Department of Mechanical Engineering,
Institute of Technology, University of Kashmir,
Zakura Campus, Srinagar

COURSE STRUCTURE, M.Tech, Design Engineering, Batch 2025

SEMESTER- 1 (One)

S.No	Course Category	Course Code	Course Name	L	T	P	Credits	Examination Scheme (Distribution of Marks)				
								ISE		ISE	ESE	Total
								MSE	IA			
1	Professional Core Course	MODECFE125	Finite Element Methods	3	1	0	4	20	10	30	70	100
2	Laboratory Course	MODELFE125	Finite Element Methods Lab	0	0	4	2	-	-	15	35	50
3	Laboratory Course	MODELPM125	Programming with MATLAB	0	0	4	2	-	-	15	35	50
4	Professional Core Course	MODECTD125	Tribology in Design	3	1	0	4	20	10	30	70	100
5	Laboratory Course	MODELTD125	Tribology in Design Lab	0	0	4	2	-	-	15	35	50
6	Professional Core Course	MODECFD125	Advanced Fluid Dynamics	3	1	0	4	20	10	30	70	100
7	Professional Elective Course	MODED**125	Professional Elective I	3	1	0	3	15	5	20	55	75
			Total Hours	**12**	**4**	**12**	21	Total Semester Marks				**525**
					28		Total Credits					

SEMESTER- 2 (Two)

S.No	Course Category	Course Code	Course Name	L	T	P	Credits	Examination Scheme (Distribution of Marks)				
								ISE		ESA	ESA	Total
								MSE	IA			
1	Professional Core Course	MODECCF225	Computational Fluid Dynamics	3	1	0	4	20	10	30	70	100
2	Laboratory Course	MODELCF225	Computational Fluid Dynamics Lab	0	0	4	2	-	-	15	35	50
3	Professional Core Course	MODECCR225	Conduction and Radiation	3	1	0	4	20	10	30	70	100
4	Professional Core Course	MODECAH225	Alloy Development & Heat Treatment	3	1	0	4	20	10	30	70	100
5	Professional Core Course	MODECFF225	Fracture Fatigue & Creep	3	1	0	4	20	10	30	70	100
6	Professional Elective Course	MODED**225	Professional Elective II	3	1	0	4	20	10	30	70	100
7	Audit Course	MODEA**225	Audit Course I	3	0	0	0	15	5	20	55	75
			Total Hours	**18**	**5**	**4**	**22**	Total Semester Marks				**625**
					27		Total Credits					

SEMESTER- 3 (Three)

S.No	Course Category	Course Code	Course Name	L	T	P	Credits	Examination Scheme (Distribution of Marks)				
								ISE		ESE	ESA	Total
								MSE	IA			
1	Professional Elective Course	MODED**325	Professional Elective III	2	1	0	3	15	5	20	55	75
2	Professional Elective Course	MODED$$325	Professional Elective IV	2	1	0	3	15	5	20	55	75
3	Project Course	MODEPDP325	Dissertation Phase-I	0	0	14	7	35	15	50	125	175
4	Seminar Course	MODEYSE325	Seminar	0	0	4	2	10	5	15	35	50
5	Open Elective Course	MODEO##325	Open Elective Course-I	3	0	0	3	15	5	20	55	75
6	Audit Course	MODEA**325	Audit Course II	3	0	0	0	15	5	20	55	75
			Total Hours	**10**	**2**	**18**	18	Total Semester Marks				**525**
					30		Total Credits					

SEMESTER- 4 (Four)

S.No	Course Category	Course Code	Course Name	L	T	P	Credits	Examination Scheme (Distribution of Marks)		
								ISE	ESA	Total
1	Project Course	MODEPDP425	Dissertation Phase-II	0	0	30	15	50	325	375
			Total Hours		**30**		**Total Credits**	Total Semester Marks		**375**
					Total Credits		**15**			

List of Professional Elective Courses, Open Elective Courses & Audit Courses			
Course Category	**Course Code**	**Course Name**	**Semester**
Professional Elective I	MODEDCM125	Computational Methods in Engineering	1st
	MODEDPP125	Programming with Python	
	MODEDCM125	Continum Mechanics	
Professional Elective II	MODEDPM225	Project Management	2nd
	MODEDDT225	Design Thinking	
Professional Elective III	MODEDMC325	Mechanics of Composite Materials	3rd
	MODEDDT325	Design of Thermal Systems	
	MODEDAS325	Advanced Solid Mechanics	
	MODEDPO325	Programming with Open Foam	
	MODEDTT325	Wind Turbine Tribology	
Professional Elective IV	MODEDAM325	Artificial Intelligence & Machine Learning	3rd
	MODEDMA325	Mathematics for AI & ML	
	MODEDSM325	SWAYM (MOOC)	
Open Elective I	MODEORE325	Renewable Energy Systems	3rd
	MODEOBH325	HVAC Systems and Sustainable Building Codes & Services	
	MODEOPA325	3D Printing & Additive Manufacturing	
	MODEOIR325	Industrial Automation & Robotics	
Audit I	MODEASD225	Academic Writing	2nd
	MODEALE225	Literature for Engineers	
Audit II	MODEADE325	Design of Experiments	3rd
	MODEARM325	Research Methodology	
	MODEASM325	Statistical Methods for Research	
	MODEAME325	Machine Learning for Experimentation	

M. Tech. Design Engineering

Programme Specific Outcomes

PSO No.	Program Specific Outcome
PSO1	Apply principles of solid mechanics, tribology, fatigue, vibration, and thermal analysis to design, optimize, and validate advanced mechanical systems and components.
PSO2	Use state-of-the-art CAD/CAE tools, finite element methods (FEM), computational fluid dynamics (CFD), and multi-physics simulations for modeling, analysis, and product development
PSO3	Develop innovative product designs integrating materials, manufacturing processes (including additive manufacturing and Industry 4.0 concepts), and lifecycle considerations
PSO4	Undertake independent research, contribute to new knowledge in mechanical design engineering, and apply ethical, sustainable, and cost-effective design solutions in industry and academia.
PSO5	Demonstrate professionalism, ethical responsibility, and safety awareness while working on mechanical engineering projects in multidisciplinary teams.

Programme Learning Outcome

PLO No.	Program Learning Outcome
PLO1	Engineering Knowledge Apply advanced knowledge of mathematics, mechanics, materials science, and mechanical engineering fundamentals to design engineering problems.
PLO2	Problem Analysis Identify, analyze, and critically evaluate complex design problems in mechanical systems using engineering principles and research-based knowledge.
PLO3	Conceptualize, model, and develop mechanical systems, components, and products that meet desired specifications considering performance, safety, ergonomics, reliability, and sustainability
PLO4	Carry out independent research and investigations in areas such as finite element analysis, computational fluid dynamics, fatigue, fracture mechanics, and tribology to arrive at valid conclusions.
PLO5	Use modern CAD/CAE/CAM tools, simulation platforms, and optimization techniques for modeling, analyzing, and validating mechanical design solutions.
PLO6	Apply mechanical engineering knowledge to assess societal, legal, ethical, and health/safety issues in the design and deployment of mechanical systems.
PLO7	Evaluate the environmental impact of design choices in mechanical systems and apply sustainable design practices including energy-efficient materials and processes.
PLO8	Demonstrate professional integrity, ethical responsibility, and adherence to engineering standards in academic, research, and industrial practices.
PLO9	Work effectively as an individual and as a member/leader in multidisciplinary teams to solve advanced design engineering problems.
PLO10	Communicate effectively in mechanical design contexts through technical reports, product documentation, CAD models, design reviews, and presentations.
PLO11	Apply engineering management and financial principles to mechanical design projects, including cost estimation, lifecycle analysis, and project scheduling
PLO12	Engage in independent learning and continuous professional development in areas such as advanced materials, computational methods, Industry 4.0, additive manufacturing, and smart product design.

SEMESTER- 1															
			Average Programme Learning Outcome (PLO) Score												
S.No.	Course Code	Course Title	1	2	3	4	5	6	7	8	9	10	11	12	Cumulative Avg
1	MODECFE125	Finite Element Methods	1.83	2.5	1.83	1.67	2.33	1	1	1.17	1.33	2	0.83	1.83	1.61
2	MODELFE125	Finite Element Methods Lab	1.83	2.5	1.83	1.67	2.33	1	1	1.17	1.33	2	0.83	1.83	1.61
3	MODELPM125	Programming with MATLAB	2.83	3	2.67	2.33	2.17	1.17	1.33	1.17	1.83	2.17	1.17	2.33	2.01
4	MODECTD125	Tribology in Design	2.83	2.83	2.33	2.33	2.17	0.33	1.5	0.17	0.17	1.33	0.33	2.33	1.55
5	MODELTD125	Tribology in Design Lab	2.67	2.5	1.83	2.67	2	0	1	0.17	1.17	2.17	1.17	2.17	1.63
6	MODECFD125	Advanced Fluid Dynamics	3	2.83	2.33	2.17	2.17	0.33	1	0.33	0.17	1.83	0.17	2.17	1.54
	MODED**125	Professional Elective-I (Any one of the following)													
	MODEDCM125	Computational Methods in Engineering	3	2.83	2.17	2.33	3	1	1	1	1.5	2.33	1.33	2.33	1.99
	MODEDPP125	Programming with Python	2.83	2.83	2.33	1.67	2.67	1.17	1.33	1.17	2	2.33	1.17	2.67	2.01
7	MODEDCM125	Continum Mechnaics	3	2.5	2.17	2.5	1.67	0.67	0.33	0.67	0.33	1.33	0.33	2.33	1.49

SEMESTER- 2															
			Average Programme Learning Outcome (PLO) Score												
S.No.	Course Code	Course Title	1	2	3	4	5	6	7	8	9	10	11	12	Cumulative Avg
1	MODECCF225	Computational Fluid Dynamics	2.83	2.83	1.33	2	0.83	0.33	0.83	0.5	0.33	1.33	0.33	2.17	1.3
2	MODELCF225	Computational Fluid Dynamics Lab	3	2.83	2.33	2.5	2.83	0.33	0.83	0.33	0.33	1.67	0.17	2.17	1.61
3	MODECCR225	Conduction and Radiation	3	3	2	2.5	2.5	1.33	2.17	1.17	1.17	2.17	1.17	2.17	2.03
4	MODECAH225	Alloy Development & Heat Treatment	2.83	2.33	2.33	1.83	1.5	1.33	1.5	1.17	1.33	1.5	0.67	2.33	1.72
5	MODECFF225	Fracture Fatigue & Creep	2.33	2.5	2	2.5	1.83	1.33	1.33	1.33	1	1.5	0.83	2.17	1.72
	MODED**225	Professional Elective II (Any one of the following)													
	MODEDPM225	Project Management	2.83	2.83	1.33	2	1.5	0.33	0.83	0.5	0.67	1.5	2.17	2.17	1.56
6	MODEDDT225	Design Thinking	2.83	2.83	1.33	2	1.5	0.33	0.83	0.5	0.67	1.5	3	2.17	1.62
	MODEA**225	Audit Course-I (Any one of the following)													
	MODEASD225	Academic Writing	1.33	2	1.33	1.33	0.67	2.17	2	2.5	1.5	2.17	1	2.17	1.68
7	MODEALE225	Literature for Engineers	0.33	1.17	0.33	0	0	2.5	2.17	2.5	1.83	2.17	0	2.17	1.26

SEMESTER- 3															
			Average Programme Learning Outcome (PLO) Score												
S.No.	Course Code	Course Title	1	2	3	4	5	6	7	8	9	10	11	12	Cumulative Avg
	MODED**325	Professional Elective III (Any one of the following)													
	MODEDMC325	Mechanics of Composite Materials	2.83	2.67	1.83	2.17	2.17	1.5	0.83	1.33	1	1.33	0.83	2	1.71
	MODEDDT325	Design of Thermal Systems	2.83	2.83	2.67	2.5	2.67	2	2.33	2	1.5	2.17	2.33	3	2.4
	MODEDAS325	Advanced Solid Mechanics	3	2.5	2	1.17	1.17	0.17	1.17	1.33	0.5	1.33	0.17	2.17	1.39
	MODEDPO325	Programming with Open Foam	2.83	2.67	2.5	2.33	2.83	1.33	1.83	1.17	2	1.83	1.33	2.17	2.07
1	MODEDTT325	Wind Turbine Tribology	2.5	2.5	2.17	2.17	2.17	1.67	1.67	1.33	0.5	2.33	1.5	2.5	1.92
	MODED$$325	Professional Elective- IV (Any one of the following)													
	MODEDAM325	Artificial Intelligence & Machine Learning	2.83	2.67	2.33	1.83	2.5	0.83	0.5	0.67	0.67	1.67	0.33	2.33	1.6
	MODEDMA325	Mathematics for AI & ML	2.83	2.83	1.33	2	0.83	0.33	0.83	0.5	0.33	1.33	0.33	2.17	1.3
	MODEDSM325	SWAYM (MOOC)													
2	MODEORE325	Renewable Energy Systems	2.5	2.33	2	2	1.83	2.17	2.83	1.33	0.5	2.17	1.5	2.33	1.96
3	MODEPDP325	Dissertation Phase-I	3	3	3	3	3	3	2	2	3	3	2	3	2.75
4	MODEYSE325	Seminar	3	3	3	3	3	3	2	3	3	3	2	3	2.83
	MODEO##325	Open Elective Course-I (Any one of the following)													
	MODEOBH325	HVAC Systems and Sustainable Building Codes & Services	2.83	2.67	2.33	1.5	2.5	1.33	1.83	0.5	0.67	1.5	0.83	2	1.71
	MODEOPA325	3D Printing & Additive Manufacturing	2.67	2.33	2.33	1.5	2.5	1.17	1.5	0.83	0.33	1.67	0.5	2.17	1.63
5	MODEOIR325	Industrial Automation & Robotics	2.83	2.5	1.17	0.33	1.17	0.5	0.5	0	0.17	1	0	1.5	0.97
	MODEA**325	Audit Course-II (Any one of the following)													
	MODEADE325	Design of Experiments	3	2.83	2.33	1.83	2.67	0.33	1	0.83	0.5	1.67	0.67	2	1.64

	MODEARM325	Research Methodology	2.5	2.67	1.5	2.5	1.67	0.83	0.67	1.83	0.83	2.17	1.33	3	1.79
	MODEASM325	Statistical Methods for Research	3	3	2	2.5	2.17	0	0	0.17	0	1	0	2	1.32
6	MODEAME325	Machine Learning for Experimentation	2.83	2.83	1.33	2	0.83	0.33	0.83	0.5	0.33	1.33	0.33	2.17	1.3

SEMESTER- 4															
			Average Programme Learning Outcome (PLO) Score												
S.No.	Course Code	Course Title	1	2	3	4	5	6	7	8	9	10	11	12	Cumulative Avg
1	MODEPDP425	Dissertation Phase-II	3	3	3	3	3	3	3	3	3	3	0.33	2.17	2.71

Course Code	**MODECFE125**	***Semester***	***First***	***Contact Hours***	***52***
Course Title	**Finite Element Methods**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	3	1	0	4	100
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Explain the fundamental mathematics and principles behind the finite element method
CLO2	Develop finite element models for different types of mechanical engineering problems.
CLO3	Solve engineering problems using FEM and interpret the results accurately.
CLO4	Use FEM software tools to simulate and analyze mechanical systems.
CLO5	Identify and discuss the limitations and sources of errors in FEM analysis.
CLO6	Present FEM analysis results clearly through technical reports and presentations

SYLLABUS

Units	**Content**	**Marks**
1	Introduction to Finite Element Analysis: Introduction, Basic Concepts of Finite ElementAnalysis, Introduction to Elasticity, Steps in Finite ElementAnalysis	20
2	Finite Element Formulation Techniques: Virtual Work and Variational Principle, Galerkin Method, DisplacementApproach, Stiffness Matrix and Boundary Conditions	20
3	Element Properties: Natural Coordinates, Triangular Elements, Rectangular Elements, Lagrange and Serendipity Elements, Solid Elements, Isoparametric Formulation, Stiffness Matrix of Isoparametric Elements, Numerical Integration; One Dimensional, Numerical Integration; Two and Three Dimensional, Worked out Examples	20
4	Analysis of Frame Structures: Stiffness of Truss Members, Analysis of Truss, Stiffness of Beam Members, Finite Element Analysis of Continuous Beam, Plane Frame Analysis, Analysis of Grid and Space Frame	20
5	FEM for Two and Three Dimensional Solids: Constant Strain Triangle, Linear Strain Triangle, Rectangular Elements, Numerical Evaluation of Element Stiffness, Computation of Stresses, Geometric Nonlinearity, Axisymmetric Element, Finite Element Formulation of Axisymmetric Element, Finite Element Formulation for 3 Dimensional Elements, Worked out Examples	20

CLO-PLO Mapping Matrix

CLO/PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO1**	**Avg CLO**
CLO1	3	2	1	2	2	0	0	0	0	1	0	2	**1.08**
CLO2	2	3	2	2	3	1	1	1	2	2	1	2	**1.83**
CLO3	2	3	2	2	2	1	1	1	1	2	1	2	**1.67**
CLO4	1	2	2	1	3	1	1	1	2	2	1	2	**1.58**
CLO5	2	3	2	2	2	2	2	2	1	2	1	2	**1.92**
CLO6	1	2	2	1	2	1	1	2	2	3	1	1	**1.58**
Avg PLO	**1.83**	**2.5**	**1.83**	**1.67**	**2.33**	**1**	**1**	**1.17**	**1.33**	**2**	**0.83**	**1.83**	1.61

Suggested reading:

1	*J. N. Reddy. An introduction to the Finite Element Method, McGraw-Hill*
2	*R. D. Cook, Concepts and Applications of Finite ElementAnalysis , Wiley*
3	*S.S. Rao, Finite ElementAnalysis, Elsevier Butterworth-Heinemann*
4	*K. J.Bathe, Finite Element Procedures, Prentice-Hall of India, New Delhi, India*
5	*C.S.Krishnamoorty, Finite ElementAnalysis, Tata McGraw-Hill*

Teaching-Learning Strategies:

Interactive Lectures, MATLAB Simulations, Industry Seminars, Assignments, Case-based Learning

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODELFE125**	*Semester*	*First*	*Contact Hours*	*52*
Course Title	**Finite Element Methods Lab**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	0	0	4	2	50
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Explain the fundamental mathematics and principles behind the finite element method
CLO2	Develop finite element models for different types of mechanical engineering problems.
CLO3	Solve engineering problems using FEM and interpret the results accurately.
CLO4	Use FEM software tools to simulate and analyze mechanical systems.
CLO5	Identify and discuss the limitations and sources of errors in FEM analysis.
CLO6	Present FEM analysis results clearly through technical reports and presentations

SYLLABUS

Units	Content	Marks
1	Stress analysis of a cantilever beam subjected to point and distributed loads.	50
2	Study of mesh convergence and its effect on FEM results.	
3	Study of steady state heat flow Example using FEM	
4	Stress analysis of a simply supported beam subjected to point and distributed loads.	
5	Modeling and analysis of a simply supported plate under uniform pressure.	
6	Contact analysis between two mechanical parts (e.g., pin and hole).	
7	Analysis of a composite or laminated structure.	
8	Static analysis of a truss structure	
9	Analysis of a composite or laminated structure.	

CLO-PLO Mapping Matrix

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO 12	Avg CLO
CLO1	3	2	1	2	2	0	0	0	0	1	0	2	**1.08**
CLO2	2	3	2	2	3	1	1	1	2	2	1	2	**1.83**
CLO3	2	3	2	2	2	1	1	1	1	2	1	2	**1.67**
CLO4	1	2	2	1	3	1	1	1	2	2	1	2	**1.58**
CLO5	2	3	2	2	2	2	2	2	1	2	1	2	**1.92**
CLO6	1	2	2	1	2	1	1	2	2	3	1	1	**1.58**
Avg PLO	**1.83**	**2.5**	**1.83**	**1.67**	**2.33**	**1**	**1**	**1.17**	**1.33**	**2**	**0.83**	**1.83**	1.61

Suggested reading:

1 *J. N. Reddy. An introduction to the Finite Element Method, McGraw-Hill*

2 *R. D. Cook, Concepts and Applications of Finite ElementAnalysis , Wiley*

3 *S.S. Rao, Finite ElementAnalysis, Elsevier Butterworth-Heinemann*

4 *K. J.Bathe, Finite Element Procedures, Prentice-Hall of India, New Delhi, India*

5 *C.S.Krishnamoorty, Finite ElementAnalysis, Tata McGraw-Hill*

Teaching-Learning Strategies:

Interactive Lectures, Simulations, Industry Seminars, Assignments, Case-based Learning

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.

Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODELPM125**	***Semester***	***First***	***Contact Hours***	***52***
Course Title	**Programming with MATLAB**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	0	0	4	2	50
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Demonstrate understanding of the MATLAB environment, syntax, variables, operators, script/function files, and debugging tools for solving engineering problems.
CLO2	Apply conditional statements, loops, and user-defined/anonymous functions to develop modular and efficient MATLAB programs.
CLO3	Manipulate vectors, matrices, cell arrays, and structures; perform file input/output operations to process engineering datasets.
CLO4	Solve algebraic equations, perform numerical differentiation/integration, and apply MATLAB solvers for ODEs, PDEs, interpolation, and optimization in mechanical engineering contexts
CLO5	Create effective 2D/3D plots, visualize experimental/mechanical data, and use Simulink for modeling and analyzing dynamic systems.
CLO6	Apply MATLAB and Simulink for vibration analysis, heat transfer, CFD basics, FEM, and robotics/control system case studies, culminating in a mini-project.

SYLLABUS

Units	Content	Marks
1	Introduction to MATLAB Environment: MATLAB desktop, workspace, command window, editor, Basic syntax and operations, Variables, data types, constants, Operators (arithmetic, relational, logical), Script files vs. function files, Input/Output commands, Debugging techniques.	50
2	Control Structures and Functions: Conditional statements: if, else, elseif, switch, Looping constructs: for, while, break, continue, User-defined functions: input/output arguments, function handles, Anonymous functions and inline functions, Recursion and vectorized operations	
3	Arrays, Data Structures, and File Handling: Vectors, matrices, and multidimensional arrays Matrix operations and linear algebra	
4	Numerical and Scientific Computing: Solving linear and nonlinear equations (fsolve, roots), Numerical differentiation and integration (diff, integral, trapz), Ordinary Differential Equations (ODE solvers: ode45, ode15s), Partial Differential Equation (PDE) introduction using MATLAB PDE toolbox Interpolation and curve fitting (polyfit, interp1, spline), Optimization basics (fminsearch, fmincon)	
5	Data Visualization and Analysis: 2D plotting: line, scatter, bar, pie, histogram, 3D plotting: surface, mesh, contour, quiver plots, Subplots and multiple figure handling, Data visualization for experimental/mechanical datasets, Exploratory data analysis and statistical functions, Introduction to Simulink for mechanical systems modeling	
6	Advanced Applications in Mechanical Engineering: MATLAB for mechanical design and analysis: Vibration analysis and modal shapes, Heat transfer and thermodynamics simulations, Computational fluid dynamics (basic MATLAB-based solvers), Finite Element Method (FEM) basics in MATLAB. MATLAB-Simulink integration for dynamic system modeling, Case studies in automation, robotics, and control systems, Mini-project: Develop a MATLAB program or Simulink model for a mechanical engineering problem (e.g., vibration response, thermal system, optimization of design parameters).	

CLO-PLO Mapping Matrix

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12	Avg CLO
CLO1	3	3	2	2	2	1	1	1	1	2	1	2	**1.75**
CLO2	3	3	3	2	2	1	1	1	1	2	1	2	**1.83**
CLO3	3	3	3	2	2	1	1	1	2	2	1	2	**1.92**
CLO4	3	3	2	3	2	1	1	1	2	2	1	2	**1.92**
CLO5	3	3	3	3	3	1	1	1	2	2	1	3	**2.17**
CLO6	2	3	3	2	2	2	3	2	3	3	2	3	**2.5**
Avg PLO	**2.83**	**3**	**2.67**	**2.33**	**2.17**	**1.17**	**1.33**	**1.17**	**1.83**	**2.17**	**1.17**	**2.33**	2.17

Suggested reading:

1	*MATLAB for Engineers – Holly Moore*
2	*MATLAB Programming for Engineers – Stephen J. Chapman*
3	*Numerical Methods with MATLAB – Gerald & Wheatley*
4	*Applied Numerical Methods with MATLAB for Engineers & Scientists – Steven Chapra*
5	*MATLAB Documentation & MathWorks Online Tutorials (latest resources)*

Teaching-Learning Strategies:

Interactive Lectures, Incremental problem-solving, MATLAB scripts/functions, Simulation-Based Learning, Pair programming for MATLAB coding tasks,

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODECTD125**	*Semester*	*First*	*Contact Hours*	*52*
Course Title	**Tribology in Design**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	3	1	0	4	100
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Distinguish between different lubrication regimes: boundary, mixed, hydrodynamic, and hydrostatic. Incorporation of Reynolds equation to 1D and 2D flow problems in journal and slider bearings.
CLO2	Calculate the load-carrying capacity, frictional force, and energy loss for idealized hydrodynamic bearings.
CLO3	Analyze the geometry and function of journal bearings using short and long bearing approximations.
CLO4	Incorporate thermal correction into Reynolds equation and evaluate performance under thermal loads.
CLO5	Implement the Finite Difference Method (FDM), Computational Fluid Dynamics (CFD) to solve lubrication problems numerically.
CLO6	Relate hydrodynamic lubrication principles to real-world systems (turbomachinery, IC engines, marine and hydro turbines) and propose energy-efficient and sustainable lubrication solutions.

SYLLABUS

Units	**Content**	**Marks**
1	Fundamentals of Lubrication: Introduction to tribology and lubrication regimes: boundary, mixed, hydrodynamic, elastohydrodynamic. Role of lubricants: viscosity, rheology, additives. Mechanisms of load support in fluid films. Historical development of lubrication theory.	16
2	Derivation of Reynolds Equation: Governing equations of fluid motion (Navier–Stokes, continuity). Assumptions for thin-film lubrication. Derivation of Reynolds equation for incompressible and compressible lubricants. Simplifications and boundary conditions.	16
3	Hydrodynamic Journal Bearings: Infinitely long and infinitely short journal bearings. Pressure distribution, load-carrying capacity, and attitude angle. Friction, power loss, and temperature rise. Sommerfeld number and bearing performance charts. Experimental correlations and design data.	16
4	Hydrodynamic Thrust Bearings: Plane inclined slider and step bearings. Tilting pad thrust bearings. Pressure distribution and load capacity. Applications in heavy-duty machinery and turbines.	18
5	Advanced Analysis of Bearings: Thermal effects: viscosity variation, temperature rise. Cavitation phenomena and boundary conditions. Dynamic characteristics: stiffness, damping, stability. Misalignment, surface roughness, and deformation effects.	18
6	Applications and Modern Trends: Hydrodynamic lubrication in IC engines, turbines, pumps, and marine bearings. Hydrostatic and hybrid bearings (brief introduction). Energy efficiency, eco-friendly lubricants, water-lubricated bearings. Numerical solution techniques (FDM, FEM, CFD approaches). Case studies & research frontiers	16

CLO-PLO Mapping Matrix

CLO/PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**	**Avg CLO**
CLO1	3	2	2	2	2	0	1	0	0	1	0	2	**1.25**
CLO2	3	3	2	2	2	0	1	0	0	1	0	2	**1.33**
CLO3	3	3	3	2	2	0	1	0	0	1	0	2	**1.42**
CLO4	3	3	2	3	2	0	2	0	0	1	0	2	**1.5**
CLO5	3	3	2	3	3	0	1	0	0	2	0	3	**1.67**
CLO6	2	3	3	2	2	2	3	1	1	2	2	3	**2.17**
Avg PLO	**2.83**	**2.83**	**2.33**	**2.33**	**2.17**	**0.33**	**1.5**	**0.17**	**0.17**	**1.33**	**0.33**	**2.33**	1.55

Suggested reading:

1	*B.C. Majumdar, Introduction to Tribology of Bearings*
3	*Harish Hirani, Fundamentals of Engineering Tribology with Application, (Cambridge University Press, 2016)*
4	*Oscar Pinkus & Beno Sternlicht, Theory of Hydrodynamic Lubrication, (Classic, 1961; reprints available)*
5	*Yukio Hori, Hydrodynamic Lubrication, (Springer Japan, 2006; reprint 2016)*

Teaching-Learning Strategies:

Interactive Lectures, MATLAB/FORTRAN Simulations, Industry Seminars, Assignments, Case-based Learning

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODELTD125**	***Semester***	***First***	***Contact Hours***	***52***
Course Title	**Tribology in Design Lab**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	0	0	4	2	50
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Distinguish between different wear testing configurations (pin-on-disc, ball-on-disc, block-on-ring) and explain their relevance to contact mechanics.
CLO2	Conduct pin-on-disc and ball-on-disc tests to measure coefficient of friction (COF) and wear rate under sliding contact.
CLO3	Perform reciprocating wear (fretting) tests and interpret fretting wear maps for engineering applications such as splines and joints.
CLO4	Evaluate wear and friction behavior in line contact using block-on-ring and four-ball tests, and interpret results for gear and bearing applications.
CLO5	Assess abrasive wear resistance of materials using dry sand/rubber wheel and Taber abrasion tests, and compare material performance.
CLO6	Analyze high-temperature wear testing data to understand material performance in turbines, brakes, and high-temperature alloys, and propose material/lubricant solutions.

SYLLABUS

Units	Content	Marks
1	Pin-on-Disc Test, Measures coefficient of friction (COF) and wear rate under sliding contact.	50
2	Ball-on-Flat / Ball-on-Disc Test, Variant of pin-on-disc using spherical contact. Useful for contact mechanics & fretting studies	
3	Reciprocating Wear (Fretting Test), Simulates oscillatory contacts (splines, joints, electrical contacts). Used to generate fretting wear maps	
4	Block-on-Ring Test, Sliding wear under line contact. Common for gear/tooth contact and bearing applications.	
5	Four-Ball Test, For lubricant evaluation (anti-wear & extreme pressure properties). Measures wear scar diameter, seizure, and weld load.	
6	Dry Sand / Rubber Wheel Abrasion Test (ASTM G65), Standard for abrasive wear resistance. Material ranking under three-body abrasion	
7	Taber Abrasion Test, Uses abrasive wheels on flat surfaces. Common in coatings, polymers, paints, and surface treatmen	
8	Model lubricant behavior in tribo-systems (four-ball test) using hydrodynamic or elastohydrodynamic lubrication (EHL) theory coupled with CFD/FEM solvers.	

CLO-PLO Mapping Matrix

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12	Avg CLO
CLO1	3	2	1	2	2	0	0	0	1	2	1	2	**1.33**
CLO2	3	2	2	3	2	0	0	0	2	2	1	2	**1.58**
CLO3	2	3	2	3	2	0	0	0	1	2	1	2	**1.5**
CLO4	3	3	2	3	2	0	1	0	1	2	1	2	**1.67**
CLO5	2	2	2	2	2	0	2	0	1	2	1	2	**1.5**
CLO6	3	3	2	3	2	0	3	1	1	3	2	3	**2.17**
Avg PLO	**2.67**	**2.5**	**1.83**	**2.67**	**2**	**0**	**1**	**0.17**	**1.17**	**2.17**	**1.17**	**2.17**	1.63

Suggested reading:

1	*B.C. Majumdar, Introduction to Tribology of Bearings*
2	*Gwidon W. Stachowiak & Andrew W. Batchelor, Engineering Tribology, (Butterworth-Heinemann, 5th Ed., 2025)*
3	*Harish Hirani, Fundamentals of Engineering Tribology with Application, (Cambridge University Press, 2016)*
4	*Oscar Pinkus & Beno Sternlicht, Theory of Hydrodynamic Lubrication, (Classic, 1961; reprints available)*
5	*Yukio Hori, Hydrodynamic Lubrication, (Springer Japan, 2006; reprint 2016)*

Teaching-Learning Strategies:

Lab-based learning, Data-driven learning, Case studies & industry linkages, Use ASTM/ISO standards, videos, and software (e.g., TRIBOLOGY freeware, ANSYS, MATLAB).

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODECFD125**	***Semester***	***First***	***Contact Hours***	***52***
Course Title	**Advanced Fluid Dynamics**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	3	1	0	4	100
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Apply vector and tensor analysis (index notation, gradient, divergence, stress tensor) to formulate fundamental fluid mechanics concepts.
CLO2	Derive and interpret governing equations of fluid flow (continuity, Navier–Stokes, energy equation) for different flow conditions.
CLO3	Analyze compressible flows through isentropic relations, shocks, expansion fans, and nozzles using theoretical and numerical methods.
CLO4	Solve boundary layer problems using Prandtl’s equations, similarity solutions (Blasius, Falkner–Skan), von Kármán integral method, and evaluate laminar vs turbulent boundary layers.
CLO5	Assess flow stability through linear perturbation methods, linear stability theory, and the Orr–Sommerfeld equation to determine laminar-to-turbulent transition.
CLO6	Relate hydrodynamic lubrication principles to real-world systems (turbomachinery, IC engines, marine and hydro turbines) and propose energy-efficient and sustainable lubrication solutions.Evaluate turbulence characteristics using Reynolds decomposition, RANS models, energy cascade concepts, Kolmogorov scales, and demonstrate basic understanding of DNS/LES approaches.

SYLLABUS

Units	Content	Marks
1	Vector and Tensor Analysis: Index notation, gradient, divergence, stress tensor.	16
2	Governing Equations: Continuity, Navier-Stokes, energy equation.	16
3	Compressible Flow: Isentropic flows, shocks, expansion fans, nozzles.	16
4	Boundary Layer Theory: Prandtl's boundary layer equations, Blasius and Falkner-Skan flows, von Kármán equation, Turbulent boundary layers,	18
5	Stability of Laminar Flows: Introduction to flow stability, Linear perturbation analysis, Linear stability theory, Orr–Sommerfeld equation.	16
6	Transition and Turbulent Flow Introduction: Mechanisms of transition from laminar to turbulent flow, Reynolds decomposition and RANS equations, Turbulent boundary layers, mixing length models, Energy cascade, Kolmogorov scales, Brief introduction to	18

CLO-PLO Mapping Matrix

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12	Avg CLO
CLO1	3	2	1	2	2	0	0	0	0	1	0	2	**1.08**
CLO2	3	3	2	2	2	0	0	0	0	1	0	2	**1.25**
CLO3	3	3	3	2	2	0	1	0	0	2	0	2	**1.5**
CLO4	3	3	3	2	2	0	2	0	0	2	0	2	**1.58**
CLO5	3	3	2	3	2	0	0	0	0	2	0	2	**1.42**
CLO6	3	3	3	2	3	2	3	2	1	3	1	3	**2.42**
Avg PLO	**3**	**2.83**	**2.33**	**2.17**	**2.17**	**0.33**	**1**	**0.33**	**0.17**	**1.83**	**0.17**	**2.17**	1.85

Suggested reading:

1	*F. M. White, Viscous Fluid Flows, McGraw Hill, 1986*
2	*L. D. Landau and E. M. Lifshitz, Fluid Mechanics, Pergamon Press, 1989.*
3	*H. Schlichting, Boundary Layer Theory, McGraw Hill, 1979.*
4	*J. D. Anderson, Modern Compressible Flow, McGraw Hill, 1989.*
5	*R. Aris, Vectors, Tensors and the Basic Equations of Fluid Mechanics*

Teaching-Learning Strategies:

Interactive Lectures, Conceptual & Mathematical Foundations, Visualization & Application-Oriented Learning, Analytical & Computational Approach, Research-Oriented Learning, Hands-on RANS equations, or mixing length model in MATLAB/Python.

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODEDCM125**	*Semester*	*First*	*Contact Hours*	*52*
Course Title	**Computational Methods in Engineering**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	3	1	0	4	100
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Apply numerical methods to formulate and solve engineering problems in mechanics, heat transfer, and fluid dynamics.
CLO2	Analyze sources of errors, convergence, and stability in computational algorithms.
CLO3	Implement numerical differentiation and integration techniques (finite differences, quadrature rules) and evaluate their accuracy and error propagation in engineering problems.
CLO4	Develop numerical solutions for systems of linear and nonlinear equations using direct and iterative techniques.
CLO5	Implement numerical integration, differentiation, and differential equation solvers for engineering case studies.
CLO6	Utilize computational tools (MATLAB, Python, ANSYS, COMSOL) to model, simulate, and optimize engineering systems.

SYLLABUS

Units	Content	Marks
1	Fundamentals of Computational Methods, Role of computational methods in engineering problem-solving, Mathematical modeling of physical systems, Review of linear algebra, error analysis, convergence, stability Matrix operations, eigenvalue problems, iterative solvers	16
2	Numerical Methods for Linear and Nonlinear Systems, Direct and iterative methods for solving linear systems (Gauss elimination, LU decomposition, Gauss-Seidel, Conjugate Gradient), Nonlinear equations: Newton–Raphson, fixed-point iteration, Condition numbers, sensitivity, stability analysis	16
3	Numerical Differentiation and Integration, Finite difference approximations, Numerical differentiation and error propagation, Quadrature methods: trapezoidal rule, Simpson's rule, Gaussian quadrature, Applications in engineering (stress analysis, fluid flow, heat transfer)	16
4	Numerical Solution of Differential Equations, Ordinary Differential Equations (ODEs): initial value and boundary value problems, Euler, Runge–Kutta, multi-step methods, Shooting method, finite difference method for BVPs, Partial Differential Equations (PDEs) in engineering: Elliptic (Laplace), Parabolic (Heat), Hyperbolic (Wave) equations, Finite Difference Method (FDM), Finite Volume Method (FVM), Finite Element Method (FEM) introduction.	18
5	Applications and Computational Tools, Case studies in structural mechanics, heat transfer, and fluid flow, Optimization techniques in engineering design (gradient-based, genetic algorithms, response surface methods)	18
6	Introduction to computational platforms (MATLAB, Python, ANSYS, COMSOL), Verification, validation, and uncertainty quantification in engineering computations.	16

CLO-PLO Mapping Matrix

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12	Avg CLO
CLO1	3	3	2	2	3	1	1	1	2	2	1	2	**1.92**
CLO2	3	3	2	2	3	1	1	1	1	2	1	2	**1.83**
CLO3	3	3	2	2	3	1	1	1	1	2	1	2	**1.83**
CLO4	3	3	2	3	3	1	1	1	1	2	1	2	**1.92**
CLO5	3	2	3	2	3	1	1	1	2	3	2	3	**2.17**
CLO6	3	3	2	3	3	1	1	1	2	3	2	3	**2.25**
Avg PLO	**3**	**2.83**	**2.17**	**2.33**	**3**	**1**	**1**	**1**	**1.5**	**2.33**	**1.33**	**2.33**	2.16

Suggested reading:

1	*S. S. Sastry – Introductory Methods of Numerical Analysis (PHI Learning, 5th Ed., 2012).*
2	*Steven C. Chapra & Raymond P. Canale – Numerical Methods for Engineers (McGraw-Hill, 8th Ed., 2015).*
3	*J.N. Reddy – An Introduction to the Finite Element Method (McGraw-Hill, 3rd Ed., 2006).*
4	*Anderson, J.D. – Computational Fluid Dynamics: The Basics with Applications (McGraw-Hill, 1995).*
5	*Hoffman, J.D. & Frankel, S. – Numerical Methods for Engineers and Scientists (CRC Press, 2nd Ed., 2001).*

Teaching-Learning Strategies:

Interactive Lectures, MATLAB/FORTRAN Simulations, Industry Seminars, Assignments, Case-based Learning

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODEDPP125**	***Semester***	***First***	***Contact Hours***	***52***
Course Title	**Programming with Python**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	3	1	0	4	100
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Set up a Python development environment and write basic scripts using variables, expressions, and standard I/O operations.
CLO2	Implement logical control structures and user-defined functions to solve repetitive and decision-based engineering problems.
CLO3	Manipulate data using Python's built-in data structures and perform file I/O operations for engineering datasets.
CLO4	Apply NumPy and SciPy libraries to perform numerical computations and solve mathematical models in mechanical engineering.
CLO5	Visualize and analyze engineering data using plotting libraries and data frames.
CLO6	Design object-oriented programs and develop automation scripts for mechanical design and analysis tasks.

SYLLABUS

Units	Content	Marks
1	Introduction to Python Programming: Python environment setup: Anaconda, Jupyter, IDEs, Python syntax and semantics, Variables, data types (int, float, string, bool), Operators, expressions, type conversion, Input/output, basic debugging.	16
2	Control Flow and Functions: Conditional statements: if, elif, else, Looping constructs: for, while, nested loops, Break and continue statements, Defining and using functions, Parameters, return values, recursion.	16
3	Data Structures and File Handling: Lists, tuples, sets, dictionaries: creation, manipulation, use cases, List comprehensions and dictionary operations, File operations: open, read, write, append, Working with CSV and tabular data.	16
4	Numerical and Scientific Computing: Introduction to NumPy: arrays, array operations, broadcasting, Matrix operations and linear algebra, Using SciPy for solving linear/non-linear equations, Numerical integration, differentiation, interpolation	18
5	Data Visualization and Analysis: Plotting with Matplotlib and Seaborn, Line charts, scatter plots, histograms, subplots, pandas for tabular data: reading, cleaning, filtering, summarizing, Exploratory data analysis (EDA)	18
6	Object-Oriented Programming & Engineering Automation: Classes and objects, Constructors, attributes, and methods, Inheritance, encapsulation, and polymorphism, Basic scripting for CAD automation (e.g., FreeCAD API), Mini-project: automation or simulation script.	16

CLO-PLO Mapping Matrix

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12	Avg CLO
CLO1	3	2	1	1	2	1	1	1	1	2	1	2	1.5
CLO2	3	3	2	1	2	1	1	1	2	2	1	2	1.75
CLO3	3	3	2	1	3	1	1	1	2	2	1	3	1.92
CLO4	3	3	3	3	3	1	1	1	2	2	1	3	2.17
CLO5	2	3	3	2	3	1	2	1	2	3	1	3	2.17
CLO6	3	3	3	2	3	2	2	2	3	3	2	3	2.58
Avg PLO	2.83	2.83	2.33	1.67	2.67	1.17	1.33	1.17	2	2.33	1.17	2.67	2.34

Suggested reading:

1	*Python Crash Course" by Eric Matthes (No Starch Press) – beginner-friendly, covers setup, syntax, variables, and debugging.*
2	*"Learning Python" by Mark Lutz – in-depth coverage of Python syntax and flow control.*
3	*Python Programming: An Introduction to Computer Science" by John Zelle – clear explanation of lists, dictionaries, and file operations.*
4	*Python for Engineers and Scientists" by Eihab B. M. Abdel-Rahman – focuses on NumPy, SciPy, and mathematical modeling.*
5	*Mastering Python Scientific Computing by Hemant Kumar Mehta – covers OOP in engineering contexts.*

Teaching-Learning Strategies:

Interactive Lectures, Problem-Based Learning, Peer review of code to encourage feedback and coding best practices., Use of Digital Tools, Case Studies & Applications.

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODEDCM125**	***Semester***	***First***	***Contact Hours***	***52***
Course Title	**Continum Mechanics**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	3	1	0	4	100
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Understand and apply the fundamental concepts and mathematical framework of continuum mechanics to analyze deformation and stress in engineering materials.
CLO2	Develop proficiency in tensor algebra and calculus to describe kinematics, strain, and stress states under various loading conditions.
CLO3	Formulate and interpret constitutive models for elastic, plastic, viscoelastic, and anisotropic materials relevant to mechanical design
CLO4	Analyze solid mechanics problems using linear elasticity theory and extend this knowledge to practical design scenarios involving beams, plates, and shells.
CLO5	Gain foundational knowledge of nonlinear continuum mechanics and large deformation theory for advanced material and structural analysis.
CLO6	Apply numerical methods, particularly the finite element method, to solve continuum mechanics problems and interpret simulation results for engineering design optimization.

SYLLABUS

Units	**Content**	**Marks**
1	Fundamentals of Continuum Mechanics: Concept of continuum and limitations of classical mechanics, Cartesian tensors: notation, operations, invariants, Coordinate transformations, index notation, Einstein summation convention, Stress and strain at a point. Introduction to continuum hypothesis and basic concepts. Kinematics of deformation; deformation gradient, strain tensor, rotation tensor. Motion and displacement fields. Strain measures; infinitesimal and finite strains. Stress measures; Cauchy stress, Piola-Kirchhoff stress tensors. Balance laws; conservation of mass, linear and angular momentum, energy	25
2	Mathematical Foundations and Constitutive Relations: : Tensor algebra and calculus for continuum mechanics. Frame-indifference and objectivity principles. Constitutive modeling: linear elasticity, nonlinear elasticity. Isotropic and anisotropic material behavior. Thermodynamic restrictions on constitutive equations. Principle of material frame indifference and symmetry of stress tensors	25
3	Solid Mechanics Applications in Continuum Mechanics: Linear elasticity theory and elasticity tensors. Stress-strain relations for isotropic and anisotropic materials. Plane stress and plane strain problems. Plasticity fundamentals and yield criteria (von Mises, Tresca). Introduction to viscoelasticity and time-dependent material behavior. Analysis of simple design components under stress (beams, plates)	25
4	Nonlinear Mechanics and Computational Methods: Nonlinear continuum mechanics and large deformations. Fluid-solid interactions basics, Introduction to finite element method (FEM) in continuum mechanics problems. Computational aspects: discretization and solution strategies. Stability, bifurcation, and failure analysis in solids. Case studies relevant to design engineering applications	25

CLO-PLO Mapping Matrix

CLO/PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**	**Avg CLO**
CLO1	3	2	1	2	1	0	0	0	0	1	0	2	**1**
CLO2	3	3	2	2	1	0	0	0	0	1	0	2	**1.17**
CLO3	3	2	2	3	1	1	0	1	0	1	0	2	**1.33**
CLO4	3	3	3	2	2	1	0	1	1	2	1	2	**1.75**
CLO5	3	2	2	3	2	1	1	1	0	1	0	3	**1.58**
CLO6	3	3	3	3	3	1	1	1	1	2	1	3	**2.08**
Avg PLO	**3**	**2.5**	**2.17**	**2.5**	**1.67**	**0.67**	**0.33**	**0.67**	**0.33**	**1.33**	**0.33**	**2.33**	1.49

Suggested reading:

1	*Spencer, A. J. M. – Continuum Mechanics – Dover Publications.*
2	*Malvern, L. E. – Introduction to the Mechanics of a Continuous Medium – Prentice-Hall*
3	*Mase, G. E., Smelser, R. E., & Mase, G. T. – Continuum Mechanics for Engineers – CRC Press.*
4	*Belytschko, T., Liu, W. K., & Moran, B. – Nonlinear Finite Elements for Continua and Structures – Wiley.*
5	*Slaughter, W. S. – The Linearized Theory of Elasticity – Birkhäuser.*

Teaching-Learning Strategies:

Interactive Lectures, Industry Seminars, Assignments, Case-based Learning

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.

Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODECCF225**	*Semester*	*Second*	*Contact Hours*	*52*
Course Title	**Computational Fluid Dynamics**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	3	1	0	4	100
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Understand the fundamental principles of fluid flow and heat transfer equations in differential and integral forms.
CLO2	Learn how to mathematically classify PDEs relevant to fluid mechanics and heat transfer problems.
CLO3	Gain in-depth knowledge of discretization techniques, with a focus on the finite volume method.
CLO4	Develop the ability to formulate and solve 1D and 2D steady and unsteady fluid flow problems using numerical schemes.
CLO5	Acquire skills to implement pressure-velocity coupling algorithms such as SIMPLE for incompressible flow.
CLO6	Understand the structure of CFD codes and gain introductory knowledge of turbulence modeling.

SYLLABUS

Units	**Content**	**Marks**
1	Introduction to CFD and Governing Equations: Applications of CFD in engineering, Conservation laws: mass, momentum, energy, Integral and differential forms of governing equations,	16
2	Mathematical Classification of PDEs: Types of PDEs: elliptic, parabolic, hyperbolic, Physical relevance and boundary conditions, Fundamentals of Discretization: Discretization methods: Finite Difference, Finite Volume, Finite Element, Criteria: consistency, conservativeness, boundedness 1D Steady-State Diffusion Equation,: Discretization using Finite Volume Method,	16
3	Types of boundary conditions, Convection–Diffusion Equation: Steady 1D convection-diffusion Upwind, central difference, hybrid, power-law schemes, False diffusion and numerical stability,	16
4	Time-Dependent Problems: Unsteady 1D heat conduction, Explicit and implicit time integration, Stability and accuracy, 2D Diffusion Equation: Finite volume discretization in two dimensions, Extension to irregular grids, Solution of Linear Systems: Matrix form of discretized equations,	18
5	Transition and Turbulent Flow Introduction: Mechanisms of transition from laminar to turbulent flow, Reynolds decomposition and RANS equations,	18
6	Direct and iterative solvers: TDMA, Gauss-Seidel, SOR, Discretization of Navier–Stokes Equations, Incompressible flow formulation, SIMPLE algorithm and pressure-velocity coupling, Staggered grids, CFD Code Structure and Turbulence Modeling: Components of a CFD code	16

CLO-PLO Mapping Matrix

CLO/PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**	**Avg CLO**
CLO1	3	2	0	0	0	0	1	1	0	2	0	2	**0.92**
CLO2	3	3	0	2	0	0	0	0	0	0	0	2	**0.83**
CLO3	3	3	2	2	0	0	0	0	0	1	0	2	**1.08**
CLO4	3	3	2	2	0	0	0	0	0	1	0	2	**1.08**
CLO5	2	3	2	3	2	0	1	0	0	1	0	2	**1.33**
CLO6	3	3	2	3	3	2	3	2	2	3	2	3	**2.58**
Avg PLO	**2.83**	**2.83**	**1.33**	**2**	**0.83**	**0.33**	**0.83**	**0.5**	**0.33**	**1.33**	**0.33**	**2.17**	1.74

Suggested reading:

1	*H.K. Versteeg and W. Malalasekera, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2nd Edition, Pearson Education.*
2	*G. K. Batchelor, An Introduction to Fluid Dynamics*
3	*P. K. Kundu, I. M. Cohen, Fluid Mechanics*
4	*R. Aris, Vectors, Tensors and the Basic Equations of Fluid Mechanics*
5	*Charles Hirsch & Pieter Wesseling – Principles of Computational Fluid Dynamics (Springer, 2009)*

Teaching-Learning Strategies:

Interactive Lectures, MATLAB/FORTRAN Simulations, Industry Seminars, Assignments, Case-based Learning

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODELCF225**	***Semester***	***Second***	***Contact Hours***	***52***
Course Title	**Computational Fluid Dynamics Lab**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	0	0	4	2	50
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Apply governing equations of fluid flow (Navier–Stokes, continuity, and energy equations) to simulate benchmark laminar and turbulent flow problems.
CLO2	Develop numerical models for internal flows (e.g., lid-driven cavity, pipe flow) and validate them against analytical or benchmark solutions.
CLO3	Simulate and analyze external flows (flow over cylinder, NACA airfoil) to investigate flow separation, wake formation, lift, and drag behavior.
CLO4	Implement CFD methods to study heat transfer in forced convection over surfaces and evaluate temperature/velocity distributions.
CLO5	How to use modern CFD tools (ANSYS Fluent, OpenFOAM, or equivalent) to perform simulations, visualize results, and interpret engineering insights for design.
CLO6	Apply turbulence modeling approaches (RANS, LES) to analyze complex flows (e.g., turbine draft tube, channel flow) and assess model accuracy.

SYLLABUS

Units	**Content**	**Marks**
1	Simulation on Laminar Lid-Driven Cavity (2D)	50
2	Simulation on Flow in a Pipe (Hagen–Poiseuille)	
3	Simulation on Flow over Circular Cylinder	
4	Simulation on NACA 0012 Airfoil (2D)	
5	Simulation on Forced Convection over Heated Plate	
6	Simulation on Nozzle (Supersonic/Transonic) – Compressible	
7	Simulation on Hydraulic Turbine Draft Tube (Steady RANS)	
8	LES of Channel Flow simulation	

CLO-PLO Mapping Matrix

CLO/PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**	**Avg CLO**
CLO1	3	2	2	2	3	0	0	0	0	1	0	2	**1.25**
CLO2	3	3	2	2	2	0	0	0	0	1	0	2	**1.25**
CLO3	3	3	2	2	3	0	0	0	0	1	0	2	**1.33**
CLO4	3	3	3	3	3	0	1	0	0	2	0	2	**1.67**
CLO5	3	3	2	3	3	1	2	1	0	2	0	2	**1.83**
CLO6	3	3	3	3	3	1	2	1	2	3	1	3	**2.33**
Avg PLO	**3**	**2.83**	**2.33**	**2.5**	**2.83**	**0.33**	**0.83**	**0.33**	**0.33**	**1.67**	**0.17**	**2.17**	1.61

Suggested reading:

1	*Anderson, J.D. – Computational Fluid Dynamics: The Basics with Applications (McGraw-Hill)*
2	*Wilcox, D.C. – Turbulence Modeling for CFD (DCW Industries) → (for RANS, LES, turbulence cases)*
3	*Versteeg, H.K. & Malalasekera, W. – An Introduction to Computational Fluid Dynamics: The Finite Volume Method (Pearson)*
4	*Anderson, J.D. – Fundamentals of Aerodynamics (McGraw-Hill) → (for flow over cylinder & airfoil cases)*
5	*Wendt, J. F. (Ed.). (2009). Computational Fluid Dynamics: An Introduction. 3rd ed. Springer.*

Teaching-Learning Strategies:

Interactive Lectures, Use Matlab/Python/CFD software (Fluent, OpenFOAM, ANSYS), Case Studies and Industrial Applications

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODECCR225**	***Semester***	***Second***	***Contact Hours***	***52***
Course Title	**Conduction and Radiation**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	3	1	0	4	100
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Formulate and solve the general heat conduction equation in Cartesian, cylindrical, and spherical coordinates with appropriate boundary and initial conditions.
CLO2	Analyze steady and unsteady conduction problems (including extended surfaces, multilayer systems, and phase-change problems) using analytical and approximate methods.
CLO3	Apply numerical techniques (Finite Difference, implicit/explicit schemes, Crank–Nicolson, etc.) to conduction problems involving complex geometries and transient heat transfer.
CLO4	Explain fundamental radiation laws, evaluate blackbody and gray body radiation, and calculate radiation exchange between surfaces using shape factors.
CLO5	Model radiation heat transfer in enclosures and participating media (absorbing, emitting, scattering gases) using analytical and approximate methods.
CLO6	Integrate conduction and radiation principles to analyze real-world thermal systems (furnaces, combustion chambers, solar collectors, spacecraft insulation) and propose energy-efficient solutions

SYLLABUS

Units	**Content**	**Marks**
1	Fundamentals of Heat Conduction: General heat conduction equation in Cartesian, cylindrical, and spherical coordinates (with and without internal heat generation). Initial and boundary conditions: Dirichlet, Neumann, Robin (convective boundary). Concept of thermal conductivity, contact resistance, and interface heat transfer.1D and 2D steady-state conduction problems.	16
2	Steady State Conduction Applications: Extended surfaces (fins): Fin efficiency and effectiveness, variable cross-section, pin fins, annular fins, and fin optimization. Multilayer walls and composite systems. Heat transfer through insulation: critical radius of insulation for cylinders and spheres. Electrical analogy for conduction problems.	16
3	Unsteady Heat Conduction: Lumped heat capacity systems – Biot and Fourier numbers, Heisler and Gröber charts. Analytical solutions: 1D transient conduction (semi-infinite and finite solids). Semi-infinite body solutions, error function solutions. Approximate methods: Heisler charts, numerical (FDM, Crank–Nicolson, implicit/explicit methods).	16
4	Heat Conduction with Phase Change: Stefan problems – melting and solidification. Moving boundary problems in conduction. Applications to casting, freezing of food, thermal energy storage, etc.	15
5	Fundamentals of Radiation Heat Transfer: Radiation laws: Planck's law, Wien's displacement law, Stefan–Boltzmann law. Blackbody, gray body, absorptivity, reflectivity, transmissivity, emissivity. View factors (shape factors): definition, reciprocity, summation rule, tabulated and analytical values. Radiation exchange between diffuse–gray surfaces.	15
6	Radiation Heat Transfer in Enclosures and Media: Radiation in absorbing, emitting, and scattering media. Equation of radiative transfer (ERT). Radiation in participating media: Rosseland approximation, optically thin/thick limits. Gas radiation (H_2O, CO_2) and spectral models. Combined radiation–conduction heat transfer problems.	16

CLO-PLO Mapping Matrix

CLO/PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**	**Avg CLO**
CLO1	3	3	2	2	2	1	2	1	1	2	1	2	**1.83**
CLO2	3	3	2	3	3	1	2	1	1	2	1	2	**2**
CLO3	3	3	2	2	2	1	2	1	1	2	1	2	**1.83**
CLO4	3	3	2	2	2	1	2	1	1	2	1	2	**1.83**
CLO5	3	3	2	3	3	2	2	1	1	2	1	2	**2.08**
CLO6	3	3	2	3	3	2	3	2	2	3	2	3	**2.58**
Avg PLO	**3**	**3**	**2**	**2.5**	**2.5**	**1.33**	**2.17**	**1.17**	**1.17**	**2.17**	**1.17**	**2.17**	2.03

Suggested reading:

1	*Incropera, F.P., DeWitt, D.P., Bergman, T.L., & Lavine, A.S. Fundamentals of Heat and Mass Transfer – Wiley.*
2	*Özişik, M.N. Heat Conduction – Wiley.*
3	*Siegel, R., & Howell, J.R. Thermal Radiation Heat Transfer – Taylor & Francis.*
4	*Modest, M.F. Radiative Heat Transfer – Academic Press.*
5	*Kakac, S., Yener, Y., & Pramuanjaroenkij, A. Heat Conduction – CRC Press.*

Teaching-Learning Strategies:

Interactive Lectures, MATLAB/FORTRAN, Ansys Simulations, Industry Seminars, Assignments, Case-based Learning

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODECAH225**	***Semester***	***Second***	***Contact Hours***	***52***
Course Title	**Alloy Development & Heat Treatment**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	3	1	0	4	100
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Explain the principles of alloy development and the role of alloying elements in controlling material properties.
CLO2	Interpret phase diagrams and phase transformations to design alloys with desired microstructures.
CLO3	Analyze the effects of various heat treatment processes on the mechanical behavior of alloys.
CLO4	Apply suitable heat treatment techniques to improve strength, toughness, and wear resistance in machine components.
CLO5	Evaluate advanced alloy systems and processing methods for specialized engineering applications.
CLO6	Integrate material selection and heat treatment principles in the design of reliable and high-performance mechanical components.

SYLLABUS

Units	Content	Marks
1	Fundamentals of Alloy Development: Introduction to alloy design and classification of alloys. Role of alloying elements and their effects on mechanical properties. Phase diagrams, phase transformations, and microstructure control. Selection criteria for alloys in mechanical design applications	25
2	Physical Metallurgy and Alloy Processing: Solidification, casting, and wrought processing of alloys Heat treatment principles and their influence on microstructure. Thermomechanical processing and its impact on alloy properties. Advanced alloy systems: stainless steels, aluminum alloys, titanium alloys, and superalloys	25
3	Heat Treatment Techniques and Mechanisms: Common heat treatment processes: annealing, normalizing, quenching, tempering, and aging. Diffusion mechanisms and kinetics of phase transformations during heat treatment. Effect of heat treatment on mechanical behavior: hardness, toughness, and fatigue. Heat treatment equipment, industrial practices, and quality control	25
4	Design Considerations and Applications: Alloy development and heat treatment for specific design requirements (strength, corrosion resistance, wear resistance). Case studies on heat treatment in machine component design. Failure analysis related to improper alloy selection or heat treatment. Emerging trends: additive manufacturing and heat treatment of novel alloys	25

CLO-PLO Mapping Matrix

CLO/PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**	**Avg CLO**
CLO1	3	2	2	1	1	1	2	1	1	1	0	2	**1.42**
CLO2	3	3	2	2	1	1	1	1	1	1	0	2	**1.5**
CLO3	3	2	2	2	1	1	1	1	1	1	0	2	**1.42**
CLO4	2	2	3	1	2	2	1	1	2	2	1	2	**1.75**
CLO5	3	2	2	3	2	1	2	1	1	1	1	3	**1.83**
CLO6	3	3	3	2	2	2	2	2	2	3	2	3	**2.42**
Avg PLO	**2.83**	**2.33**	**2.33**	**1.83**	**1.5**	**1.33**	**1.5**	**1.17**	**1.33**	**1.5**	**0.67**	**2.33**	1.72

Suggested reading:

1	*Dieter, G. E., Mechanical Metallurgy, McGraw-Hill.*
2	*Davis, J. R., Heat Treatment, Selection, and Application of Tool Steels, ASM International.*
3	*Totten, G. E., Steel Heat Treatment: Metallurgy and Technologies, CRC Press.*
4	*Bhadeshia, H. K. D. H., and Honeycombe, R. W. K., Steels: Microstructure and Properties, Elsevier*
5	*Callister, W. D., and Rethwisch, D. G., Materials Science and Engineering: An Introduction, Wiley.*

Teaching-Learning Strategies:

Interactive Lectures, Simulations, Industry Seminars, Assignments, Case-based Learning

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODECFF225**	*Semester*	*Second*	*Contact Hours*	*52*
Course Title	**Fracture Fatigue and Creep**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	3	1	0	4	100
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Explain the fundamental concepts of fracture, fatigue, and creep in engineering materials.
CLO2	Analyze different types of fracture, fatigue, and creep failures using theoretical and practical approaches.
CLO3	Apply fracture mechanics concepts such as stress intensity factor, strain energy release rate, and fracture toughness in design and failure
CLO4	Interpret and evaluate the results from fracture, fatigue, and creep tests as well as metallographic and fractography investigations.
CLO5	Assess the impact of material properties, metallurgical factors, and environmental effects on failure modes and life prediction.
CLO6	Propose suitable materials, testing methods, and design modifications to improve component reliability against fracture, fatigue, and creep.

SYLLABUS

Units	Content	Marks
1	Foundations & historical context of fracture mechanics, Role in modern design and failure prevention, theoretical cohesive strength of metals, types of fracture in metals , Griffith theory of brittle fracture, fracture of single crystals, metallographic aspects of fracture, fractography, fracture under combined stresses. Brittle fracture problems, notched bar impact tests, significance of transition temperature curve, metallurgical factors affecting transition temperature, fracture analysis diagram	25
2	Fracture Mechanics approach to design; strain energy release rate, stress intensity factor, fracture toughness and design, KIC plane strain toughness testing, plasticity corrections, crack opening displacement, J integral, R curve.	25
3	Characteristics of fatigue failure, initiation and propagation of fatigue cracks; methods of improving fatigue behaviour, fatigue testing; analysis of fatigue data, fracture mechanics of fatigue crack propagation, corrosion fatigue, case studies	25
4	Introduction to creep- creep mechanisms, creep curve, Presentation and practical application of creep data; accelerated creep testing, time-temperature parameters for conversion of creep data; creep resistant alloys, creep testing, stress rapture test	25

CLO-PLO Mapping Matrix

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO 12	Avg CLO
CLO1	3	2	1	2	1	1	1	1	0	1	0	2	**1.25**
CLO2	2	3	2	3	2	1	1	1	1	1	0	2	**1.58**
CLO3	3	3	2	3	2	1	1	1	1	2	1	2	**1.83**
CLO4	2	2	2	3	2	1	1	1	1	2	1	2	**1.67**
CLO5	2	2	2	2	2	2	2	2	1	1	1	2	**1.75**
CLO6	2	3	3	2	2	2	2	2	2	2	2	3	**2.25**
Avg PLO	**2.33**	**2.5**	**2**	**2.5**	**1.83**	**1.33**	**1.33**	**1.33**	**1**	**1.5**	**0.83**	**2.17**	1.72

Suggested reading:

1	*Anderson, T. L., Fracture Mechanics: Fundamentals and Applications, CRC Press.*
2	*Dowling, N. E., Mechanical Behavior of Materials: Engineering Methods for Deformation, Fracture, and Fatigue, Pearson.*
3	*Lemaitre, J., and Desmorat, R., Engineering Damage Mechanics: Ductile, Creep, Fatigue, and Brittle Failures, Springer.*
4	*Comer, J. J., and Handrock, J. L., Fundamentals of Metal Fatigue Analysis, McGraw-Hill.*
5	*Penny, R. K., and Marriott, D. L., Design for Creep, Elsevier.*

Teaching-Learning Strategies:

Interactive Lectures, Simulations, Industry Seminars, Assignments, Case-based Learning

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODEDPM225**	*Semester*	*Second*	*Contact Hours*	*52*
Course Title	**Project Management**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	3	1	0	4	100
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Explain the fundamental concepts of project management, including project characteristics, life cycle stages, and methods of project selection such as NPV, IRR, and Payback Period.
CLO2	Apply decision-making tools such as Decision Trees, Expected Monetary Value (EMV), and basic Game Theory concepts (e.g., Nash Equilibrium) to evaluate project alternatives under risk and uncertainty.
CLO3	Develop project plans and schedules using techniques such as CPM, PERT, WBS, Gantt Charts, and milestone setting for effective time and resource management. (Application)
CLO4	Utilize resource optimization and cost estimation techniques, including Linear Programming and estimating methods (Analogous, Parametric, Bottom-Up), to create accurate project budgets.
CLO5	Assess project performance using Earned Value Management (EVM) metrics such as SPI, CPI, CV, SV, ETC, and EAC for monitoring and controlling project progress.
CLO6	Evaluate and recommend risk mitigation strategies through tools like Sensitivity Analysis, Scenario Planning, Monte Carlo Simulation, Queuing Theory, and inventory models (EOQ, ABC Analysis) to ensure project sustainability.

SYLLABUS

Units	Content	Marks
1	Fundamentals of Project Management: Introduction to Project Management, definition, characteristics, and importance of projects. Stages of the project life cycle and their relevance in practice.	15
2	Project Selection and Decision-Making Techniques: Project Selection Methods including Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period. Theoretical understanding of decision-making under risk and uncertainty, use of Decision Tree and Expected Monetary Value (EMV). Basics of Game Theory, Two-Person Games, and the concept of Nash Equilibrium in project bidding situations.	20
3	Project Planning Fundamentals: Overview of project planning and scheduling fundamentals, purpose, and benefits of effective scheduling. Theoretical concepts of Work Breakdown Structure (WBS), Gantt Charts, and milestone setting for project tracking.	15
4	Project Scheduling & Resource Planning: Study of Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT). Resource management using Linear Programming techniques. Basic cost estimation methods such as Analogous, Parametric, and Bottom-Up Estimating for project budgeting.	15
5	Project Monitoring and Control: Introduction to project monitoring and control with theoretical foundations of performance measurement. Application of Earned Value Management (EVM) concepts including Schedule Performance Index (SPI), Cost Performance Index (CPI), Cost Variance (CV), Schedule Variance (SV), Estimate to Complete (ETC), and Estimate at Completion (EAC).	20
6	Project Risk & Resource Optimization: Understanding project risk management concepts. Application of Sensitivity Analysis, Scenario Planning, and Monte Carlo Simulation for risk assessment. Basics of Queuing Theory for managing workflow bottlenecks and inventory management models such as Economic Order Quantity (EOQ) and ABC Analysis to optimize project resource procurement.	15

CLO-PLO Mapping Matrix

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12	Avg CLO
CLO1	3	2	0	0	0	0	1	1	0	2	2	2	**1.08**
CLO2	3	3	0	2	0	0	0	0	0	0	2	2	**1**
CLO3	3	3	2	2	2	0	0	0	2	2	2	2	**1.67**
CLO4	3	3	2	2	2	0	0	0	0	1	3	2	**1.5**
CLO5	2	3	2	3	2	0	1	0	0	1	2	2	**1.5**
CLO6	3	3	2	3	3	2	3	2	2	3	2	3	**2.58**
Avg PLO	**2.83**	**2.83**	**1.33**	**2**	**1.5**	**0.33**	**0.83**	**0.5**	**0.67**	**1.5**	**2.17**	**2.17**	1.86

Suggested reading:

1 *Kerzner, H. (2017). Project management: A systems approach to planning, scheduling, and controlling (12th ed.). Wiley.*
2 *PMI. (2021). A guide to the project management body of knowledge (PMBOK guide) (7th ed.). Project Management Institute.*
3 *Ashar, K., & Vibrant Publishers. (2022). Project Management Essentials You Always Wanted To Know. Vibrant Publishers.*
4 *Heagney, J. (2016). Fundamentals of Project Management (5th ed.). Mcgraw-Hill.*
5 *Nieto-Rodriguez, A. (2021). Harvard Business Review project management handbook how to launch, lead, and sponsor successful projects. Boston, Ma Harvard Business Review Press.*

Teaching-Learning Strategies:

Interactive Lectures, Industry Seminars, Assignments, Case-based Learning

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	MODEDDT225	Semester	Second	Contact Hours	52
Course Title	Design Thinking				
Scheme & Credits	L	T	P	Credits	Max marks
	3	1	0	4	100
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO2	Apply empathy techniques such as user interviews, observations, surveys, and journey mapping to gather both qualitative and quantitative user data.
CLO3	Analyze user research data using descriptive statistics and scoring models to define problem areas and prioritize ideas objectively.
CLO4	Develop prototypes of varying fidelity (low and high) and evaluate them using usability metrics (e.g., task success rate, time-on-task) and A/B testing methods.
CLO5	Assess design solutions using quantitative evaluation methods, including survey-based feedback analysis, statistical measures (mean, median, variance), and ROI or cost-benefit calculations.
CLO6	Integrate Design Thinking methodologies to address real-world problems, drawing insights from case studies across industries to propose scalable, user-centered innovations.

SYLLABUS

Units	Content	Marks
1	Introduction to Design Thinking and Its Principles: Overview of Design Thinking including its human-centered focus and stages: Empathize, Define, Ideate, Prototype, and Test. Introduction to basic quantitative data collection methods during empathy (e.g., surveys with Likert scales) to support user research. Using simple descriptive statistics to analyze user data and define problem areas numerically. Discussion on mindset and skills required for effective design thinking.	15
2	Tools for Empathy and Problem Definition: Techniques for Empathy: user interviews, observation, and journey mapping. Methods of defining problems through problem statements and insights. Role of quantitative data in validating user needs.	15
3	Tools for Ideation and Creativity: Ideation methods including brainstorming, mind mapping, and SCAMPER. Applying scoring models and weighted decision matrices for prioritizing ideas. Linking creativity with structured quantitative decision-making approaches.	15
4	Prototyping and Testing Techniques: Basics of prototyping: low-fidelity vs high-fidelity prototypes. Introduction to usability metrics (task success rate, time-on-task). Application of A/B testing principles during experimentation phases to compare prototype versions objectively.	15
5	Data-Driven Design Evaluation: Applying quantitative feedback analysis using survey data and user metrics to measure impact and improvements. Introduction to statistical methods (mean, median, variance) for analyzing test results. Using cost-benefit or ROI calculations to assess feasibility and scalability of design solutions.	20
6	Applications and Case Studies in Design Thinking: Exploring real-world applications of Design Thinking across industries such as healthcare, technology, and education. Case studies showcasing successful projects and lessons learned. Linking theory with practice by reflecting on how design thinking, when supported by data, improves outcomes.	20

CLO-PLO Mapping Matrix

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12	Avg CLO
CLO1	3	2	0	0	0	0	1	1	0	2	3	2	**1.17**
CLO2	3	3	0	2	0	0	0	0	0	0	3	2	**1.08**
CLO3	3	3	2	2	2	0	0	0	2	2	3	2	**1.75**
CLO4	3	3	2	2	2	0	0	0	0	1	3	2	**1.5**
CLO5	2	3	2	3	2	0	1	0	0	1	3	2	**1.58**
CLO6	3	3	2	3	3	2	3	2	2	3	3	3	**2.67**
Avg PLO	**2.83**	**2.83**	**1.33**	**2**	**1.5**	**0.33**	**0.83**	**0.5**	**0.67**	**1.5**	**3**	**2.17**	1.63

Suggested reading:

1	*Brown, T. (2009). Change by design: How design thinking creates new alternatives for business and society. HarperBusiness.*
2	*Lewrick, M., Link, P., & Leifer, L. (2020). The design thinking toolbox: A guide to mastering the most popular and valuable innovation methods. Wiley.*
3	*Liedtka, J., & Ogilvie, T. (2011). Designing for growth: A design thinking tool kit for managers. Columbia Business School Publishing.*
4	*Liedtka, J., & Ogilvie, T. (2011). Designing for growth: A design thinking tool kit for managers. Columbia Business School Publishing.*
5	*Falk Uebernickel, Jiang, L., Brenner, W., Pukall, B., Naef, T., & Bernhard Schindlholzer. (2020). Design Thinking: The Handbook. World Scientific.*

Teaching-Learning Strategies:

Interactive Lectures, Industry Seminars, Assignments, Case-based Learning

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODEASD225**	*Semester*	*Second*	*Contact Hours*	*39*
Course Title	**Academic Writing**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	3	0	0	0	75
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Understand engineering-specific academic writing.
CLO2	Learn to structure technical reports, research papers and proposals.
CLO3	Develop the skills for clarity, precision and persuasive argumentation.
CLO4	Understand the ethics of academic writing.
CLO5	Apply critical reading, analytical thinking, and evidence-based argumentation skills to develop clear, concise, and original academic writing.
CLO6	Demonstrate the ability to plan, structure, and produce coherent academic essays, reports, and research papers following standard conventions of academic style and citation.

SYLLABUS

Units	**Content**	**Marks**
1	Introduction to Academic Writing: Definition/Types/Forms, Tone/Style/Objectivity/Critical Thinking/Structure	10
2	The Foundations and Purpose of Academic Writing: General Writing, Scientific and Technical Writing: Writing Technical Reports/Abstracts/Research Proposals/Papers, Skill Development/Knowledge Production and Dissemination/Critical Inquiry	15
3	The Foundations and purpose of Academic Writing: General Writing, Scientific and Technical Writing, Skill	15
4	Effective Academic Writing Skills: Understanding/Planning/Research/Drafting/Citation and Referencing/Revising/Editing/Proof Reading, Introduction, Methods, Results, Discussion (IMRD), Synthesizing Sources/ Organizing data (tables, graphs, appendices)/ Avoiding Plagiarism	15
5	Citation and Referencing: Citation styles: APA, IEEE, Chicago	10
6	Publishing Ethics: Authorship norms, Copyright, Open access	10

CLO-PLO Mapping Matrix

CLO/PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**	**Avg CLO**
CLO1	2	1	0	2	0	1	1	2	0	2	0	2	**1.08**
CLO2	1	2	1	1	1	1	1	2	2	3	1	2	**1.5**
CLO3	1	1	1	0	0	3	2	3	2	2	1	2	**1.5**
CLO4	1	2	2	1	1	2	2	2	2	2	1	2	**1.67**
CLO5	1	3	2	2	1	3	3	3	1	2	1	2	**2**
CLO6	2	3	2	2	1	3	3	3	2	2	2	3	**2.33**
Avg PLO	**1.33**	**2**	**1.33**	**1.33**	**0.67**	**2.17**	**2**	**2.5**	**1.5**	**2.17**	**1**	**2.17**	1.68

Suggested reading:

1	*Bailey. S. 2015. Academic Writing: A Handbook for International Students. London and New York: Routledge*
2	*Alley, M. (2018). The Craft of Scientific Writing (4th ed.). Springer*
3	*Pennock, G. (2020). Writing for Engineering and Science. Pearson*
4	*Academic Writing for Engineering Publications: A Guide for Graduate Students and Researchers" by Zhongchao Tan (Springer, 2021)*
5	*Writing in Engineering: A Brief Guide" by Traci Gardner (Oxford University Press, 2018)*

Teaching-Learning Strategies:

Interactive Lectures/Case-Based Learning with Literary Texts/ollaborative Creative Projects

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODEALE225**	***Semester***	***Second***	***Contact Hours***	***39***
Course Title	**Literature for Engineers**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	3	0	0	0	75
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Identify and explain key literary texts (poems, fiction, drama) that engage with themes of nature, science, technology, and society.
CLO2	To develop critical thinking, communication, and interpretative skills through literature.
CLO3	To cultivate empathy, ethical awareness, and a broader humanistic perspective in engineering students
CLO4	To foster creativity and appreciation of cultural and social dimensions in technical practice.
CLO5	Evaluate the social, cultural, and moral implications of technological progress as depicted in literature.
CLO6	Apply insights from literature to foster responsible, ethical and creative approaches in engineering practice

SYLLABUS

Units	Content	Marks
1	Introduction to Literature and Engineering:, Role of literature in shaping human imagination and values., Relevance of humanities for engineers., Literature as a mirror of society, science, and technology.	15
2	Machines and the Emotions by Bertrand Russell/ The Machine Stops by E.M. Forster	10
3	The Secret of the Machines by Rudyard Kipling/Walt Whitman's When I Heard the Learn'd Astronomer	10
4	Life of Galileo by Bertolt Brecht	10
5	Literature, Technology and Society: Literary reflections on industrialization, digital culture and globalization., Critical reading of texts that explore surveillance, AI, and ethics. Linking storytelling with contemporary debates in science and technology.	15
6	Ethics, Values and Creativity through Literature: Literature as a resource for moral reflection and ethical engineering practice. Texts on integrity, responsibility and social justice. Using literary imagination to foster empathy, teamwork and human-centered innovation.	15

CLO-PLO Mapping Matrix

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12	Avg CLO
CLO1	1	1	0	0	0	2	2	2	1	2	0	2	**1.08**
CLO2	1	2	1	0	0	2	1	2	2	3	0	2	**1.33**
CLO3	0	1	0	0	0	3	2	3	2	2	0	2	**1.25**
CLO4	0	1	1	0	0	2	2	2	2	2	0	2	**1.17**
CLO5	0	1	0	0	0	3	3	3	2	2	0	2	**1.33**
CLO6	0	1	0	0	0	3	3	3	2	2	0	3	**1.42**
Avg PLO	**0.33**	**1.17**	**0.33**	**0**	**0**	**2.5**	**2.17**	**2.5**	**1.83**	**2.17**	**0**	**2.17**	1.26

Suggested reading:

1	*Martha C. Nussbaum – Love's Knowledge: Essays on Philosophy and Literature (1990).*
2	*N. Katherine Hayles – How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics (1999).*
3	*C.P. Snow – The Two Cultures (1959).*
4	*David Nye – Technology Matters: Questions to Live With (2006).*
5	*Caroline Whitbeck – Ethics in Engineering Practice and Research (2nd ed., 2011).*

Teaching-Learning Strategies:

Interactive Lectures/Case-Based Learning with Literary Texts/ollaborative Creative Projects

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODEDMC325**	***Semester***	***Third***	***Contact Hours***	***39***
Course Title	**Mechanics of Composite Materials**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	2	1	0	3	75
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Explain the fundamental concepts, types, and applications of composite materials in engineering design.
CLO2	Analyze the mechanical behavior of composite constituents using micromechanical models.
CLO3	Predict the elastic properties and strength of composite lamina using appropriate theories.
CLO4	Apply classical lamination theory to determine stresses and strains in laminated composite structures.
CLO5	Evaluate failure criteria for composite materials under different loading conditions.
CLO6	Integrate composite material mechanics into the design and analysis of advanced mechanical components.

SYLLABUS

Units	Content	Marks
1	Introduction to Composite Materials: Classification and types of composite materials (fiber-reinforced, particulate, laminates). Advantages, applications, and design considerations of composites. Basic concepts of anisotropy and heterogeneity in composites. Overview of fiber and matrix materials and interface characteristics	15
2	Micromechanics of Composites: Mechanics of fiber and matrix phases. Rule of mixtures and micromechanical models for stiffness and strength prediction. Stress and strain distribution in composite constituents. Longitudinal and transverse properties of unidirectional composites	20
3	Macromechanics and Lamina Analysis: Constitutive equations for orthotropic lamina. Failure theories and criteria for composite lamina. Analysis of lamina under different loading conditions: tension, compression, shear. Experimental methods for characterization of lamina properties	20
4	Laminate Theory and Structural Analysis: Classical lamination theory (CLT) for laminated composites. Calculation of stiffness matrices and laminate properties. Analysis of laminate stresses and strains under mechanical and thermal loads. Failure analysis of laminated composite structures and design guidelines	20

CLO-PLO Mapping Matrix

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12	Avg CLO
CLO1	2	1	1	1	1	1	1	1	0	2	0	1	**1**
CLO2	3	3	1	2	2	1	0	1	1	1	0	2	**1.42**
CLO3	3	3	2	2	2	1	1	1	1	1	1	2	**1.67**
CLO4	3	3	2	3	3	1	1	1	1	1	1	2	**1.83**
CLO5	3	3	2	2	2	3	0	2	1	1	1	2	**1.83**
CLO6	3	3	3	3	3	2	2	2	2	2	2	3	**2.5**
Avg PLO	**2.83**	**2.67**	**1.83**	**2.17**	**2.17**	**1.5**	**0.83**	**1.33**	**1**	**1.33**	**0.83**	**2**	1.85

Suggested reading:

1	*Jones, R. M., Mechanics of Composite Materials, Taylor & Francis.*
2	*Agarwal B. D. and Broutmen L. J. "Analysis and performance of Fiber Composites", John Wiley and Sons, New York 1990.*
3	*Gay, D., and Hoa, S. V., Composite Materials: Design and Applications, CRC Press.*
4	*Daniel, I. M., and Ishai, O., Engineering Mechanics of Composite Materials, Oxford University Press.*
5	*Hull, D., and Clyne, T. W., An Introduction to Composite Materials, Cambridge University Press*
6	*Mallick, P. K., Fiber-Reinforced Composites: Materials, Manufacturing, and Design, CRC Press.*

Teaching-Learning Strategies:

Interactive Lectures, Teaching-Learning Strategies, Real-World Case Studies, simulation tools for laminate analysis.

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODEDDT325**	*Semester*	*Third*	*Contact Hours*	*39*
Course Title	**Design of Thermal Systems**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	2	1	0	3	75
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Understand the methodology of thermal system design and the role of performance criteria..
CLO2	Apply thermodynamic, heat transfer, and fluid flow principles to design components like heat exchangers and cooling systems.
CLO3	Develop mathematical and simulation models for analyzing complex thermal systems.
CLO4	Optimize thermal system designs using analytical and computational techniques.
CLO5	Evaluate economic feasibility of thermal systems considering life-cycle costs and trade-offs.
CLO6	Design and analyze integrated thermal systems for power, cooling, and renewable energy applications.

SYLLABUS

Units	Content	Marks
1	Introduction to Thermal System Design, Role of design in thermal engineering, Design methodology & problem-solving strategies, Mathematical modeling of thermal systems Performance evaluation & constraints	10
2	Heat Exchanger Design, Types of heat exchangers & applications, LMTD and effectiveness–NTU methods, Compact and extended surface exchangers, Pressure drop, fouling, and design optimization	10
3	Thermal System Simulation & Modeling, Formulation of governing equations, Numerical methods for thermal design, System simulation techniques, Case studies: HVAC, solar thermal, power plants	15
4	Optimization of Thermal Systems, Objective functions & constraints, Classical optimization techniques (Lagrange multipliers, search methods), Modern optimization (genetic algorithms, simulated annealing),Case applications in thermal design	15
5	Economic Analysis of Thermal Systems, Life-cycle costing, Present worth, annualized cost, and rate of return Payback analysis, Trade-off between performance and cost.	15
6	Case Studies and Applications, Design of power plant subsystems, Refrigeration & air-conditioning systems, Solar-thermal energy systems, Cogeneration and combined-cycle systems	10

CLO-PLO Mapping Matrix

CLO/PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**	**Avg CLO**
CLO1	3	3	2	2	2	2	2	2	1	2	2	3	**2.17**
CLO2	3	3	3	2	3	2	2	2	1	2	2	3	**2.33**
CLO3	3	3	3	3	3	2	2	2	1	2	2	3	**2.42**
CLO4	3	3	3	3	3	2	2	2	2	2	2	3	**2.5**
CLO5	2	2	2	2	2	2	3	2	2	2	3	3	**2.25**
CLO6	3	3	3	3	3	2	3	2	2	3	3	3	**2.75**
Avg PLO	**2.83**	**2.83**	**2.67**	**2.5**	**2.67**	**2**	**2.33**	**2**	**1.5**	**2.17**	**2.33**	**3**	2.4

Suggested reading:

1	*Stoecker, W.F. – Design of Thermal Systems (McGraw-Hill, Latest Edition)*
2	*Jaluria, Y. – Design and Optimization of Thermal Systems (CRC Press, Latest Edition)*
3	*Bejan, A. – Thermal Design and Optimization (Wiley, 1996)*
4	*Incropera, F.P., DeWitt, D.P., Bergman, T.L., Lavine, A.S. – Fundamentals of Heat and Mass Transfer (Wiley, Latest Edition)*
5	*Holman, J.P. – Heat Transfer (McGraw-Hill, Latest Edition)*

Teaching-Learning Strategies:

Interactive Lectures, MATLAB/FORTRAN Simulations, Industry Seminars, Assignments, Case-based Learning

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODEDAS325**	***Semester***	***Third***	***Contact Hours***	***39***
Course Title	**Advanced Solid Mechanics**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	2	1	0	3	75
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Apply stress–strain transformation principles in Cartesian and polar coordinates, construct 3D Mohr's circles, and determine principal, octahedral, hydrostatic, and deviatoric stresses.
CLO2	Formulate differential equations of equilibrium, enforce compatibility conditions, and apply generalized Hooke's law and failure theories to predict safe design limits under complex loading.
CLO3	Utilize energy methods (strain energy, Castigliano's theorem, unit load method) to evaluate displacements, deflections, and internal forces in structural and mechanical components.
CLO4	Analyze bending of symmetric/unsymmetric beams, curved beams, and thin-walled sections; determine shear center, shear flow, and stresses in advanced beam geometries.
CLO5	Solve torsion problems in prismatic solid and thin-walled sections using membrane analogy; evaluate stresses and deformations in thick/thin-walled cylinders, composite tubes, and rotating disks.
CLO6	Evaluate column stability using Euler's buckling and beam–column equations; apply experimental stress analysis techniques such as strain gages and photoelasticity to validate theoretical results.

SYLLABUS

Units	Content	Marks
1	Stress–Strain Fundamentals in Cartesian and Polar Coordinates, Cauchy's stress formula, Stress and strain transformation in rectangular and polar coordinates, Principal stresses and principal strains, 3D Mohr's Circle, Octahedral stresses, hydrostatic and deviatoric stress	10
2	Equilibrium, Compatibility & Constitutive Relations, Differential equations of equilibrium in 2D and 3D, Plane stress and plane strain assumptions, Compatibility conditions, Introduction to curvilinear coordinates, Generalized Hooke's law, Theories of failure (maximum stress, maximum strain, von Mises, Tresca, etc.)	15
3	Energy Methods in Solid Mechanics, Strain energy and complementary energy, Castigliano's theorems, Unit load method, Applications in beams, shafts, and trusses.	10
4	Bending & Shear in Beams, Bending of symmetric and unsymmetric straight beams, Effect of shear stresses in bending, Curved beams (Winkler–Bach theory), Shear center and shear flow, Shear stresses in thin-walled sections, Thick curved bars.	15
5	Torsion & Pressure Vessels, Torsion of prismatic solid sections (circular, rectangular, elliptical bars), Thin-walled closed and open sections under torsion, Membrane analogy for torsion, Thick and thin-walled cylinders under internal/external pressure, Compound (composite) tubes, Rotating disks and cylinders.	15
6	Stability & Experimental Stress Analysis, Euler's buckling load for columns, Beam–column equations (axial + bending loads), Strain measurement techniques using strain gages (characteristics, instrumentation), Principles of photoelasticity, Experimental approaches in stress analysis.	10

CLO-PLO Mapping Matrix

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12	Avg CLO
CLO1	3	2	0	0	0	0	0	2	0	1	0	2	**0.83**
CLO2	3	3	2	0	0	1	1	2	0	0	0	2	**1.17**
CLO3	3	2	2	2	0	0	0	0	0	0	0	2	**0.92**
CLO4	3	3	3	0	2	0	2	2	1	2	0	2	**1.67**
CLO5	3	3	3	2	2	0	2	0	0	2	0	2	**1.58**
CLO6	3	2	2	3	3	0	2	2	2	3	1	3	**2.17**
Avg PLO	**3**	**2.5**	**2**	**1.17**	**1.17**	**0.17**	**1.17**	**1.33**	**0.5**	**1.33**	**0.17**	**2.17**	1.39

Suggested reading:

1	*Timoshenko SP and Goodier JN. 1970. Theory of Elasticity, McGraw-Hill, 3rd edition*
2	*Schmerr LW Jr. 2015. Advanced Mechanics of Solids, Springer, 2nd edition*
3	*Jose S. 2017. Advanced Mechanics of Materials, Narosa Publishing House, 1st edition*
4	*Kazimi SMA. 2007. Solid Mechanics, Tata McGraw-Hill Education, 1st edition*
5	*Jose S. 2017. Advanced Mechanics of Materials, Narosa Publishing House, 1st edition*

Teaching-Learning Strategies:

Interactive Lectures, visual aids, Problem-Solving & Numerical Exercises, Research-Oriented Learning, Collaborative & Active Learning

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODEDPO325**	***Semester***	***Third***	***Contact Hours***	***39***
Course Title	**Programming with Open Foam**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	2	1	0	3	75
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Demonstrate proficiency in C++ syntax, data structures, object-oriented principles, and template programming.
CLO2	Explore the core architecture and class hierarchy of OpenFOAM and how it handles fields, meshes, I/O, and time control.
CLO3	Write custom OpenFOAM utilities and boundary conditions using proper C++ and OpenFOAM conventions.
CLO4	Modify and develop OpenFOAM solvers based on the finite volume method (FVM) and algorithms
CLO5	Simulate real-world problems involving heat transfer, multiphase flows, and mesh motion using OpenFOAM.
CLO6	Utilize tools for mesh generation, visualization (ParaView), and code debugging for effective CFD workflows.

SYLLABUS

Units	Content	Marks
1	C++ Fundamentals for OpenFOAM: Introduction to C++, Functions and Namespaces, Pointers and References, Data Structures, Object-Oriented Programming, OpenFOAM Core Classes and Utility Programming, Key OpenFOAM Classes,	10
2	Data Handling and Processing, Writing Utilities, Boundary Conditions and Generic Programming: Boundary Conditions in OpenFOAM, Generic Programming, Implementing Custom Boundary Conditions,	10
3	Solver Development: OpenFOAM Solver Structure, Finite Volume Method (FVM), Discretization Schemes, Linear Solvers and Algorithms, Modifying and Developing Solvers,	15
4	Advanced Topics in OpenFOAM: Mesh Generation using blockMesh and snappyHexMesh for complex geometries, Dynamic Mesh and Mesh Motion,	15
5	Multiphase Flows and Lagrangian Particles, Lagrangian tracking of particles or droplets Heat Transfer and Radiation,	15
6	Parallel Computing, Debugging, and Visualization: Parallel Execution, Function Objects, Visualization using ParaView, Debugging and Optimization.	10

CLO-PLO Mapping Matrix

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12	Avg CLO
CLO1	3	2	2	1	2	1	1	1	1	1	1	2	**1.5**
CLO2	3	3	2	2	3	1	1	1	2	1	1	2	**1.83**
CLO3	3	3	3	3	3	1	2	1	2	2	1	2	**2.17**
CLO4	3	3	3	3	3	2	2	1	2	2	1	2	**2.25**
CLO5	2	2	2	2	3	1	2	1	2	2	2	2	**1.92**
CLO6	3	3	3	3	3	2	3	2	3	3	2	3	**2.75**
Avg PLO	**2.83**	**2.67**	**2.5**	**2.33**	**2.83**	**1.33**	**1.83**	**1.17**	**2**	**1.83**	**1.33**	**2.17**	2.12

Suggested reading:

1	*M. Greenshields, OpenFOAM User Guide and Programmer's Guide, OpenFOAM Foundation.*
2	*Bjarne Stroustrup – Programming: Principles and Practice Using C++ (Addison-Wesley, 2nd Ed.)*
3	*Stanley B. Lippman, Josée Lajoie, Barbara E. Moo – C++ Primer (5th Ed.)*
4	*Scott Meyers – Effective C++ (3rd Ed.)*
5	*Syeda Beenish Javed, Jasbir Singh Saini – OpenFOAM for Fluid Dynamics and Heat Transfer (CRC Press, 2022).*

Teaching-Learning Strategies:

Interactive Lectures, MATLAB/C++ Simulations, Industry Seminars, Assignments, Case-based Learning

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODEDTT325**	*Semester*	*Third*	*Contact Hours*	*39*
Course Title	**Wind Turbine Tribology**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	2	1	0	3	75
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Understands the principles of friction, wear, and lubrication relevant to wind turbine applications.
CLO2	Analyze the performance, design considerations, and failure mechanisms of wind turbine bearings.
CLO3	Evaluate tribological behavior and damage modes in wind turbine gear systems under different loading and lubrication regimes.
CLO4	Implement Finite Difference and FEM-based solvers for conduction and compare with commercial software outputs.
CLO5	Assess lubricants, additives, and lubrication systems for wind turbines with emphasis on contamination control.
CLO6	Apply condition monitoring and diagnostic techniques to identify tribological issues in wind turbines.

SYLLABUS

Units	**Content**	**Marks**
1	Fundamentals of Tribology; Friction, wear, lubrication basics, Contact mechanics in wind turbine applications, Environmental effects (onshore vs. offshore)	10
2	Gear and Gearbox Tribology, Gear types and load transmission, Lubrication regimes (EHL, boundary, mixed), Gear wear and damage mechanisms	10
3	Bearings in Wind Turbines, Main shaft, gearbox, generator, pitch & yaw bearings, Materials, coatings, failure modes (WEC, micropitting, fretting), Bearing life and monitoring	15
4	Lubrication and Greases, Lubricants: oils, greases, additives, Lubrication systems and contamination control, Oil condition monitoring	15
5	Condition Monitoring & Diagnostics, Vibration, acoustic emission, thermography, Oil analysis and wear particle detection, Predictive maintenance strategies	15
6	Advances and Future Trends,Surface engineering and nanolubricants, Offshore wind turbine tribology challenges, Digital twins and AI in tribological monitoring	10

CLO-PLO Mapping Matrix

CLO/PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**	**Avg CLO**
CLO1	3	2	1	1	1	1	2	0	0	2	0	3	**1.33**
CLO2	3	3	2	2	2	2	1	2	0	2	1	2	**1.83**
CLO3	3	3	3	2	2	1	1	1	0	2	2	2	**1.83**
CLO4	2	2	2	2	2	2	2	1	0	2	1	2	**1.67**
CLO5	2	3	2	3	3	2	1	2	1	3	2	3	**2.25**
CLO6	2	2	3	3	3	2	3	2	2	3	3	3	**2.58**
Avg PLO	**2.5**	**2.5**	**2.17**	**2.17**	**2.17**	**1.67**	**1.67**	**1.33**	**0.5**	**2.33**	**1.5**	**2.5**	**1.92**

Suggested reading:

1	*Hutchings, I.M. & Shipway, P. – Tribology: Friction and Wear of Engineering Materials (2nd Ed., Elsevier)*
2	*Errichello, R. & Sheng, S. (NREL Reports) – Wind Turbine Gearbox Reliability Database*
3	*Burton, T., Sharpe, D., Jenkins, N., Bossanyi, E. – Wind Energy Handbook (2nd Edition, Wiley, 2011).*
4	*Parker O-Ring & Seal Lubrication Handbook – For seal design in wind turbine gearboxes.*
5	*Bloch, H.P. – Practical Lubrication for Industrial Facilities (CRC Press)*

Teaching-Learning Strategies:

Interactive Lectures, Use ANSYS (Mechanical/Fluent), COMSOL Multiphysics, OpenFOAM (with swak4foam/chtMultiRegion).

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODEDAM325**	***Semester***	***Third***	***Contact Hours***	***39***
Course Title	**Artificial Intelligence and Machine Learning**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	2	1	0	3	75
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Explain the fundamentals of Artificial Intelligence, its evolution, applications, and analyze intelligent agent architectures, neural networks, and genetic algorithms.
CLO2	Apply logical reasoning techniques using propositional and first-order logic, and design knowledge-based agents for problem-solving.
CLO3	Implement Bayesian and computational learning models such as Bayes theorem, Naïve Bayes, and K-Nearest Neighbor for decision-making and classification tasks.
CLO4	Differentiate between supervised and unsupervised learning paradigms and illustrate real-world applications of machine learning across industries.
CLO5	Analyze and implement supervised learning methods (Decision Trees, SVM, Kernel methods) and unsupervised techniques (Clustering, K-means, PCA) for pattern recognition and data analysis.
CLO6	Evaluate machine learning algorithms and ensemble methods and develop deep learning models (autoencoders, Boltzmann machines, deep generative models) for sequence and time-series data.

SYLLABUS

Units	Content	Marks
1	Introduction: Definition of Artificial Intelligence, Evolution, Need, and applications in real world. Intelligent Agents, Agents and environments; Good Behavior-The concept of rationality, the nature of environments, structure of agents. Neural Networks and Genetic Algorithms: Neural network representation, problems, perceptrons,multilayer networks and back propagation algorithms, Genetic algorithms.	10
2	Knowledge Representation and Reasoning: Logical Agents: Knowledge based agents, the Wumpus world, logic. Patterns in Propositional Logic, Inference in First-Order Logic-Propositional vs first order inference, unification and lifting	10
3	Bayesian and Computational Learning: Bayes theorem , concept learning, maximum likelihood, minimum description length principle, Gibbs Algorithm, Naïve Bayes Classifier, Instance Based Learning- K-Nearest neighbour learning	15
4	Introduction to Machine Learning (ML): Definition, Evolution, Need, applications of ML in industry and real world, classification; differences between supervised and unsupervised learning paradigms.	15
5	Basic Methods in Supervised Learning: Distance-based methods, Nearest-Neighbors, Decision Trees, Support Vector Machines, Nonlinearity and Kernel Methods. Unsupervised Learning: Clustering, K-means, Dimensionality Reduction, PCA and kernel.	15
6	Machine Learning Algorithm Analytics: Evaluating Machine Learning algorithms, Model, Selection, Ensemble Methods (Boosting, Bagging, and Random Forests). Modeling Sequence/Time-Series Data and Deep Learning: Deep generative models, Deep Boltzmann Machines, Deep auto-encoders, Applications of Deep Networks.	10

CLO-PLO Mapping Matrix

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12	Avg CLO
CLO1	3	2	2	1	2	1	1	1	0	1	0	2	**1.33**
CLO2	3	3	2	2	2	1	0	1	1	2	0	2	**1.58**
CLO3	3	3	2	2	3	0	0	0	0	1	0	2	**1.33**
CLO4	2	2	2	1	2	2	1	1	1	2	0	3	**1.58**
CLO5	3	3	3	2	3	0	0	0	1	2	0	2	**1.58**
CLO6	3	3	3	3	3	1	1	1	1	2	2	3	**2.17**
Avg PLO	**2.83**	**2.67**	**2.33**	**1.83**	**2.5**	**0.83**	**0.5**	**0.67**	**0.67**	**1.67**	**0.33**	**2.33**	1.6

Suggested reading:

1 *Russell, S. & Norvig, P. – Artificial Intelligence: A Modern Approach (Pearson, latest edition)*

2 *Goodfellow, I., Bengio, Y., & Courville, A. – Deep Learning (MIT Press)*

3 *Haykin, S. – Neural Networks and Learning Machines (Pearson)*

4 *Bishop, C.M. – Pattern Recognition and Machine Learning (Springer)*

Teaching-Learning Strategies:

Lecture & Interactive Discussion, Problem-Solving Sessions, Laboratory / Practical Work, Case-Based and Project-Based Learning, Experiential / Simulation-Based Learning, Blended Learning & Flipped Classroom,

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODEDMA325**	***Semester***	***Third***	***Contact Hours***	***39***
Course Title	**Mathematics for AI and ML**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	2	1	0	3	75
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Understing of theory of learning basics
CLO2	Convex functions and sets, Convex Optimization problem Formulations
CLO3	Gradient and Sub-gradient descent for non- smooth functions, Regularization, Lasso and Ridge, Applications with medical data
CLO4	Support Vector Regression, Logistic Regression for dichotomous variable
CLO5	Dynamical systems and control, Fourier transform and its applications
CLO6	Bayesian Machine Learning

SYLLABUS

Units	**Content**	**Marks**
1	Introduction to Theory of Learning: Define and explain different types and definitions of learning, understand and identify overfitting and underfitting, analyze learning problems using the PAC learning framework	10
2	Convex functions and sets, Convex Optimization problem Formulations:Optimization Problem Basics: Feasible Sets, Objective Functions, Optimality Conditions: Fermat's Rule, Subgradients, Duality Theory: Lagrange Dual Function, KKT Conditions and Their Interpretation	10
3	Gradient and Sub-gradient descent for non- smooth functions, Regularization, Lasso and Ridge, Applications with medical data: Introduction to Optimization in Data Science & Medical Applications, Gradient Descent: Algorithms, Step Size, Convergence, Sub-gradient Descent for Non-smooth Convex Functions.	10
4	Introduction to Supervised Learning,Linear Regression, Optimization Concepts,Linear vs Nonlinear Kernels, Hyperparameter Tuning in SVR, Log-Odds, Likelihood, Sigmoid Function,Fourier Transform: Discrete Fourier Transform (DFT) and FFT	15
5	Introduction to Dynamical Systems: State, Input, Output, Linear Time-Invariant (LTI) Systems, First-order and Second-order Systems, Feedback and Control Concepts: Open-loop vs Closed-loop.	15
6	Bayesian Machine Learning:Bayes' Rule, Priors, Likelihoods, Posteriors, Bayesian Decision Theory: Loss Functions and Optimal Decisions, Bayesian Linear Regression and Logistic Regression.	15

CLO-PLO Mapping Matrix

CLO/PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**	**Avg CLO**
CLO1	3	2	0	0	0	0	1	1	0	2	0	2	**0.92**
CLO2	3	3	0	2	0	0	0	0	0	0	0	2	**0.83**
CLO3	3	3	2	2	0	0	0	0	0	1	0	2	**1.08**
CLO4	3	3	2	2	0	0	0	0	0	1	0	2	**1.08**
CLO5	2	3	2	3	2	0	1	0	0	1	0	2	**1.33**
CLO6	3	3	2	3	3	2	3	2	2	3	2	3	**2.58**
Avg PLO	**2.83**	**2.83**	**1.33**	**2**	**0.83**	**0.33**	**0.83**	**0.5**	**0.33**	**1.33**	**0.33**	**2.17**	1.74

Suggested reading:

1	*Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong,Mathematics for Machine Learning*
2	*Christopher M. Bishop, Pattern Recognition and Machine Learning*
3	*Gareth JamesDaniela WittenTrevor HastieRobert Tibshirani, An Introductionto StatisticalLearning*
5	*Michael I. Jordan, Jon Krohn, Mathematics for Machine Learning and Data Science*

Teaching-Learning Strategies:

Softwares: Python, Matlab; Mathematical Tools: Wolfram Alpha, Symbolab, GeoGebra

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	MODEORE325	Semester	Third	Contact Hours	39
Course Title	**Renewable Energy System**				
Scheme & Credits	L	T	P	Credits	Max marks
	3	0	0	3	75
Prerequisites	Nil				

Course Learning Outcomes (CLOs):

CLO1	Understands the principles, need, and global context of renewable energy systems.
CLO2	Analyze solar energy systems (thermal & PV) and evaluate their performance.
CLO3	Assess wind resource potential and turbine performance under different operating conditions.
CLO4	Evaluate biomass conversion technologies for sustainable energy generation.
CLO5	Compare hydro, geothermal, and ocean energy systems in terms of feasibility and applications.
CLO6	Investigate energy storage, hybrid systems, and smart grid integration for future renewable deployment.

SYLLABUS

Units	Content	Marks
1	Introduction to Renewable Energy, Energy demand and supply trends, Conventional vs. renewable energy, Global and Indian energy scenario, Sustainability, energy policy, and challenges	10
2	Solar Energy Systems, Solar radiation principles, Solar thermal technologies (collectors, concentrators), Solar PV systems: cells, modules, arrays, inverters, Grid integration and storage	10
3	Wind Energy Systems, Wind resource assessment, Aerodynamics of wind turbines, Types of wind turbines (HAWT, VAWT), Power curve, efficiency, control systems	15
4	Biomass and Bioenergy, Biomass resources and conversion routes, Biogas production and utilization, Biofuels (biodiesel, ethanol), Biomass gasification and pyrolysis	10
5	Hydro, Geothermal & Other Renewables, Small hydro power systems, Geothermal resources and power plants, Ocean energy: wave, tidal, OTEC, Emerging hybrid renewable systems	15
6	Energy Storage, Integration & Future Trends, Batteries, fuel cells, supercapacitors, Hybrid renewable systems and microgrids, Smart grid integration of renewables, Future trends: hydrogen economy, green energy transition	15

CLO-PLO Mapping Matrix

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12	Avg CLO
CLO1	3	2	1	1	1	2	3	1	0	2	0	3	**1.58**
CLO2	3	3	2	2	2	2	2	1	0	2	1	2	**1.83**
CLO3	3	3	2	2	2	2	3	1	0	2	2	2	**2**
CLO4	2	2	2	2	2	3	3	2	0	2	1	2	**1.92**
CLO5	2	2	2	2	1	2	3	1	1	2	2	2	**1.83**
CLO6	2	2	3	3	3	2	3	2	2	3	3	3	**2.58**
Avg PLO	**2.5**	**2.33**	**2**	**2**	**1.83**	**2.17**	**2.83**	**1.33**	**0.5**	**2.17**	**1.5**	**2.33**	2.15

Suggested reading:

1	*Boyle, G. (Ed.) – Renewable Energy: Power for a Sustainable Future (Oxford University Press)*
2	*Kalogirou, S.A. – Solar Energy Engineering: Processes and Systems (Academic Press)*
3	*Godfrey Boyle & Bob Everett – Energy Systems and Sustainability (Oxford)*
4	*Duffie, J.A. & Beckman, W.A. – Solar Engineering of Thermal Processes (Wiley)*
5	*Burton, T., Jenkins, N., Sharpe, D., Bossanyi, E. – Wind Energy Handbook (Wiley)*

Teaching-Learning Strategies:

Interactive Lectures, , Industry Seminars, Assignments, Case-based Learning

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODEYSE325**	*Semester*	*Second*	*Contact Hours*	**52**
Course Title	**SEMINAR**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks**
	0	0	4	2	50

Course Learning Outcome (CLO):

CLO1: The seminar course is designed to develop students' technical communication, critical thinking, and research presentation skills. It provides a platform for students to explore contemporary topics in power systems and control, conduct literature reviews, and analyze recent advancements in the field. Students are required to select a relevant research topic, prepare a structured presentation, and effectively communicate their findings to an audience. Emphasis is placed on clarity, technical depth, and the ability to engage in discussions. Through peer interactions and faculty feedback, students enhance their ability to present complex ideas concisely and confidently, preparing them for future academic and professional endeavors.

Mapping to PLOs:

CLO/PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**	**Avg CLO**
CLO1	3	3	3	3	3	3	2	3	3	3	2	3	**2.83**
Avg PLO	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**2**	**3**	2.83

Course Code	**MODEOIR325**	***Semester***	***First***	***Contact Hours***	***39***
Course Title	**Industrial Automation and Robotics**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	3	0	0	3	75
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Explain the need, types, and levels of automation and computer process control.
CLO2	Analyze NC systems, their classifications, applications, and manual part programming.
CLO3	Evaluate manual and automated assembly/transfer lines with and without buffers.
CLO4	Describe robot anatomy, configurations, drive systems, sensors, and end effectors.
CLO5	Apply D-H parameters to solve forward and inverse kinematics of robotic mechanisms
CLO6	Compare different robot actuators and sensors for industrial manufacturing applications.

SYLLABUS

Units	Content	Marks
1	Introduction to Automation: Automation - need-types, basic elements of an automated system, levels of automation computer process control, forms of computer process control, input/output devices for discrete data, overview of material handling equipment.	15
2	Numerical Control: Introduction-NC procedure, NC coordinate systems, elements of NC systems, classification of NC systems, advantages and dis-advantages of NC systems, applications of NC, NC manual part programming, apt language. Manual Assembly Lines and Transfer Lines: Fundamentals of manual assembly lines and automated production lines, alternative assembly systems, design for assembly, applications of automated production lines, analysis of transfer lines with no internal storage, analysis of transfer lines with storage buffers.	15
3	Introduction to Industrial Robots: Robotics definition - robot configurations, robot anatomy, joint system, types of joints, work volume, robot drive systems, precision of movement, robotic sensors and actuators, end effectors, grippers, different types of grippers.	15
4	Manipulator Kinematics: representation of position and orientation of body, transformation of rigid body, homogenous transformation, the manipulator kinematics, d-h parameters, 2r and 3r mechanism d-h analysis, forward and inverse kinematics.	15
5	Robot Actuators and Feed Back Computers: Actuators- pneumatic-hydraulic actuators, electric & stepper motors, comparison, position sensors – potentiometers- resolvers- encoders – velocity sensors-tactile sensors proximity sensors, robot applications in manufacturing.	15

CLO-PLO Mapping Matrix

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12	Avg CLO
CLO1	3	2	0	0	0	0	0	0	0	1	0	1	**0.58**
CLO2	3	3	1	0	2	0	0	0	0	1	0	2	**1**
CLO3	2	3	2	0	0	0	2	0	1	1	0	1	**1**
CLO4	3	2	2	0	0	1	0	0	0	1	0	1	**0.83**
CLO5	3	3	1	2	3	0	0	0	0	1	0	2	**1.25**
CLO6	3	2	1	0	2	2	1	0	0	1	0	2	**1.17**
Avg PLO	**2.83**	**2.5**	**1.17**	**0.33**	**1.17**	**0.5**	**0.5**	**0**	**0.17**	**1**	**0**	**1.5**	0.97

Suggested reading:

1	*Mikell P. Groover, B. Automation, Production Systems and CIM, Prentice-Hall of India Pvt. Ltd, 2016.*
3	*Nicholas Odrey, Mitchell Weiss, Mikell Groover, Roger Nagel, Ashish Dutta, Industrial Robotics -Technology, Programming and Applications (SIE), McGraw-Hill 2nd Edition, 2017*
4	*Niku, S. B, John, Introduction to robotics: analysis, control, applications. Wiley & Sons, 2020*
5	*K.S.Fu., R.C.Gonzalez, C.S.G. Lee, Robotics: Control Sensing, Vision and Intelligence Indian Edition, McGraw Hill Book Co., 2008.*

Teaching-Learning Strategies:

Interactive Lectures, Lab Experiments, Seminars, Assignments, Case-based Learning

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.

Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODEPDP325**	*Semester*	*Third*	*Contact Hours*	*78*
Course Title	**PHASE-I DISSERTATION**				

Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks**
	0	0	12	6	150

Course Learning Outcome (CLO):

CLO1: Phase I of the dissertation focuses on problem formulation, literature review, and initial research development in Mechanical Design Engineering . Students identify a relevant research problem, analyze existing work, and develop a preliminary methodology. This phase emphasizes research planning, model development, and initial simulations or experimental setups. By the end of Phase I, students are expected to present a well-structured research proposal with preliminary results, laying the foundation for in-depth analysis and implementation in Phase II.

Mapping to PLOs:

CLO/PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**	**Avg CLO**
CLO1	3	3	3	3	3	3	2	2	3	3	2	3	**2.75**
Avg PLO	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**2**	**3**	**2.75**

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Presentations, faculty advisor assessment.

Semester End Examination (SEE): 72% weightage; Comprehensive asessment of work including presentation, report, viva-voce, etc.

Course Code	**MODEAME325**	***Semester***	***Third***	***Contact Hours***	***52***
Course Title	**Machne Learning for Experimentation**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	3	1	0	4	100
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Distinguish between different lubrication regimes: boundary, mixed, hydrodynamic, and hydrostatic. Incorporation of Reynolds equation to 1D and 2D flow problems in journal and slider bearings.
CLO2	Calculate the load-carrying capacity, frictional force, and energy loss for idealized hydrodynamic bearings.
CLO3	Analyze the geometry and function of journal bearings using short and long bearing approximations.
CLO4	Incorporate thermal correction into Reynolds equation and evaluate performance under thermal loads.
CLO5	Implement the Finite Difference Method (FDM), Computational Fluid Dynamics (CFD) to solve lubrication problems numerically.
CLO6	Relate hydrodynamic lubrication principles to real-world systems (turbomachinery, IC engines, marine and hydro turbines) and propose energy-efficient and sustainable lubrication solutions.

SYLLABUS

Units	**Content**	**Marks**
1	Fundamentals of Lubrication: Introduction to tribology and lubrication regimes: boundary, mixed, hydrodynamic, elastohydrodynamic. Role of lubricants: viscosity, rheology, additives. Mechanisms of load support in fluid films. Historical development of lubrication theory.	16
2	Derivation of Reynolds Equation: Governing equations of fluid motion (Navier–Stokes, continuity). Assumptions for thin-film lubrication. Derivation of Reynolds equation for incompressible and compressible lubricants. Simplifications and boundary conditions.	16
3	Hydrodynamic Journal Bearings: Infinitely long and infinitely short journal bearings. Pressure distribution, load-carrying capacity, and attitude angle. Friction, power loss, and temperature rise. Sommerfeld number and bearing performance charts. Experimental correlations and design data.	16
4	Hydrodynamic Thrust Bearings: Plane inclined slider and step bearings. Tilting pad thrust bearings. Pressure distribution and load capacity. Applications in heavy-duty machinery and turbines.	18
5	Advanced Analysis of Bearings: Thermal effects: viscosity variation, temperature rise. Cavitation phenomena and boundary conditions. Dynamic characteristics: stiffness, damping, stability. Misalignment, surface roughness, and deformation effects.	18
6	Applications & Modern Trends: Hydrodynamic lubrication in IC engines, turbines, pumps, and marine bearings. Hydrostatic and hybrid bearings (brief introduction). Energy efficiency, eco-friendly lubricants, water-lubricated bearings. Numerical solution techniques (FDM, FEM, CFD approaches). Case studies & research frontiers	16

CLO-PLO Mapping Matrix

CLO/PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**	**Avg CLO**
CLO1	3	2	0	0	0	0	1	1	0	2	0	2	**0.92**
CLO2	3	3	0	2	0	0	0	0	0	0	0	2	**0.83**
CLO3	3	3	2	2	0	0	0	0	0	1	0	2	**1.08**
CLO4	3	3	2	2	0	0	0	0	0	1	0	2	**1.08**
CLO5	2	3	2	3	2	0	1	0	0	1	0	2	**1.33**
CLO6	3	3	2	3	3	2	3	2	2	3	2	3	**2.58**
Avg PLO	**2.83**	**2.83**	**1.33**	**2**	**0.83**	**0.33**	**0.83**	**0.5**	**0.33**	**1.33**	**0.33**	**2.17**	1.74

Suggested reading:

1	*B.C. Majumdar, Introduction to Tribology of Bearings*
2	*Gwidon W. Stachowiak & Andrew W. Batchelor, Engineering Tribology, (Butterworth-Heinemann, 5th Ed., 2025)*
3	*Harish Hirani, Fundamentals of Engineering Tribology with Application, (Cambridge University Press, 2016)*
4	*Oscar Pinkus & Beno Sternlicht, Theory of Hydrodynamic Lubrication, (Classic, 1961; reprints available)*
5	*Yukio Hori, Hydrodynamic Lubrication, (Springer Japan, 2006; reprint 2016)*

Teaching-Learning Strategies:

Interactive Lectures, MATLAB/FORTRAN Simulations, Industry Seminars, Assignments, Case-based Learning

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.

Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODEPDP425**	*Semester*	*Fourth*	*Contact Hours*	*30*
Course Title	**PHASE-II DISSERTATION**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max Marks**
	0	0	30	15	375

Course Objective:

1. To execute and refine the research work initiated in Phase I.
2. To implement advanced computational, analytical, or experimental techniques.
3. To analyze results critically and compare them with existing literature.
4. To contribute novel insights or methodologies to Design , Coupled simulations (e.g., Structural integrity of mechnaical components, fluid–structure interaction, thermal–mechanical design, tribological modeling).
5. To develop technical writing skills and prepare a high-quality dissertation and research publication.

Course Learning Outcomes (CLOs):

CLO1: Phase II of the dissertation involves the full-scale implementation, validation, and refinement of the research initiated in Phase I. Students apply advanced computational, analytical, or experimental techniques to validate their hypotheses and compare results with existing benchmarks. This phase focuses on deriving meaningful conclusions, addressing research challenges, and contributing novel insights to Structural integrity of mechnaical components, fluid–structure interaction, thermal–mechanical design, tribological modeling. The outcome is a well-documented dissertation, accompanied by research publications and a final defense demonstrating the originality and impact of the work.

Mapping to PLOs:

CLO/PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**Avg CLO**
CLO1	3	3	3	3	3	3	3	3	3	3	**3**
Avg PLO	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	3

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Presentations, faculty advisor assessment.
Semester End Examination (SEE): 72% weightage; Comprehensive asessment of work including presentation, report, viva-voce, etc.

Course Code	**MODEOBH325**	***Semester***	***Second***	***Contact Hours***	***39***
Course Title	**HVAC Systems and Sustainable Building code and Services**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	3	0	0	3	75
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Explain the fundamentals of HVAC systems including modes of heat transfer, refrigeration cycles, and functions of major components using pressure–enthalpy charts.
CLO2	Identify and compare different types of compressors, condensers, expansion valves, evaporators, accessories, refrigerants, and brines used in HVAC systems.
CLO3	Analyze various classifications of air-conditioning systems (Window, Split, Ductable Split, VRV/VRF, Package systems) and illustrate their working with line diagrams.
CLO4	Interpret psychrometric charts to determine properties such as dry bulb temperature, wet bulb temperature, dew point, relative humidity, and evaluate psychrometric processes including heating, cooling, humidification, and dehumidification.
CLO5	Perform cooling load calculations by conducting building surveys, evaluating heat transfer through walls/roofs/glass, determining ventilation requirements, and applying E-20 forms for load estimation (ESHF, ADP & Air Flow Rate).
CLO6	Design and evaluate HVAC system components by performing static pressure and pump head calculations, selecting fans/blowers, motors, hydronic piping systems, pipe sizing, and associated fittings and valves.

SYLLABUS

Units	Content	Marks
1	Introduction to HVAC: Fundamentals-Modes of Heat Transfer-Sensible Heat and Latent Heat-Basic Components of Air-Conditioning and Refrigeration machines-Basic Refrigeration System or Vapor Compression Cycle-Pressure –Enthalpy Chart-Function.	10
2	Types of Compressor- Function & Types of Condenser-Function & Types of Expansion Valves, Function & Types of Evaporator-Accessories used in the System-Refrigerant and Brines	15
3	Classification Of Air-Conditioning System: Window A/C-Working of Window A/C with Line Diagrams-Split A/C-Types - Working of Split A/C with Line Diagrams-Ductable Split A/C- Working of Ductable Split A/C with Line Diagrams-Variable Refrigerant Volume (VRV)/ Variable Refrigerant Flow (VRF)-Ductable Package A/C-Working of Ductable Package A/C with Line Diagrams	15
4	Study of Psychrometric Charts: Dry Bulb Temperature-Wet Bulb Temperature-Dew Point Temperature-Relative Humidity-Humidity Ratio-Processes, Heating, Cooling, Cooling and Dehumidification, Heating and Humidification	15
5	Load Calculation: Survey of Building- Cooling Load Steps-Finding Temperature difference(ΔT)- Wall, Glass, Roof, partition-Finding 'U' Factor-Wall, Glass, Roof, Partition-Finding Ventilation requirement for IAQ-Load Calculations (Manually using E-20 form)- ESHF, ADP & Air Flow Rate (CFM)Calculation	10
6	Static Pressure Calculation: Selection of Motor HP-Selection Fan/Blower RPM-Hydronic System-Classification of Water Piping-Pipe sizing for chill water system-Fittings used in the HVAC Piping System-Valves used in the HVAC Piping System-Function of Valves-Openings for CHW Pipes passing through Wall-Sectional drawing @ CHW Pipe supports-Pump Head Calculation- Selection of Pump	10

CLO-PLO Mapping Matrix

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12	Avg CLO
CLO1	3	2	1	1	2	1	1	0	0	1	0	2	**1.17**
CLO2	3	2	2	1	2	1	2	1	0	1	0	2	**1.42**
CLO3	2	3	3	1	2	1	1	1	1	2	0	2	**1.58**
CLO4	3	3	2	2	3	1	2	0	0	1	0	2	**1.58**
CLO5	3	3	3	2	3	2	2	0	1	2	2	2	**2.08**
CLO6	3	3	3	2	3	2	3	1	2	2	3	2	**2.42**
Avg PLO	**2.83**	**2.67**	**2.33**	**1.5**	**2.5**	**1.33**	**1.83**	**0.5**	**0.67**	**1.5**	**0.83**	**2**	1.71

Suggested reading:

1	*James E. Brumbou, HVAC Fundamentals Volume-l, James E. Brumbou, Audel, 4Edition.*
2	*Robert Mcdowal, Fundamentals of HVAC Systems , Robert Mcdowall, Academic Press (2007)*
3	*F.C. McQuiston and J.D. Parker, Heating, Ventilating, and Air Conditioning Analysis and Design, John Wiley & Sons, Inc. 5th Edition, 2000.*
4	*R&AC, Hand Book by ISHRAE*
5	*Neil McManus, Portable Ventilation Systems Hand Book, CRC Press, 2000.*

Teaching-Learning Strategies:

Interactive Lectures, Simulation software demonstration, HVAC design tools, AutoCAD MEP, Case-based learning

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODEADE325**	***Semester***	***Third***	***Contact Hours***	***39***
Course Title	**Design of Experiments**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	3	0	0	0	75
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Explain the basic principles of experimental design, optimization techniques, and fundamental statistical concepts including data types, measures of central tendency/dispersion, and skewness.
CLO2	Apply statistical tests of significance (t-test, F-test, Chi-square test) for comparing means and variances, and interpret results using randomized and paired comparison designs.
CLO3	Develop and analyze linear regression models using least squares estimation, perform hypothesis testing, and evaluate model adequacy through lack-of-fit tests.
CLO4	Design and evaluate factorial experiments (full and fractional), construct design matrices, and conduct regression diagnostics for model improvement.
CLO5	Implement the Taguchi method for quality improvement through concept, parameter, and tolerance design; utilize orthogonal arrays, quality loss functions, and signal-to-noise ratios for parameter optimization.
CLO6	Perform Analysis of Variance (ANOVA) for one-way and two-way designs, calculate degrees of freedom, and interpret results in case studies involving factorial design, Taguchi method, and ANOVA.

SYLLABUS

Units	Content	Marks
1	Introduction: Brief introduction of optimization techniques, Strategy of experimentation, Basic principles of Design, Terminology used in Design of Experiment, Guidelines for designing experiments, Basic statistical concepts: Types of Data, Graphical representation of Data, Measures of Central Tendency and Dispersion, Skewness.	10
2	Simple Comparative Experiments: Sampling and sampling Distribution, Test of significance for single mean and for difference of means of two samples, Inferences about the Differences in means: randomized designs, Inferences about the Differences in means: Paired comparison Designs, Inferences about the Variances of Normal Distributions. Test of significance based on t, F and Chi square distribution.	10
3	Fitting Regression Models: Introduction, Linear regression models, Estimate of parameters in linear regression models, The method of least square, Hypothesis testing : Null Hypothesis, Alternative Hypothesis, Prediction of new response observations, Testing for lack of fit.	10
4	Factorial Design: Basic definition and principles, Advantages of factorials, Types of factorial design: Full factor factorial design and fraction factorial design, Design Matrix, Development of mathematical model, Regression model diagnostics.	15
5	Taguchi Method: Introduction, Concept design, Parameter design, Tolerance design, Orthogonal array experiments Taguchi quality loss function, Signal-to Noise ratio, Quality characteristics, Parameter optimization experiment, Parameter design case study.	15
6	Analysis of Variance (ANOVA): Introduction, One way ANOVA process, Two way ANOVA process, Degrees of freedom, Case studies on Factorial design, Taguchi Method and ANOVA.	15

CLO-PLO Mapping Matrix

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12	Avg CLO
CLO1	3	2	1	1	2	0	0	0	0	1	0	2	**1**
CLO2	3	3	2	2	2	0	0	1	0	1	0	2	**1.33**
CLO3	3	3	2	2	3	0	0	1	0	2	0	2	**1.5**
CLO4	3	3	3	2	3	0	1	1	1	2	0	2	**1.75**
CLO5	3	3	3	2	3	1	2	1	1	2	2	2	**2.08**
CLO6	3	3	3	2	3	1	3	1	1	2	2	2	**2.17**
Avg PLO	**3**	**2.83**	**2.33**	**1.83**	**2.67**	**0.33**	**1**	**0.83**	**0.5**	**1.67**	**0.67**	**2**	1.64

Suggested reading:

1	*Douglas C Montgomery, John Wiley, Design and Analysis of Experiments,*
2	*John P.W.M., Macmillan, Statistical Design and Analysis of Experiments*
3	*Montgomery D.C., Runger G. C., Introduction to Linear Regression Analysis,*
4	*George. E. P. Box, J. Stuart Hunter, William G. Hunter, Statistics for Experimenters: Design, Innovation, and Discovery, 2nd Edition, Wiley, 2005.*
5	*S. C. Gupta & V. K. Kapoor, Fundamentals of Applied Statistics, Sultan Chand&Sons, New Delhi.*

Teaching-Learning Strategies:

Interactive Lectures, ANOVA, Case-Based and Project-Based Learning, Assignments, Real-time data analysis, Practical experiments, Simulation exercises

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODEOPA325**	*Semester*	*Third*	*Contact Hours*	*39*
Course Title	**3D Printing and Additive Manufacturing**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	3	0	0	3	75
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Explain the fundamentals, classifications, advantages, and applications of Additive Manufacturing (AM) and differentiate it from conventional manufacturing processes.
CLO2	Demonstrate understanding of CAD data formats, STL files, and data translation issues relevant to Additive Manufacturing.
CLO3	Analyze various Additive Manufacturing techniques (SLA, LOM, FDM, SLS, SLM, Binder Jet) and evaluate their process parameters and selection criteria for different applications.
CLO4	Identify and assess application domains of Additive Manufacturing across industries such as aerospace, healthcare, defence, automotive, construction, and food processing.
CLO5	Examine different materials used in Additive Manufacturing (polymers, metals, ceramics, composites), their forms (liquid, solid, wire, powder), properties, and suitability for specific processes.
CLO6	Evaluate and apply knowledge of AM equipment, bonding mechanisms, troubleshooting methods, post-processing techniques, and quality inspection/testing for defect analysis and product improvement.

SYLLABUS

Units	Content	Marks
1	3D Printing (Additive Manufacturing): Introduction, Process, Classifications, Advantages, Additive v/s Conventional	10
2	CAD for Additive Manufacturing: CAD Data formats, Data translation, Data loss, STL format.	10
3	Additive Manufacturing Techniques: Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology, Process, Process parameter, Process Selection for various applications. Additive Manufacturing	10
4	Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools	15
5	Materials: Poly3D printing process mers, Metals, Non-Metals, Ceramics Process, Process parameter, Process Selection for various applications. Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties. Support Materials.	15
6	Additive Manufacturing Equipment: Process Equipment- Design and process parameters, Governing Bonding Mechanisms, Common faults and troubleshooting, Process Design. Post Processing: Requirement and Techniques: Support Removal, Sanding, Acetone treatment, and polishing. Product Quality: Inspection and testing, Defects and their causes.	15

CLO-PLO Mapping Matrix

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12	Avg CLO
CLO1	3	2	2	1	1	1	2	1	0	1	0	2	**1.33**
CLO2	2	2	2	1	3	0	0	0	0	2	0	2	**1.17**
CLO3	3	3	3	2	3	1	1	1	0	2	0	2	**1.75**
CLO4	2	2	2	1	2	2	2	1	1	2	1	2	**1.67**
CLO5	3	2	2	2	3	1	2	1	0	1	0	2	**1.58**
CLO6	3	3	3	2	3	2	2	1	1	2	2	3	**2.25**
Avg PLO	**2.67**	**2.33**	**2.33**	**1.5**	**2.5**	**1.17**	**1.5**	**0.83**	**0.33**	**1.67**	**0.5**	**2.17**	1.63

Suggested reading:

1	*Gibson, I., Rosen, D.W., & Stucker, B. – Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing (Springer, latest edition.*
2	*Khanna Editorial, 3D Printing and Design, Khanna Publishing House, Delhi.*
3	*Kalpakjian, S. & Schmid, S. – Manufacturing Engineering and Technology (Pearson)*
4	*Pham, D.T. & Dimov, S.S. – Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling (Springer)*
5	*Ian Gibson, Brent Stucker, & Mahyar Khorasani – Additive Manufacturing Technologies (Springer, 2nd Ed.)*

Teaching-Learning Strategies:

Interactive Lectures, Comparison charts and case studies, Hands-on CAD workshops, Material selection assignments, Capstone project, Industry exposure

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODEARM325**	*Semester*	*Third*	*Contact Hours*	*39*
Course Title	**Research Methodology**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	3	0	0	0	75
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Explain the fundamentals of research methodology including objectives, types, processes, problem identification, literature review, ethical aspects, and IPR issues.
CLO2	Design appropriate research strategies by applying principles of research design, experimental design, and sampling methods for effective data collection and analysis.
CLO3	Demonstrate the ability to use various data collection methods, measurement scales, scaling techniques, and distinguish between primary and secondary data sources.
CLO4	Apply statistical tools for data processing and analysis, including measures of dispersion, skewness, regression, correlation, and sampling fundamentals.
CLO5	Formulate and test research hypotheses using parametric and non-parametric tests, including ANOVA, ANCOVA, Chi-square, and multivariate analysis.
CLO6	Develop skills for research interpretation and report writing by preparing structured reports, research papers, and understanding publishing processes, impact factor, and citation practices.

SYLLABUS

Units	**Content**	**Marks**
1	An Introduction to Reasearch Methodology: Meaning, Objectives & Motivation of Research, Types of Research, Research Process, Identifying and Defining the Research Problem, Literature survey /review and its importance, Ethical aspects, IPR issues like patenting, copyrights etc.	10
2	Conceptualising a Research Design: Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Sampling Design, Implications of a Sample Design, Criteria of Selecting a Sampling Procedure, Different Types of Sample Designs.	10
3	Data Collection Methods: Measurement in Research, Measurement Scales, Tests of Sound Measurement, Scaling, Scale Classification Bases, Important Scaling Techniques, Scale Construction Techniques, Different Methods of Data Collection, Difference between Questionnaires and Schedules, Collection of Secondary Data.	15
4	Data Processing and Analysis: Processing Operations, Elements/Types of Analysis, Data Processing Operations, Elements of Analysis, Statistics in Research, Measures of Dispersion, Measures of Skewness, Regression Analysis, Correlation, Sampling Fundamentals.	15
5	Hypothesis: Introduction to Hypothesis, Procedure for Hypothesis Testing, Parametric and nonparametric Hypothesis test, testing of hypothesis using various tests like Analysis of Variance and Covariance, Chi square test, Multivariate analysis.	15
6	Interpretation and Report Writing: Research Report, Mechanics of Writing a Research Report, Research Paper writing, Layout of research paper, Paper publishing, Impact factor, Citation & Acknowledgements.	10

CLO-PLO Mapping Matrix

CLO/PLO	**PLO1**	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**	**PLO11**	**PLO12**	**Avg CLO**
CLO1	2	2	1	2	1	2	1	3	1	2	1	3	**1.75**
CLO2	3	3	2	3	2	1	1	2	1	2	2	3	**2.08**
CLO3	2	3	1	2	2	1	1	2	1	2	1	3	**1.75**
CLO4	3	3	2	3	2	0	0	1	0	2	1	3	**1.67**
CLO5	3	3	2	3	2	0	0	1	0	2	1	3	**1.67**
CLO6	2	2	1	2	1	1	1	2	2	3	2	3	**1.83**
Avg PLO	**2.5**	**2.67**	**1.5**	**2.5**	**1.67**	**0.83**	**0.67**	**1.83**	**0.83**	**2.17**	**1.33**	**3**	1.79

Suggested reading:

1	*Research Methodology — C.R.Kothari*
2	*Business Research Methods — Donald Cooper & Pamela Schindler, TMGH, 9th edition Business Research*
3	*Methods — Alan Bryman& Emma Bell, Oxford University Press.*

Teaching-Learning Strategies:

Interactive Lectures, Problem-solving worksheets, Workshops on research report structure, citations, and referencing (APA/MLA), Industry/Research Exposure.

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.

Course Code	**MODEASM325**	***Semester***	***Third***	***Contact Hours***	***39***
Course Title	**Statistical Methods and Research**				
Scheme & Credits	**L**	**T**	**P**	**Credits**	**Max marks**
	3	0	0	0	75
Prerequisites	*Nil*				

Course Learning Outcomes (CLOs):

CLO1	Explain probability distributions, the principle of least squares, and regression techniques (linear, non-linear, and multiple regression).
CLO2	Apply correlation analysis, variable selection methods, and model validation techniques for developing reliable statistical models.
CLO3	Demonstrate knowledge of sampling techniques, determine appropriate sample sizes, and evaluate sampling distributions of mean and proportion.
CLO4	Perform hypothesis testing using p-values, Student's t-test, large sample tests, confidence intervals, and regression-based ANOVA.
CLO5	Analyze experimental data using one-way and two-way ANOVA and implement data transformation methods to meet statistical assumptions.
CLO6	Evaluate and employ nonparametric statistical tests (Run-test, Sign test, Median test, Wilcoxon, Chi-square, Kruskal–Wallis, Friedman's ANOVA, Kendall's concordance) when parametric assumptions are violated.

SYLLABUS

Units	Content	Marks
1	Probability and Regression Basics: Probability and probability distributions, Principle of least squares, Linear and non-linear	10
2	Correlation and Model Building: Correlation analysis, Selection of variables, Validation of models.	10
3	Sampling and Sampling Distribution: Sampling techniques, Determination of sample size, Sampling distribution of mean and proportion.	10
4	Hypothesis Testing and ANOVA: Hypothesis testing, Concept of p-value, Student's t-test, Large sample tests, Confidence intervals, ANOVA and testing of hypothesis in regression analysis.	15
5	Advanced ANOVA and Data Transformation: Analysis of variance for one way and two way classification (with equal cell frequency),Transformation of data.	15
6	Nonparametric Statistical Tests: Advantages and disadvantages of nonparametric statistical tests, Scales ofmeasurements, Run-test, Sign test. Median test, Wilcoxon-Mann Whitney test, Chi-square test, Kruskal-Walli's one way and Friedman's two way ANOVA by ranks, Kendall's Coefficient of concordance.	15

CLO-PLO Mapping Matrix

CLO/PLO	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11	PLO12	Avg CLO
CLO1	3	3	2	2	2	0	0	0	0	1	0	2	**1.25**
CLO2	3	3	2	2	3	0	0	0	0	1	0	2	**1.33**
CLO3	3	3	2	2	2	0	0	0	0	1	0	2	**1.25**
CLO4	3	3	2	3	2	0	0	0	0	1	0	2	**1.33**
CLO5	3	3	2	3	2	0	0	0	0	1	0	2	**1.33**
CLO6	3	3	2	3	2	0	0	1	0	1	0	2	**1.42**
Avg PLO	**3**	**3**	**2**	**2.5**	**2.17**	**0**	**0**	**0.17**	**0**	**1**	**0**	**2**	1.32

Suggested reading:

1	*Gerald CF and Wheatley PO. 2003. Applied Numerical Analysis, Pearson, 7th Edition.*
2	*Jain MK, Iyengar SRK and Jain RK. 2012. Numerical Methods for Scientific and Engineering Computation, New Age International Publishers, 6th edition*
3	*Chappra SC. 2014. Numerical Methods for Engineers, McGraw-Hill Higher Education; 7th edition.*
4	*Mathew JH. 1992. Numerical Methods for Mathematics, Science and Engineering, Prentice*
5	*Burden RL and Faires JD. 2004. Numerical Analysis, Brooks Cole, 8th edition.*

Teaching-Learning Strategies:

Interactive Lectures, visual aids, Problem-Solving & Numerical Exercises, Research-Oriented Learning, Collaborative & Active Learning

Assessment Methods:

Continuous Internal Evaluation (CIE): 28% weightage; Quizzes, assignments, and mid-term exams mapped to CLOs.
Semester End Examination (SEE): 72% weightage; Comprehensive exam covering all CLOs.