M. Tech in Digital Manufacturing in Energy Systems

1st Sem M. Tech					
Subject Code	**Subject**	**L**	**T**	**P**	**C**
BS-5111	Advanced Numerical Methods	3	0	0	3
ME 5101	Fundamentals of Energy Systems	3	0	0	3
ME 5102	Additive Manufacturing	3	0	0	3
ME 5103A ME 5103B	**Elective-I** (1) Renewable Energy Technology (2) Energy Storage Systems	3	0	0	3
ME 5104A ME 5104B	**Elective-II** (1) Advanced Mechatronics (2) Robotics	3	0	0	3
ME 5105	CNC Lab	0	0	3	1.5
ME 5106	Computational lab	0	0	3	1.5
	Total Credit	**15**	**0**	**6**	**18**

2nd Sem M. Tech

Subject Code	Subject	L	T	P	C
ME 5201	Sustainable Manufacturing	3	0	0	3
ME 5202	Advanced thermal systems	3	0	0	3
ME 5203	Finite Element Method (FEM)	3	0	0	3
ME 5204A ME 5204B	**Elective-III** (1) AI and Machine Learning in Manufacturing System (2) Optimization technique	3	0	0	3
ME 5205A ME 5205B	**Elective-IV** (1) High precision manufacturing (2) Multi-functional composite	3	0	0	3
ME 5206	Technical report writing & seminar	0	0	3	1.5
ME 5207	Digital Manufacturing Lab	0	0	3	1.5
	Credit	**15**	**0**	**6**	**18**

3rd Sem M. Tech

Subject Code	Subject	L	T	P	C
ME-6101	Project phase -I	**0**	**0**	**28**	**14**

4th Sem M. Tech

ME-6201	Project phase -II	**0**	**0**	**30**	**15**

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Programme	Master of Technology in Digital Manufacturing in Energy Systems	**Academic Year of Regulation**	**2025-26**
Department	Mechanical Engineering	**Semester**	**I**

Course Code	**Course Name**	**Credit Structure**					**Marks Distribution**				**Bloom's taxonomy**
		L	**T**	**P**	**C**	**INT**	**MID**	**END**	**Total**		
ME-5101	Fundamentals of Energy Systems	**3**	**0**	**0**	**3**	**20**	**30**	**50**	**100**		

Course Objectives		**Course Outcomes**		**Bloom's taxonomy**
	1. To introduce the basic principles and components of conventional and non-conventional energy systems. 2. To provide an understanding of energy conversion, utilization, and system efficiency. 3. To expose students to the structure, operation, and analysis of various energy systems. 4. To prepare students for advanced study and digital application in energy systems.		**CO1** Understand the classification, structure, and components of different energy systems.	*Remembering/ Understanding*
			CO2 Analyze thermodynamic and fluid dynamic processes in energy conversion systems.	*Understanding/ Analyzing*
			CO3 Evaluate performance and efficiency of mechanical, thermal, and electrical energy systems.	*Applying/ Analyzing*
			CO4 Interpret system design considerations in the context of sustainability and digital integration.	*Evaluating/ Creating*
			CO5 Apply foundational knowledge to advanced modeling, simulation, and optimization of energy systems.	*Applying/ Analyzing*

No.	**COs**	**Mapping with Program Outcomes (POs)**												**Mapping with PSOs**		
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	CO1															
2	CO2															
3	CO3															

SYLLABUS

No.	**Content**	**Hours**	**COs**
I	Definition and types of energy systems, Classification: centralized vs. decentralized, renewable vs. non-renewable, Global and Indian energy scenarios, Energy units, metrics, and data analytics	**6**	**CO1**
II	Definition and types of energy systems, Classification: centralized vs. decentralized, renewable vs. non-renewable, Global and Indian energy scenarios, Energy units, metrics, and data analytics	**8**	**CO1, CO2**
III	Steam and gas turbine power plants, Diesel and combined cycle power plants, Thermal power plant components and layout, Efficiency improvements and waste heat utilization	**6**	**CO1, CO3**
IV	Solar, wind, hydro, geothermal, biomass overview, Key parameters and site selection criteria, Hybrid energy systems, Role in smart grids and distributed generation	**8**	**CO2, CO3, CO4**
V	Types of energy storage: mechanical, thermal, electrochemical, Batteries, supercapacitors, hydrogen storage, Basics of electrical energy transmission and grid systems, Smart grids and digital energy management	**6**	**CO1, CO3**
VI	Energy and environment: emissions, footprint, LCA, Integration of AI, and IoT in energy systems, Role of Industry 4.0 in energy sector	**6**	**CO2, CO3, CO5**
	Total Hours	**40**	

Text Books:

1. Richard E. Sonntag, Claus Borgnakke, Fundamentals of Thermodynamics, Wiley.
2. G.D. Rai, Non-Conventional Energy Sources, Khanna Publishers.
3. D.Y. Goswami, F. Kreith, Energy Conversion, CRC Press.

Reference Books:

1. J. Twidell & T. Weir, Renewable Energy Resources, Taylor & Francis.
2. Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, Springer.

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Programme	Master of Technology in Digital Manufacturing in Energy Systems	**Academic Year of Regulation**	**2025-26**
Department	Mechanical Engineering	**Semester**	**I**

Course Code	**Course Name**	**Credit Structure**					**Marks Distribution**			
		L	**T**	**P**	**C**	**INT**	**MID**	**END**	**Total**	**Bloom's taxonomy**
ME-5102	Additive Manufacturing	**3**	**0**	**0**	**3**	**20**	**30**	**50**	**100**	

Course Objectives		**Course Outcomes**			
	1. To provide students with a fundamental understanding of additive manufacturing (AM) principles. 2. To familiarize them with various AM processes and their applications. 3. To equip them with the ability to select appropriate techniques and post-processing operations for specific components, and to develop the skills required to design and fabricate functional models using additive manufacturing technologies.		**CO1**	Understand the working principles and process parameters of additive manufacturing processes	*Remembering/ Understanding*
			CO2	Explore different additive manufacturing processes and suggest suitable methods for building a particular component	*Understanding/ Analyzing*
			CO3	Perform suitable post processing operation based on product repair requirement	*Applying/ Analyzing*
			CO4	Design and develop a working model using additive manufacturing Processes	*Evaluating/ Creating*

No.	**COs**	**Mapping with Program Outcomes (POs)**												**Mapping with PSOs**		
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	CO1															
2	CO2															
3	CO3															

SYLLABUS

No.	**Content**	**Hours**	**COs**
I	Introduction to Additive Manufacturing: Introduction to AM, AM evolution, Distinction between AM & CNC machining, Steps in AM, Classification of AM processes, Advantages of AM and Types of materials for AM.	**6**	**CO1**
II	AM Processes: Vat Photopolymerization; Material Jetting; Binder Jetting; Extrusion-Based AM Processes; Sheet Lamination AM Processes; Powder Bed Fusion AM Processes; Directed Energy Deposition AM Processes; Wire Arc Additive Manufacturing	**18**	**CO1, CO2**
III	Materials science for AM - Multifunctional and graded materials in AM, Role of solidification rate, Evolution of non-equilibrium structure, microstructural studies, Structure property relationship, case studies.	**6**	**CO1, CO3**
IV	Post Processing of AM Parts: Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-thermal and Thermal Techniques, case studies. Guidelines for Process Selection: Introduction, Selection Methods for a Part, Challenges of Selection, Example System for Preliminary Selection, Process Planning and Control.	**10**	**CO2, CO3, CO4**
	Total Hours	**40**	

Text Books:

1. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson, David W Rosen, Brent Stucker, Springer, 2015, 2nd Edition.
2. 3D Printing and Additive Manufacturing: Principles & Applications, Chua Chee Kai, Leong Kah Fai, World Scientific, 2015, 4th Edition.

Reference Books:

1. Rapid Prototyping: Laser-based and Other Technologies, Patri K. Venuvinod and Weiyin Ma, Springer, 2004.
2. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, D.T. Pham, S.S. Dimov, Springer 2001.
3. Rapid Prototyping: Principles and Applications in Manufacturing, Rafiq Noorani, John Wiley & Sons, 2006.
4. Additive Manufacturing, Second Edition, Amit Bandyopadhyay Susmita Bose, CRC Press Taylor & Francis Group, 2020.
5. Additive Manufacturing: Principles, Technologies and Applications, C.P Paul, A.N Junoop, McGrawHill, 2021.

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Programme	Master of Technology in Digital Manufacturing in Energy Systems	**Academic Year of Regulation**	**2025-26**
Department	Mechanical Engineering	**Semester**	**I**

Course Code	Course Name	Credit Structure				Marks Distribution				Bloom's taxonomy
		L	T	P	C	INT	MID	END	Total	
ME-5103A	Renewable Energy Technology	3	0	0	3	20	30	50	100	

Course Objectives		Course Outcomes			Bloom's taxonomy
Course Objectives	1. To study the basic principles and working mechanism involved in the generation of solar energy. 2. To gain insight into the conversion processes and operational aspects of bioenergy and wind power systems. 3. To learn about the production, potential, and methods of energy extraction from hydropower sources.	**Course Outcomes**	**CO1**	Understand the fundamental working principles and components of solar, bio, wind, and hydro power plants.	*Remembering/ Understanding*
			CO2	Understand the operation and characteristics of various renewable energy systems based on their energy conversion methods.	*Understanding/ Analyzing*
			CO3	Analyze biomass resources, identify suitable conversion technologies, and analyze their feasibility for specific end-use applications.	*Applying/ Analyzing*
			CO4	Apply the principles of energy conversion devices to evaluate performance, and propose improvements or optimized configurations for efficient operation.	*Evaluating/ Creating*

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1															
2	CO2															
3	CO3															

SYLLABUS

No.	Content	Hours	COs
I	Solar Radiation: Sun as Energy Source, Solar Radiation at The Earth's Surface, Solar Radiation Geometry, Solar Time and Equation of Time, Sun Earth angles, Sun path diagram, Sunshine hours, Measurement of Solar Diffuse, Global and Direct Solar Radiation, Equipment, Estimation of Solar radiation on horizontal and tilted Surfaces.	**8**	**CO1**
II	Solar Cells: Conversion of Solar energy into Electricity - Photovoltaic Effect, Equivalent Circuit of the Solar Cell, Analysis of PV Cells: Dark and illumination characteristics, Figure of merits of solar cell, Efficiency limits, Variation of efficiency with band-gap and temperature, Efficiency measurements, High efficiency cells.	**10**	**CO1, CO2**
III	Wind and Hydro energy: Bentz limit, Wind energy conversion systems: classification, applications, power, torque and speed Characteristics Aerodynamic design principles; Aerodynamic theories: Axial momentum, Blade element and Combine theory, Rotor characteristics, Maximum power coefficient, Tip loss correction. Hydrology, Resource assessment, Potential of hydropower in India, Classification of Hydropower Plants, Small Hydropower Systems: Overview of micro, mini and small hydro systems.	**10**	**CO1, CO2**
IV	Thermo-chemical conversions: Thermal Decomposition Mechanisms of Bio-Renewable: Direct Combustion, Technology of Biomass gasification, Pyrolysis, Hydrothermal Liquefaction of Bio-renewable Feed stocks, Direct Liquefaction Chemical Conversion Hydrolysis and hydrogenation. Bio- Energy Systems: Biomass Gasifiers: Principle, Design of Bio mass Gasifiers, updraft gasifier, downdraft gasifier, zero carbon biomass gasification plants, applications for cooking, electricity generation, Gasifier Engines, Operation of spark ignition and compression ignition engine with wood gas, methanol, ethanol and biogas, Biomass integrated gasification/combined cycles systems.	**12**	**CO2, CO3, CO4**
	Total Hours	**40**	

Text Books:

1. Solar Energy: Principles of Thermal Collection and Storage by SP Sukhatme, 1984, Tata McGraw-Hill

Reference Books:

1. Renewable Energy by B Sorensen, 4th Ed., 2011, Academic press, New York.
2. Principles of Solar Engineering by DY Goswami, 3rd Ed., 2015, CRC Press.
3. Wind Energy Systems by GL Johnson, 1985, Prentice Hall.
4. Introduction to Hydro Energy Systems: Basics, Technology and Operation by H Wagner and J Mathur, 2011, Springer.

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Course Code	**Course Name**	**Credit Structure**					**Marks Distribution**			**Bloom's taxonomy**
		L	T	P	C	INT	MID	END	Total	
ME-5103B	Energy Storage Systems	3	0	0	3	20	30	50	100	

Course Objectives

1. To introduce the need, classification, and design principles of energy storage systems.
2. To study electrochemical, mechanical, and thermal energy storage technologies in depth.
3. To explore integration of energy storage with renewable and digital manufacturing systems.
4. To apply performance modeling, diagnostics, and digital tools in energy storage applications.

Course Outcomes

		Bloom's taxonomy
CO1	Identify and classify various energy storage systems based on type, duration, and application.	*Remembering/ Understanding*
CO2	Analyze design, working, and performance metrics of thermal, electrical, and mechanical storage devices.	*Understanding/ Analyzing*
CO3	Design energy storage strategies for distributed and hybrid renewable systems.	*Applying/ Analyzing*
CO4	Use digital manufacturing techniques in developing energy storage components.	*Evaluating/ Creating*
CO5	Evaluate techno-economic and lifecycle performance of energy storage in energy systems.	*Applying/ Analyzing*

No.	**COs**	**Mapping with Program Outcomes (POs)**												**Mapping with PSOs**		
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	CO1															
2	CO2															
3	CO3															

SYLLABUS

No.	**Content**	**Hours**	**COs**
I	Role of energy storage in modern energy systems, Classification: short-term vs. long-term, power vs. energy storage, Performance metrics: energy density, power density, round-trip efficiency, life cycle, Applications in grid stability, e-mobility, and renewables integration	**7**	**CO1**
II	Working principles and classification: batteries, fuel cells, supercapacitors, Lithium-ion, lead-acid, sodium-ion, flow batteries: materials and characteristics, Battery management systems (BMS), thermal management, Smart battery systems and real-time monitoring	**9**	**CO1, CO2**
III	Sensible heat storage: water, molten salts, rocks, Latent heat storage: phase change materials (PCMs), Thermochemical energy storage, Thermal storage in solar thermal, HVAC and industrial waste heat recovery	**7**	**CO1, CO3**
IV	Pumped hydro storage: design and efficiency, Compressed air energy storage (CAES), flywheel energy storage, Hydrogen storage methods: compressed, liquid, metal hydrides, Role of hydrogen in future energy systems and fuel cell vehicles	**8**	**CO2, CO3, CO4**
V	Additive manufacturing of battery components and thermal interfaces, Smart materials and printed electronics, Design for manufacturability (DfM) of battery packs and enclosures, Robotics and automation in battery assembly and recycling	**9**	**CO3, CO5**
	Total Hours	**40**	

Text Books:

1. Ibrahim Dincer & Mark A. Rosen, Thermal Energy Storage: Systems and Applications, Wiley.
2. Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, Springer.

Reference Books:

1. A.G. Ter-Gazarian, Energy Storage for Power Systems, IET.

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CURRICULUM

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Department	Mechanical Engineering	**Semester**	**I**

Course Code	**Course Name**	**Credit Structure**					**Marks Distribution**			**Bloom's taxonomy**
		L	**T**	**P**	**C**	**INT**	**MID**	**END**	**Total**	
ME-5104A	Advanced Mechatronics	**3**	**0**	**0**	**3**	**20**	**30**	**50**	**100**	

Course Objectives

1. Generate conceptual design for Mechatronics systems based on potential customer requirements.
2. Selection of appropriate sensors and transducers and devise an instrumentation system for collecting information about processes, control systems.
3. Design a control system for effective functioning of Mechatronics systems using digital electronics, microprocessors, microcontrollers and programmable logic controllers.
4. Selection of appropriate actuators for physical systems.
5. Analyse PD, PI and PID controllers for a given mechatronics system.
6. Develop pneumatic and hydraulic circuits.
7. Determine the performance of different Mechatronics system.

Course Outcomes

		Bloom's taxonomy
CO1	An ability to identify, select, and integrate mechatronic components to meet product requirements.	*Remembering/ Understanding*
CO2	An ability to analyse PD, PI and PID controllers for a given mechatronics system.	*Understanding/ Analyzing*
CO3	An ability to develop pneumatic and hydraulic circuits.	*Applying/ Analyzing*
CO4	An ability to design, analyze, and optimize mechatronic products.	*Evaluating/ Creating*
CO5	An ability to determine the performance of different Mechatronics system.	*Applying/ Analyzing*

No.	**COs**	**Mapping with Program Outcomes (POs)**												**Mapping with PSOs**		
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	CO1															
2	CO2															
3	CO3															

SYLLABUS

No.	**Content**	**Hours**	**COs**
I	Introduction: Introduction to Mechatronics, need and applications, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modeling, Analysis and Simulation, Man Machine Interface; role of mechatronics in automation, manufacturing and product development.	**6**	**CO1**
II	Importance of sensors in Mechatronics, characteristics of sensors, classification of sensors basic working principles errors and output impedance of sensors, transducers for measurement of displacement, LVDT, strain, position, velocity, noise, flow, pressure, temperature, humidity, vibration, liquid level, vision sensors.	**10**	**CO1, CO2**
III	Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control; Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems;	**6**	**CO1, CO5**
IV	Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators, Microsensors, Microactuators.	**8**	**CO2, CO3, CO4**
V	Case studies based on the application of mechatronics in manufacturing, Machine Diagnostics, Road vehicles and Medical Technology, bionics and avionics. Industrial robotics, types of Industrial robots, classification based on work envelope, Generations configurations and control loops, coordinate systems, need for robot, basic parts and functions, specifications.	**10**	**CO1, CO5**
	Total Hours	**40**	

Text Books:

1. Bolton, W., "Mechatronics, Electronic control systems in mechanical and electrical engineering", 5th edition, 2011, Pearson Education.
2. Alcaiatore, G.D., Michel B. H., "Introduction to Mechatronics and Measuring Systems", 3rd edition, 2006, Mc. Graw Hill International.
3. Robert H. B., "The Mechatronics Handbook", 2nd edition, 2007, CRC Press.

Reference Books:

1. Stenersons, J., "Fundamentals of Programmable Logic Controllers Sensors and Communications", 3rd Ed., 2004, Pearson Education.
2. Kuttan K. A., "Introduction to Mechatronics", 2007, Oxford University Press.

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Programme	Master of Technology in Digital Manufacturing in Energy Systems	**Academic Year of Regulation**	**2025-26**
Department	Mechanical Engineering	**Semester**	**I**

Course Code	Course Name	Credit Structure				Marks Distribution				Bloom's taxonomy
		L	T	P	C	INT	MID	END	Total	
ME-5104B	Robotics	3	0	0	3	20	30	50	100	

Course Objectives		Course Outcomes			Bloom's taxonomy
	1. Classify robots based on joints and arm configurations. 2. Design application specific End Effectors for robots. 3. Compute forward and inverse kinematics of robots and determine trajectory plan. 4. Program robot to perform typical tasks including Pick and Place, Stacking and Welding 5. Design and select robots for Industrial and Non-Industrial applications.		**CO1**	Classify robots based on their joints, arm configurations, and degrees of freedom, and describe their functional characteristics.	*Remembering/ Understanding*
			CO2	Understand the design principles of End Effectors and analyze their suitability for specific industrial applications.	*Understanding/ Analyzing*
			CO3	Analyze the forward and inverse kinematics of robotic manipulators and develop appropriate trajectory plans for motion control.	*Applying/ Analyzing*
			CO4	Develop and program robots to perform typical industrial operations such as Pick and Place, Stacking, and Welding, and evaluate or design robots for both industrial and non-industrial applications.	*Evaluating/ Creating*

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1															
2	CO2															
3	CO3															

SYLLABUS

No.	Content	Hours	COs
I	Introduction: Multibody systems, Automation, Classification of robots, Anatomy, Sensors (velocity, proximity, touch, torque etc), Grippers, selection of Robot based on the application. Demonstration of different types of Robots & tools using Robot Simulator Software.	**8**	**CO1**
II	Kinematics: Manipulators Kinematics, Rotation Matrix, Homogenous Transformation Matrix, Direct and Inverse Kinematics for industrial robots for Position and orientation. Demonstrate FK and IK using simulation tools. Differential Kinematics, statics and Dynamics: Jacobian, Lagrangian Formulation, Newton-Euler Formulation for RR & RP Manipulators. Demonstrate differential kinematics using simulation tools.	**12**	**CO1, CO2**
III	Trajectory planning & Control: Motion Control- Interaction control, Rigid Body mechanics, Control architecture- position, path velocity and force control systems, computed torque control, adaptive control, and Servo system for robot control. Demonstrate trajectory planning using simulation tools. Advanced Topics in Robotics: Motion Planning (Methods of Path planners), Robot Vision (Feature Detection & Matching, Motion Tracking, Machine Learning methods).	**12**	**CO1, CO3**
IV	Programming of Robots: Overview of various programming languages. Application of Robots in production systems: Application of robot in welding, machine tools, material handling, and assembly operations parts sorting and parts inspection.	**8**	**CO2, CO3, CO4**
	Total Hours	**40**	

Text Books:

1. Introduction to Robotics Mechanics and Control, Craig, J.J., Addison Wesley, 1999.

Reference Books:

1. Robotics control, Sensing, Vision and Intelligence, Fu, K.S., Gonzalez, R.C., and Lee, C.S.G., McGraw-Hill Publishing company, New Delhi, 2003.
2. Engineering: An Integrated Approach, Prentice Hall of India, Klafter, R.D., Chmielewski, T.A., and Negin. M, Robot New Delhi, 2002.
3. Modern Robotics: Mechanics, Kevin M. Lynch, Frank C. Park, Planning, and Control, Cambridge University Press, 2017.

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Department	Mechanical Engineering	**Semester**	**I**

Course Code	Course Name	Credit Structure				Marks Distribution				Bloom's taxonomy
		L	T	P	C	INT	MID	END	Total	
ME-5105	CNC Lab	0	0	3	1.5	50	0	50	100	

Course Objectives		Course Outcomes			
	1. To familiarize students with the basic machining operations on CNC lathe and milling machines. 2. To impart knowledge of CNC codes (G & M codes) and coordinate systems used in CNC programming. 3. To enable students to develop part programs for different turning and milling operations. 4. To enhance students' ability to analyze machining parameters and performance measures such as MRR, surface roughness, and cutting time.		**CO1**	Explain the basic concepts of CNC machining, including machine structure, coordinate systems, and G & M codes used in CNC operations.	*Remembering/ Understanding*
			CO2	Demonstrate understanding of tool geometry and grinding, and analyze how cutting parameters affect machining responses such as MRR, surface finish, and cutting time.	*Understanding/ Analyzing*
			CO3	Develop and execute CNC part programs for various turning and milling operations, including linear, circular, facing, and finishing cycles.	*Applying/ Analyzing*
			CO4	Evaluate machining performance and optimize process parameters, and create CNC programs for complex profiles and multi-step operations using simulation tools.	*Evaluating/ Creating*

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1															
2	CO2															
3	CO3															

SYLLABUS

No.	Content	Hours	COs
I	1. To perform step turning, facing chamfering and taper turning on a cylinder work piece. 2. To grind a single point cutting tool using a square billet and to identify the different angles in ASA system and to convert the angles from ASA system to ORS and NRS co-ordinate system. 3. To perform plain turning on a lathe and measure the output response like MRR, RA and TTC to study the effect of the input cutting parameters. 4. To study the "g" codes and "m" codes for the CNC machine tools. 5. To study the co-ordinate system for a CNC lathe. 6. To write a part program and simulate the tools path for turning operation using linear command (g01) and turning cycle (g90). 7. To write a part program for linear (g01) and circular (g03) profile for a given component drawing. 8. To write a part program for multiple facing (g72) and finishing cycle (g70) operations for a given component drawing. 9. To study the contour milling using vertical milling machine on a work piece. 10. To perform spur gear cutting using vertical milling machine on a work piece.	**20**	**CO1, CO2, CO3, CO4**
	Total Hours	**20**	

Text Books:

Reference Books:

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CURRICULUM

Programme	Master of Technology in Digital Manufacturing in Energy Systems	**Academic Year of Regulation**	**2025-26**
Department	Mechanical Engineering	**Semester**	**I**

Course Code	Course Name	Credit Structure					Marks Distribution			Bloom's taxonomy
		L	T	P	C	INT	MID	END	Total	
ME-5106	Computational lab	**0**	**0**	**3**	**1.5**	**50**	**0**	**50**	**100**	

Course Objectives		Course Outcomes			Bloom's taxonomy
	• Equip students with hands-on skills in CAD modelling, assembly and simulation relevant to energy-system components. • Enable students to progress from 2D drawing (AutoCAD) to 3D modelling (SolidWorks) to simulation & validation (ANSYS). • Encourage understanding of modelling assumptions, meshing, boundary conditions, results interpretation and manufacturing implications.		**CO1**	• Student will produce 2D drawings, 3D CAD models & assemblies of components used in energy systems (e.g., heat exchanger parts, turbine bracket, solar-panel mounting, etc.).	*Remembering/ Understanding*
			CO2	• Student will set up simulation(s) to evaluate mechanical/thermal behaviour of those components under relevant loads.	*Understanding/ Analyzing*
			CO3	• Student will interpret results (stress, deformation, heat flux, etc), assess manufacturability/optimisation, and prepare a report with engineering insight.	*Applying/ Analyzing*

No.	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1															
2	CO2															
3	CO3															

SYLLABUS

No.	Content			Hours	COs
I	2D Technical Drawing of an Energy-system Component	AutoCAD	Draw the detailed 2D drawing of a simplified component e.g., bracket for solar panel mount, or turbine support. Includes front/side/top views, section, dimensions, title-block.	**04**	**CO1**
II	3D Modelling & Assembly of the Component	SolidWorks	Using the 2D drawing as basis, create the part in SolidWorks, then assemble with other related parts (e.g., mounting plate, fasteners). Use features like extrude, revolve, fillet, chamfer, pattern, assembly mates.	**04**	**CO2**
III	Structural/Thermal Simulation of the Component	SolidWorks + ANSYS Workbench	Import the SolidWorks model (or create in ANSYS), define material(s), boundary conditions relevant to energy system (e.g., thermal load, mechanical load, support). Mesh, solve, view results (stress, deformation / heat flux). Use guidelines from ANSYS tutorials.	**05**	**CO3**
IV	Manufacturability & Optimisation Study	ANSYS	Investigate manufacturing constraints (e.g., minimum wall thickness, fillet radii, part orientation for additive / subtractive manufacturing), then in ANSYS conduct parametric study/optimisation (e.g., reduce weight while keeping stress < allowable).	**05**	**CO3**
	Total Hours			**18**	

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Department	Mechanical Engineering	**Semester**	**II**

Course Code	**Course Name**	**Credit Structure**					**Marks Distribution**			
		L	T	P	C	INT	MID	END	Total	**Bloom's taxonomy**
ME-5201	Sustainable Manufacturing	3	0	0	3	20	30	50	100	

Course Objectives

1. To understand the importance of sustainable manufacturing
2. To study various tools/techniques of sustainable manufacturing
3. To perform Life Cycle Assessment and assess environmental impacts of manufacturing processes
4. To develop eco-friendly products/processes

Course Outcomes

		Bloom's taxonomy
CO1	Understand the concept of sustainable manufacturing	*Understand*
CO2	Utilise tools and techniques of sustainable manufacturing	*Apply*
CO3	Evaluate product sustainability and environmental parameters.	*Evaluate*
CO4	Perform life cycle assessment and assess environmental impacts of manufacturing processes	*Analyze/ Evaluate*

No.	**COs**	**Mapping with Program Outcomes (POs)**												**Mapping with PSOs**		
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	CO1															
2	CO2															
3	CO3															

SYLLABUS

No.	**Content**	**Hours**	**COs**
I	Sustainable Manufacturing - Concept of Triple bottom line, Environmental, Economic and Social Dimensions of Sustainability, Relation between lean and sustainable manufacturing.	**10**	**CO1**
II	Tools and Techniques – Environmental Conscious Quality Function Deployment, Life cycle assessment, Design for Environment, R3 and R6 cycles, Design for Disassembly, Design for recycling, Eco friendly product design methods.	**10**	**CO2**
III	Environmental Impact Assessment Methods –CML, EI 95 and 99, ISO 14001 EMS and PAS 2050 standards, Environmental Impact parameters. Sustainability Assessment – Concept Models and Various Approaches, Product Sustainability and Risk/Benefit assessment– Corporate Social Responsibility.	**10**	**CO3**
IV	Sustainable characteristics of manufacturing processes - Energy efficiency analysis of manufacturing processes - Software packages for sustainability analysis and LCA - Scope of sustainable manufacturing centres.	**10**	**CO4**
	Total Hours	**40**	

Text Books:

1. G. Atkinson, S. Dietz, E. Neumayer, "Handbook of Sustainable Manufacturing". Edward Elgar Publishing Limited, 2007.
2. D. Rodick, Industrial Development for the 21st Century: Sustainable Development Perspectives, UN New York, 2007.

Reference Books:

1. P. Lawn, Sustainable Development Indicators in Ecological Economics, Edward Elgar Publishing Limited.
2. S. Asefa, The Economics of Sustainable Development, W.E. Upjohn Institute for Employment Research, 2005.

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Programme	Master of Technology in Digital Manufacturing in Energy Systems	**Academic Year of Regulation**	**2025-26**
Department	Mechanical Engineering	**Semester**	**II**

Course Code	Course Name	Credit Structure				Marks Distribution				Bloom's taxonomy
		L	T	P	C	INT	MID	END	Total	
ME-5202	Advanced Thermal Systems	3	0	0	3	20	30	50	100	

Course Objectives

1. To provide advanced knowledge of thermal systems and their components.
2. To enable students to model, analyze, and optimize thermal systems for energy applications.
3. To explore thermal system integration with digital monitoring, simulation, and control technologies.
4. To prepare students for application of advanced thermal technologies in energy systems and smart manufacturing.

Course Outcomes

CO	Outcome	Bloom's taxonomy
CO1	Apply thermodynamic and heat transfer principles to complex thermal systems.	*Remembering/ Understanding*
CO2	Model and simulate performance of integrated energy systems.	*Understanding/ Analyzing*
CO3	Analyze energy efficiency and optimize thermal system performance.	*Applying/ Analyzing*
CO4	Design thermal systems with renewable and waste heat recovery components.	*Evaluating/ Creating*
CO5	Integrate control, monitoring, and digital tools with thermal systems for smart operation.	*Applying/ Analyzing*

No.	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
		Mapping with Program Outcomes (POs)												Mapping with PSOs		
1	CO1															
2	CO2															
3	CO3															

SYLLABUS

No.	Content	Hours	COs
I	Classification and applications of thermal systems, Review of thermodynamic cycles and heat transfer modes, Role of thermal systems in energy conversion and storage, Digital trends in thermal energy systems	**5**	**CO1**
II	Types and configurations of heat exchangers, Design equations and effectiveness–NTU method, Compact and microchannel heat exchangers, Fouling, pressure drop, and performance enhancement techniques	**7**	**CO1, CO2**
III	Sensible, latent, and thermochemical storage, Phase Change Materials (PCMs) and thermal batteries, Design considerations for energy storage systems, Applications in solar, HVAC, and industrial systems	**6**	**CO1, CO3**
IV	Combined heat and power (CHP) systems, Gas turbine–steam turbine combined cycles, Organic Rankine Cycle and Kalina cycle, Industrial waste heat recovery integration	**7**	**CO2, CO3, CO4**
V	Solar collectors: flat plate, evacuated tube, CPC, parabolic trough, Thermal modeling and efficiency calculations, Solar-assisted absorption cooling systems, Hybrid systems integrating solar, biomass, and fossil sources	**6**	**CO1, CO3**
VI	Lumped and distributed parameter models, Use of MATLAB, TRNSYS, and ANSYS Fluent for system simulation, Dynamic behavior, control strategies, and digital twins, Optimization using genetic algorithms and neural networks	**5**	**CO2, CO3, CO5**
VII	IoT in thermal system control, Sensors and data acquisition in real-time monitoring, Machine learning in thermal performance forecasting, Smart thermal grids and Industry 4.0 applications	**4**	**CO1, CO5**
	Total Hours	**40**	

Text Books:

1. Y.A. Cengel & M.A. Boles, Thermodynamics: An Engineering Approach, McGraw-Hill.
2. F.P. Incropera et al., Fundamentals of Heat and Mass Transfer, Wiley.
3. Dincer & Rosen, Thermal Energy Storage: Systems and Applications, Wiley.

Reference Books:

1. G. Tsilingiris, Advanced Thermodynamics Engineering, Taylor & Francis.
2. W.F. Stoecker, Design of Thermal Systems, McGraw-Hill.
3. Tiwari & Ghosal, Renewable Energy Resources: Basic Principles and Applications, Narosa Publishing.
4. ASHRAE Handbook – HVAC Systems and Equipment.

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Department	Mechanical Engineering	**Semester**	**II**

Course Code	Course Name	Credit Structure				Marks Distribution				Bloom's taxonomy
		L	T	P	C	INT	MID	END	Total	
ME-5203	Finite Element Method	3	0	0	3	20	30	50	100	

Course Objectives

1. To Familiarize with the fundamental concepts of finite element method.
2. To Inculcate the formulation of finite element models by selecting a suitable element, developing element matrices & vectors, and incorporating boundary conditions.
3. To Familiarize with finite element procedures to solve structural, thermal, and fluid flow problems using commercial finite element packages

Course Outcomes

CO	Description	Bloom's taxonomy
CO1	Make use of the concept of finite element method for solving machine design problems.	*Applying*
CO2	Solve problems in 1-D structural systems involving bars, trusses, beams and frames.	*Evaluating*
CO3	Develop 2-D and 3-D FE formulations involving triangular, quadrilateral elements and higher order elements.	*Creating*
CO4	Apply the knowledge of FEM for stress analysis, modal analysis, heat transfer analysis and flow analysis.	*Applying*

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1															
2	CO2															
3	CO3															

SYLLABUS

No.	Content	Hours	COs
I	Introduction: Historical background, basic concept of the finite element method, comparison with finite difference method; Variational methods: calculus of variation, the Rayleigh-Ritz and Galerkin methods	8	CO1, CO4
II	Finite element analysis of 1-D problems: formulation by different approaches (direct, potential energy and Galerkin); Derivation of elemental equations and their assembly, solution and its postprocessing. Applications in heat transfer, fluid mechanics and solid mechanics. Bending of beams, analysis of truss and frame.	12	CO1, CO2, CO4
III	Finite element analysis of 2-D problems: finite element modelling of single variable problems, triangular and rectangular elements; Applications in heat transfer, fluid mechanics and solid mechanics. Three Dimensional Problems: Finite element formulation for 3-D problems, mesh preparation, tetrahedral and hexahedral elements, case studies.	10	CO1, CO3, CO4
IV	Numerical considerations: numerical integration, error analysis, mesh refinement. Plane stress and plane strain problems; Bending of plates; Eigen value and time dependent problems; Discussion about preprocessors, postprocessors and finite element packages.	10	CO1, CO4
	Total Hours	**40**	

Text Books:

1. J. N. Reddy, An introduction to the Finite Element Method, 3rd edition, McGraw-Hill, 2006.
2. R. D. Cook, D. S. Malkus and M. E. Plesha, Concepts and Applications of Finite Element Analysis, 4th edition, John Wiley, 2007.
3. K. J. Bathe, Finite Element Procedures in Engineering Analysis, 2nd edition (reprint), Prentice-Hall, 2009.

Reference Books:

1. O. C. Zienkiewicz and R. L. Taylor, The Finite Element Method, 7th edition, Butterworth-Heinemann, 2013.
2. T. J. R. Hughes, The Finite Element Method, Prentice-Hall, 1986.

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Department	Mechanical Engineering	**Semester**	**II**

Course Code	**Course Name**	**Credit Structure**				**Marks Distribution**				**Bloom's taxonomy**
		L	**T**	**P**	**C**	**INT**	**MID**	**END**	**Total**	
ME-5204A	AI and Machine Learning in Manufacturing	**3**	**0**	**0**	**3**	**20**	**30**	**50**	**100**	

Course Objectives		**Course Outcomes**			**Bloom's taxonomy**
	1. Introduce the fundamental concepts, scope, and applications of Artificial Intelligence in engineering and real-world problem solving. 2. Develop the ability to formulate problems and apply search strategies and production systems for effective solutions. 3. Provide knowledge of reasoning and decision-making approaches using Fuzzy Logic, Neural Networks, and Decision Trees.		**CO1**	Explain the fundamentals of Artificial Intelligence (AI) and formulate problems suitable for AI-based solutions.	*Remembering/ Understanding*
			CO2	Apply classical search strategies and production system approaches for solving AI problems.	*Understanding/ Analyzing*
			CO3	Analyze and implement reasoning techniques using Fuzzy Logic, Neural Networks, and Decision Trees.	*Applying/ Analyzing*
			CO4	Assess the performance of machine learning algorithms using appropriate evaluation metrics and validation techniques.	*Evaluating/ Creating*

No.	**COs**	**Mapping with Program Outcomes (POs)**												**Mapping with PSOs**		
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	CO1															
2	CO2															
3	CO3															

SYLLABUS

No.	**Content**	**Hours**	**COs**
I	Introduction to artificial intelligence, problem formulation, solving problem by searching	**14**	**CO1**
II	AI in production system, Fuzzy logic, Neural networks, decision trees, population-based search	**16**	**CO1, CO2, CO3**
III	Machine learning, supervised learning algorithm, unsupervised learning algorithms, performance assessment of machine learning algorithms.	**10**	**CO1, CO4**
	Total Hours	**40**	

Text Books:

1. Artificial Intelligence: A Modern Approach, Second Edition, Russell, S. and Norvig, P., Pearson Education (2009).

Reference Books:

1. Machine Learning, First Edition, Dutt, S., Chandramouli, S. and Das, A.K. Pearson Education (2018).

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Department	Mechanical Engineering	**Semester**	**II**

Course Code	Course Name	Credit Structure					Marks Distribution				Bloom's taxonomy
		L	T	P	C	INT	MID	END	Total		
ME-5204B	Optimization techniques	3	0	0	3	20	30	50	100		

Course Objectives		Course Outcomes			Bloom's taxonomy
	1. Introduce the fundamental concepts of optimization and its significance in solving engineering problems. 2. Enable students to formulate optimization problems with suitable objectives, design variables, and constraints. 3. Familiarize students with modern optimization algorithms such as Genetic Algorithms, Simulated Annealing, Ant Colony Optimization, Tabu Search, and Fuzzy approaches.		**CO1**	Formulate and classify engineering optimization problems with appropriate objectives, constraints, and design variables.	*Remembering/ Understanding*
			CO2	Apply linear programming methods and post-optimality analysis to solve engineering design and manufacturing problems.	*Understanding/ Analyzing*
			CO3	Implement gradient-based algorithms (steepest descent, Newton's method, conjugate gradient method) for solving unconstrained optimization problems.	*Applying/ Analyzing*
			CO4	Evaluate and apply modern optimization techniques such as Genetic Algorithms, Simulated Annealing, Ant Colony Optimization, Tabu Search, Neural-Network based Optimization, and Fuzzy Optimization.	*Evaluating/ Creating*

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1															
2	CO2															
3	CO3															

SYLLABUS

No.	Content	Hours	COs
I	Introduction to Optimization: Engineering application of Optimization – Statement of an Optimization problem – Optimal Problem formulation – Classification of Optimization problem. Optimum design concepts: Definition of Global and Local optima – Optimality criteria – Review of basic calculus concepts – Global optimality	10	CO1
II	Linear programming methods for optimum design: Review of Linear programming methods for optimum design – Post optimality analysis – Application of LPP models in design and manufacturing.	10	CO1, CO2
III	Optimization algorithms for solving unconstrained optimization problems – Gradient based method: Cauchy's steepest descent method, Newton's method, Conjugate gradient method. Optimization algorithms for solving constrained optimization problems – direct methods – penalty function methods – steepest descent method – Engineering applications of constrained and unconstrained algorithms.	12	CO1, CO3
IV	Modern methods of Optimization: Genetic Algorithms – Simulated Annealing – Ant colony optimization – Tabu search – Neural-Network based Optimization – Fuzzy optimization techniques – Applications. Use of Matlab to solve optimization problems.	8	CO2, CO3, CO4
	Total Hours	**40**	

Text Books:

1. Rao S. S. – 'Engineering Optimization, Theory and Practice' – New Age International Publishers – 2012 – 4th Edition

Reference Books:

1. Deb K. – 'Optimization for Engineering Design Algorithms and Examples' – PHI – 2000
2. Arora J. – 'Introduction to Optimization Design' – Elsevier Academic Press, New Delhi – 2004
3. Saravanan R. – 'Manufacturing Optimization through Intelligent Techniques' – Taylor & Francis (CRC Press) – 2006
4. Strikwerda, J. C., "Finite Difference Schemes and Partial Differential Equations", 2nd edition, 2004, SIAM.
5. Lapidus, L. and Pinder, G. F., "Numerical Solution of Partial Differential Equations in Science and Engineering", 1982, John Wiley. E.

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Department	Mechanical Engineering	**Semester**	**II**

Course Code	Course Name	Credit Structure				Marks Distribution				Bloom's taxonomy
		L	T	P	C	INT	MID	END	Total	
ME-5205A	High Precision Manufacturing	**3**	**0**	**0**	**3**	**20**	**30**	**50**	**100**	

Course Objectives

1. To understand the principles and techniques of high precision manufacturing and metrology.
2. To introduce advanced processes and machines capable of micro- and nano-scale fabrication.
3. To study the role of high precision systems in energy, aerospace, medical, and digital manufacturing domains.
4. To equip students with the knowledge of measurement, control, and quality assurance in ultra-precision engineering.

Course Outcomes

CO	Outcome	Bloom's taxonomy
CO1	Understand fundamental principles of high precision machining and surface generation.	*Remembering/ Understanding*
CO2	Select appropriate high-precision processes for specific energy and microfabrication applications.	*Understanding/ Analyzing*
CO3	Analyze and design systems for nano/micro-level tolerance and finish.	*Applying/ Analyzing*
CO4	Integrate high precision machines with control systems and environmental management.	*Evaluating/ Creating*
CO5	Apply advanced metrology techniques for accuracy validation and digital manufacturing feedback loops.	*Applying/ Analyzing*

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	CO1															
2	CO2															
3	CO3															

SYLLABUS

No.	Content	Hours	COs
I	Definition, scope, and significance of high precision manufacturing, Precision, accuracy, repeatability, and resolution, Challenges in micro/nano manufacturing, Applications in energy systems, aerospace, medical devices, and electronics	**5**	**CO1**
II	Ultra-precision machine tool elements (spindles, slides, bearings), Vibration isolation and thermal control, Hydrostatic and aerostatic systems, CNC controllers and real-time feedback systems	**7**	**CO1, CO2**
III	Diamond turning, fly-cutting, micro-milling, and grinding, Ductile vs. brittle mode cutting, Tool wear, process monitoring, and surface integrity, Applications in optics, dies, and micro-mold manufacturing	**6**	**CO1, CO3**
IV	Laser Beam Machining (LBM), Focused Ion Beam (FIB) and Electron Beam Machining (EBM), Electrical Discharge Machining (EDM) at micro-scale, Ultrasonic and abrasive jet machining	**7**	**CO2, CO3, CO4**
V	Surface roughness and finish requirements in high-precision applications, Polishing, lapping, magnetorheological finishing (MRF), and chemo-mechanical polishing (CMP), Nano-finishing techniques and thin film coatings, Surface integrity and residual stresses	**6**	**CO1, CO3**
VI	Principles of high precision measurement, Interferometry, profilometry, and coordinate measuring machines (CMMs), Surface topography and 3D optical metrology, Calibration and traceability	**5**	**CO2, CO3, CO5**
VII	Adaptive control and real-time correction in high-precision manufacturing, Use of AI and ML for predictive quality assurance, Integration with Industry 4.0: digital twins and cyber-physical precision systems, Case studies in precision parts for energy, electronics, and biomedical applications	**4**	**CO1, CO5**
	Total Hours	**40**	

Text Books:

1. Murthy, R.L., Precision Engineering in Manufacturing, New Age International.
2. McKeown, P.A., Precision Engineering: An Evolutionary View, CRC Press.
3. Venkatesh & Sudin, High Precision Manufacturing, Narosa Publishing.

Reference Books:

1. Dornfeld & Lee, Precision Manufacturing, Springer.
2. J.A. McGeough, Advanced Methods of Machining, Chapman & Hall.
3. Liang & Zhu, Micro-Cutting: Fundamentals and Applications, Wiley.

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Department	Mechanical Engineering	**Semester**	**II**

Course Code	**Course Name**	**Credit Structure**				**Marks Distribution**				**Bloom's taxonomy**
		L	**T**	**P**	**C**	**INT**	**MID**	**END**	**Total**	
ME-5205B	Multifunctional Composites	**3**	**0**	**0**	**3**	**20**	**30**	**50**	**100**	

Course Objectives

1. To provide a fundamental understanding of composite materials and the role of various types of reinforcements.
2. To enable students to select suitable constituent materials for the development of application-specific composites.
3. To introduce and explain key fabrication methods used in the manufacturing of composite materials.
4. To develop the ability to analyze both micromechanical and macromechanical properties of fiber-reinforced composites.

Course Outcomes

CO1	Understand composite material and their reinforcements.	*Understand*
CO2	Select constituent materials to develop appropriate composites.	*Analyze*
CO3	Describe the important fabrication methods.	*Apply*
CO4	Evaluate the micromechanical and micromechanical properties of fibre reinforced composites.	*Evaluate*

No.	**COs**	**Mapping with Program Outcomes (POs)**												**Mapping with PSOs**		
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	CO1															
2	CO2															
3	CO3															

SYLLABUS

No.	**Content**	**Hours**	**COs**
I	Introduction: Basic Concepts, Definition and Classification of Composites, Design Process, Composites Design Methods, Fracture Mechanics, Design for Reliability, Basic design concepts of sandwich construction, introduction to Nano composites, advantages and disadvantages,	**6**	**CO1**
II	Materials: Fiber Reinforcements, Fiber Types, Fiber-Matrix Compatibility, Fiber Forms, Matrix Materials, Thermoset Matrices, Thermoplastic Matrices, Biodegradable Matrices, Corrosion Resistance, Flammability	**10**	**CO2**
III	Manufacturing Processes: Hand Layup, Prepreg Layup, Bag Molding, Autoclave Processing, Compression Molding, Resin Transfer Molding, Vacuum-Assisted Resin Transfer Molding, Pultrusion, Filament Winding, Textile Manufacturing	**10**	**CO3**
IV	Micromechanics: Basic Concepts, Stiffness, Moisture and Thermal Expansion, Temperature-Dependent Properties, Strength; Ply Mechanics: Coordinate Systems, Stress–Strain Equations, Off-Axis Stiffness; Macromechanics: Plate Stiffness and Compliance, Computation of Stresses, Common Laminate Types, Laminate Moduli, Universal Carpet Plots, Hygrothermal Stress	**14**	**CO4**
	Total Hours	**40**	

Text Books:

1. Introduction to Composite Materials Design; Second Edition, Ever J. Barbero, CRC Press
2. Composite Materials Science and Engineering, Chawla, Springer
3. Mechanics of Composite Materials, Scripta Book Co., Jones, R M

Reference Books:

1. ASM Handbook Composites, Steven L. Donaldson, Volume 21, 2001.
2. Process Modelling in Composites Manufacturing, Suresh G. Advani, E. Murat Sozer, 2nd Ed. CRC Press, 2009.

राष्ट्रीय प्रौद्योगिकी संस्थान अरुणाचलप्रदेश

NATIONAL INSTITUTE OF TECHNOLOGY ARUNACHAL PRADESH

(शिक्षामंत्रालय, भारत सरकारकेतहतराष्ट्रीयमहत्वकासंस्थान)

(Institute of National Importance under Ministry of Education, Govt. of India)

CURRICULUM

Programme	Master of Technology in Digital Manufacturing in Energy Systems	**Academic Year of Regulation**	**2025-26**
Department	Mechanical Engineering	**Semester**	**II**

Course Code	Course Name	Credit Structure					Marks Distribution			Bloom's taxonomy
		L	T	P	C	INT	MID	END	Total	
ME-5206	Technical report writing & seminar	0	0	3	1.5	50	0	50	100	

Course Objectives

1. Knowledge acquisition: Students gain a deeper understanding of a specific topic through focused study and discussion.
2. Communication skills: Students develop their abilities in both written and oral communication.
3. Active participation: Students are expected to actively participate in discussions, share their insights with their peers' perspectives.
4. Confidence Building: Seminars help students to build confidence in their knowledge, communication skills, and ability to present their ideas.

Course Outcomes

CO	Outcome	Bloom's taxonomy
CO1	Explain the process of identifying, locating, and evaluating relevant information from diverse academic and professional sources.	*Remembering/ Understanding*
CO2	Demonstrate the ability to analyze and organize information effectively for clear and purposeful communication.	*Understanding/ Analyzing*
CO3	Apply appropriate language, style, and delivery techniques to articulate ideas clearly and confidently in different contexts.	*Applying/ Analyzing*
CO4	Develop and demonstrate a professional approach toward continuous learning, self-improvement, and career-oriented growth.	*Evaluating/ Creating*

No.	COs	Mapping with Program Outcomes (POs)												Mapping with PSOs		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO1															
2	CO2															
3	CO3															

SYLLABUS

No.	Content	Hours	COs
I	Individual students or group of students (maximum of two) are required to choose a topic of their interest preferably from outside the M.Tech projects and give a seminar on that topic about 30 minutes. The course coordinator shall assess the presentation of the seminar and award marks to the students. Each student/group shall submit two copies of a write up of his / her seminar topic. One copy shall be returned to the student after duly certifying it by the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.	**20**	**CO1, CO2, CO3, CO4**
	Total Hours	**20**	

Text Books:

Reference Books:

	राष्ट्रीय प्रौद्योगिकी संस्थान अरुणाचलप्रदेश NATIONAL INSTITUTE OF TECHNOLOGY ARUNACHAL PRADESH (शिक्षामंत्रालय, भारत सरकारकेतहतराष्ट्रीयमहत्वकासंस्थान) (Institute of National Importance under Ministry of Education, Govt. of India)	CURRICULUM

Programme	Master of Technology in Digital Manufacturing in Energy Systems	**Academic Year of Regulation**	**2025-26**
Department	Mechanical Engineering	**Semester**	**II**

Course Code	**Course Name**	**Credit Structure**					**Marks Distribution**			**Bloom's taxonomy**
		L	**T**	**P**	**C**	**INT**	**MID**	**END**	**Total**	
ME 5207	Digital Manufacturing Lab	**0**	**0**	**3**	**1.5**	**50**	**0**	**50**	**100**	

Course Objectives		**Course Outcomes**			**Bloom's taxonomy**
	1. Provide hands-on experience with digital design and manufacturing tools used in modern industries. 2. Integrate CAD/CAM with product lifecycle management (PLM) for efficient design-to-production workflows. 3. Demonstrate additive manufacturing (3D printing) and CNC processes for prototyping and precision production.		**CO1**	CO1: Model, simulate, and optimize mechanical and energy system components using digital tools.	*Remembering/ Understanding*
			CO2	CO2: Generate tool paths and operate CNC and additive manufacturing systems.	*Understanding/ Analyzing*

No.	**COs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	CO1															
2	CO2															
3	CO3															

(Mapping with Program Outcomes (POs): PO1–PO12; Mapping with PSOs: PSO1–PSO3)

SYLLABUS

No.	**Content**	**Hours**	**COs**
I	Introduction to Digital Manufacturing Tools: Overview of CAD, CAM, and PLM integration environments	**03**	**CO1**
II	3D Modelling and Parametric Design: Creation of energy system components (e.g., turbine blade, heat exchanger fins) using CAD software (SolidWorks/Creo).	**03**	**CO1**
III	Finite Element Analysis (FEA): Stress, thermal, and fatigue analysis of components relevant to renewable energy systems.	**02**	**CO1**
IV	Computational Fluid Dynamics (CFD): Flow and heat transfer simulation in energy devices using ANSYS/COMSOL.	**03**	**CO1**
V	CAM-based Tool Path Generation: G-code development for CNC machining using CAM software (e.g., Fusion 360, Master CAM).	**03**	**CO2**
VI	CNC Machining Operation: Cutting and surface finishing of a designed component using CNC milling/lathe.	**02**	**CO2**
VII	Additive Manufacturing: Fabrication of a 3D printed prototype of an energy device	**02**	**CO2**
	Total Hours	**18**	