Centurion University of Technology and Management, Odisha

M. Tech in Design and Manufacturing
(Two years Programme)

School of Engineering & Technology

Centurion University of Technology and Management, Odisha

2023


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Index


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Programme Objectives; Job/Higher studies/Entrepreneurship

POs: The Programme Outcomes (POs) of an M.Tech (Master of Technology) program are:

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

PSOs

PSO1. Develop hands-on skills related to Manufacturing, Design, Welding and Automobile field.
PSO2. Build software competencies for product design, simulation, analysis, and manufacturing.
PSO3. Become a valuable technocrat to be fit for the industry or entrepreneur through manufacturing and management practices.

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
CO6	Environment and Sustainability
CO7	Ethics & Team work
CO8	Soft skill

Department of Mechanical Engineering
M. Tech (Design and Manufacturing) Course Structure

First Year - 1st Semester

Sl. No.	*Code*	*Course*	*T*	*P*	*Pr*	*Credits*
		Theory Courses				
1	MTDM1101	*Design Engineering*	*3*	*1*	*0*	*4*
2	MTDM1102	*Manufacturing Technology*	*3*	*0*	*0*	*3*
3	MTDM1103	*CAD/CAM*	*3*	*0*	*0*	*3*
4	MTDM1104	*Finite Elements Method in Engineering*	*3*	*0*	*0*	*3*
5		*Elective I*	*3*	*0*	*0*	*3*
		Practice Courses				
6	MTDM1105	*CAD Lab (CATIA / UGNX)*	*0*	*2*	*0*	*2*
7	MTDM1106	*Manufacturing Technology Lab*	*0*	*2*	*0*	*2*
		Total Credits				*20*

First Year - 2nd Semester

Sl. No.	*Code*	*Course*	*T*	*P*	*Pr*	*Credits*
		Theory Courses				
1	MTDM1201	*Theory of Elasticity*	*3*	*0*	*0*	*3*
2	MTDM1202	*Theory of Metal Cutting*	*3*	*0*	*0*	*3*
3	MTDM1203	*Instrumentation and Experimental Stress Analysis*	*3*	*0*	*0*	*3*
4	MTRM1201	*Research methodology & IPR*	*2*	*0*	*0*	*2*
5		*Elective - 2*	*3*	*0*	*0*	*3*
		Practice Courses				
6	MTDM1204	Design and Analysis Lab	0	2	0	2
7	MTDM1205	*3D Printing and Prototyping Lab*	*0*	*2*	*0*	*2*
		Total Credits				*18*

Second Year

Sl. No.	*Code*	*Course*	*T*	*P*	*Pr*	*Credits*
		3rd Semester				
1	MTIP2101	*Industry Internship and Project - I*			*16*	*16*
		Total Credits				*16*
		4th Semester				
1	MTIP2201	*Industry Internship and Project - II*			*16*	*16*
		Total Credits				*16*
Total Course Credits = 70						

Electives

Code	*Course*	*T*	*P*	*Pr*	*Credits*
	Elective 1				
MTDM1107	*Tribology*	*3*	*0*	*0*	*3*
MTDM1108	*Fracture, Fatigue and Failure Analysis*	*3*	*0*	*0*	*3*
MTDM1109	*Composite Materials*	*3*	*0*	*0*	*3*
	Elective 2				
MTDM1206	*Mechanical vibration*	*3*	*0*	*0*	*3*
MTDM1207	*Tool Design*	*3*	*0*	*0*	*3*
MTDM1208	*Engineering Design Methodology*	*3*	*0*	*0*	*3*

Design Engineering

Course	Code	Type of Course	T-P-Pr
Design Engineering	MTDM1101	Theory + Practice	3-1-0

Course Objective:

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

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

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Understand the process of design and product development	PO1(3), PO2(1), PO3(3)
CO2	Solve problem solving related to design problem formulation	PO2(3), PO4(3)
CO3	Analyze different CAE & Process Optimization Tools	PO3(3), PO5(3)
CO4	Evaluate the strength of a product	PO1(2), PO3(3), PO5(3)
CO5	Research in Product Design & Analysis.	PO2 (3), PO3 (2)

Module-I

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.

Module-II

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

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.

Text Book

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

Manufacturing Technology

Course	Code	Type of Course	T-P-Pr
Manufacturing Technology	MTDM1102	Theory	**3-0-0**

Course Objective:

- 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:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Understand various manufacturing Processes	PO1 (3), PO7 (1)
CO2	Apply the principles of process planning and optimization to design efficient and cost-effective manufacturing systems.	PO2(3), PO9(1)
CO3	Analyze appropriate materials and manufacturing methods	PO1(2), PO2(3), PO3(1)
CO4	Evaluate manufacturing processes for their environmental impact and incorporate sustainable practices.	PO2 (3), PO3 (2)
CO5	Research in advancement in Manufacturing Process	PO2 (3), PO3 (2)

Module-I

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

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

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

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 Book

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

CAD / CAM

Course	Code	Type of Course	T-P-Pr
CAD/CAM	MTDM1103	Theory	**3-0-0**

Course Objective:

- 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:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Gain knowledge in three dimension modeling and assembly of machine parts	PO1(3)
CO2	Identify and resolve the solid modeling problems and help to take decision in product design	PO2(3), PO3(1)
CO3	Acquire hands-on skill in modeling using different modeling software	PO3(3), PO2(1)
CO4	Carry out research in design field	PO4(2)

Module I

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

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

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

Module II

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

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

Module IV

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. M P Groover, CAD/CAM, PHI Learning
2. Ibrahim Zeid, CAD/CAM Theory & Practice, Tata McGraw Hill

Finite Elements Method in Engineering

Course	Code	Type of Course	T-P-Pr
Finite Element Method in Engineering	MTDM1104	Theory	**3-0-0**

Course Objective:

- 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:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Gain knowledge numerically solving differential equations arising in engineering and mathematical modeling.	PO1 (3), PO2 (3)
CO2	Do hands-on practice in Dassault Systemes Tools	PO2(3), PO3(3)
CO3	Analyze different stresses applied on a product	PO2(3), PO3(2), PO4(1)

Module I

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

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

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

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 Book:

1. S S Rao, Introduction to Finite Element Method
2. Robert D. Cook., Concepts and Applications of Finite Element Analysis

CAD Laboratory (CATIA / UGNX)

Course	Code	Type of Course	T-P-Pr
CAD Laboratory (CATIA / UGNX)	MTDM1105	Practice	**0-2-0**

Course Objective

- 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:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Gain knowledge in Calculating and/or measuring product lengths, areas, or mass	PO1(3), PO2(2)
CO2	Produce computer-aided mechanical drawings of components and assemblies of industrial machines, machinery parts	PO3(1), PO3(1)
CO3	Prepare Bills of Material in a CAD environment	PO1(1), PO4(2)

Practice

1. Part Design, Assembly and GSD Workbench tools Training
2. Creation of assemblies of products in CATIA/UG NX.
3. Simulation of assemblies with Digital Mock ups.
4. Creation of digital mockup addition of behavior.
5. Ergonomic and aesthetic studies.

Manufacturing Technology Laboratory

Course	Code	Type of Course	T-P-Pr
Manufacturing Technology Laboratory	MTDM1106	Practice	**0-2-0**

Course Objective:

- To study the basics of CAD and CAM
- To understand the relation between product manufacturing and inspection

Course Outcomes:

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

Cos	Course outcomes	Mapping Cos with Pos (High-3, Medium-2, Low-1)
CO1	Gain Knowledge of Various Engineering Manufacturing Processes	PO1 (3), PO7 (1)
CO2	Do hands-on practice in Product Processing & Development; CAD/CAM Software	PO2(3), PO3(3), PO5(3),
CO3	Apply manufacturing processes to fabricate a product	PO2 (3), PO3 (2)

Practices

1. Exercise in computer aided drafting and design, mesh generation, modeling, use of packages
2. Assembly drawings using drafting package.
3. Surface flatness measurement using slip gauges.
4. Experiments on CAM using CNC Miller.
5. Experiments on CAM using CNC Lathe.
6. Study of various machine tools their operational details and attachments.
7. Study of Moulds with single pattern and split pattern.
8. Experiment on surface grinding with measurement of surface roughness.

2nd Semester

Theory of Elasticity

Course	Code	Type of Course	T-P-Pr
Theory of Elasticity	MTDM1201	Theory	**3-0-0**

Course objective:

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

Course Outcomes:

Cos	Course outcomes	Mapping Cos with Pos (High-3, Medium-2, Low-1)
CO1	Knowledge on principles of elasticity theory to solve 2D & 3D problems.	PO1 (3), PO2 (3)
CO2	Formulate and solve boundary value problems & planar problems	PO1(3), PO3(3), PO4(3)
CO3	Analyze the bending stresses of a beam	PO2(3), PO2(3), PO4(2)

Module I

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 co-ordinates. Airy's stress function.

Module II

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, Kirkhhof and Mindlin concept. Solid circular plates with different load and support conditions.

Module III

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.

Theory of Metal Cutting

Course	Code	Type of Course	T-P-Pr
Theory of Metal Cutting	MTDM1202	Theory	**3-0-0**

Course Objective:

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

Course Outcomes:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Knowledge on various aspects in Machining Processes	PO1 (3)
CO2	Identifying and solving problems related to mechanics of metal cutting	PO2(3), PO4(2)

Module I

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

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 continues 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

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

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. G.Boothroyd and W.A.Knight, Fundamentals of Machining and Machine Tools, CRC Press
2. M.C.Shaw, Metal Cutting Principles, , Oxford University Press

Instrumentation & Experimental Stress Analysis

Course	Code	Type of Course	T-P-Pr
Instrumentation & Experimental Stress Analysis	MTDM1203	Theory	**3-0-0**

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:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Overall knowledge of stress/strain analysis	PO1 (3)
CO2	Identifying and solving problems related to stress, strains and Photo Elasticity	PO2(3), PO4(2)

Module I

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

Photo elasticity: Photo elasticity – Polariscope – 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

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. J.W. Dally and W.F. Riley, Experimental Stress Analysis, 2nd Ed. MGH.
2. Mubin Khanna, Experimental Stress Analysis.

Research Methodology and IPR

Course	Code	Type of Course	T-P-Pr
Research Methodology and IPR	MTRM 1201	**Theory**	**2-0-0**

Course Objective:

- 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:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Knowledge in the selection, approaches of research problem.	PO1 (3)
CO2	Identifying and solving problems related characteristics of a good research, ethical issues, effective technical writing, and developing a research proposal	PO2(3), PO4(2), PO8(3)

Syllabus Contents

Unit 1: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

Unit 2: Effective literature studies approaches, analysis Plagiarism, Research ethics,

Unit 3: Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

Unit 4: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting,

development. International Scenario: International cooperation on Intellectual Property.

Procedure for grants of patents, Patenting under PCT.

Unit 5: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology.Patent information and databases.Geographical Indications.

Unit 6: New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc.

Traditional knowledge Case Studies, IPR and IITs.

References:

- Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
- Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
- Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
- Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007. Mayall, "Industrial Design", McGraw Hill, 1992.
- Asimov, "Introduction to Design", Prentice Hall, 1962.
- Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.

Design and Analysis Lab

Course	Code	Type of Course	T-P-Pr
Instrumentation & Experimental Stress Analysis	MTDM1204	Practice	**0-2-0**

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:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Knowledge of mechanics of machining.	PO1 (3)
CO2	Hands-on practice in Dynamometer, Profile Projector, EDM, CMM, and Profilometer.	PO2(3), PO4(3), PO5(3),

1. Study of the chip formation in turning process
2. Study of operation of tool and cutter grinder, twist drill grinder, centreless grinder
3. Determination of cutting forces in turning;
4. Determination of cutting forces in Milling
5. Inspection of parts using CMM
6. Experiments and demonstration of EDM
7. Experiments on surface technology.
8. Operation of FMS

3D Printing and Prototyping Lab

Course	Code	Type of Course	T-P-Pr
3D Printing and Prototyping Lab	MTDM1205	Practice	**0-2-0**

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:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Knowledge of Additive Manufacturing & prototyping	PO1 (3)
CO2	Hands-on practice in 3D Printer	PO2(3), PO4(3), PO5(3),
CO3	Research on 3D printing technology	PO3 (3), PO4(3)

1. Design Considerations and Rapid Prototyping using 3D Printing.
2. Design and production of Automotive Plastic Part in Prototype level using 3D Printing.
3. Reverse engineering and Prototyping of some Existing Components

Tribology

Course	Code	Type of Course	T-P-Pr
Tribology	MTDM1108	Theory	**3-0-0**

Course Objectives:

- To expose the student to different types of bearings, bearing materials and lubrication
- To learn theory and concepts about different types of lubrication

Course Outcomes:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain knowledge in friction characteristics and power losses in journal bearings	PO1(3)
CO2	Able to measure the lubricant's properties by using different instruments	PO2(2), PO3(2)
CO3	Able to carry out research in different applications of tribology	PO4(3), PO5(2)

Module I

Introduction-Historical background, 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-Strokes equations. Order of magnitude analysis, General Reynolds equation-2D and 3D (Cartesian and Cylindrical)

Module II

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

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

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. B.C.Majumdar, Introduction to Tribology of Bearings, S.Chand
2. Bernard J.Hamrock, Fundamentals of fluid film lubricant, Mc Graw-Hill Co.

Fracture, Fatigue and Failure Analysis

Course	Code	Type of Course	T-P-Pr
Fracture, Fatigue and Failure Analysis	MTDM1109	Theory	**3-0-0**

Course Objective

- To provide students with an understanding of fracture, fatigue and creep behavior of engineering materials and their analysis.

Course Outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Knowledge on mechanical behavior of materials, stress and strain based approaches to fatigue analysis, fatigue crack growth and creep behavior	PO1 (3)
CO2	Solving problems related to fracture mechanics; fatigue of materials; stress-based approach to fatigue; strain-based approach to fatigue; fatigue crack growth in materials; creep in materials.	PO2(3), PO4(3)

Module I

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 facture, contact fatigue fracture, thermal fatigue failure.

Module II

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

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. J. M. Lessels, Strength and Resistance of Metals, John Wiley and Sons
2. J Marin Mechanical Behaviour of Engineering Materials, PHI
3. R B Hathaway, Fatigue Testing and Analysis, Elsevier Press

Composite Material

Course	Code	Type of Course	T-P-Pr
Composite Material	MTDM1110	Theory	**3-0-0**

Course Objective

- To get basic ideas of composite materials and their manufacturing techniques

Course Outcomes

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain knowledge on various type of composite materials, its fabrication technique	PO1(2)
CO2	Able to identify design parts, tools to prepare, gain skill on material selection	PO2(3)

Module I

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 born carbide fibres. Particulate composites, Polymer composites, Thermoplastics, Thermosetting, Metal matrix and ceramic composites.

Module II

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

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. R. M. Jones, Mechanics of Composite Materials. Taylor & Francis.
2. K.K. Chawla, Composite Materials – Science & Engineering, Springer.

Mechanical Vibration

Course	Code	Type of Course	T-P-Pr
Mechanical Vibration	MTDM1207	Theory	**3-0-0**

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.

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Knowledge free and forced vibrations, Degree of freedom, Vibration Measuring Instruments	PO1 (3)
CO2	Solving problems related to various techniques of measurement and control of vibration.	PO2(3), PO4(3)

Module I

Review of vibration fundamentals for SDOF systems. Model study through single degree of freedom analysis:Un-damped free Vibration : Equilibrium method, Energy method, Raylegh'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

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, Langrange's equations, Dynamic Vibration absorber.

Multi-degree of freedom system : Derivation of Equations, influence co-efficients, modal analysis, orthogonality of normal modes. Torsional Vibration multi-rotor systems and branched system.

Module III

Vibration of continuous system. Vibration of strings, membranes, rods and beams with different end conditions Euler-Bernoulli equation for beams.

Vibration Measuring Instruments: Vibro-meters, velocity meters & accelerometers, Vibration testing equipment. Critical speeds without and with damping.

Text Books:

1. W. T. Thomson, Theory of Vibration with Applications, CBS Publ.
2. P. Srinivasan, Mechanical Vibration analysis, TMH

Tool Design

Course	Code	Type of Course	T-P-Pr
Tool Design	MTDM1208	Theory	**3-0-0**

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 Outcome:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Able to gain knowledge in three dimension modeling and assembly of machine parts	PO1(3)
CO2	Designing tools to maintain precision, accuracy of the component produced	PO2(3), PO3(2)
CO3	Carry out research in tool design	PO4(2)

Module I

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

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

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

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. Mehta N.K.; Machine Tool Design and Numerical Control; TMH
2. Sen G.C, Bhattacharya A; Principles of Machine Tools; New Central Book Agency.
3. Donaldson; Tool Design T.M.H.
4. Jain KC and Chitale A K; Text Book Of Production Engineering; PHI Learning

Text Books:

1. C R Kothari, Research Methodology: Methods and Techniques, PHI.
2. Panneerselvam, Research Methodology, PHI

Engineering Design Methodology

Course	Code	Type of Course	T-P-Pr
Engineering Design Methodology	MTDM1209	Theory	**3-0-0**

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:

COs	Course outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Knowledge on design process and product development	PO1(3), PO3(3)
CO2	Problem solving related to design problem formulation	PO2(3), PO4(3)
CO3	Use of CAE & Process Optimization Tools	PO3(3), PO5(3)
CO4	Research in Product Design & Analysis.	PO2 (3), PO3 (2)

Module-I

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

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

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 Book

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

Reference Book

1. K. Otto and K. wood, Product Design – techniques in reverse engineering and new product development, Pearson Education, New Delhi, 2004.
2. A. Ertas and J. C. Jones, The Engineering Design Process, 2nd ed., John Wiley and Sons, 1996.