / TS process steps**, give the **key formulae** for work and thermal efficiency, and list practical performance parameters you can compute (mean effective pressure, specific work, back-work ratio, etc.). I'll cover **Otto, Diesel, Dual (Otto-Diesel), Brayton (gas-turbine)** and briefly mention **Atkinson**. Assumptions (common to all air-standard cycles): working fluid = ideal gas, processes inside the cycle are internally reversible (idealized), heat addition

	happens from an external source (combustion modelled as heat addition), and exhaust/emission details are ignored.

SECTION 5: Complex Engineering Problem Solving

Projects, Problem Solving, and Practical Assignments

The behavior of thermodynamic systems is governed by the fundamental laws of energy and mass conservation, expressed through the First and Second Laws of Thermodynamics. These laws form mathematical models that relate heat transfer, work interaction, and changes in internal energy and entropy for various engineering processes. In practical applications, thermodynamic problems often involve analyzing power cycles, refrigeration systems, combustion processes, and gas mixtures under different operating conditions.

To solve such complex problems, systems are modeled using energy and entropy balance equations, and property data are obtained from steam tables, refrigerant charts, or real-gas correlations. Numerical methods and computational tools such as MATLAB, EES (Engineering Equation Solver), ANSYS Fluent, and COMSOL Multiphysics are employed to simulate these processes and evaluate key performance characteristics like efficiency, work output, heat rate, and coefficient of performance (COP).

Programming projects in thermodynamics typically focus on developing algorithms for cycle analysis (Otto, Diesel, Rankine, and Brayton), property estimation, and energy optimization. Such computational approaches enable accurate and efficient evaluation of real-world thermal systems, supporting design improvement and performance prediction under variable operating and boundary conditions.

SECTION 6A: Assessment Methods – Direct

Item	Evaluation Components	Week in / out	Marks
AAT: 1 - 1	Tech-Talk	Week – 2 / 5	05
AAT: 1 - 2	Assignmenta	Week – 4 / 7	05
AAT: 2 - 1	Complex Engineering Problem Solving	Week – 9 / 12	05
AAT: 2 - 2	Definitions and 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:

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	Support sustainable development solutions by ensuring functional	✓

	development of solutions (CA)	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

The course equips learners with strong analytical and problem-solving skills essential for understanding, modeling, and analyzing thermodynamic systems and energy conversion processes. Through exposure to real-world engineering problems, students gain practical experience in applying the laws of thermodynamics, interpreting property data, and evaluating the performance of power and refrigeration cycles. The course also nurtures teamwork, computational thinking, and project management abilities that prepare learners for careers in energy systems, design, and sustainable engineering applications.

Employability Skills:

- Problem-solving skills for formulating and analyzing engineering problems involving energy, heat, and work interactions in thermodynamic systems.
- Analytical reasoning to apply the First and Second Laws of Thermodynamics for open and closed systems and interpret cycle performance.
- Numerical and computational abilities to evaluate thermodynamic properties using MATLAB, EES, or Python-based tools and perform cycle simulations.
- Experimental and data interpretation skills for analyzing laboratory results related to engines, compressors, and refrigeration units.
- Optimization and critical thinking for improving energy efficiency and reducing losses in thermal systems.

Project Management:

- Planning and organizing thermodynamic analyses including problem definition, data collection, and result validation.
- Managing computational projects such as power plant performance analysis, refrigeration cycle

optimization, and gas turbine simulations.

- Efficient resource utilization by selecting appropriate analytical and numerical methods for solving energy balance problems.
- Collaborating and communicating effectively with team members and stakeholders in energy system design projects.
- Identifying and minimizing sources of error in measurement, modeling, and simulation of thermodynamic processes.

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		**Affordable and Clean Energy:** 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		**Climate Action:** Enables the creation of smart city technologies (e.g., optimized traffic systems, resource management) using graph and tree structures.

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
CO2	PO 1	•	•	•	•	•	•		•			•	•	•																													10

	PO 2	•	•	•	•	•	•		•			•	•	•																								10
CO3	PO 2	•	•	•	•	•	•		•			•	•	•																								10
	PO 3																•	•	•		•																	4
	PSO 2		•	•			•		•			•	•	•								•	•	•														10
CO4	PO 1	•	•	•	•	•	•		•			•	•	•																								10
	PO 3																•	•	•		•																	4
	PO 6	•															•	•	•		•																	5
CO 5	PO 1	•	•	•	•	•	•		•			•	•	•																								10
	PO 3																•	•	•		•																	4
	PSO 2		•	•			•		•			•	•	•								•	•	•														10
CO 6	PO 2	•	•	•	•	•	•		•			•	•	•																								10
	PO 4																									•	•	•			•	•							5
	PO 6	•															•	•	•		•																	5
	PSO 2		•	•			•		•			•	•	•								•	•	•														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	-	-	63	-	40	-	-	-	-	-	-	100	-
CO2	100	60	-	-	-	-	-	-	-	-	-	-	100	-
CO3	100	-	40	-	-	-	-	-	-	-	-	-	100	-
CO4	100	40	40	-	-	-	-	-	-	-	-	-	-	-
CO5	100	-	40	-	-	-	-	-	-	-	-	-	50	-
CO6	100	60	-	63	-	-	-	-	-	-	-	-	100	-

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	-	-	7	-	2	-	-	-	-	-	-	2	-
CO2	3	6	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	-	4	-	-	-	-	-	-	-	-	-	2	-
CO4	3	4	4	-	-	-	-	-	-	-	-	-	-	-
CO5	3	-	4	-	-	-	-	-	-	-	-	-	1	-
CO6	3	6	-	7	-	-	-	-	-	-	-	-	6	-
Total	18	16	12	14	-	2	-	-	-	-	-	-	13	-
Average	**3**	**3**	**2**	**2**	**-**	**0.3**	**-**	**-**	**-**	**-**	**-**	**-**	**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	CIE / SEE / AAT:1 – 2 Assignments / Open-ended problems	3

	complex engineering problems.		
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 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 2	Focus on improving software reliability, network security or information retrieval systems.	AAT: 2 – 1 Complex Engineering Problem Solving	**3**

SECTION 11: Course Content	
MODULE - I	**BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS**
	System, control volume, surrounding, boundaries, universe, types of systems, macroscopic and microscopic viewpoints, concept of continuum, thermodynamic equilibrium, state, property, process, cycle, reversibility, quasi static process, irreversible process, causes of irreversibility, various flow and non-flow processes ,energy in state and in transition, types-work and heat, point and path function, Zeroth law of thermodynamics, concept of quality of temperature, Principles of thermometry, reference points, constant volume gas thermometer, ideal gas scale, Joule's experiment, first law of thermodynamics, PMM1, corollaries first law applied to a process, applied to a flow system, steady flow energy equation.
MODULE - II	**SECOND LAW OF THERMODYNAMICS**
	Thermal reservoir, heat engine, heat pump, parameters of performance, second Law of thermodynamics, Kelvin Planck and Clausius statements and their equivalence, Corollaries, PMM of second kind, Carnot's principle, Carnot cycle and its specialties, thermodynamic scale of temperature, Clausius inequality, Entropy, principle of Entropy increase, availability and irreversibility, thermodynamic potentials, Gibbs and Helmholtz functions, Maxwell relations, Clapeyron equation, elementary treatment of the Third Law of thermodynamics.
MODULE - III	**PURE SUBSTANCES &GAS LAWS**
	Phase transformations, T-S and H-S diagrams, P-V-T surfaces, triple point at critical state properties during change of phase, dryness fraction, Mollier charts, various thermodynamic processes and energy transfer, steam calorimeter. Gas Laws: Equation of state, specific and universal gas constants, throttling and free expansion processes, Vander Waals equation.
MODULE - IV	**MIXTURES OF PERFECT GASES**

	Mole fraction, mass friction, gravimetric and volumetric analysis, volume fraction, Dalton's law of partial pressure, Avogadro's laws of additive volumes, and partial pressure, equivalent gas constant, internal energy, enthalpy, specificheats and entropy of mixture of perfect gases; psychometric properties, dry bulb temperature, wet bulb temperature, dew point temperature, thermodynamic wet bulb temperature, specific humidity, relative humidity, saturated air, vapour pressure, degree of saturation, adiabatic saturation, Carrier's equation, Psychometric chart.
MODULE - V	**POWER CYCLES**
	Otto, Diesel, Dual combustion cycles, description and representation on P-V and T-S diagram, thermal efficiency, mean effective pressures on air standard basis, comparison of cycles.

SECTION 12: Tentative Schedule of Instructions		
Week Number	**Topics**	**Duration (Hours)**
1	1.1 System, control volume, surrounding, boundaries, universe, types of systems. 1.2 Macroscopic and microscopic viewpoints, concept of continuum 1.3 Thermodynamic equilibrium, state, property, process, cycle, reversibility 1.4 Quasi static process, irreversible process, causes of irreversibility. 1.5 Various flow and non-flow processes , energy in state and in transition, types-work	5
2	2.1 Concept of quality of temperature, Principles of thermometry, reference points. 2.2 Heat, point and path function, Zeroth law of thermodynamics 2.3 First law of thermodynamics, corollaries first law applied to a process 2.4 Applied to a flow system, steady flow energy equation. 2.5 Thermal reservoir ,heat engine ,heat pump	5
3	3.1 Parametersofperformance,secondLawof thermodynamics 3.2 Kelvin Planck,Claussius statements and their equivalence 3.3 Corollaries,PMM of second kind, Carnot 's principle 3.4 Problems 3.5 Problems	5
4	4.1 Carnot cycle and its specialties 4.2 Thermodynamic scale of temperature, Claussius inequality	5
5	5.1 Entropy ,principle of Entropy increase, availability and irreversibility 5.2 Thermodynamic potentials	5
6	6.1 Problems 6.2 Problems	5
7	7.1 Gibbs and Helmholtz functions, Max well relations 7.2 Problems	5
8	8.1 Elementary treatment of the Third Law of thermodynamics 8.2 Phase transformations-S and H-S diagrams, P-V-T surfaces 8.3 Problems	5
CONTINIUOUS INTERNAL EXAMINATION (CIE- I)		
9	9.1 Triple point at critical state properties during change of Phase 9.2 Dry ness fraction, Mollier charts, various thermodynamic processes 9.3 Energy transfer ,steam calorimeter	5
10	10.1 Equation of state, specific and universal gas constants. 10.2 Throttling and free expansion processes 10.3 Deviations from perfect gas model , Vander Waals equation of state. 10.4 Mole fraction, mass friction, gravimetric and volumetric analysis, volume fraction	5
11	11.1 Dalton's law of partial pressure, Avogadro's laws of additive volumes, and partial pressure 11.2 Equivalent gas constant, internal energy, enthalpy, specific heats	5

	11.3 Entropy of mixture of perfect gases; psychometric properties	
12	12.1 Dry bulb temperature, wet bulb temperature, dew point temperature 12.2 Thermodynamic wet bulb temperature, specific humidity, relative humidity, saturated air. 12.3 Vapor pressure, degree of saturation, adiabatic saturation, Carrier‘s equation, Psychometric chart	5
13	13.1 Otto,Diesel,Dual combustion cycles, Problems on cycles 13.2 Description and representation on P-V and T-S diagram 13.3 Thermal efficiency, mean effective pressure	5
14	14.1 Energy transfer,steam calorimeter 14.2 Equation of state, specific and universal gas constants.	5
15	15.1 Throttling and free expansion processes 15.2 Deviations from perfect gas model, VanderWaals equation of state.	5
16	16.1 Problems 16.2 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: Basic concepts of thermodynamics: system, surroundings, properties, process, and cycles • Zeroth, First, Second, and Third Laws of Thermodynamics • Energy forms: internal energy, enthalpy, heat, and work • Thermodynamic equilibrium and state functions • Pure substances, phase change processes, and property diagrams (P–v, T–s, h–s) • Use of thermodynamic property tables and charts • Concept of entropy and irreversibility • Closed and open system energy analysis (control mass and control volume) • Steady flow energy equation and its applications • Air-standard cycles: Otto, Diesel, Dual, and Brayton cycles • Vapour power cycles (Rankine cycle) and refrigeration cycles • Psychrometrics and air-conditioning processes • Boilers, compressors, turbines, nozzles, and heat exchangers • Availability, exergy, and energy efficiency • Recent advances in energy systems and waste-heat recovery	**Learners can:** Identify thermodynamic systems and perform energy balance calculations • Apply the First Law of Thermodynamics to steady and unsteady flow systems • Analyze gas and vapour power cycles for thermal efficiency and work output • Interpret thermodynamic property data from tables, charts, and software (REFPROP, CoolProp) • Calculate entropy changes and determine system reversibility • Evaluate performance of boilers, turbines, compressors, and heat exchangers • Perform psychrometric calculations for HVAC design and comfort analysis • Develop MATLAB/Python programs for cycle analysis and efficiency computation • Simulate thermodynamic cycles using EES or MATLAB • Conduct experiments to determine calorific value, heat transfer rate, and efficiency • Apply exergy analysis for energy optimization and waste minimization • Analyze combustion processes and emission characteristics • Design and select components for thermodynamic systems based on load and efficiency • Prepare technical reports on performance evaluation of thermal systems • Integrate renewable energy systems (solar thermal, biomass, waste-to-energy) into thermodynamic analysis

Administrative Information

SECTION 14: History of changes		
Regulations	**Description of change**	**BOS Date**
R 16	From R15 JNTUH, Hyderabad to R16 IARE regulations with no change	24.07.2016
R 18	Continued from R16 to R18 regulation with no changes	16.07.2018
UG 20	Continued from R18 to UG20 regulation with no changes	17.11.2020
BT 23	From UG 20 to BT 23 regulation with no changes	21.08.2023
BT25		

Course Outline Approvals	
Course Coordinator Name: Mr. Phaninder Reddy Signature: Date:05.01.2026	**Head of the Department** Name: Dr. S Devaraj Signature: Date: 12.3.2025
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:	**Dean of Academics** Name: Dr.GVR Seshagiri 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	**Data Structures**
Course Code	ACSE05
Course Start	Second Semester
Course Type	Core
Regulation	IARE - BT 25
Prerequisite Courses	Object-Oriented Programming (ACSE01)
Department	Aeronautical Engineering
Number of Credits	3 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Theory and laboratory
Course Administrator	**Dr. Venu M**, Professor of Civil Engineering IARE10607 venu@iare.ac.in
Course Coordinator's Name	**Dr. Venu M**, Professor of Civil Engineering IARE10607 venu@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	**Compare** common algorithms for sorting and searching data.	Analyse
CO5	**Apply** collision resolution techniques to resolve collisions within the hash table.	Apply
CO6	**Choose** the appropriate data structure to solve real-world problems and to defend the selection.	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 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.
	• **Array:**
	  o A collection of elements identified by index or key.
	  o Fixed size, fast access time (O(1) for accessing elements).
	  o Examples: Lists in Python / Arrays in C / C++ / Java.
	  o **Use cases:** Storing data in contiguous memory for quick access, such as in numerical computations.
	• **Linked List:**
	  o A linear collection of elements where each element (node) points to the next one.
	  o Dynamic size, slower access (O(n) to find an element), but efficient for insertions and deletions (O(1)).
	  o **Types:**
	  ▪ **Singly Linked List:** Each node points to the next.
	  ▪ **Doubly Linked List:** Each node points to both the next and previous node.
	  o **Use cases:** Efficient insertion/deletion in dynamic scenarios (e.g., implementing stacks and queues).
	• **Stack:**
	  o Follows **Last In, First Out (LIFO)** principle.
	  o Operations: **push** (add), **pop** (remove), **peek** (view top element).
	  o **Use cases:** Undo functionality, depth-first search (DFS).
	• **Queue:**
	  o Follows **First In, First Out (FIFO)** principle.
	  o Operations: **enqueue** (add), **dequeue** (remove), **front** (view front element).
	  o **Use cases:** Task scheduling, breadth-first search (BFS), buffering.
	• **Tree:**
	  o A hierarchical structure with a root node and child nodes.
	  o **Binary Tree:** Each node has at most two children.
	  o **Binary Search Tree (BST):** Left child is less, right child is greater than the parent.
	  o **Use cases:** Efficient searching, sorting, hierarchy representation.
	• **Hash Table:**
	  o A collection of key-value pairs, optimized for fast lookups, insertions, and deletions.
	  o Operations: **insert**, **delete**, **search** with O(1) average time complexity.
	  o **Use cases:** Database indexing, caching, implementing associative arrays.
	• **Graph:**
	  o A collection of nodes (vertices) and edges (connections between nodes).
	  o **Types:**
	  ▪ **Directed:** Edges have direction.
	  ▪ **Undirected:** Edges have no direction.
	  ▪ **Weighted:** Edges have weights (values).
	  o **Use cases:** Representing networks, social media connections, dependency structures.

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. You should teach learners, **when is it not advisable to use Hashing / Hash Tables?** • In general, hashing provides great time complexity for operations like as Insert, Search, and Delete. • Because hash tables take up more memory, it's better to use arrays for smaller applications. • Some operations, such as iterating through entries when the keys are inside a defined range, identifying the entry with the largest/smallest key, and so on, are not supported by hash tables. Arrays are preferable in certain situations.
CO6	**Choose the appropriate data structure to solve real-world problems and to defend the selection.**
	You should make the learners to choosing the right data structure and algorithm • When designing an application, the choice of data structures and algorithms directly impacts performance. • For example, a **hash table** is ideal when fast lookups are needed, but a **binary search tree** might be better if the dataset needs to be kept ordered. • Similarly, an algorithm like **quick sort** is fast for general use cases, but in some scenarios, **merge sort** might be preferred due to its stability and predictable performance. • Usage of **hash tables design and implement** two different versions of the hash table interface: Open addressing (Linear probing, Quadratic probing, Double hashing, Rehashing) and chaining. • Analyze and assess the **running-time complexity** of basic hash table operations (insert, delete, and search). **Understanding complexity analysis** in terms of **time complexity** and **space complexity** is crucial for evaluating the efficiency of algorithms. Big-O notation (e.g., O(n), O(log n), $O(n^2)$) is used to describe the worst-case scenario for an algorithm's performance, helping developers choose the most efficient solution. • **Time Complexity:** Describes the amount of time an algorithm takes to complete as a function of the input size. • **Space Complexity:** Describes the amount of memory an algorithm uses.

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:

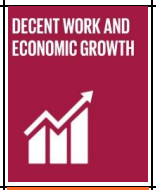
- Problem-solving skills for designing efficient solutions.
- Logical and analytical thinking for data organization.
- Proficiency in programming languages like C / C++ / Java / Python.
- Optimization skills for time and space complexity.
- Knowledge of scalable and robust system design.
- Teamwork and 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
CO3	PO 1	•	•	•	•	•	•		•			•	•	•																													10
	PO 2	•	•	•	•	•	•		•			•	•	•																													10
	PO 3																•	•	•			•																					4
	PO 4																													•	•	•			•	•							5
	PO 5		•	•	•	•	•		•														•	•	•																	9

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

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	-	-
CO3	67	67	67	71	82	-	-		-	-	-	71	53	-	-
CO4	67	67	67	71	82	-	-		-	-	-	71	53	-	-
CO5	67	67	67	71	82	-	-		-	-	-	71	53	-	-
CO6	67	67	67	71	82	80	-		-	-	-	71	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	2	-	-
CO2	3	3	3	3	3	-	-	-	-	-	3	2	-	-
CO3	3	3	3	3	3	-	-	-	-	-	3	2	-	-
CO4	3	3	3	3	3	-	-	-	-	-	3	2	-	-
CO5	3	3	3	3	3	-	-	-	-	-	3	2	-	-
CO6	3	3	3	3	3	3	-	-	-	-	3	2	-	-
Total	18	18	18	15	15	3	-	-	-	-	18	12	-	-
Average	**3**	**3**	**3**	**3**	**3**	**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 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 the prototype of UAVs and aero-foil models for testing by using low speed wind tunnel towards research in the area of experimental aerodynamics.	AAT: 1 – 1 Tech-Talk	**2**

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	3

	6.3 Implementation of queues using arrays	
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 • 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.	**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 • Data Structures and algorithms are implemented using C programming language	24.07.2016
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
BT25	The course has been retained without any changes	26.08.2025

Course Outline Approvals	
Course Coordinator Name: Dr. Venu M Signature: Date: 21-01-2026	**Head of the Department** Name: Dr. S. Devaraj Signature: Date: 21-01-2026
Dean of Outcome Based Teaching and Learning Name: Dr. Ch. Srinivasulu Signature: Date: 21-01-2026	**Dean of Academics** Name: Dr. G. V. R. Seshagiri Rao Signature: Date: 21-01-2026

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	

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**Basic Electrical and Electronics Engineering**
Course Code	AEEE01
Course Start	Second Semester
Course Type	Core
Regulation	IARE - BT 25
Prerequisite Courses	Nil
Department	Aeronautical Engineering
Number of Credits	3 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Theory
Course Administrator	**Dr. Sk.Abdul Pasha** Assistant Professor of Electrical and Electronics Engineering IARE11106 **Shaik.abdulpasha@iare.ac.in**
Course Coordinator's Name	**Mr. K. Linga Reddy** Assistant Professor of Electrical and Electronics Engineering IARE10079 **k.lingaswamyreddy@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	The course introduces the basic concepts of circuit analysis which is the foundation for all subjects of the electrical and electronics engineering. It includes the basic fundamental laws of electricity and magnetism with an emphasis on resistors, inductors and capacitors (RLC) circuits applied to alternating current (AC) or direct current (DC) of electrical networks. This course provides the hands-on experience on designing circuits using Diodes, Bipolar Junction Transistors, and Field Effect Transistors. Provides the capability to extract the characteristics of semiconductor devices and circuits with simulation tools.
Course Objectives	**The students will try to learn:** I. The fundamental principles of electrical circuits including DC and AC systems, and their analysis using laws like KVL and KCL. II. The electrical installations, components of LT switchgear, battery characteristics, and methods for calculating power and energy consumption. III. The construction, working principles, and performance analysis of electrical machines such as transformers, DC motors/generators, and induction motors. IV. The basics of semiconductor devices including diodes, rectifiers, BJTs, and FETs, along with their applications in electronics.

Text and Reference Books	**Text Books** 1. M. S. Sukhija, T. K. Nagsarkar, *Basic Electrical and Electronics Engineering*, Oxford, 1st Edition, 2012. 2. Salivahanan, *Electronics Devices & Circuits*, TMH 4th Edition 2012. **Reference Books** 1. CL Wadhwa, *Electrical Circuit Analysis including Passive Network Synthesis*, International, 2nd Edition, 2009.
	2. David A Bell, *Electric circuits*, Oxford University Press,7th Edition,2009. 3. PS Bimbra, *Electrical Machines*, Khanna Publishers, 2nd Edition, 2008. 4. D.P. Kothari and I. J. Nagrath, *Basic Electrical Engineering*, Tata McGraw Hill, 4th Edition, 2019. 5.CL Wadhwa,Basic Electrical Engineering,4/E,20007,new age international publishers.New Delhi 6. J.B. GUPTA A Course in Electrical Installation Estimation and Costing,S.K.Kataria and Sons,Daryaganj New Delhi
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=SU_hPJVJ5lc&list=PLzkMouYverAIUUtpfVXu_PUDtXwArqngn • https://www.youtube.com/watch?v=7KIHgpAiROU&list=PLzkMouYverAIUUtpfVXu_PUDtXwArqngn&index=16
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=hwN-8VzbUBU
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	Analyze and solve simple electrical circuits using Ohm's Law, Kirchhoff's laws, and phasor techniques for both DC and single-phase/three-phase AC circuits.	Understand
CO2	Identify various components of LT switchgear, types of batteries, and perform basic calculations related to energy consumption and battery backup.	Understand
CO3	Explain the construction, working principles, and characteristics of electrical machines including transformers, DC motors/generators, and three-phase induction motors.	Understand
CO4	Demonstrate an understanding of the operation and characteristics of P-N junction and Zener diodes, and their role in rectifier and filter circuits	Understand
CO5	Analyze BJT and FET configurations to understand their working, amplification modes, and performance comparisons.	Apply
CO6	Apply the knowledge of electrical and electronic components to real-world applications such as power systems, electronic circuits, and energy management	Apply

SECTION 3B: Cognitive Levels

Blooms Taxonomy Level	Cognitive Level in Percentage (%)
Remember	0
Understand	78
Apply	22
Analyse	0
Evaluate	0
Create	0

SECTION 4: Content and Context of Elements of Electrical and Electronics Engineering

CO1	**Analyze and solve simple electrical circuits using Ohm's Law, Kirchhoff's laws, and phasor techniques for both DC and single-phase/three-phase AC circuits..**

	Make the student to understand about basic circuit concepts. They should make to know that fundamentals of Electrical course to be utilized in complex networks and theorem analysis. Teach learners about complex network solving methods and laws. They should understand the parameters of circuit elements applying complex problems. Familiarise with the common laws and fundamental characteristics of circuit elements. **DC Circuits** 1. **Identify the Circuit Type:** Is it a series circuit, a parallel circuit, or a combination? 2. **Apply Ohm's Law:** Use Ohm's Law to relate voltage, current, and resistance for individual components. 3. **Apply Kirchhoff's Laws:** Use KCL and KVL to analyze current flow and voltage drops in different parts of the circuit. **AC Circuits** AC circuits are a bit more complex because voltage and current vary with time. Here's how the laws apply:
	1. **Impedance:** In AC circuits, resistance is replaced by impedance (Z), which includes resistance and reactance (from inductors and capacitors). Impedance is a complex quantity. 2. **Phasors:** Voltages and currents in AC circuits are represented as phasors, which are complex numbers that take into account both magnitude and phase. 3. **Ohm's Law for AC:** V = IZ (where V and I are phasors) 4. **Kirchhoff's Laws for AC:** KCL and KVL still apply, but you need to work with phasors. 5. **Solve for Unknowns:** Use complex number algebra to solve for unknown voltages, currents, or impedances. **Important Considerations** · **Component Behavior:** Understand how resistors, inductors, and capacitors behave in both DC and AC circuits. · **Circuit Analysis Techniques:** Learn techniques like nodal analysis and mesh analysis to simplify complex circuits. · **Power Calculations:** Know how to calculate power in DC circuits (P = VI) and AC circuits
CO2	**Identify various components of LT switchgear, types of batteries, and perform basic calculations related to energy consumption and battery backup.**

	To explain the components of LT switchgear, the types of batteries, and also show how to calculate energy consumption and battery backup. **1. <u>LT (Low Tension) Switchgear</u>** • Switchgear refers to electrical devices that protect, control, and isolate electrical equipment in power systems. • LT switchgear operates at low voltages (up to 1000 V AC), commonly used in homes, industries, and commercial setups. **Components of LT Switchgear:** **1. Circuit Breakers (MCB, MCCB, ACB)** o Protect circuits from overcurrent and short circuits. o MCB (Miniature Circuit Breaker): Used for small loads (like in homes). o MCCB (Moulded Case Circuit Breaker): For larger loads in industries. o ACB (Air Circuit Breaker): Used in main panels for high current**.** **2. Fuses** o Protect equipment by melting when excess current flows. o Simple, cheap, but need replacement after operation. **3. Contactors** o Electrically operated switches for controlling motors, heaters, and large loads**.** **4. Relays** o Sense abnormal conditions (like overcurrent, under-voltage, earth fault) and give signals to breakers to trip**.** **5. Isolators / Disconnectors** o Mechanical switches used to completely disconnect a circuit for maintenance. o Operated only when circuit is OFF (no load). **6. Switches** o Manually operated for turning ON/OFF loads**.** **7. Bus Bars** o Conductors (usually copper or aluminium) that distribute power to multiple outgoing circuits. **2. <u>Types of Batteries</u>** Batteries store electrical energy in chemical form and release it when required. **Common Types:** **1. Primary Batteries (Non-rechargeable)** o Used once, then discarded. o Example: Dry cells (AA, AAA, pencil cells). **2. Secondary Batteries (Rechargeable)** o Can be charged and reused many times. o **Types:** ▪ Lead-Acid Battery (used in cars, UPS systems) ▪ Nickel-Cadmium (Ni-Cd) (used in emergency lights, old electronics) ▪ Lithium-Ion (Li-ion) (used in laptops, mobile phones, EVs) ▪ Nickel-Metal Hydride (NiMH) (used in cameras, toys)
CO3	**Explain the construction, working principles, and characteristics of electrical machines including transformers, DC motors/generators, and three-phase induction motors.**

	Fundamentals of Electromagnetism 1. **Magnetic Fields and Electric Currents:** o A fundamental principle is that an electric current flowing through a conductor creates a magnetic field around it. This is the basis for electromagnets. o Conversely, a changing magnetic field can induce an electric current in a conductor. This is known as electromagnetic induction. 2. **Force on a Current-Carrying Conductor in a Magnetic Field:** o When a conductor carrying an electric current is placed in a magnetic field, it experiences a force. The direction of this force is perpendicular to both the direction of the current and the magnetic field. This force is what causes the rotation in electric motors. **DC Machines** · **Construction:** o DC machines have a stationary part called the stator, which provides a constant magnetic field (either from permanent magnets or electromagnets). o The rotating part is called the rotor or armature, which has windings carrying DC current. o A commutator and brushes are used to ensure that the current in the rotor windings reverses direction at the right time, maintaining continuous rotation. · **Operation:** o When DC current flows through the rotor windings, they create their own magnetic field. o This rotor's magnetic field interacts with the stator's magnetic field, resulting in forces that cause the rotor to rotate. o The commutator and brushes play a crucial role in switching the current direction in the rotor windings every half rotation, ensuring that the torque on the rotor is always in the same direction. **AC Machines** · **Construction:** o AC machines also have a stator and a rotor. However, the stator windings are connected to an AC power source. o The rotor can be of various types (e.g., squirrel cage, wound rotor), depending on the specific AC machine design. · **Operation:** o When AC current flows through the stator windings, it creates a rotating magnetic field. This rotating field is the key difference from DC machines. o This rotating magnetic field induces currents in the rotor windings (in the case of induction motors). o The interaction between the rotating magnetic field and the induced currents in the rotor produces forces that cause the rotor to rotate. o In synchronous motors, the rotor is designed to rotate at the same speed as the rotating magnetic field. **Key Differences and Considerations** · **Power Source:** DC machines operate on direct current, while AC machines operate on alternating current. · **Magnetic Field:** DC machines typically have a stationary magnetic field, while AC machines rely on a rotating magnetic field. · **Commutation:** DC machines require a commutator and brushes for current reversal in the rotor, which can lead to wear and tear. AC machines generally do not have these components.
	· **Applications:** DC machines are often used in applications requiring variable speed control, while AC machines are widely used in various industrial and domestic applications due to their simplicity and robustness. **In summary,** both DC and AC machines utilize the fundamental principles of electromagnetism to convert electrical energy into mechanical energy (motors) or vice versa (generators). The key differences lie in the type of current used, the nature of the magnetic field, and the specific design features that enable their operation.
CO4	**Demonstrate an understanding of the operation and characteristics of P-N junction and Zener diodes, and their role in rectifier and filter circuits.**

	Diodes are fundamental semiconductor devices that allow current to flow in only one direction. This unique characteristic makes them essential components in rectifier and regulator circuits. Let's explore how diodes are utilized in these circuits: **1. Rectifier Circuits** · **Purpose:** Rectifiers convert alternating current (AC) into direct current (DC). This is crucial because most electronic devices require DC power to operate. · **Types of Rectifiers:** o **Half-wave rectifier:** Uses a single diode to allow only one half of the AC waveform to pass through. The output is a pulsating DC with gaps. o **Full-wave rectifier:** Employs multiple diodes (typically four in a bridge configuration) to rectify both halves of the AC waveform. This results in a smoother DC output with less ripple. · **How Diodes Work in Rectifiers:** o During the positive half-cycle of the AC input, the diode(s) are forward-biased, allowing current to flow through the circuit and produce a positive voltage across the load. o During the negative half-cycle, the diode(s) are reverse-biased, blocking current flow. In a full-wave rectifier, the diodes are arranged so that the negative half-cycle is inverted, contributing to the DC output. · **Applications:** Rectifiers are used in power supplies, adapters, and various electronic devices to convert AC mains power to DC power. **2. Regulator Circuits** · **Purpose:** Regulators maintain a constant output voltage despite variations in the input voltage or load current. This is important to protect sensitive electronic components from voltage fluctuations. · **Zener Diodes:** o Zener diodes are special diodes designed to operate in the reverse breakdown region. They maintain a relatively constant voltage across them when a reverse current is applied. o In a regulator circuit, a Zener diode is connected in parallel with the load. When the input voltage increases, the Zener diode conducts more current, keeping the output voltage relatively stable. · **How Diodes Work in Regulators:** o The Zener diode acts as a voltage reference. It "clamps" the voltage across it to its Zener voltage. o Any excess voltage from the input is dropped across a series resistor, protecting the load from overvoltage. · **Applications:** Regulators are found in power supplies, electronic circuits, and devices requiring a stable voltage supply. **Key Diode Characteristics Utilized:** · **Forward Bias:** Diodes allow current to flow when a positive voltage is applied to the anode
	and a negative voltage to the cathode. · **Reverse Bias:** Diodes block current flow when the voltage polarity is reversed. · **Zener Breakdown:** Zener diodes exhibit a controlled breakdown at a specific reverse voltage, allowing them to regulate voltage. **In summary,** diodes are crucial components in rectifier and regulator circuits due to their ability to control current flow in one direction and maintain a stable voltage. Their unique characteristics enable the conversion of AC to DC and the regulation of voltage for various electronic applications. Sources and related content
CO5	**Analyze BJT and FET configurations to understand their working, amplification modes, and**

	performance comparisons.
	Understanding Transistor Configurations Transistors are three-terminal devices (base, collector, emitter) that can be configured in three main ways: · **Common Emitter (CE):** o The emitter is common to both the input and output circuits. o Offers high voltage and current gain, making it the most commonly used configuration for amplification. · **Common Collector (CC) (Emitter Follower):** o The collector is common to both the input and output circuits. o Provides high input impedance and low output impedance, making it suitable for impedance matching and buffering applications. · **Common Base (CB):** o The base is common to both the input and output circuits. o Offers high voltage gain but low current gain, often used in high-frequency applications. **Optimizing the Operating Point (Q-point)** The operating point, also known as the quiescent point or Q-point, is the DC voltage and current conditions at which the transistor operates in the absence of an input signal. It's crucial to properly bias the transistor to set the Q-point within the active region for optimal performance. **Why is Q-point Important?** · **Amplification:** For the transistor to function as an amplifier, the Q-point must be in the active region, allowing the transistor to amplify the input signal without distortion. · **Stability:** A stable Q-point ensures that the transistor's operation is predictable and not significantly affected by temperature variations or changes in transistor parameters. **Factors Affecting Q-point** · **Transistor Parameters:** The transistor's current gain (β) and base-emitter voltage (VBE) can vary, affecting the Q-point. · **Temperature:** Changes in temperature can alter transistor parameters and shift the Q-point. · **Supply Voltage:** Variations in the supply voltage can also affect the Q-point. **Biasing Techniques for Q-point Optimization** Several biasing techniques can be used to set and stabilize the Q-point: · **Fixed Bias:** Simple but has poor stability due to its sensitivity to transistor parameter variations. · **Emitter Bias:** Provides better stability than fixed bias by using an emitter resistor to provide negative feedback. · **Voltage Divider Bias:** Offers good stability and is widely used due to its relative insensitivity to transistor parameter variations. · **Collector Feedback Bias:** Provides excellent stability by using feedback from the collector to the base. **Choosing the Right Configuration and Biasing Technique** The choice of transistor configuration and biasing technique depends on the specific application and desired characteristics: · **Amplification:** CE configuration with voltage divider bias or collector feedback bias is often preferred for amplifiers. · **Impedance Matching:** CC configuration (emitter follower) is suitable for impedance matching. · **High-Frequency Applications:** CB configuration may be used in certain high-frequency circuits. **In summary,** understanding transistor configurations and biasing techniques is essential for optimizing the operating point and ensuring the desired performance of transistor circuits. Careful selection of the
	configuration and biasing method, considering factors like stability, gain, and impedance requirements, is crucial for successful circuit design.
CO6	**Apply the knowledge of electrical and electronic components to real-world applications such as power systems, electronic circuits, and energy management.**

Understanding Hybrid Parameters (h-parameters)

- **Definition:** h-parameters are a set of parameters used to describe the behavior of two-port networks, like transistors. They are called "hybrid" because they have mixed units:
  - h11 (hi): Input impedance (ohms)
  - h12 (hr): Reverse voltage transfer ratio (dimensionless)
  - h21 (hf): Forward current transfer ratio (dimensionless)
  - h22 (ho): Output admittance (siemens)
- **Importance:** h-parameters provide a convenient way to analyze and model transistor amplifiers, especially for small-signal analysis.

Transistor Amplifier Circuits for h-parameter Determination

To determine the h-parameters of a transistor, we typically use two basic amplifier configurations:

1. Common Emitter (CE) Amplifier

Common Emitter Amplifier Circuit

- **Why CE Amplifier?** The CE configuration is commonly used for h-parameter determination because it provides both voltage and current gain, making it easier to measure the parameters accurately.
- **Procedure:**
  1. **Biasing:** Properly bias the transistor to set the operating point (Q-point) in the active region.
  2. **Measurements:** Apply small AC signals at the input and output, and measure the following:
     - Input voltage (Vi) and current (Ii)
     - Output voltage (Vo) and current (Io)
  3. **Calculations:** Use the following equations to calculate the h-parameters:
     - h11 = Vi / Ii (with Vo = 0)
     - h12 = Vi / Vo (with Ii = 0)
     - h21 = Io / Ii (with Vo = 0)
     - h22 = Io / Vo (with Ii = 0)

2. Common Collector (CC) Amplifier (Emitter Follower)

Why CC Amplifier? The CC configuration is sometimes used to determine specific h-parameters, especially those related to input and output impedance.

- **Procedure:** Similar to the CE amplifier, bias the transistor, apply AC signals, and measure the necessary voltages and currents. Then, use the appropriate equations to calculate the h-parameters.

Important Considerations

- **Small-Signal Analysis:** h-parameters are typically used for small-signal analysis, where the input signals are small enough not to significantly alter the transistor's operating point.
- **Frequency Dependence:** h-parameters can vary with frequency, so measurements should be performed at the desired frequency range.
- **Hybrid Model:** Once the h-parameters are determined, they can be used to create a hybrid model of the transistor, which simplifies the analysis of more complex amplifier circuits.

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 – 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 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 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	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	Understand, design and analyze computer programs in the areas related to Algorithms, System Software, Web design, and Big data, Artificial Intelligence, Machine Learning and Networking.	AAT: 1 – 1 Tech-Talk	**2**
PSO 2	Focus on improving software reliability, network security or information retrieval systems.	AAT: 2 – 1 Complex Engineering Problem Solving	**3**
PSO 3	Make use of modern computer tools for creating innovative career paths, to be an entrepreneur and desire for higher studies.	AAT: 2 – 1 Complex Engineering Problem Solving	**3**

SECTION 11: Course Content	
MODULE - I	**INTRODUCTION TO ELECTRICAL CIRCUITS**
	D.C. Circuits: Electrical circuit elements (R, L and C), voltage and current sources, KVL and KCL, analysis of simple circuits with dc excitation. **A.C. Circuits**: Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor, Analysis of single-phase ac circuits, Three phase balanced circuits, voltage and current relations instar and delta connections.
MODULE - II	**ELECTRICAL INSTALLATIONS**
	Electrical Installations: Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup..
MODULE - III	**ELECTRICAL MACHINES**
	Electrical Machines: Working principle of Single-phase transformer, equivalent circuit, losses in transformers, efficiency, three phase transformer connections. Construction and working principle of DC generators, EMF equation, working principle of DC motors. Torque equations and Speed control of DC motors, Construction and working principle of Three phase Induction motor, Torques equations and Speed control of Three phase induction motor. Construction and working principle of synchronous generators.
MODULE - IV	**DIODES AND RECTIFIERS**
	P-N Junction and Zener Diode: Principle of Operation Diode equation, Volt, Ampere characteristics, Temperature dependence, Ideal versus practical, Static and dynamic resistances, Equivalent circuit, Zener diode characteristics and applications. **Rectifiers and Filters**: P-N junction as a rectifier, Half Wave Rectifier, Ripple Factor, Full Wave Rectifier, Bridge Rectifier, Harmonic components in Rectifier Circuits, Filters – Inductor Filters, Capacitor Filters, L- section Filters, π- section Filters.
MODULE - V	**BIPOLAR JUNCTION TRANSISTORS AND FIELD EFFECT TRANSISTOR**
	Bipolar Junction Transistor (BJT): Construction, Principle of Operation, Amplifying Action, Common Emitter, Common Base and Common Collector configurations, Comparison of CE, CB and CC configurations. **Field Effect Transistor (FET)**: Construction, Principle of Operation, Comparison of BJT and FET, Biasing FET.

SECTION12		
	Tentative Schedule of Instructions	
Week Number	**Topics**	**Duration (Hours)**
1	1.1 Introduction to Electrical Circuits 1.2 voltage and current sources, 1.3 KVL and KCL 1.4 analysis of simple circuits with dc excitation	5
2	2.1 Representation of sinusoidal waveforms, 2.2 peak and rms values 2.3 phasor representation 2.4 real power, 2.5 reactive power, 2.6 apparent power, 2.7 power factor	5
3	3.1 Analysis of single-phase ac circuits 3.2 Three phase balanced circuits, 3.3 voltage and current relations instar and delta connections	5

4	4.1 Components of LT Switchgear: 4.2 Switch Fuse Unit (SFU), 4.3 MCB, ELCB, MCCB, 4.4 Types of Wires and Cables, 4.5 Earthing. 4.6 Types of Batteries,	5
5	5.1 Important Characteristics for Batteries 5.2 Elementary calculations for energy consumption, 5.3 power factor improvement and battery backup. 5.4 Problems	5
6	6.1 Working principle of Single-phase transformer 6.2 equivalent circuit, losses in transformers, efficiency, 6.3 three phase transformer connections 6.4 Problems	5
7	7.1 three phase transformer connections 7.2 Construction and working principle of DC generators 7.3 EMF equation 7.4 Constructional details of DC machines 7.5 Problems	5
8	8.1 three phase transformer connections 8.2 Construction and working principle of DC generators 8.3 EMF equation 8.4 problems	5
CONTINIUOUS INTERNAL EXAMINATION (CIE- I)		
9	9.1 working principle of DC motors 9.2 Torque equations and Speed control of DC motors, 9.3 Construction and working principle of Three phase Induction motor, 9.4 Torques equations and Speed control of Three phase induction motor 9.5 **Mock Test-3**	5
10	10.1Construction and working principle of synchronous generators 10.2 Principle of Operation Diode equation 10.3 Volt, Ampere characteristics, 10.4 Temperature dependence, 10.5 Ideal versus practical,	5
11	10.6Static and dynamic resistances, 10.7 Equivalent circuit 11.1 Zener diode characteristics and applications. 11.2P-N junction as a rectifier 11.3 Half Wave Rectifier,	5
12	11.4Ripple Factor, 11.5 Full Wave Rectifier, 12.1 Bridge Rectifier, 12.2Harmonic components in Rectifier Circuits, 12.3 Filters – Inductor Filters, 12.4 Bipolar junction transistors	5
13	13.1Capacitor Filters, 13.2 L- section Filters, π- section Filters. 13.3 Problems 13.4 **Mock Test – 4** 13.5 Characteristics and configurations 13.6 Working principle of NPN transistors	5
14	14.1 Working principle of PNP transistors 14.2 CE configurations 14.3 CB configurations 14.4 CC configurations 14.5 Bipolar Junction Transistor (BJT): Construction, Principle of Operation,	5
15	15.1Common Base and Common Collector configurations 15.2 Comparison of CE, 15.3 CB and CC configurations	5
16	16.1Field Effect Transistor (FET): 16.2Construction, Principle of Operation 16.3Comparison of BJT and FET 16.4 Biasing FET. 16.5 **Mock Test-5**	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 III module RLC circuits: Natural, step and sinusoidal steady state responses, series and parallel RLC circuits. AC signal measurement: Complex, apparent, active and reactive power, power factor. Introduction to three phase supply: Three phase circuits, star-delta transformations, balance and unbalanced three phase load, power measurement, two wattmeter method.	24.07.2016
R 18	Changes from R16 to R18 regulation · Credit weightage is reduced from 4 to 3. · **Module – IV:** Concept of real, reactive, apparent power and complex power, power factor in single phase AC circuits consisting of R, L, C, RL, RC and RLC combinations.	16.07.2018
UG 20	Changes from R18 to UG 20 regulation · MODULE –IV: SINGLE PHASE TRANSFORMERS (08) Single Phase Transformers: Principle of operation, construction, types of transformers, EMF equation, operation of transformer under no load and on load, Phasor diagrams, equivalent circuit, efficiency, regulation and numerical problems. MODULE – V: AC MACHINES (09) Three Phase Induction motor: Principle of operation, slip, slip -torque characteristics, efficiency and applications; Alternators: Introduction, principle of operation, constructional features, calculation of regulation by synchronous impedance method and numerical problems.	17.11.2020
BT 23	Incorporated the following additions in BT 23 regulations · **MODULE-V**: TRANSISTOR AMPLIFIERS Amplifier circuits: Two port devices and network, small signal models for transistors, concept of small signal operation, amplification in CE amplifier, h parameter model of a BJT- CE, CB and emitter follower analysis	21.08.2023

Course Outline Approvals	
Course Coordinator Name: Dr SK.Abdul Pasha Signature: Date:	**Head of the Department** Name: Dr Damodhar Reddy Signature: Date:
Course Outline Approvals: The course outline description approved by Outcome Based Teaching Learning (OBTL) committee on *date* in meetings *IARE - OBTL – COD /28/1/26*	
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 LABORATORY**
Course Code	AHSE06
Course Start	IISemester
Course Type	Foundation
Regulation	IARE - BT 25
Prerequisite Courses	Basic principles of chemistry
Department	AERONAUTICAL ENGINEERING
Number of Credits	1Credit hours
Academic Year	2025-26
Method(s) of Instruction	Theory and laboratory
Course Coordinator's Name	**Dr. S Anusha Kathyayani,** AssistantProfessor Department of Chemistry IARE11136 s.kathyayani@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.
CourseObjectives	**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

BloomsTaxonomy Level	CognitiveLevel in Percentage (%)
Remember	0
Understand	33.33
Apply	66.66
Analyse	0
Evaluate	0
Create	0

SECTION 4: Engineering Chemistry laboratory	
CO1	**Useanalytical 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	**Utilizethe 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	**Implementthe 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	**Synthesizethe 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	**Identifythe 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 withSustainability 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 providesawareness 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 ACIDSOLUTIONS BY CONDUCTOMETRY**
	2.1 Estimation of theconcentration of strong acid using conductometer
WEEK- 3	**MEASUREMENT OF STRENGTH OF MIXTURE OF ACIDIC SOLUTIONS BY CONDUCTOMETRY**
	3.1Estimation of concentration of strong and weak acid in an acid mixture using conductometer
WEEK- 4	**MEASUREMENT OF ELECTROMOTIVE FOR SOLUTIONS BY POTENTIOMETRY**
	4.1Estimation 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**
	6.1Determination of strength of given hydrochloric acid using pH meter
WEEK- 7	**MEASUREMENT OFTOTAL DISSOLVED SOLIDS IN WATER**
	7.1Measurement of total dissolved solids (TDS) in different water samples
WEEK- 8	**COMPLEXOMETRY METHOD**
	8.1Estimate the total hardness of water by EDTA
WEEK- 9	**PRECIPITATION METHOD**
	9.1Determination of chloride content in water by Argentometry.
WEEK- 10	**PREPARATION OF POLYMER**
	10.1Preparation of Thiokol rubber by using sodium polysulphide.
WEEK- 11	**VISCOSITY OF LUBRICANT**
	11.1Determine the viscosity of the lubricants using Ostwald's viscometer
WEEK- 12	**PROPERTIES OF LUBRICANTS**
	12.1Determine the flash and fire points of lubricants
WEEK- 13	**CLOUD AND POUR POINT OF LUBRICANTS**
	13.1Determination of cloud and pout point of lubricants
WEEK- 14	**COLORIMETRY**
	14.1Estimate the metal ion concentration using colorimeter

SECTION 13: Tentative Schedule of Instructions

Week Number	Topics	Duration (Hours)
1	1.1 Estimationof 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 S Anusha Kathyayani 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, AE**
Dr S Anusha Kathyayani, Assistant Professor

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

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**Basic Electrical and Electronics Engineering Laboratory**
Course Code	AEEE03
Course Start	II- Semester
Course Type	Core
Regulation	IARE - BT 25
Prerequisite Courses	----
Department	AE
Number of Credits	1.0 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Laboratory
Course Coordinator's Name	**SK.ABDUL PASHA** Assistant Professor of Electrical and Electronics Engineering IARE11106 **Shaik.abdulpasha@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/eee/bee.lab
Course Description	This first-year laboratory builds core competency in measurement, instrumentation, and device-level behavior across basic electrical and electronic domains. Students develop hands-on skills with circuit laws, transformers, machines, and foundational semiconductor devices. Emphasis is placed on safe lab practice, precise measurement, troubleshooting, and interpreting device/ circuit characteristics to support later courses.
Course Objectives	**The students will try to learn:** 1) Apply fundamental circuit laws and theorems to analyze and verify behavior in basic networks. 2) Understand magnetic circuits and single-/three-phase AC circuits alongside DC circuits. 3) Recognize operating principles and characteristics of key electrical machines and transformers. 4) Identify components and good practice in low-voltage electrical installations. 5) Define power and power factor in AC systems and outline methods to improve power factor. 6) Characterize PN junction and Zener diodes for rectification and regulation applications. 7) Study characteristics of BJT and FET devices and relate configurations to typical applications.
Text and Reference Books	**Textbooks** **1.** M.S. Sukija, T.K. Nagasarkar, "Basic Electrical and Electronics

	Engineering", Oxford University Press, 1st Ed., 2012. 2. D.P. Kothari, I.J. Nagrath, "Basic Electrical and Electronics Engineering", McGraw Hill Education, 2nd Ed., 2020. **Reference Books** • J.P. Millman, C.C. Halkias, Satyabrata Jit, "Millman's Electronic Devices and Circuits", Tata McGraw Hill, 2nd Ed., 1998. • R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Pearson/PHI, 9th Ed., 2006. • V.D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 2nd Ed., 1989.
Learning and Teaching Strategies	Safety briefing and equipment familiarization in Week-1. • Brief pre-lab concept capsules and checklists. • Demonstrations followed by guided experiments and reflective observation. • Simulation support (where appropriate) to reinforce measurement concepts. • Rubric-based day-to-day assessment and viva-voce.

SECTION 2: Teaching Learning Scheme

At least 45 lecture hours of scheduled laboratories activities (TLA) will be delivered in person,

Notional Study Time:45Hours (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	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	Apply KCL, KVL and network theorems to analyze and verify basic DC/AC circuits.	Apply

CO2	Interpret electric and magnetic circuit behavior, and measure active/reactive power in AC systems	Analyze
CO3	Measure and interpret performance of transformers and electrical machines.	Analyze
CO4	Identify and use low-voltage installation components and test instruments correctly.	Apply
CO5	Characterize PN and Zener diodes; implement and evaluate regulation/rectification.	Analyze
CO6	Obtain and interpret BJT/FET characteristics in practical configurations.	Analyze

SECTION 3B: Cognitive Levels

BloomsTaxonomyLevel	CognitiveLevel in Percentage (%)
Remember	0
Understand	0
Apply	33
Analyse	67
Evaluate	0
Create	0

SECTION 4: Electrical Measurements and Instrumentation Laboratory

CO1	Apply KCL, KVL and network theorems to analyze and verify basic DC/AC circuits.
	• Verify KCL and KVL on breadboard/test benches using precision meters. • Use source transformation/ Thevenin–Norton ideas to plan measurements. • Record and compare analytical vs. measured values; compute % error. • Document safe procedures and instrument range selection.
CO2	Interpret electric and magnetic circuit behavior, and measure active/reactive power in AC systems
	• Configure single- and three-phase circuits for active/reactive power measurements. • Use wattmeter(s) and power factor indicators; compute pf and improvement routes. • Relate B–H concepts to practical cores; discuss eddy/hysteresis implications. • Interpret power triangle and tabulate observations.
CO3	Measure and interpret performance of Transformers and Electrical Machines.
	• Measure voltage/current/power on primary and secondary sides of a 1-Φ transformer. • Verify star–delta/ delta–delta/ delta–star/ star–star relations in 3-Φ transformers. • Obtain performance curves for DC shunt motor and 3-Φ induction motor. • Record no-load characteristics of a 3-Φ alternator.
CO4	Identify and use low-voltage installation components and test instruments correctly.
	• Identify MCBs, fuses, sockets, earthing practice; perform continuity/polarity tests. • Use CRO, function generator, regulated supplies, and DMM safely and effectively. • Follow standard test report formats including circuit sketches and results. • Execute basic troubleshooting with systematic checks.
CO5	Characterize PN and Zener diodes; implement and evaluate regulation/rectification.
	• Plot PN diode V–I; determine cut-in voltage and dynamic resistance. • Plot Zener V–I; design a simple regulator and validate line/load regulation.Expose students to virtual instrumentation methods for accurately analysing and measuring passive components in both time and frequency domains. • Build and test a full-wave rectifier with/without filters; measure ripple factor.

	• Compare simulated vs. practical waveforms.
CO6	Obtain and interpret BJT/FET characteristics in practical configurations.
	• Plot input/output characteristics of BJT in CB/CE; derive h-parameters experimentally • Determine transistor operating regions and discuss bias stability qualitatively. • Plot FET characteristics in CS; extract mutual conductance and output resistance. • Comment on device selection for simple amplifier stages.

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

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

Employability Skills:

- Problem-Solving Skills: Ability to solve real-world electrical and Electronic challenges through experimentation, data analysis, and system design.
- Analytical and Critical Thinking: Expertise in interpreting test data, identifying trends, and making informed decisions to optimize performance.
- Proficiency in Testing Equipment: Skilled in using Theorems, electricity flow tools, and diode applications in system analysis.
- Optimization Skills: Ability to apply principles of electrical and electronics to improve efficiency, performance, and safety in experimental setups.
- Knowledge of electrical and electronics: Strong understanding of circuit parameters and compare theoretical and practical values.
- Teamwork and Collaboration: Effective communication and collaboration within multidisciplinary teams, ensuring smooth coordination of experiments and results.

Project Management Skills:

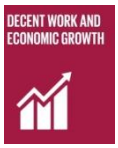
- Planning and Organizing: Ability to design and manage laboratory experiments, ensuring efficient use of resources and time.
- Resource Allocation: Proficient in managing laboratory materials, equipment, and personnel to ensure successful experiment execution.
- Collaboration and Communication: Clear 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 of aerodynamic and propulsion

systems to ensure they meet safety, reliability, and performance standards.

- These skills, developed through the study of Aerodynamics and Propulsion Laboratory, not only enhance employability but also improve the effectiveness of experimental work, ensuring successful contributions to the advancement of cutting-edge aerodynamics and propulsion technologies in the aerospace industry.

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:** 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 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 5																													•	•		•	•	•								5
CO2	PO 1	•	•	•	•	•	•	•				•	•	•	•																											11
	PO 2	•	•	•	•	•	•	•				•	•	•	•																											11
	PO 5																													•	•		•	•	•								5
CO3	PO 1	•	•	•	•	•	•	•				•	•	•	•																											11
	PO 2	•	•	•	•	•	•	•				•	•	•	•																											11
	PO 3	•	•	•	•	•	•	•				•	•	•	•																											11
	PO 5																													•	•			•	•	•								5
	PSO 1	•	•	•	•	•	•	•				•	•	•	•																											11
CO4	PO 1	•	•	•	•	•	•					•	•	•	•																											11
	PO 2	•	•	•	•	•	•					•	•	•	•																											11
	PO 3																													•	•			•	•	•								5
	PO 5	•	•	•	•	•	•	•				•	•	•	•																											11
CO 5	PO 1	•	•	•	•	•	•					•	•	•	•																											11
	PO 2	•	•	•	•	•	•					•	•	•	•																											11
	PO 3																													•	•			•	•	•								5

	PO 5	•		•	•			•				•	•	•																									7
CO 6	PO 1	•		•	•	•	•	•				•	•	•	•																								10
	PO 2	•		•	•	•	•	•				•	•	•	•																								10
	PO 5																										•	•			•	•	•						5
	PO 10	•		•	•	•	•	•				•	•	•	•																								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	12	1	2	3
CO1	100	50	-	-	100	-	-	-	-	60	-	-	-	-	-
CO2	100	50	-	-	100	-	-	-	-	60	-	-	-	-	-
CO3	100	50	33	-	100	-	-	-	-	60	-	-	33	-	-
CO4	100	50	33	-	100	-	-	-	-	60	-	-	-	-	-
CO5	100	50	33	-	100	-	-	-	-	60	-	-	-	-	-
CO6	100	50	-	-	100	-	-	-	-	60	-	-	-	-	-

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	-	-	-	-	2	-	-	-	-
CO2	3	2	-	1	3	-	-	-	-	2	-	-	-	-
CO3	3	2	1	-	3	-	-	-	-	2	-	1	-	-
CO4	3	2	1	-	3	-	-	-	-	2	-	-	-	-
CO5	3	2	1	-	3	-	-	-	-	2	-	-	-	-
CO6	3	2	-	-	3	-	-	-	-	2	-	-	-	-
Total	18	12	3		18	-	-	-		12	-	1	-	-
Maximum value	3	2	3 1 1 1 1		1 1	3	-	-	-	-	2	-	1	-	-

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,		CIE / SEE / AAT:1 – 2 Assignments / Open-	3

	computing, engineering fundamentals and an engineering specialization as specified in **WK1 to WK4** respectively to develop to the solution of **complex engineering problems**.		ended problems	
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 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	Understand, design and analyse computer programs in the areas related to Algorithms, System Software, Web design, and Big data, Artificial Intelligence, Machine Learning and Networking.		AAT: 1 – 1 Tech-Talk	**3**

SECTION 12: Course Content	
WEEK- I	**VERIFICATION OF KVL AND KCL.**
	Verify KCL and KVL for simple Electrical Circuits
WEEK- 2	(I) MEASUREMENT OF VOLTAGE, CURRENT AND REAL POWER IN PRIMARY AND SECONDARY CIRCUITS OF A SINGLE PHASE TRANSFORMER , (II) VERIFICATION OF RELATIONSHIP BETWEEN VOLTAGES AND CURRENTS (STAR-DELTA, DELTA-DELTA, DELTA-STAR, STAR-STAR) IN A THREE PHASE TRANSFORMER
	Measurement of voltage, Current and Power in Transformer
WEEK- 3	**MEASUREMENT OF ACTIVE AND REACTIVE POWER IN A BALANCED THREE PHASE CIRCUIT**
	Measurement of active and reactive power in Three Phase Circuit
WEEK- 4	**PERFORMANCE CHARACTERISTICS OF A SEPARATELY EXCITED DC SHUNT MOTOR**
	Observe the Performance Characteristics of a D.C. Shunt Generator
WEEK- 5	**PERFORMANCE CHARACTERISTICS OF A THREE PHASE INDUCTION MOTOR**
	Conduct a Load test on Three Phase Induction Motor to obtain performance Characteristics
WEEK- 6	**NO LOAD CHARACTERISTICS OF A THREE PHASE ALTERNATOR.**
	Alternator is operated at no-load to obtain characteristics.
WEEK- 7	**STUDY AND OPERATION OF** **(I) MULTIMETERS (II) FUNCTION GENERATOR (III) REGULATED POWER SUPPLIES (IV) CRO.**
	Measurement of voltage, current, power and observe waveform parameters
WEEK- 8	P-N JUNCTION DIODE CHARACTERISTICS

	Forward and Reverse Bias Characteristics of PN junction diode are obtained by conducting a test.
WEEK- 9	ZENER DIODE CHARACTERISTICS AND ZENER AS VOLTAGE REGULATOR
	Forward and Reverse Bias Characteristics of Zener diode junction diode are obtained by conducting a test.
WEEK- 10	INPUT AND OUTPUT CHARACTERISTICS OF TRANSISTOR IN CB, CE CONFIGURATION
	Transistor applications as Amplifier is observed by operating Transistor in CE, CB configurations.
WEEK- 11	FULL WAVE RECTIFIER WITH AND WITHOUT FILTERS
	Measurement and display of voltage, current wave forms after applying it through a HWR and FWR
WEEK- 12	INPUT AND OUTPUT CHARACTERISTICS OF FET IN CS CONFIGURATION
	FET characteristics are observed after conducting a test.

SECTION 13: Tentative Schedule of Instructions

Week Number	Topics	Duration (Hours)
1	Verification of KVL and KCL	3
2	(i) Measurement of Voltage, Current and Real Power in primary and Secondary Circuits of a Single Phase Transformer , (ii) Verification of Relationship between Voltages and Currents (Star-Delta, Delta-Delta, Delta-Star, Star-Star) in a Three Phase Transformer.	3
3	Measurement of Active and Reactive Power in a balanced Three phase circuit	3
4	Performance Characteristics of a Separately Excited DC Shunt Motor	3
5	Performance Characteristics of a Three phase Induction Motor	3
6	No Load Characteristics of a Three phase Alternator.	3
7	Study and operation of (i) Multimeters (ii) Function Generator (iii) Regulated Power Supplies (iv) CRO.	3
8	P-N Junction diode characteristics	3
9	Zener diode characteristics and Zener as voltage Regulator	3
10	Input and Output characteristics of Transistor in CB, CE configuration	3
11	Full Wave Rectifier with and without filters	3
12	Input and Output characteristics of FET in CS configuration	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: • Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL) fundamentals in electrical circuits • Operating principles of single-phase and three-phase transformers. • Relationship between phase and line voltages/currents in different 3-phase transformer connections (Star-Delta, Delta-Delta, Delta-Star, Star-Star). • Measurement of active and reactive power in three-phase circuits. • Characteristics of DC machines and their performance under load conditions. • Characteristics and performance of three-phase induction motors. • No-load characteristics of synchronous machines (alternators). • Working principles and usage of common test instruments: multimeters, function generators, regulated power supplies, CRO. • V-I characteristics of PN junction diodes. • Input/output characteristics of Bipolar Junction Transistor (BJT) in CB and CE configurations. • Rectification principles and effect of filters in rectifier circuits. • Input/output characteristics of Field Effect Transistor (FET) in CS configuration.	**Learners can:** • Apply KVL and KCL to verify practical electrical networks. • Measure voltage, current, and real power in single-phase transformer circuits. • Verify and compare voltage and current relationships for different transformer connections. • Accurately measure active and reactive power in balanced 3-phase loads. • Plot performance curves of a separately excited DC shunt motor and analyse efficiency, speed, and torque. • Conduct tests and determine performance characteristics of a 3-phase induction motor. • Conduct no-load test on a 3-phase alternator and evaluate generated EMF characteristics. • Operate electrical measuring instruments and use them effectively for diagnostics and circuit testing. • Obtain and interpret forward and reverse bias characteristics of PN junction diodes. • Plot Zener diode characteristics and implement Zener diode as a voltage regulator. • Conduct transistor experiments and analyse input/output characteristics in CB, CE modes. • Design and test full-wave rectifiers with and without filters and Measure and interpret FET characteristics in common source mode..

EXPERIMENTS FOR ENHANCED LEARNING (EEL):

S.No	Design Oriented Experiments
1	Simulation of real-world circuits using MULTISIM
2	Apply energy measuring circuits using NI Lab view.
3	Measurement and display of voltage, current wave forms, frequency Lissajous patterns and THD using Lab VIEW.
4	Inductance measurement using Anderson bridge and capacitance measurement using Schering bridge and verification with Lab VIEW.

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 experiments NET METERING	24.07.2016
R 18	No changes in the Title of the lab as usual Changes from R16 to R18 regulation Expt. 10: Crompton Dc Potentiometer Expt. 11: Analysis Of Wave Forms, Frequency and Thd Using Digital Simulation Expt. 13: Working Of Static Energy Meter Using Digital Simulation	09.07.2018
UG 20	No changes in the Title of the lab and experiments	17.11.2020
BT 23	No changes in the Title of the lab and experiments	21.08.2023
BT25	Experiment 02: (i) Measurement of Voltage, Current and Real Power in primary and Secondary Circuits of a Single-Phase Transformer, (ii) Verification of Relationship between Voltages and Currents (Star-Delta, Delta-Delta, Delta-Star, Star-Star) in a Three Phase Transformer Experiment 03: Measurement of Active and Reactive Power in a balanced Three phase circuit Experiment 05: Performance Characteristics of a Three phase Induction Motor. Experiment 06: No Load Characteristics of a Three phase Alternator. Experiment 07: Study and operation of (i) Multimeters (ii) Function Generator (iii) Regulated Power Supplies (iv) CRO.	26-08-2025

Course Outline Approvals	
Course Coordinator Name: Dr. SK. Abdul Pasha Signature: Date:	**Head of the Department** Name: Dr. Damodhar Reddy Signature: Date:
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	

Signature of Course Coordinator
Dr. SK. Abdul Pasha, Assistant Professor

HOD, EEE

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

COURSE OUTLINE DESCRIPTION

SECTION 1: General Information about the Course	
Course Title	**PROGRAMMING FOR PROBLEM SOLVING LABORATORY**
Course Code	ACSE07
Course Start	SECOND SEMESTER
Course Type	Core
Regulation	IARE - BT 25
Prerequisite Courses	Object Oriented Programming
Department	Aeronautical Engineering
Number of Credits	2 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Laboratory
Course Coordinator's Name	**Dr. S. Srikanth**
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=1684
Course Description	The course is designed with the fundamental programming skills and problem-solving strategies necessary to tackle a wide range of computational challenges. Through hands-on programming exercises 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. Martin C. Brown. "Python: The Complete Referencel ", Mc. Graw Hill, Indian Edition,2018. **REFERENCE BOOKS:** 1. Paul Barry "Head First Python: A Brain-Friendly Guide", O'Reilly, 2nd Edition, 2016 2. Taneja Sheetal, Kumar Naveen "Python Programming – A Modular Approach", Pearson, 1st Edition, 2017. 3. 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 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	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	**Adapt** programming concepts, syntax, and data structures through hands on coding exercises.	Apply

CO2	**Develop** the ability to solve a variety of programming problems and algorithms using python.	Apply
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.	Understand
CO5	**Develop** critical thinking skills to solve the various real-world applications using graph theory.	Apply
CO6	**Illustrate** 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	66.66
Analyse	0
Evaluate	0
Create	0

SECTION 4: Programming For Problem Solving Laboratory	
CO1	**Adapt programming concepts, syntax, and data structures through hands on coding exercises.**
	1. Getting Started Exercises
CO2	**Develop the ability to solve a variety of programming problems and algorithms using python.**
	1. Exercises on simple problems using lists I. 2. Exercises on simple problems using lists II. 3. Exercises on simple problems using tuples. 4. Exercises on simple problems using dictionaries. 5. Exercises on simple problems using sets.
CO3	**Implement complex and custom data structures to solve real-world problems.**
	1. Exercises on matrix operations
CO4	**Demonstrate proficiency in implementing graph algorithms to solve variety of problems and scenarios.**
	1. Exercises on graph representation 2. Exercises on Graph Routing Algorithms
CO5	**Develop critical thinking skills to solve the various real-world applications using graph theory.**
	1. Exercises on graph colouring 2. Exercises on Shortest Path Algorithms
CO6	**Illustrate the importance of numerical methods and apply them to tackle a wide range of computational problems.**
	1. Exercise on Functions I 2. Exercise on Functions II

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: Project based skills

Studying Essentials of problem solving equips the students with a range of employability skills that are highly valued in industries.

Employability Skills:

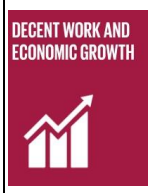
- Problem-solving skills for designing efficient solutions.
- Logical and analytical thinking for data organization.
- Proficiency in programming languages like C / C++ / Java / Python.
- Optimization skills for time and space complexity.
- Knowledge of scalable and robust system design.
- Teamwork and 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 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:** 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	•	•	•	•	•	•		•	•		•	•	•	•																											12
	PO 2	•	•	•	•	•	•		•	•		•	•	•	•																											12
	PO 3																•	•	•			•																					4
	PO 11																													•	•	•			•	•							5
	PSO 1	•	•	•			•		•																																	5
	PSO 3	•	•	•			•		•																																	5
CO2	PO 1	•	•	•	•	•	•		•	•		•	•	•	•																											12
	PO 2	•	•	•	•	•	•		•	•		•	•	•	•																											12
	PO 3																•	•	•			•																					4
	PO 4																													•	•	•			•	•							5
	PO 5		•	•	•	•	•		•														•	•	•																	9
	PO 11																													•	•	•			•	•							5
	PSO 1		•	•			•		•			•																															5
	PSO 3		•	•			•		•			•																															5
CO3	PO 1	•	•	•	•	•	•		•	•		•	•	•	•																											12
	PO 2	•	•	•	•	•	•		•	•		•	•	•	•																											12

	PO 3																•	•	•			•																				4
	PO 4																													•	•	•			•	•							5
	PO 5		•	•	•	•	•		•														•	•	•																		9
	PO 11																													•	•	•			•	•							5
	PSO 1		•	•			•		•			•																															5
	PSO 3		•	•			•		•			•																															5
CO4	PO 1	•	•	•	•	•	•		•	•		•	•	•	•																												12
	PO 2	•	•	•	•	•	•		•	•		•	•	•	•																												12
	PO 3																•	•	•			•																					4
	PO 4																													•	•	•			•	•							5
	PO 5		•	•	•	•	•		•														•	•	•																		9
	PO 11																													•	•	•			•	•							5
	PSO 1		•	•			•		•			•																															5
	PSO 3		•	•			•		•			•																															5
CO 5	PO 1	•	•	•	•	•	•		•	•		•	•	•	•																												12
	PO 2	•	•	•	•	•	•		•	•		•	•	•	•																												12
	PO 3																•	•	•			•																					4
	PO 4																													•	•	•			•	•							5
	PO 5		•	•	•	•	•		•														•	•	•																		9
	PO 11																													•	•	•			•	•							5
	PSO 1		•	•			•		•			•																															5
	PSO 3		•	•			•		•			•																															
CO 6	PO 1	•	•	•	•	•	•		•	•		•	•	•	•																												12
	PO 2	•	•	•	•	•	•		•	•		•	•	•	•																												12
	PO 3																•	•	•			•																					4
	PO 4																													•	•	•			•	•							5
	PO 5		•	•	•	•	•		•														•	•	•																		9
	PO 6	•															•	•	•			•				•	•		•														8
	PO 11																													•	•	•			•	•							5
	PSO 1		•	•			•		•			•																															5
	PSO 3		•	•			•		•			•																															5

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	80	80	67	-	-	-	-	-	-	-	71	50	-	80
CO2	80	80	67	71	82	-	-	-	-	-	71	50	-	80
CO3	80	80	67	71	82	-	-	-	-	-	71	50	-	80
CO4	80	80	67	71	82	-	-	-	-	-	71	50	-	80

CO5	80	80	67	71	82	-	-	-	-	-	71	50	-	80
CO6	80	80	67	71	82	72	-	-	-	-	71	50	-	80

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		3
CO2	3	3	3	3	3	-	-	-	-	-	3	2		3
CO3	3	3	3	3	3	-	-	-	-	-	3	2		3
CO4	3	3	3	3	3	-	-	-	-	-	3	2		3
CO5	3	3	3	3	3	-	-	-	-	-	3	2		3
CO6	3	3	3	3	3	3	-	-	-	-	3	2		3
Total	18	18	18	15	15	3	-	-	-	-	18	12		**18**
Maximum value	**3**	**3**	**3**	**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**.	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 for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)	Laboratory experiments, internal and external lab examinations	**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)	Laboratory experiments, internal and external lab examinations	**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).	Laboratory experiments, internal and external lab examinations	**3**
PO 6	Analyze and evaluate societal and environmental aspects while solving **complex engineering problems** for its impact on sustainability with reference to	Laboratory experiments, internal and external lab examinations	**3**

	economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7)		
PO 11	Build the prototype of UAVs and aero-foil models for testing by using low speed wind tunnel towards research in the area of experimental aerodynamics.	Laboratory experiments, internal and external lab examinations	3
PSO 1	Focus on formulation and evaluation of aircraft elastic bodies for characterization of aero elastic phenomena.	Laboratory experiments, internal and external lab examinations	2
PSO 3	Make use of multi physics, computational fluid dynamics and flight simulation tools for building career paths towards innovative startups, employability and higher studies.	Laboratory experiments, internal and external lab examinations	3

a. SECTION 12: Course Content	
WEEK- I	**GETTING STARTED EXERCISES**
	1.1 Bookstore Catalog 1.2 Where Are You From? 1.3 What's Your Favorite Song? 1.4 Quiz Grading System 1.5 Exam Grading System 1.6 Acronym Generator 1.7 Name Numerology Value Calculator 1.8 Sentence Word Counter 1.9 Average Word Length Calculator 1.10 Future Value Calculator
WEEK- 2	**List I**
	2.1 Art Gallery Inventory Checker 2.2 Shoe Store 2.3 Currency Exchange Office 2.4 Getting a New Bike 2.5 Ordering a T-shirt Online 2.6 Alan Turing 2.7 Four Seasons 2.8 Word Search 2.9 Spelling Competition 2.10 Bookstore
WEEK- 3	**List II**
	3.1 Two Sum 3.2 Contains Duplicate 3.3 Roman to Integer 3.4 Plus One 3.5 Majority Element 3.6 Richest Customer Wealth 3.7 Fizz Buzz 3.8 Number of Steps to Reduce a Number to Zero

	3.9 Running Sum of 1D Array 3.10 Remove Element
WEEK- 4	**Tuple**
	4.1 Student Report Card 4.2 Grocery Inventory Tracker 4.3 Quiz Master Analyzer 4.4 Library Book Tracker 4.5 Banking Transaction Log
WEEK- 5	**Dictionary**
	5.1 Student Information 5.2 New T-shirts in the Store 5.3 Colosseum 5.4 At a Pet Clinic 5.5 Juices 5.6 Olympic Games 5.7 Teaching Python 5.8 Furniture Store 5.9 Shifting List Elements 5.10 Numbers in a Triangle
WEEK- 6	**Set**
	6.1 Count the Number of Vowels 6.2 Common Letters between Two English Words 6.3 Missing Letters Finder 6.4 City Travel Tracker 6.5 DNA Sequence Comparison 6.6 Panagram Detector 6.7 Shopping List Optimizer 6.8 Unique Words in Two Articles 6.9 College Course Enrollment 6.10 Lucky Draw Participants
WEEK- 7	**Functions I**
	7.1 Sum of Natural Numbers and Their Cubes 7.2 Compute nth Fibonacci Number 7.3 Next Guess for Square Root Approximation 7.4 Letter Grade from Score 7.5 Convert List of Number Strings to Numeric Values 7.6 Guess the Number Game 7.7 Playing with Numbers 7.8 Flipping Coins – Counting Heads and Tails 7.9 Comparator – Comparing Two Integers Using Boolean Operators 7.10 Digit Power Sum
WEEK- 8	**Functions II**
	8.1 Power and Energy Calculator 8.2 Interest Analyzer 8.3 Statistician’s Data Analyzer

	8.4 Astronomer's Orbit Calculator 8.5 Farmer's Field Division 8.6 Banker's Loan Evaluator
WEEK- 9	**Matrix Operations**
	9.1 Add Two Matrices 9.2 Multiply Two Matrices 9.3 Transpose of a Matrix 9.4 Matrix Product 9.5 Find Maximum Element in Each Row of a Matrix
WEEK-10	**Graph Representation**
	10.1 Build a graph 10.2 Number of Sink Nodes in a Directed Acyclic Graph (DAG) 10.3 Represent a Graph using an Adjacency Matrix 10.4 Represent a Graph using an Adjacency List 10.5 Count the Number of Edges in an Undirected Graph
WEEK-11	**Graph Routing Algorithms**
	11.1 The Seven Bridges of Konigsberg 11.2 Hamiltonian Cycle Detection in a Graph 11.3 Count the Number of Hamiltonian Cycles in a Graph
WEEK-12	**Shortest Path Algorithms**
	12.1 Travelling Salesman Problem 12.2 Shortest Paths from Source to all Vertices (Dijkstra's Algorithm) 12.3 Shortest Cycle in an Undirected Unweighted Graph 12.4 Count Unique and all Possible Paths in a M x N Matrix 12.5 All-Pairs Shortest Paths (Floyd-Warshall Algorithm)
WEEK-13	**Graph Coloring**
	13.1 Graph Coloring using Greedy Algorithm 13.2 Coloring a Cycle Graph 13.3 M-Coloring Problem 13.4 Edge Coloring of a Graph
WEEK-14	**Final Notes**
	Final Notes

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	Final Notes	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 Python programming and its applications in problem-solving. • Data types, variables, and operators in Python. • Conditional statements and loops for decision-making and iteration. • Functions and recursion for modular programming. • Lists, tuples, dictionaries, and sets for data storage and manipulation.	**Learners can:** • Write Python programs to solve real-world problems. • Use conditional statements and loops effectively. • Implement functions and recursion to break problems into sub-problems. • Work with lists, tuples, dictionaries, and sets to manipulate data. • Perform file handling to store and retrieve data. Find the frequency of tuning fork by using Melde's experiment.

EXPERIMENTS FOR ENHANCED LEARNING (EEL): NA

S.No	Design Oriented Experiments
1	Traffic Signal Simulation using Python
2	Smart Home Automation using Python
3	Speech-to-Text and Text-to-Speech Converter using Python
4	Chatbot Development using Python and Natural Language Processing

Administrative Information

SECTION 15: History of changes		
Regulations	**Description of change**	**BOS Date**
BT 23	60% syllabus changed (Change of course name)	21.08.2023
BT 25	30% syllabus changed	29.08.2025

Course Outline Approvals	
Course Coordinator Name: Mr. Srikanth S Signature: Date:	**Head of the Department** Name: Dr. K Rajendra Prasad Signature: Date:
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	**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	Aeronautical Engineering
Number of Credits	3 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Theory
Course Administrator	**Dr. Madhusudan Dolai** Assistant Professor of Mathematics IARE11180 madhusudandolai@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=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/resources/#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	
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.

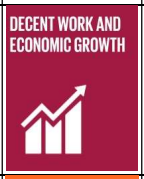
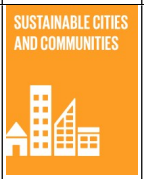
Employability Skills:

- 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																																							
	PSO3																																							

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	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	-	-	-	-	-	-	-	-	-	-	-	-
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 the prototype of UAVs and aero-foil models for testing by using low speed wind tunnel towards research in the area of experimental aerodynamics.	AAT: 1 – 1 Tech-Talk	
PSO 2	Focus on formulation and evaluation of aircraft elastic bodies for characterization of aero elastic phenomena.	AAT: 2 – 1 Complex Engineering Problem Solving	
PSO 3	Make use of multi physics, computational fluid dynamics and flight simulation tools for building career paths towards innovative startups, employability and higher studies.	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^n 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 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:** Law of natural growth and decay	02.09.2025

	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. 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. 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	**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	Aeronautical Engineering
Number of Credits	2 Credit hours
Academic Year	2025-26
Method(s) of Instruction	Laboratory
Course Coordinator's Name	**R Srinivas,** Assistant Professor of Mechanical Engineering IARE10884 **r.srinivas@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 the prototype of UAVs and aero-foil models for testing by using low speed wind tunnel towards research in the area of experimental aerodynamics.	AAT: 1 – 1 Tech-Talk	2
PSO 2	Focus on formulation and evaluation of aircraft elastic bodies for characterization of aero elastic phenomena.	AAT: 2 – 1 Complex Engineering Problem Solving	3
PSO 3	Make use of multi physics, computational fluid dynamics and flight simulation tools for building career paths towards innovative startups, employability and higher studies.	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	**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

Industry-Specific Knowledge – Applying AutoCAD skills in civil, Electronics and Communication , 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.	tasks, meeting deadlines, and handling revisions. 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	**Head of the Department**
Name:	Name:
Signature:	Signature:
Date:	Date:
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	