

COURSE STRUCTURE AND SYLLABI

M.Tech in Design and Manufacturing

2025-26 Batch



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UNIVERSITY

Shaping Lives...
Empowering Communities...

SCHOOL OF ENGINEERING AND TECHNOLOGY
CENTURION UNIVERSITY OF TECHNOLOGY & MANAGEMENT
Odisha-761211, India

Web Site: - www.cutm.ac.in

**CENTURION UNIVERSITY OF TECHNOLOGY AND MANAGEMENT,
ODISHA**

CERTIFICATE



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This is to certify that the syllabus of the Programme M.Tech in Design and Manufacturing of the School of Engineering and Technology is approved in the 15th Academic Council Meeting held on 22nd November 2025.

**Dean
School of Engineering and Technology,
CUTM, Odisha**

**Pro-Vice Chancellor
CUTM, Odisha**

Centurion University of Technology and Management, Odisha

Course Structure & Syllabus

M. Tech in Design and Manufacturing

2-Years Programme



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Shaping Lives...
Empowering Communities...

School of Engineering & Technology

2025-2026

Index

Course Code	Course Title	Page No
	Course Structure	v
MTDM1101	Design Engineering	1
MTDM1102	Manufacturing Technology	4
MTDM1103	CAD/CAM	7
MTDM1104	Finite Elements Method in Engineering	9
MTDM1105	CAD Lab (CATIA / UGNX)	11
MTDM1106	Manufacturing Technology Lab	13
MTDM1201	Theory of Elasticity	15
MTDM1202	Theory of Metal Cutting	17
MTDM1203	Instrumentation and Experimental Stress Analysis	20
MTRM1201	Research methodology & IPR	22
MTDM1204	Design and Analysis Lab	25
MTDM1205	3D Printing and Prototyping Lab	27
MTDM1108	Tribology	30
MTDM1109	Fracture, Fatigue and Failure Analysis	32
MTDM1110	Composite Materials	34
MTDM1207	Mechanical vibration	37
MTDM1208	Tool Design	39
MTDM1209	Engineering Design Methodology	42
MTIP2101	Industry Internship and Project - I	
MTIP2201	Industry Internship and Project - II	

Programme Objectives: At the end of the program, students will be able to:

PO	Outcomes
PO1	Engineering knowledge: Apply knowledge of mathematics, science, engineering fundamentals, and mechanical engineering to the solution of engineering problems
PO2	Problem analysis: Identify, formulate, review literature and analyze Mechanical Engineering problems to design, conduct experiments, analyze data and interpret data
PO3	Design /development of solutions: Design solution for Mechanical Engineering problems and design system component of processes that meet the desired needs with appropriate consideration for the public health and safety, and the cultural, societal and the environmental considerations
PO4	Conduct investigations of complex problems: Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions in Mechanical Engineering
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to Mechanical Engineering activities with an understanding of the limitations
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to Mechanical Engineering practice
PO7	Environment and sustainability: Understand the impact of the Mechanical Engineering solutions in societal and environmental contexts, and demonstrate the knowledge and need for sustainable development
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the Mechanical Engineering practice
PO9	Individual and team work: Function affectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings in Mechanical Engineering
PO10	Communication: Communicate effectively on complex engineering activities with the engineering committee and with society at large, such as, being able to comprehend and write affective reports and design documentation, make effective presentations in Mechanical Engineering
PO11	Project Management and finance: Demonstrate knowledge & understanding of the mechanical engineering principles and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments in Mechanical Engineering
PO12	Life- long learning: Recognize the need for, and the preparation and ability to engage in independent research and lifelong learning in the broadest contest of technological changes in Mechanical Engineering

PEOs/PSOs

Programme Educational Objectives (PEOs):

PEO1: Build students' competency in modern tools and methods so they can meet industry demands as skilled professionals.

PEO2: Build a strong conceptual base and domain understanding in students, enabling them to conduct research and design solutions for a range of challenges.

PEO3: Prepare graduates to innovate, generate fresh concepts and start their own ventures.

Programme Specific Outcomes (PSOs):

PSO1: Graduates will build hands-on abilities across manufacturing and product design applications.

PSO2: Strengthen software proficiency needed for designing products, running simulations, performing analysis and supporting manufacturing.

PSO3: Grow into a skilled professional suited for industry roles or entrepreneurial paths by applying sound manufacturing and management principles.

Course Outcomes Attributes

Course Outcomes	Attributes
CO1	Knowledge
CO2	Analytical skill and Critical Thinking
CO3	Problem Solving and Decision taking ability
CO4	Use of Tool, Design and Development (Hands-on/Technical skill)
CO5	Research

Master of Technology (M.Tech in Design and Manufacturing)	
Programme Structure – Post-Graduate Study	
Type of Course	2 Years
Major (Core) Courses	38
Elective Core/ Domain	6
Skill + AEC	4
Research Project	32
TOTAL	80

Course Structure

Design and Manufacturing

SEMESTER - I					
Sl No	Code	Subject name	Credits	T+P+J	NcRF Level
1	MTDM1101	Design Engineering	4	3+1+0	6.5
2	MTDM1102	Manufacturing Technology	3	3+0+0	6.5
3	MTDM1103	CAD/CAM	3	3+0+0	6.5
4	MTDM1104	Finite Elements Method in Engineering	3	3+0+0	6.5
5		Elective-I	3	3+0+0	6.5
6	MTDM1110	CAD Lab (CATIA / UGNX)	4	0+2+2	6.5
7	CUTM3046	Fabrication (Skill Course)	4	0+3+1	6.5
		TOTAL	24		
SEMESTER - II					
1	MTDM1201	Theory of Elasticity	3	3+0+0	6.5
2	MTDM1202	Theory of Metal Cutting	3	3+0+0	6.5
3	MTDM1203	Instrumentation and Experimental Stress Analysis	3	3+0+0	6.5
4	CUTM 2378	Research methodology & IPR	4	2+0+2	6.5
5		Elective-II	3	3+0+0	6.5
6	MTDM1204	Design and Analysis Lab	2	0+2+0	6.5
7	MTDM1209	3D Printing and Prototyping Lab	4	0+2+2	6.5
8	MTDM1106	Manufacturing Technology Lab	2	0+2+0	6.5
		TOTAL	24		
SEMESTER - III					
1	MTIP2101	Industry Internship and Project - I	16	0+0+16	7
					7
		TOTAL	16		
SEMESTER - IV					
1	MTIP2201	Industry Internship and Project - II	16	0+0+16	7
		TOTAL	16		

Electives

Sl No.	Code	Credits	T+P+J	NcRF Level
		Elective I		
1	MTDM1107	3	3+0+0	6.5
2	MTDM1108	3	3+0+0	6.5
3	MTDM1109	3	3+0+0	6.5
		Elective II		
4	MTDM1206	3	3+0+0	6.5
5	MTDM1207	3	3+0+0	6.5
6	MTDM1208	3	3+0+0	6.5

Design Engineering (3-1-0) (50 Hours)

Course	Code	T-P-Pr	Credit
Design Engineering	MTDM1101	3-1-0	4

Course Objectives:

- To know design concepts and methodologies.
- To identify needs and constraints of product development system
- To design a product using reverse engineering.

Course Outcomes:

At the end of the course, students will be able to;

- **CO1:** Understand the process of design and product development
- **CO2:** Solve problem solving related to design problem formulation
- **CO3:** Analyze different CAE & Process Optimization Tools
- **CO4:** Evaluate the strength of a product
- **CO5:** Research in Product Design & Analysis.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	3												
CO2		3		3											
CO3			3		3										
CO4	2		3		3										
CO5		3	2												

*High-3, Medium-2, Low-1

Module-I (15 Hrs)

Theory:

Fundamentals: principles of design, systematic approach, need analysis and design of specification; Conceptual design: developing function structure, developing concepts by systematic search with physical principles, classifying schemes; Concept selection: matrix methods, necessity methods, probability methods, fuzzy set based methods, case study on consumer product.

Practices:

1. Identify user needs and write a design specification.
2. Develop a function structure for a chosen product.
3. Generate multiple design concepts using systematic search.

Module II (15 Hrs)

Theory:

Embodiment design: basic rules, system modeling, preliminary design calculations and material selection, design considerations like force alignment, vibration etc., failure modes and effects analysis, design for manufacturability and assembly, case studies on design of machines.

Practices:

1. Model basic systems and subsystems for a given product.
2. Perform preliminary design calculations for strength, stiffness or performance.
3. Apply Design for Manufacturability (DFM) and Design for Assembly (DFA) guidelines.

Module 3 (20 Hrs)

Theory:

Optimal and robust design: design problem formulation for analytical and numerical solution, design of experiments, Taguchi's method; Reverse engineering; Physical prototyping; Lab: conceptual design, reverse engineering, design of simple sensors and actuators, hydraulic and pneumatic systems, motors and

controller, product teardown and redesign, embodiment design, CAE analysis, prototyping, design project.

Practices:

1. Formulate an engineering design problem for optimization.
2. Perform analytical or numerical optimization.
3. Conduct basic Design of Experiments (DOE).
4. Use Taguchi's method for parameter design.

Text Books

1. H. Yousef, *Engineering Design Process*, Vikas Publishing house, New Delhi, 2003.
2. G. Pahl, and W. Beitz, *Engineering Design – A Systematic Approach*, Springer – Verlag, 1996.

Reference Books

1. Groover, M. P. (2020). *Automation, production systems, and computer-integrated manufacturing* (5th ed.). Pearson.
2. Ulrich, K. T., & Eppinger, S. D. (2015). *Product design and development* (6th ed.). McGraw-Hill.

Manufacturing Technology (50 Hours)

Subject Name	Code	T-P-PR	(Credit)
Manufacturing Technology	MTDM1102	3+0+0	3

Course Objectives:

- To study the basic manufacturing processes and tools used.
- To understand the relation between product specifications and manufacturing technology.
- To understand the concept of powder metallurgy for manufacturing a product.

Course Outcomes:

After completion of the course, students will be able to:

- **CO1:** Understand various manufacturing Processes
- **CO2:** Apply the principles of process planning and optimization to design efficient and cost-effective manufacturing systems.
- **CO3:** Analyze appropriate materials and manufacturing methods
- **CO4:** Evaluate manufacturing processes for their environmental impact and incorporate sustainable practices.
- **CO5:** Research in advancement in Manufacturing Process

Course Outcome to Program Outcome Mapping:

COs/ POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3						1								
CO2		3							1						
CO3	2	3	1												
CO4		3	2												
CO5		3	2												

*High-3, Medium-2, Low-1

Module I (10 Hours)

Manufacturing concepts: Product cycle; Job, batch and mass production; Primary and secondary manufacturing processes.

Casting: Steps involved in making a casting; Advantage of casting and its applications.

Patterns and Pattern making Types of patterns. Materials used for patterns, pattern allowances and their construction, Principles of Gating, Gating ratio and design of Gating systems. Solidification of casting. Concept, Solidification of pure metal and alloys, short & long freezing range alloys. Risers: Types, function and design, casting design considerations, special casting processes 1) Centrifugal 2) Die, 3) Investment.

Methods of Melting: Crucible melting and cupola operation, steel making processes.

Module II (15 Hours)

Welding: Classification of welding process, types of welds and welded joints and their characteristics, design of welded joints, Gas welding, ARC welding, Forge welding, resistance welding, Thermit welding and Plasma (Air and water) welding.

Inert Gas welding, TIG & MIG welding, Friction welding, Induction welding, Explosive welding, Laser welding, Soldering & Brazing. Heat affected zones in welding & its effects. Welding defects, causes and remedies. Destructive & nondestructive testing of welds.

Cutting of Metals: Oxy Acetylene Gas cutting, water plasma. Cutting of ferrous, nonferrous metals.

Module III (15 Hours)

Hot working, cold working, strain hardening, recovery, recrystallisation and grain growth, Comparison of properties of Cold and Hot worked parts.

Rolling fundamentals: theory of rolling, types of Rolling mills and products. Forces in rolling and power requirements. Stamping, forming and other cold working processes: Blanking and piercing. Bending and forming. Drawing and its types: wire drawing and Tube drawing. Coining. Hot and cold spinning. Types of presses and press tools. Forces and power requirement in the above operations.

Module IV (10 Hours)

Basic extrusion process and its characteristics. Hot extrusion and cold extrusion - Forward extrusion and backward extrusion. Impact extrusion. Hydrostatic extrusion.

Forging processes: Principles of forging. Tools and dies. Types Forging: Smith forging, Drop

Forging, roll forging, forging hammers: Rotary forging, forging defects.

Brief introduction to powder metallurgy: Advantages and limitations of powder metallurgy, Manufacture of metal powders, mixing & blending, compacting, sintering and secondary operations.

Text Books

1. P N Rao, Manufacturing Technology, McGraw Hill.
2. Richard W. Heine, Principles of Metal Castings, McGraw Hill.
3. R S Parmar, Welding Process, Khanna Publishers

Reference Books

1. Chattopadhyay, S. (2015). Manufacturing processes (Vols. 1 & 2). PHI Learning.
2. Degarmo, E. P., Black, J. T., & Kohser, R. A. (2019). Materials and processes in manufacturing (12th ed.). Wiley.

CAD / CAM (45 Hours)

Subject Name	Code	T-P-PR	(Credit)
CAD/CAM	MTDM1103	3-0-0	3

Course Objectives:

- To provide basic knowledge in computer aided design & manufacturing
- To learn the working principles of NC machines, CNC control, and part programming

Course Outcomes:

After completion of the course, students will be able to:

- **CO1:** Gain knowledge in three-dimension modeling and assembly of machine parts
- **CO2:** Identify and resolve the solid modeling problems and help to take decision in product design
- **CO3:** Acquire hands-on skill in modeling using different modeling software
- **CO4:** Develop 2D and 3D models, generate manufacturing drawings, create toolpaths, and simulate CNC machining operations using CAD/CAM software.
- **CO5:** Carry out research in design field

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3	1												
CO3		1	3												
CO4				3					3						
CO5				2	2										

***High-3, Medium-2, Low-1**

Module I (15 Hours)

Introduction: contents & tools, definition of CAD/CAM tools, industrial look at CAD/CAM

Hardware: types of systems, system evaluation criteria, I/O device

Software: graphic standards, basic definitions, user interface, software modules, modelling & viewing

Module-II (10 Hours)

Representation of curves: wire frame models, wire frame entities, representation of analytic & synthetic curves.

Representation of surfaces: models and entities, parametric representation of analytic & synthetic surfaces.

Module-III (10 Hours)

Representation of solids: set theory, half – spaces, boundary representations, CSG, sweep representation, analytic solid modelling.

Module-IV (10 Hours)

CAD/CAM data exchange: IGES, PDES

Numerical control: NC, NC models, NC elements, NC machine tools, structure of CNC machine tools, features of machining centre, turning centre.

CNC part programming: fundamentals, manual part programming methods, computer aided part programming, ATP programming.

Text books:

1. Groover, M. P., & Zimmers, E. W. (1984). CAD/CAM: Computer-aided design and manufacturing. Prentice Hall.
2. Zeid, I. (2012). Mastering CAD/CAM (2nd ed.). McGraw-Hill.

Reference books:

1. Krishnamurthy, C. S. (2000). Computer-Aided Design and Manufacture. Alpha Science International.
2. P. N. Rao (2010). CAD/CAM: Principles and Applications (2nd ed.). Tata McGraw-Hill.

Finite Elements Method in Engineering (50 Hours)

Subject Name	Code	T-P-PR	(Credit)
Finite Elements Method in Engineering	MTDM1104	3-0-0	3

Course Objectives:

- To understand the mathematical and physical principles underlying the Finite Element Method (FEM).
- To learn the theory and characteristics of finite elements that represent engineering structures.

Course Outcomes:

After completion of the course, students will be able to:

- **CO1:** Gain knowledge numerically solving differential equations arising in engineering and mathematical modeling.
- **CO2:** Do hands-on practice in Dassault Systems' Tools
- **CO3:** Analyze different stresses applied on a product
- **CO4:** Model, analyze and interpret engineering systems using commercial FEM software such as ANSYS or similar tools.
- **CO5:** Explore advanced FEM topics such as nonlinear analysis, dynamic behavior, mesh refinement and convergence studies to support research-based problem solving.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3													
CO2		3	3												
CO3		3	2	1											
CO4		3	2	2											
CO5	3	3	2	3											

***High-3, Medium-2, Low-1**

Module I (10Hours)

Fundamental Concepts: Introduction, Historical background, Outline of presentation, Stresses and Equilibrium, Boundary conditions, Strain-Displacement relations, Stress-Strain relations, Plane stress, Plane strain problems, Temperature effects, Potential energy and equilibrium. The Rayleigh-Ritz method, Hamilton's principle. Galerkin's method, Saint Venant's principle.

Module II (15 Hours)

One-dimensional Problems: Introduction, Finite element modeling, Coordinates and Shape functions. The potential energy approach. The Galerkin approach, Assembly of the global stiffness matrix- mass matrix and load vector, Treatment of boundary conditions, Quadratic shape functions, Temperature effects. Trusses: Introduction, Plane trusses, Three-dimensional trusses, Assembly of global stiffness matrix for the Banded and Skyline solutions.

Module III (15 Hours)

Two-dimensional Problems Using Constant Strain Triangles: Introduction, Finite element modeling, Constant strain triangle, In plane and Bending, problem modeling and boundary conditions. Axisymmetric Solids Subjected to Axisymmetric Loading: Introduction, Axisymmetric formulation, Finite element modeling, Triangular element, Problem modeling and boundary conditions.

Module IV (10 Hours)

Two-dimensional Isoparametric Elements and Numerical Integration: Introduction, The four- node quadrilateral, Numerical integration, Higher-order elements. Beams and Frames: Introduction, Finite element formulation, Load vector, Boundary considerations, Shear force and bending moment, Beams on elastic supports, Plane frames.

Text Books:

1. Reddy, J. N. (2019). An Introduction to the Finite Element Method (4th ed.). McGraw-Hill.
2. Cook, R. D., Malkus, D. S., Plesha, M. E., & Witt, R. J. (2001). Concepts and Applications of Finite Element Analysis (4th ed.). Wiley.

Reference Books:

1. Logan, D. L. (2016). A First Course in the Finite Element Method (6th ed.). Cengage Learning.
2. Zienkiewicz, O. C., Taylor, R. L., & Zhu, J. Z. (2013). The Finite Element Method: Its Basis and Fundamentals (7th ed.). Butterworth-Heineman

CAD Laboratory (60 Hours)

Subject Name	Code	T-P-PR	(Credit)
CAD Laboratory (CATIA / UGNX)	MTDM1105	0-2-2	4

Course Objectives:

- To create and analyze assemblies and to produce a drawing with different views
- To learn part design and assembly of different machine tools

Course Outcomes:

After completion of the course, students will be able to:

- **CO1:** Understand the fundamentals of computer-aided drafting, 2D drawing standards and 3D modeling principles.
- **CO2:** Produce computer-aided mechanical drawings of components and assemblies of industrial machines, machinery parts
- **CO3:** Prepare Bills of Material in a CAD environment
- **CO4:** Develop 2D drawings, 3D parts, assemblies and basic simulations using CAD software.
- **CO5:** Explore advanced CAD features like surface modeling, sheet metal design or parametric modeling to support design innovations.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				2										
CO2		3		3			2								
CO3			2												
CO4				3											
CO5		3			2										

*High-3, Medium-2, Low-1

Practices:

1. Part Design, Assembly and GSD Workbench tools Training.
2. Exploring workspace, toolbars, sketcher interface and basic settings in CATIA/UG NX.
3. Creating 2D sketches with geometric and dimensional constraints for basic machine components.
4. Creating solid models using pad/extrude, revolve, hole, slot, fillet and chamfer tools.
5. Surface Modeling: Creating advanced surfaces using loft, sweep, blend and boundary techniques.
6. Designing sheet metal components using flanges, bends, cutouts, reliefs and flat pattern generation.
7. Generating 2D engineering drawings with views, sections, dimensions, GD&T symbols and BOM.
8. Simulating simple mechanisms (gear pair, slider-crank, linkage) using CATIA DMU or NX Motion.
9. Modifying dimensions, checking interferences, exploring design variants and creating rendered outputs.
10. Modify an existing CAD model (chair, helmet, mouse, handle) based on ergonomic assessment and aesthetic improvement.

Manufacturing Technology Lab (40 Hours)

Subject Name	Code	T-P-PR	(Credit)
Manufacturing Technology Lab	MTDM1106	0-2-0	2

Course Objectives:

- To provide hands-on experience with basic manufacturing processes such as machining, welding, forming and casting, enabling students to understand equipment operation and process capabilities.
- To develop the ability to select appropriate manufacturing methods and parameters through practical exercises, measurements and inspection, reinforcing concepts of accuracy, quality and process optimization.

Course Outcomes:

After completion of the course, students will be able to:

- **CO1:** Describe the working principles, tools and operations involved in basic manufacturing processes such as machining, welding, forming and casting.
- **CO2:** Analyze machining parameters, process variables and material behavior to understand their influence on product quality and dimensional accuracy.
- **CO3:** Select appropriate manufacturing processes, tools and cutting conditions to meet the functional and dimensional requirements of components.
- **CO4:** Operate machine tools, set up workpieces, measure finished parts and perform manufacturing processes safely and effectively.
- **CO5:** Explore process optimization, surface finish improvement and parameter–output relationships for different manufacturing operations.

Course Outcome to Program Outcome Mapping:

COs/ POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				2										
CO2		3		3			2								
CO3			2										3	3	
CO4				3								3			
CO5		3			2										

***High-3, Medium-2, Low-1**

Practices:

1. Exercise in computer aided drafting and design, mesh generation, modeling, use of packages.
2. Study and calibration of precision measuring instruments.
3. Advanced turning and milling parameter analysis
4. Experiments on CAM using CNC Miller and CNC Lathe.
5. Machining optimization experiment.
6. Casting Process Study- from mold & core to mechanical evaluation
7. Welding process and weld quality assessment.
8. Metal forming experiment- Study of deep drawing, forging or rolling.
9. Experiment on surface grinding with measurement of surface roughness.
10. Computer-integrated manufacturing (CIM)

SECOND SEMESTER

Theory of Elasticity (50 Hours)

Subject Name	Code	T-P-PR	Credit
Theory of Elasticity	MTDM1201	3-0-0	3

Course objective:

- To understand the theoretical fundamentals of elasticity.
- To inculcate knowledge on basic governing equations of elasticity.

Course Outcomes:

After completion of the course, students will be able to:

- **CO1:** Knowledge on principles of elasticity theory to solve 2D & 3D problems.
- **CO2:** Formulate and solve boundary value problems & planar problems.
- **CO3:** Analyze the bending stresses of a beam.
- **CO4:** Apply elasticity principles in computational tools or symbolic solvers to model and evaluate stresses in engineering components.
- **CO5:** Explore advanced topics like complex variable methods, anisotropic elasticity and stress function formulations to support research in solid mechanics.

Course Outcome to Program Outcome Mapping:

COs/ POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3													
CO2	3		3	3											
CO3		3		2	3										
CO4						3							3		
CO5							2					3			

***High-3, Medium-2, Low-1**

Module I (10 Hrs)

Revision of two-dimensional elasticity – introduction to three dimensional elasticity-equations of equilibrium and Generalized Hooke’s law, constitutive relations. Kinematic relations, compatibility equations – equations of equilibrium in terms of strains and displacements, compatibility equations in terms of stresses – in Cartesian and cylindrical coordinates. Airy’s stress function.

Module II (20 Hrs)

Variational techniques, principle of minimum potential energy-Euler equations-derivation of governing equation and natural boundary conditions for a beam. Solution of axisymmetric problems, Bending of beams and axi-symmetric plates, Kirchhoff and Mindlin concept. Solid circular plates with different load and support conditions.

Module III (20 Hrs)

Theoretical concepts of plasticity of structural metals under tension, compression and combined stress, Yield criteria - Tresca and Von Mises criterion of yielding, Plastic stress strain relationship, Elastic plastic problems in bending and torsion. Theory of plastic constitutive equations; Axisymmetric and spherically symmetric problems;

Text Books:

1. Timoshenko, S. and Goodier J.N. Theory of Elasticity, McGraw Hill Book Co.
2. J. Chakrabarty, Theory of Plasticity, McGraw-Hill Book Company.

Reference Books:

1. Chandrashekhara, K. (1998). Theory of elasticity. PHI Learning.
2. Sokolnikoff, I. S. (1956). Mathematical theory of elasticity (2nd ed.). McGraw-Hill.

Theory of Metal Cutting (60 Hours)

Subject Name	Code	T-P-PR	(Credit)
Theory of Metal Cutting	MTDM1202	3-0-0	3

Course Objectives:

- To study the basics of metal machining and mechanics of metal machining
- To gain fundamental knowledge and principles in material removal processes.

Course Outcomes:

After completion of the course, students will be able to:

- **CO1:** Knowledge on various aspects in Machining Processes.
- **CO2:** Identify and solve problems related to mechanics of metal cutting.
- **CO3:** Select appropriate cutting tools, materials and machining conditions to improve performance, accuracy and tool life.
- **CO4:** Evaluate machining operations using cutting force calculations, tool life equations and basic simulation or digital machining tools.
- **CO5:** Explore advanced topics such as high-speed machining, hard cutting, coatings, cryogenic machining and chip control techniques for research applications.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3		2											
CO3	2		3												
CO4		3		2									3		
CO5		3	3									3			

***High-3, Medium-2, Low-1**

Module I (15Hrs)

Machining Process: Introduction, Different type of machining processes, Machining with single edge cutting tools, Tool nomenclature: tool axis reference system, machine reference system. Geometry of cutting tools in ASA, ORS & Normal working system. Conversion of tool angles, selection of tool angles. Effect of Geometrical parameters on cutting force and surface finish. Introduction to multi point cutting tools.

Module II (20Hrs)

Review of deformation mechanism, an overview of chip formation, classification of chips: irregular shaped chips, continuous chips with no built-up edge, continuous chips with built up edge, element chips & partially continuous chips.

Measurement of cutting forces: Measurement of forces, Electrical transducers for force measurement. Dynamometers for measuring forces during turning process, drilling process and milling process. Theoretical determination of cutting forces: Analytical approach, Merchant's circle method.

Module III (15Hrs)

Cutting temperature – causes, effects, assessment and control of cutting temperature and cutting fluid application.

Tool wear and tool life: Introduction, tool wear, types of tool wear: flank wear, crater wear. Progressive tool wear. Tool life, variables affecting tool life, determination of tool life equations. Economics of machining: Introduction, machining cost, optimum cutting speed. Restriction on cutting conditions, comparison of the three criteria.

Module IV (10Hrs)

Grinding of metals: Introduction, the grinding wheel, mechanics of grinding process, grinding forces and specific energy, wheel wear and grinding performances, grinding temperature, surface roughness.

Text Books:

1. Boothroyd, G., & Knight, W. A. (2006). *Fundamentals of machining and machine tools* (3rd ed.). CRC Press.
2. Shaw, M. C. (2005). *Metal cutting principles* (2nd ed.). Oxford University Press.

Reference Books:

1. Stephenson, D. A., & Agapiou, J. S. (2006). Metal cutting theory and practice (2nd ed.). CRC Press.
2. Kalpakjian, S., & Schmid, S. R. (2014). Manufacturing engineering and technology (7th ed.). Pearson.

Instrumentation & Experimental Stress Analysis (45 Hours)

Subject Name	Code	T-P-PR	(Credit)
Instrumentation & Experimental Stress Analysis	MTDM1203	3-0-0	3

Course Objectives:

- To recognize the various techniques available to measure the stress and strains using different sources.
- To know the theory and practice of common experimental stress analysis methods

Course Outcomes:

After completion of the course, students will be able to:

- **CO1:** Gain overall knowledge of stress/strain analysis
- **CO2:** Identify and solve problems related to stress, strains and Photo Elasticity.
- **CO3:** Select suitable experimental methods—strain gauges, photoelasticity, brittle coatings, Moiré, or digital methods—to solve specific stress analysis problems.
- **CO4:** Install, calibrate and use instrumentation such as strain-gauge setups, load cells, transducers and optical systems to measure mechanical responses.
- **CO5:** Explore advanced measurement systems including digital image correlation (DIC), electronic instrumentation and real-time data logging for research applications.

Course Outcome to Program Outcome Mapping:

COs / POs / PSO3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3							2		2				
CO3				2			2							2	
CO4		3			2										
CO5		2	3			3									

***High-3, Medium-2, Low-1**

Module I (15Hrs)

Basic elasticity theory, Stress analysis by strain measurement: Principal stresses and strains. Basic Characteristics of a Strain Gauge, Types of Shell Gauge; Mohr's circle-measurement of strains-Strain gauges- Electric Resistance strain gauges, semiconductor strain gauges, Grid Method of Strain Analysis, Factors Influencing Strain sensitivity in Metallic Alloys, Gauge Construction Temperature Compensation, Factors-Influencing Gauge Section Gauge Sensitivity and Gauge Factor, Correction for transverse Strain Effects, strain gauge circuits, transducer applications, recording instruments for static and dynamic applications

Module II (15Hrs)

Photo elasticity: Photo elasticity – Polariscopes – Plane and circularly polarized light, Bright and dark field setups, Photo elastic materials – Isochromatic fringes – Isoclinics. Three-dimensional Photo elasticity: Introduction, locking in model deformation, materials for three-dimensional photo elasticity, machining cementing and slicing three-dimensional models, slicing the model and interpretation of the resulting fringe patterns, effective stresses, the shear difference method in three dimensions, applications of the Frozen-stress method, the scattered light method.

Module III (15Hrs)

Gauges. Rosette Analysis - three element rectangular Rosette, the three and Four Element Delta Rosette, The Stress Gauge, Strain Circuits, Potentiometer Circuits, The Wheatstone Bridge. Brittle Coating Method: Coating Stresses, Failure Theories. Brittle Coating Crack Patterns Produced by Direct Loading, refrigeration Techniques and Releasing the Load. Double Crack Pattern, Crack Detection, Load-Time Relation and Its influence on the threshold Strain Effects of a Biaxial stress Field.

Text Books:

1. Sadhu Singh. (1981). Experimental stress analysis (4th ed.). Khanna Publishers.
2. Dally, J. W., & Riley, W. F. (1991). Experimental stress analysis (3rd ed.). McGraw-Hill.

Reference Books:

1. Freddi, A. (2015). Experimental stress analysis for materials and structures. Springer.
2. Frocht, M. M. (1968). Photoelasticity. John Wiley & Sons.

Research Methodology and IPR (65 Hours)

Subject Name	Code	T-P-PR	(Credit)
Research Methodology and IPR	CUTM 2378	2-0-2	4

Course Objectives:

- To understand research related information and research problem formulation.
- To understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- To understand ethical issues and Adequate knowledge on IPR

Course Outcomes:

After completion of the course, students will be able to:

- **CO1:** Gain knowledge in the selection, approaches of research problem.
- **CO2:** Identify and solve problems related characteristics of a good research, ethical issues, effective technical writing, and developing a research proposal.
- **CO3:** Prepare a well-structured research paper and scientific presentations.
- **CO4:** Apply statistical tools, referencing software and research documentation techniques to prepare research proposals and technical reports.
- **CO5:** Design small-scale research studies, compile findings and understand publication standards, plagiarism checks and ethical practices.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		3						3		3				
CO2				3		2						3		2	
CO3		2		3						2		3			

CO4					2								2		
CO5							2	3							2

***High-3, Medium-2, Low-1**

Module I (10 Hours)

Elementary Research Methodology

Research Concept, Objective, characteristics, Steps and Significance of Research, Arbitrary and Scientific Research, Research approaches. Types of research: Historical, Descriptive, Analytical, Case Study, Quantitative vs. qualitative, Conceptual, Empirical Action Research, Research Methods vs Methodology. Research Problems: Selection and definition of the research problems, formulating a research problem, identifying variables and Constructing hypothesis; Choosing a mentor, lab and research question; maintaining a lab notebook; Selection of problems - stages in the execution of research.

Module II (10 Hours)

Academic Writing and Presentation

Technical writing skills - types of reports; layout of a formal report; standard of Journal (Impact Factor, Citation Index), Scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and non-blind review; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.

Module III (15 Hours)

Scientific Communication Skills

Concept of effective communication- setting clear goals for communication; determining outcomes and results; barriers to effective communication; non-verbal communication- importance of body language, power of effective listening; Presentation skills - formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific

research - web browsing for information search.

Module IV (15 Hours)

Introduction to IPR

Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; plant variety protection and farmers rights.

Module V (15 Hours)

Types of Patents

Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; filing of a patent application; role of a Country Patent Office; precautions before patenting-disclosure/non-disclosure – patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications.

Projects

1. Write a review article and submit to a journal
2. Write a book chapter/ book for publishing
3. Write an original article for a journal

Text Books:

1. Geoffrey Marczyk, David DeMatteo, David Festinger (2005) Essentials of Research Design and Methodology, John Wiley & Sons, Inc.
2. Kothari CR (2016) Research Methodology: Methods and Techniques, New Age Pvt Ltd.

Reference Books:

1. Sinha, S.C. and Dhiman, A.K., (2002). Research Methodology, Ess. Publications.
2. Trochim, W.M.K., (2005). Research Methods: the concise knowledge base, Atomic Dog Publishing.

Design and Analysis Lab

Course	Code	T-P-PR	(Credit)
Design and Analysis Lab	MTDM1204	0-2-0	2

Course Objectives:

- To understand the design aspects of Machining Process, Cutting Tools and Machine Tools.
- To measure and inspect the product dimension and quality.
- To know the FMS to change in the type and quantity of goods being produced.

Course Outcomes:

After completion of the course, students will be able to:

- **CO1:** Gain knowledge of mechanics of machining.
- **CO2:** Do hands-on practice in Dynamometer, Profile Projector, EDM, CMM, and Profilometer.
- **CO3:** Select appropriate manufacturing-friendly design strategies, machining parameters and analysis methods to solve real engineering problems.
- **CO4:** Create 3D models, perform simulations (structural, thermal, modal or manufacturing-related) and optimize components using CAD/CAE software.
- **CO5:** Apply Design for Manufacturing (DFM), Design for Assembly (DFA) and design optimization principles to improve manufacturability, cost and performance.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3	2												
CO3				3											
CO4					3										
CO5	2			2								3		2	

***High-3, Medium-2, Low-1**

Practices

1. Study of the chip formation in turning process
2. Determination of cutting forces and surface roughness in turning process.
3. Inspection of parts using CMM.
4. Experiments and demonstration of EDM.
5. 3D Modeling of Mechanical Components.
6. Design for Assembly (DFA) Evaluation.
7. Simulate toolpaths, cutting parameters and chip removal in software like Master-CAM, NX CAM, and Fusion 360.
8. Model a sheet metal component and generate its development.
9. Create a simple casting or injection mold design using CAD tools.
10. Design Improvement Case Study -Modify a product to improve manufacturability, strength or sustainability.

Text Books

1. Budynas, R. G., & Nisbett, J. K. (2020). *Shigley's mechanical engineering design* (11th ed.). McGraw-Hill.
2. Zeid, I. (2012). *Mastering CAD/CAM* (2nd ed.). McGraw-Hill.

Reference Books

1. Groover, M. P. (2020). *Fundamentals of modern manufacturing: Materials, processes, and systems* (7th ed.). Wiley.
2. Ulrich, K. T., & Eppinger, S. D. (2015). *Product design and development* (6th ed.). McGraw-Hill.

3D Printing and Prototyping Lab

Course	Code	T-P-Pr	(Credits)
3D Printing and Prototyping Lab	MTDM1205	0-2-2	4

Course Objectives:

- To introduce the methods and technologies of additive manufacturing or 3D printing and its application in modern industrial, design, and creative fields.
- To apply iterative design principles, CAD, and modeling tools for visualization, ideation, and prototyping via additive manufacturing platforms.

Course Outcomes:

After completion of the course, students will be able to:

- **CO1:** Gain knowledge on additive manufacturing & prototyping.
- **CO2:** Do hands-on practice in 3D printer.
- **CO3:** Select suitable printing technologies, materials, slicing strategies and post-processing methods for specific engineering applications.
- **CO4:** Prepare CAD models, optimize them for additive manufacturing, generate G-code using slicing software and operate 3D printers to fabricate prototypes.
- **CO5:** Explore advanced additive manufacturing topics such as multi-material printing, topology optimization and lightweight design for research applications.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3		3	3										
CO3			3	3											
CO4		2													
CO5			2		2										

***High-3, Medium-2, Low-1**

Practices

1. Design Considerations and Rapid Prototyping using 3D Printing.
2. CAD Preparation & Printability Check.
3. Multi-material / multi-color printing and product development.
4. Reverse Engineering to Prototype- Scan a simple object, create CAD model and reproduce via 3D printing.
5. Mechanical Testing of 3D-Printed Specimens
6. Reverse engineering and Prototyping of some Existing Components.
7. Non-Destructive Evaluation (NDE) of Printed Parts
8. Sustainability, Recycling & Cost Analysis
9. CAD Automation & Scripting for Design for Additive Manufacturing (DfAM)
10. Multi-Part Assembly and Functional Prototype Construction

Text Books

1. Gibson, I., Rosen, D. W., & Stucker, B. (2021). Additive manufacturing technologies: 3D printing, rapid prototyping, and direct digital manufacturing (3rd ed.). Springer.
2. Bandyopadhyay, A., & Bose, S. (2019). Additive manufacturing (2nd ed.). CRC Press.

Reference Books

1. Chua, C. K., Leong, K. F., & Lim, C. S. (2010). Rapid prototyping: Principles and applications (3rd ed.). World Scientific.
2. Gebhardt, A. (2012). Understanding additive manufacturing: Rapid prototyping, rapid tooling, rapid manufacturing. Hanser Publishers.

ELECTIVES			
Elective I			
Course	Code	T-P-Pr	Credits
Tribology	MTDM1107	3-0-0	3
Fracture, Fatigue and Failure Analysis	MTDM1108	3-0-0	3
Composite Materials	MTDM1109	3-0-0	3
Elective II			
Course	Code	T-P-Pr	Credits
Mechanical vibration	MTDM1206	3-0-0	3
Tool Design	MTDM1207	3-0-0	3
Engineering Design Methodology	MTDM1208	3-0-0	3

Tribology (60 Hours)

Course	Code	T-P-PR	(Credit)
Tribology	MTDM1107	3-0-0	3

Course Objectives:

- To familiarize the student with different types of bearings, bearing materials and lubrication.
- To learn theory and concepts about different types of lubrication

Course Outcomes:

After completion of the course, students will be able to:

- **CO1:** Gain knowledge in friction characteristics and power losses in journal bearings.
- **CO2:** Measure the lubricant's properties by using different instruments.
- **CO3:** Select suitable materials, surface treatments and lubrication strategies to reduce friction, wear and energy losses in engineering applications.
- **CO4:** Evaluate tribological behavior through experiments or simulation tools, and interpret friction, wear-rate and lubrication performance results.
- **CO5:** Carry out research in different applications of tribology.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		1	2												
CO3				1							1				
CO4		2			3										
CO5	2			2								1			

***High-3, Medium-2, Low-1**

Module I (15 Hrs)

Bearing concepts and typical applications. Lubricant and lubrication, Types of bearings, properties and testing of lubricants, Basic equations: Generalized Reynolds equation, Flow and Shear Stress, Energy equation, Equation of state. Viscous flow concepts-Conservation of laws and its derivations: continuity, momentum (N-S equations) and energy, Solutions of Navier-Stokes equations. Order of magnitude analysis, General Reynolds equation-2D and 3D (Cartesian and Cylindrical)

Module II (15 Hrs)

Hydro dynamic lubrication: Mechanism of pressure development and load carrying capacity, Plane- slider bearing, Idealized slider bearing with a pivoted shoe, Step bearing, Idealized journal bearing. Infinitely long journal bearing, Petroffs equation for a lightly loaded bearing, narrow bearing, Oil flow and thermal equilibrium - Heat balance of lubricants

Module III (15 Hrs)

Hydrostatic Bearing: Principles, Component of hydrostatic lubrication, Hydrostatic circular thrust bearing, calculation of pressure, load carrying capacity, flow rate, power loss in bearing due to friction. Concept of gas lubricated bearing Concept of Elasto-hydrodynamic lubrication, Design and selection of antifriction bearing

Module IV (15 Hrs)

Friction and wear of metals: Theories of friction, surface contaminants, Effect of sliding speed on friction, classification and mechanism of wear, Wear resistant materials.

Wear and wear types: Mechanisms of wear - Adhesive, abrasive, corrosive, erosion, fatigue, fretting, etc., wear of metals and non-metals. Wear models - asperity contact, constant and variable wear rate, geometrical influence in wear models, wear damage. Wear in various mechanical components, wear controlling techniques.

Text Books

1. Majumdar, B. C. (2010). *Introduction to tribology of bearings*. S. Chand Publishing.
2. Bhushan, B. (2013). *Introduction to tribology* (2nd ed.). Wiley.

Reference Books

1. Hamrock, B. J., Schmid, S. R., & Jacobson, B. O. (2004). *Fundamentals of fluid film lubrication* (2nd ed.). CRC Press.
2. Stachowiak, G. W., & Batchelor, A. W. (2014). *Engineering tribology* (4th ed.). Elsevier.

Fracture, Fatigue and Failure Analysis (60 Hours)

Course	Code	T-P-Pr	Credits
Fracture, Fatigue and Failure Analysis	MTDM1108	3-0-0	3

Course Objectives:

- To introduce the fundamentals of fracture mechanics.
- To study different failure mechanisms in engineering components.
- To familiarize students with failure analysis procedures.

Course Outcomes:

After completion of the course, students will be able to:

- **CO1:** Explain the fundamental principles of fracture mechanics, fatigue behavior and common failure mechanisms in engineering materials.
- **CO2:** Analyze stress fields near cracks, evaluate stress intensity factors and assess fatigue life using theoretical models and empirical data.
- **CO3:** Identify appropriate fracture and fatigue design approaches, predict failure under cyclic and static loading, and recommend corrective actions.
- **CO4:** Use analytical tools, simulation software or laboratory methods (fractography, NDT, crack measurement) to evaluate structural integrity.
- **CO5:** Explore advanced topics such as nonlinear fracture mechanics, crack arrest strategies, high-cycle/low-cycle fatigue and microstructural influences on failure.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3													
CO3			2	1											
CO4	2				3	1									
CO5	2			2										2	

*High-3, Medium-2, Low-1

Module I (20 Hrs)

Fatigue: Types of fatigue loading and failure, endurance limit and S-N diagram; Fatigue under combine stresses; Notch sensitivity, Fatigue test methods; Various failure relations; Factors influencing fatigue strength; Influence of stress concentration; Fatigue crack growth initiation and propagation. Fatigue failures: characteristics of fatigue, unidirectional bending fatigue, torsion fatigue failure, contact fatigue fracture, thermal fatigue failure.

Module II (20 Hrs)

Creep: The evolution of creep damage, primary, secondary and tertiary creep. Micro-mechanisms of creep in materials and the role of diffusion. Ashby creep deformation maps. Stress dependence of creep, power law dependence. Comparison of creep performance under different conditions, extrapolation and the use of Larson-Miller parameters. Creep-fatigue interactions. Creep-stress-time temperature relations, Mechanics of creep in tension, bending, torsion, creep buckling. Members subjected to creep and combined stresses

Module III (20 Hrs)

Fracture: Basic modes of fracture, Griffith of brittle fracture, Irwin's theory of fracture in elastic- plastic materials. Theories of linear elastic fracture mechanics, stress intensity factors, fracture toughness testing. Mechanisms of crack growth and fracture; Basic modes of fracture; Stress Concentration factor.

Text Books

1. Broek, D. (1991). Elementary engineering fracture mechanics (4th ed.). Springer.
2. Suresh, S. (1998). Fatigue of materials (2nd ed.). Cambridge University Press.

Reference Books

1. Dieter, G. E. (1988). Mechanical metallurgy (3rd ed.). McGraw-Hill.
2. Hertzberg, R. W., Vinci, R. P., & Hertzberg, J. L. (2013). Deformation and fracture mechanics of engineering materials (5th ed.). Wiley.

Composite Material (45 Hours)

Course	Code	T-P-Pr	Credits
Composite Material	MTDM1110	3-0-0	3

Course Objectives

- To introduce the fundamental concepts of composite materials, including types, constituents, manufacturing methods and their mechanical behavior.
- To develop an understanding of micromechanics and macro-mechanics, enabling students to analyze stiffness, strength and failure criteria of composite laminates.
- To enable students to select, design and evaluate composite materials for engineering applications based on performance requirements, environmental factors and sustainability considerations.

Course Outcomes:

After completion of the course, students will be able to:

- **CO1:** Explain the classification, constituents, manufacturing processes and fundamental behavior of composite materials.
- **CO2:** Analyze the mechanical properties of composites using micromechanics and macro-mechanics, including stiffness, strength and laminate theory.
- **CO3:** Select suitable composite materials, fiber–matrix combinations and lay-up configurations for specific engineering applications.
- **CO4:** Model and evaluate composite structures using analytical methods or CAE tools to determine stress distribution, failure modes and performance.
- **CO5:** Explore advanced topics such as hybrid composites, nanocomposites, bio-composites and modern fabrication techniques for research applications.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3	1												
CO3				2	1										
CO4	2			3		2									
CO5			2			2							1		

***High-3, Medium-2, Low-1**

Module I (15 Hrs)

Introduction to Composite Materials – Classification and characteristics of composite materials, Metal Matrix Composites, Ceramic Matrix Composites, Carbon–Carbon Composites, Fiber- Reinforced Composites and nature-made composites, and applications. Reinforcements: Fibres- Glass, Silica, Kevlar, carbon, boron, silicon carbide, and boron carbide fibres. Particulate composites, Polymer composites, Thermoplastics, Thermosetting, Metal matrix and ceramic composites.

Module II (15 Hrs)

Micromechanical Analysis of a Lamina: Introduction, Definitions: Stress, Strain, Elastic moduli, Strain Energy. Hooke’s Law for Different Types of Materials, Hooke’s Law for a Two- dimensional unidirectional lamina, Plane Stress Assumption, Reduction of Hooke’s Law in Three Dimensions to Two Dimensions, Relationship of Compliance and Stiffness Matrix to Engineering, Elastic Constants of a Lamina.

Module III (15 Hrs)

Micromechanical Analysis of Laminates: Introduction, Laminate Code, Stress–Strain Relations for a Laminate, In-Plane and Flexural Modulus of a Laminate, Hygrothermal Effects in a Laminate, Warpage of Laminates.

Failure, Analysis, and Design of Laminates: Introduction, Special Cases of Laminates, Failure Criterion for a Laminate, Design of a Laminated Composite, Other Mechanical Design Issues.

Text Books:

1. Jones, R. M. (1999). *Mechanics of composite materials* (2nd ed.). Taylor & Francis.
2. Chawla, K. K. (2012). *Composite materials: Science and engineering* (3rd ed.). Springer.

Reference Books:

1. Gibson, R. F. (2016). Principles of composite material mechanics (4th ed.). CRC Press.
2. Hull, D., & Clyne, T. W. (1996). An introduction to composite materials (2nd ed.). Cambridge University Press.

Mechanical Vibration (45 Hours)

Course	Code	T-P-Pr	Credits
Mechanical Vibration	MTDM1206	3-0-0	3

Course Objectives:

- To learn the basic concepts of vibration, mathematical modeling of vibration systems.
- To formulate equations of motion, and solve equations of motion to analyze vibration system response.

Course Outcomes:

After completion of the course, students will be able to:

- **CO1:** Explain the fundamental principles of vibration systems, including free and forced vibrations, damping, resonance and multi-degree-of-freedom behavior.
- **CO2:** Analyze vibration responses of mechanical systems using mathematical modeling, differential equations and frequency-domain methods.
- **CO3:** Evaluate vibration parameters and recommend suitable design modifications, balancing, isolation or damping techniques.
- **CO4:** Model, simulate and interpret vibration responses using software tools such as MATLAB, ANSYS, SolidWorks Simulation or similar CAE platforms.
- **CO5:** Explore advanced vibration topics including modal analysis, nonlinear vibrations, condition monitoring and signal analysis.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		2	1												
CO3	2			3											
CO4		2			2										
CO5			2			2							2		

*High-3, Medium-2, Low-1

Module I (15 Hrs)

Review of vibration fundamentals for SDOF systems. Model study through single degree of freedom analysis: Un-damped free Vibration: Equilibrium method, Energy method, Rayleigh's method, Stiffness of spring elements. Damped Vibrations: Viscous damping, Laws of damping, Logarithmic decrement. Forced vibrations; coulomb damping; Response to harmonic excitation; Steady state solution with viscous damping, method of complex algebra rotating unbalance and support excitation; Vibration isolation and transmissibility. Energy dissipated by damping. Equivalent viscous damping, structural damping, sharpness of resonance.

Module II (15 Hrs)

Two degrees and multi-degree of freedom systems with applications: Two degree of freedom systems: Generalized Derivation of Equation of motion, Normal mode vibration, coordinate coupling, Lagrange's equations, Dynamic Vibration absorber. Multi-degree of freedom system: Derivation of Equations, influence co-efficient, modal analysis, orthogonality of normal modes. Torsional Vibration multi-rotor systems and branched system.

Module III (15 Hrs)

Vibration of continuous system. Vibration of strings, membranes, rods and beams with different end conditions Euler-Bernoulli equation for beams. Vibration Measuring Instruments: Vibrometers, velocity meters & accelerometers, Vibration testing equipment. Critical speeds without and with damping.

Text Books:

1. Thomson, W. T. (n.d.). Theory of vibration with applications. CBS Publishers.
2. Srinivasan, P. (n.d.). Mechanical vibration analysis. Tata McGraw-Hill.

Reference Books:

1. Thomson, W. T., & Dahleh, M. D. (1998). Theory of vibration with applications (5th ed.). Prentice Hall.
2. Kelly, S. G. (2020). Mechanical vibrations: Theory and applications (3rd ed.). Cengage Learning.

Tool Design (45 Hours)

Course	Code	T-P-Pr	Credits
Tool Design	MTDM1207	3-0-0	3

Course Objective:

- Provide simple and smooth, easy operation machine tools to maximize the efficiency.
- To produce the components of high quality that required fewer secondary operations on them.

Course Outcomes:

After completion of the course, students will be able to:

- **CO1:** Gain knowledge in three-dimension modeling and assembly of machine parts.
- **CO2:** Analyze forces, stresses, tolerances and fits involved in designing jigs, fixtures, cutting tools, dies and gauges.
- **CO3:** Select suitable tool materials, design parameters and manufacturing methods to create efficient and economical tooling solutions.
- **CO4:** Develop detailed tool drawings and 3D models of jigs, fixtures, dies, punches and cutting tools using CAD/CAE software.
- **CO5:** Explore advanced tooling technologies such as carbide tooling, coatings, additive manufacturing for tooling and high-speed machining tools.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		2	1												
CO3				3											
CO4	2					1	1								
CO5		2		1										3	

*High-3, Medium-2, Low-1

Module I (10 Hrs)

Basic Features and Kinematics of Machine Tools: Features of basic machine tools construction and operation, types of machine tools, machine tools motions, transmission-rotation in to rotation, rotation in to translation, kinematic-structures of machine tools: elementary, complex and compound structure, kinematic-features of gear shapers and gear hobbing machine.

Module II (10 Hrs)

Regulation of Speed: Design of gear boxes- need for variation of speed, selection of speed range, laws of stepped regulation, standardization of speeds, speed diagram, analysis of productivity loss, kinematic advantage of GP, structural diagrams, ray diagram and speed chart. Gear Drives: Belt and cone pulley, slip gear type, north gear drive, draw key gear drive, clutch type, mechanical step less drives, electrical drives; hydraulic drive.

Module III (10 Hrs)

Design of Metal working Tools: Design of press working tools, shearing, piercing, blanking, dies, compound die design principles for forging dies, bending, forming drawing dies, tooling for forging- design principles for forging dies, drop forging, upset forging, design principles and practice for rolling, roll press design.

Module IV (15 Hrs)

Design of Jigs and Fixtures: Principles of location, locating method and devices, principles of clamping, clamping devices, drilling jigs, types, drill bushes, fixture and economics, types of fixture, milling, grinding, broaching, assembly fixtures indexing jig and fixtures, indexing devices.

Design of Gauges and Inspection Features: Design of gauges for tolerance for dimensions and form inspection; dies and mould design for Ppastics & rubber parts: compression molding, transfer molding, blow molding.

Text Books:

1. Donaldson, C., Lecain, G. H., & Goold, V. C. (n.d.). Tool design. Tata McGraw-Hill.

2. Mehta, N. K. (n.d.). Machine tool design and numerical control. Tata McGraw-Hill.
3. Jain, K. C., & Chitale, A. K. (n.d.). Textbook of production engineering. PHI Learning.

Reference Books:

1. Sen, G. C., & Bhattacharyya, A. (1999). Principles of machine tools. New Central Book Agency.
2. Krar, S. F., & Check, C. (1997). Technology of machine tools (6th ed.). McGraw-Hill.

Engineering Design Methodology (45 Hours)

Course	Code	T-P-Pr	Credits
Engineering Design Methodology	MTDM1208	3-0-0	3

Course objective:

- To understand the elements or activities that comprise the engineering design process
- To identify needs and constraints of product development system

Course Outcomes:

After completion of the course, students will be able to:

- **CO1:** Gain knowledge on design process and product development.
- **CO2:** Analyze user needs, functional requirements and engineering constraints to develop viable design specifications.
- **CO3:** Apply structured design methods to generate multiple concepts, evaluate alternatives and select the most appropriate solution.
- **CO4:** Use design tools such as CAD software, modeling techniques, decision matrices and product architecture methods to develop detailed design solutions.
- **CO5:** Explore modern design approaches including reverse engineering, design optimization, biomimetic design and design for sustainability.

Course Outcome to Program Outcome Mapping:

COs / POs / PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		3												
CO2		3	1	3											
CO3			3	1	3										
CO4		3	2												
CO5		2		2								2		2	

***High-3, Medium-2, Low-1**

Module-I (15 Hrs)

Fundamentals: principles of design, systematic approach, need analysis and design of specification; Conceptual design: developing function structure, developing concepts by systematic search with physical principles, classifying schemes; experimental and design criteria. Design methodologies: axiomatic design methodology, design for manufacturing, design for assembly.

Module-II (15 Hrs)

Concept selection: matrix methods, necessity methods, probability methods, fuzzy set based methods, case study on consumer product; Embodiment design: basic rules, system modeling, preliminary design calculations and material selection, design considerations like force alignment, vibration etc., failure modes and effects analysis, design for manufacturability and assembly, case studies on design of machines.

Module-III (15 Hrs)

Optimal and robust design: Algorithms for constructing optimal design, design problem formulation for analytical and numerical solution, design of experiments, Taguchi's method; Physical prototyping, reverse engineering, product teardown and redesign, embodiment design, CAE analysis, prototyping, design project.

Text Books:

1. Haik, Y. (2003). Engineering design process. Vikas Publishing House.
2. Pahl, G., & Beitz, W. (1996). Engineering design: A systematic approach. Springer-Verlag.

Reference Book

1. Otto, K., & Wood, K. (2004). Product design: Techniques in reverse engineering and new product development. Pearson Education.
2. Ertas, A., & Jones, J. C. (1996). The engineering design process (2nd ed.). John Wiley & Sons.