

ANNA UNIVERSITY, CHENNAI
NON- AUTONOMOUS COLLEGES
AFFILIATED TO ANNA UNIVERSITY
M.E. MANUFACTURING ENGINEERING
REGULATIONS 2025

PROGRAMME OUTCOMES (POs):

PO	Programme Outcomes
PO1	An ability to independently carry out research /investigation and development work to solve practical problems
PO2	An ability to write and present a substantial technical report/document.
PO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PROGRAMME SPECIFIC OUTCOMES (PSOS)

PSO	Programme Specific Outcomes
PSO1	Apply advanced manufacturing technologies, computational tools, and intelligent systems for design, analysis, and optimization of manufacturing processes.
PSO2	Develop sustainable, innovative, and industry-oriented solutions in manufacturing with emphasis on quality, reliability, and emerging technologies.



ANNA UNIVERSITY, CHENNAI

POSTGRADUATE CURRICULUM (NON-AUTONOMOUS AFFILIATED INSTITUTIONS)

Programme: M.E. Manufacturing Engineering

Regulations: 2025

Abbreviations:

BS – Basic Science (Mathematics)

L – Laboratory Course

ES – Engineering Science (General (**G**), Programme Core (**PC**), Programme Elective (**PE**))

T – Theory

SD – Skill Development

LIT – Laboratory Integrated Theory

OE – Open Elective

PW – Project Work

TCP – Total Contact Period(s)

Semester I

S. No.	Course Code	Course Title	Type	Periods			TCP	Credits	Category
				L	T	P			
1.	MF25101	Computational Methods in Engineering	T	3	0	0	3	3	ES (PC)
2.	MF25102	Advanced Materials Technology	T	3	0	0	3	3	ES (PC)
3.	MF25103	Metrology and Computer Aided Inspection	LIT	3	0	2	5	4	ES (PC)
4.	MF25104	Computer Aided Design in Manufacturing	LIT	3	0	2	5	4	ES (PC)
5.	MF25105	Computer Numerical Control and Adaptive Control	LIT	2	0	2	4	3	ES (PC)
6.	MF25106	Advances in Welding and Casting Technology	T	3	0	0	3	3	ES (PC)
7.	MF25107	Advanced Manufacturing Laboratory	L	0	0	4	2	2	ES (PC)
8.	MF25108	Technical Seminar	-	0	0	2	2	1	SD
Total							27	23	

Semester II

S. No.	Course Code	Course Title	Type	Periods			TCP	Credits	Category
				L	T	P			
1.		Finite Element Applications in Manufacturing	LIT	3	0	2	5	4	ES (PC)
2.		Thin Film Technology	T	3	0	0	3	3	ES (PC)
3.		Quality and Reliability Engineering	LIT	3	0	2	5	4	ES (PC)
4.		Machine Learning for Intelligent Systems	LIT	3	0	2	5	4	ES (PC)
5.		Programme Elective – I	T	3	0	0	3	3	ES (PE)
6.		Programme Elective – II	T	3	0	0	3	3	ES (PE)
7.		Advanced Machining and Forming Laboratory	L	0	0	2	2	1	ES (PC)
8.		Finite Element Analysis Laboratory	L	0	0	4	2	2	ES (PC)
9.		Industry Oriented Course I	---	1	0	0	1	1	SD
10.		Self Learning Course	---	-	-	-	-	1	-
Total							29	26	

Semester III

S. No.	Course Code	Course Title	Type	Periods			TCP	Credits	Category
				L	T	P			
1.		Programme Elective II	T	3	0	0	3	3	ES (PE)
2.		Programme Elective III	T	3	0	0	3	3	ES (PE)
3.		Programme Elective IV	T	3	0	0	3	3	ES (PE)
4.		Open Elective	T	3	0	0	3	3	ES (OE)
5.		Industry Oriented Course II	---	1	0	0	1	1	SD
6.		Project Work I	-	0	0	12	12	6	SD
Total							25	19	

Semester IV

S. No.	Course Code	Course Title	Type	Periods			TCP	Credits	Category
				L	T	P			
1.		Project Work II	---	0	0	24	24	12	SD
Total							24	12	

PROGRAMME ELECTIVE COURSES (PE)

S. No.	Course Code	Course Title	Periods			Total Contact Periods	Credits
			L	T	P		
1.		Laser Processing of Materials	3	0	0	3	3
2.		solid freeform manufacturing	3	0	0	3	3
3.		Manufacturing Systems and Models	3	0	0	3	3
4.		Micro and Nano Manufacturing	3	0	0	3	3
5.		Bio-inspired Manufacturing	3	0	0	3	3
6.		Operations Management	3	0	0	3	3
7.		Quality and Reliability Engineering	3	0	0	3	3
8.		Lean Six Sigma	3	0	0	3	3
9.		Green Manufacturing	3	0	0	3	3
10.		Supply Chain Systems and Management	3	0	0	3	3
11.		Smart Materials	3	0	0	3	3
12.		Material Testing and Characterization	3	0	0	3	3
13.		Manufacturing Metrology	3	0	0	3	3
14.		Bio Materials	3	0	0	3	3
15.		Powder metallurgy	3	0	0	3	3
16.		Mechatronics in Manufacturing	3	0	0	3	3
17.		Industrial Robotics	3	0	0	3	3
18.		Fluid power automation	3	0	0	3	3
19.		Digital Twin and Industry 5.0	3	0	0	3	3
20.		System Simulation for Manufacturing Engineers	3	0	0	3	3

Semester I

MF25101	Computational Methods in Engineering	L	T	P	C
		3	0	0	3
Course objectives: The main objective of this course is to equip students with fundamental knowledge of integer programming, problem-solving skills using dynamic and non-linear programming, and familiarity with factorial design and Taguchi's design of experiments. It also aims to develop an understanding of decision-making tools applied in manufacturing.					
Integer Programming: Branch and bound technique, Cutting plane algorithm method, Travelling Salesman Problem, 0/1 Knapsack Problem, Chinese Postman Problem, Vehicle Routing Problem. Activities: Solve a 0/1 knapsack problem using branch and bound, Implement a heuristic for the Travelling Salesman Problem (TSP).					
Dynamic Programming: Characteristics of Dynamic Programming Problems, Deterministic Dynamic Programming, Forward and Backward recursive recursion, selected dynamic programming application, investment model, inventory model, replacement model, reliability model, stagecoach problem. Activities: Solve an inventory model using forward recursion, Find shortest route using backward recursion in the stagecoach problem.					
Nonlinear Programming: Types of Nonlinear Programming Problems, One-Variable Unconstrained Optimization, Multivariable Unconstrained Optimization, The Karush-Kuhn-Tucker (KKT), Quadratic Programming, Separable Programming Activities: Use gradient descent to minimize a single-variable nonlinear function, Apply KKT conditions to a constrained optimization problem.					
Design of Experiments: Fundamentals, fractional, factorial experiments, 2^k factorial design – 3 level and mixed level factorials, Response Surface Methods and Designs, Robust Parameters Design and Process Robustness Studies Activities: Conduct a 2^3 factorial design and analyze effects, Use Taguchi's L9 array to identify robust parameters.					
Decision Making: Fundamentals of Decision Making, Decision Tables, Types of decision making environments, Under certainty, under uncertainty, under risk, Expected Value of Perfect Information, Decision Trees, Poker Decision Process Activities: Build a decision tree and calculate expected values, Create a decision table for scheduling under uncertainty.					

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Quiz (5%), Project (10%), Assignment (10%), Practical (25%), Review of Question papers (IES, SSC, GATE) (20%), Internal Examinations (30%):

References:

1. Hillier, F. S., & Lieberman, G. J. (2021). *Introduction to operations research*. McGraw Hill Inc.
2. Deb, K. (2012). *Optimization for engineering design*. PHI Learning Private Ltd.
3. Ravindran, A., Phillips, D. T., & Solberg, J. J. (2007). *Operations research: Principles and practice*. John Wiley India.
4. Rao, S. S. (2020). *Engineering optimization: Theory and practices*. John Wiley & Sons.
5. Krishnaiah, K., & Shahabudeen, P. (2012). *Applied design of experiments and Taguchi methods*. PHI Learning.
6. Heizer, J., & Render, B. (2019). *Operations management*. Pearson.

	Description of CO	Mapped POs	PSO1	PSO2
CO1	Apply optimization techniques (integer and dynamic programming) to solve manufacturing and engineering problems.	PO1 (3), PO3 (2)	3	–
CO2	Analyze nonlinear programming problems and design of experiments (Taguchi/factorial) for process improvement.	PO1 (3), PO2 (2)	3	2
CO3	Apply decision-making tools under certainty, risk, and uncertainty to develop sustainable manufacturing solutions.	PO1 (3), PO2 (3)	–	3

MF25102	Advanced Materials Technology	L	T	P	C
		3	0	0	3
Course objectives: This course aims to provide a strong foundation in metallic and non-metallic materials, covering atomic structure, crystal defects, strengthening, phase diagrams, and heat treatment, while analyzing their properties, processing, and applications. It also emphasizes material characterization techniques such as mechanical testing, microscopy, X-ray diffraction, and thermal analysis for effective material selection, quality control, and performance evaluation.					
Metallic Materials: Fundamental of metallic materials; Atomic structure and Crystal structure, Imperfection of Solids-Slip systems-Strengthening mechanisms-Phase diagrams Heat treatment processes, iron-carbon-equilibrium diagrams, Advanced Steels and cast irons Transformation hardening in steels-TTT diagrams-CCT diagrams. Modern Metallic Materials 8 Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel, Intermetallics, Ni and Ti aluminides, smart materials, shape memory alloys, Metallic glass and nano crystalline materials Activities: Analyze iron-carbon phase diagrams and interpret TTT/CCT diagrams for steels, Compare strengthening mechanisms in dual-phase and TRIP steels, □ Study properties and applications of shape memory alloys and metallic glasses, Research the microstructure and uses of maraging and nitrogen steels.					
Non Ferrous materials: Structure, physical metallurgy, manufacturability and properties of Al, Cu, Mg and Ti alloys. Activities: Investigate the physical metallurgy of Al and Ti alloys with case studies, Compare manufacturing processes of Mg and Cu alloys.					
Non Metallic Materials: Composites with polymer matrix- metal matrix and ceramic matrix, Fabrication methods of in-situ, ex-situ and Nano composites-Mechanics of composites Machining and joining of composites, Polymers, types of polymer, commodity and engineering polymers, Properties and applications, Engineering Ceramics, Properties and applications Activities: Design a composite using polymer, metal, or ceramic matrices and discuss fabrication methods, Examine properties and applications of engineering ceramics and polymers.					

Characterization:

Principle, Application and Applied theory of: Hardness testing, Tensile testing-Fatigue testing, Optical Microscopy, Electron microscopy techniques and XRD analysis, Thermal Analysis:

Thermogravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC), Differential Thermal Analysis (DTA), Principles and measurement analysis.

Activities: Perform a hardness or tensile test on a metallic sample and analyze results, Use XRD or thermal analysis data (DSC/TGA) to identify phase changes or material properties.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Quiz (5%), Project (10%), Assignment (10%), Practical (25%), Review of Question papers (IES, SSC, GATE) (20%), Internal Examinations (30%)

References:

1. Callister, W. D., Jr., & Rethwisch, D. G. (2024). Materials science and engineering: An introduction. Wiley.
2. Advani, S. G., & Hsiao, K.-T. (2022). Manufacturing techniques for polymer matrix composites (PMCs). CRC Press.
3. Dieter, G. E., & Schmidt, L. C. (2023). Engineering materials: Properties and selection. Pearson.
4. Raghavan, V. (2022). Materials science and engineering: A first course. PHI Learning.
5. Zhang, S., Li, L., & Kumar, A. (2022). Materials characterization techniques. CRC Press.
6. Shackelford, J. F. (2023). Introduction to materials science for engineers. Pearson.

	Course Outcomes (COs)	Mapped POs	PSO1	PSO2
CO1	Explain the fundamentals of metallic, non-metallic, and modern advanced materials including their structures, mechanisms, and treatments.	PO1 (3), PO3 (2)	3	–
CO2	Analyze the properties, processing, and applications of alloys, composites, polymers, ceramics, and smart materials.	PO1 (3), PO2 (2)	3	2
CO3	Apply material characterization techniques (mechanical, microscopy, XRD, thermal analysis) for selection, quality control, and performance evaluation.	PO1 (3), PO2 (3)	–	3

MF25103	Metrology and Computer Aided Inspection	L	T	P	C
		3	0	2	4
Course objectives: This course aims to impart knowledge of metrology concepts, train students in surface roughness, form measurement and interferometry, and introduce fundamental principles of CAI, laser metrology, and machine vision-based image processing.					
Metrology concepts, Abbe's principle-need for high precision measurements, problems associated with high precision measurements.					
Standards for length measurement, Shop floor standards and their classification, Light interference, Method of coincidence, Slip gauge calibration-measurement errors. Various tolerances and their specifications, gauging principles, selective assembly, comparators.					
Practical: 1. Calibration of comparators using slip gauges and assessment of gauge surfaces using optical flats					
Flatness, Straightness, Roundness and Angular measurements, principles and Instruments, Gear and Thread measurements.					
Practical: 1. Roundness and cylindricity measurement of components 2. Study on flatness measurement of surface using autocollimator					
Surface and form metrology, Flatness, roughness, waviness, roundness, cylindricity, etc. Computer Aided Metrology, principles and interfacing, software metrology.					
Practical: 1. Measurement of Surface roughness of specimens using contact method 2. Non-contact surface roughness measurement of specimens					
Laser metrology, Applications of lasers in precision measurements, Laser interferometer, speckle measurements, laser scanners.					
Coordinate Measuring Machine, Non contact CMM Electro optical sensors for dimensional metrology, Non contact sensors for surface finish measurements Image processing and its application in metrology.					
Practical: 1. Measurement of dimensional features of a specimen - Contact type using CMM. 2. Measurement of dimensional features using machine vision system					
Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%					

Assessment Methodology: Quiz (5%), Project (10%), Assignment (10%), Practical (25%), Review of Question papers (IES, SSC, GATE) (20%), Internal Examinations (30%):

References:

1. ASTE Handbook of Industries Metrology. (1992). Prentice Hall of India Ltd., India.
2. Bewoor, A. K., & Kulkarni, V. A. (2009). *Metrology and Measurement*. Tata McGraw-Hill, India.
3. Galyer, J. F. W., & Shotbolt, C. R. (1990). *Metrology for Engineers*. Cassell.
4. Jain, R. K. (2022). *Engineering Metrology*. Khanna Publishers, India.
5. Smith, G. T. (2016). *Machine Tool Metrology: An Industrial Handbook*. Springer, Switzerland

	Description of CO	Mapped POs	PSO1	PSO2
CO1	Explain the principles of metrology, precision measurement, standards, tolerances, and gauging methods.	PO1 (3), PO3 (2)	3	–
CO2	Apply surface roughness, form, and geometrical measurement techniques using conventional and modern instruments.	PO1 (3), PO2 (2), PO4 (2)	3	2
CO3	Utilize laser metrology, CMM, and non-contact methods for dimensional and surface measurements.	PO1 (3), PO2 (3), PO4 (2)	–	3
CO4	Implement computer-aided inspection, image processing, and machine vision systems for advanced quality control applications.	PO2 (3), PO3 (2), PO5 (2)	3	3

MF25104	Computer Aided Design in Manufacturing	L	T	P	C
		3	0	2	4
Course objectives: This course aims to provide fundamental knowledge of computer graphics and geometric modeling, develop clear understanding of CAD systems for 3D modeling and viewing, and build strong skills in assembly modeling to enable effective use of CAD standards.					
Fundamentals of Computer Graphics & 2D/3D Transformations, Graphic display fundamentals; Line and circle drawing algorithms; Filled area primitives and their attributes; Two-dimensional geometric transformations; Viewing and clipping; Coordinate transformations; Three-dimensional transformations					
Activities: Implement line and circle drawing algorithms using CAD software or programming tools, Perform and visualize 2D and 3D geometric transformations on simple shapes.					
Curves, Surfaces, and NURBS Modeling, Curves: Hermite cubic spline, Bezier curve, B-spline curve, curve manipulations; Analytical surfaces: Plane, ruled, surface of revolution, tabulated cylinder; Synthetic surfaces: Hermite bicubic, Bezier surface, B-spline surface, surface manipulations; NURBS basics: curves, lines, arcs, circles, bilinear surfaces.					
Activities: Create and manipulate Bezier and B-spline curves for a given profile, Model analytical and synthetic surfaces like planes, ruled surfaces, and Bezier surfaces.					
Solid Modeling and Visual Realism, Solid modeling: Regularized Boolean set operations, primitive instantiation, sweep representations, boundary representations, constructive solid geometry (CSG), comparison of representations, user interfaces for solid modeling; Visual realism: Hidden line removal, hidden surface removal, hidden solid removal algorithms; Shading and coloring techniques; Animation: Conventional, computer animation, engineering animation – types and techniques.					
Activities: Build solid models using Boolean operations and primitive instantiation, Apply hidden line and surface removal algorithms to a complex 3D model.					
Assembly Modeling and Product Life Cycle Management, Mass properties and assembly modeling; Product data exchange; Geometric tolerances and tolerance practices in drafting and manufacturing; Tolerance modeling, analysis, and synthesis; Product life cycle management principles and tools.					
Activities: Assemble multiple parts using constraints and check for interferences, Draft detailed assembly drawings with GD&T (Geometric Dimensioning & Tolerancing) standards.					
LIST OF EXPERIMENTS: 1. Sketching and Part modelling (Solid modelling, Surface modelling, Feature manipulation) of mechanical components using CAD software package.					

2. Assembly (Constraints, Exploded Views, Interference check) and Drafting (Layouts, Geometric Dimensions & Tolerance Standards, Sectional Views, & Detailing) of mechanical components using CAD software package.
3. Working with CAD Data Exchange formats: IGES, PDES, PARASOLID, DXF and STL.
4. Study and exercise on freeform modelling.
5. Reverse engineering the given product/component and convert the data into 3D model.
6. Exercise on. STL file Preparation, Slicing, Support Structure Generation & Build setup Preparation

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Quiz (5%), Project (10%), Assignment (10%), Practical (25%), Review of Question papers (IES, SSC, GATE) (20%), Internal Examinations (30%)

References:

1. Zeid, I. (2004). Mastering CAD/CAM. McGraw-Hill.
2. Rogers, D., & Adams, J. A. (1976). Mathematical elements for computer graphics. Tata McGraw-Hill.
3. Boothroyd, G. (2005). Assembly automation and product design. CRC Press (Taylor & Francis).
4. Chitale, A. K., & Gupta, R. C. (2023). Product design and manufacturing. PHI Learning Private Limited.
5. Hearn, D. D., & Baker, M. P. (1996). Computer graphics C version. Prentice Hall, Inc.
6. Newman, W. M., & Sproull, R. F. (1979). Principles of interactive computer graphics. McGraw-Hill Book Co.

	Course Outcomes (COs)	Mapped POs	PSO1	PSO2
CO1	Apply fundamentals of computer graphics, 2D/3D transformations, and visualization for engineering design.	PO1 (3), PO2 (2)	3	–
CO2	Develop geometric models of curves, surfaces, solids, and apply shading and rendering techniques.	PO1 (3), PO2 (3), PO3 (2)	3	–
CO3	Perform assembly modeling, tolerance analysis, and product data exchange using CAD tools.	PO2 (3), PO3 (3), PO4 (2)	–	3
CO4	Integrate CAD with PLM, reverse engineering, and 3D printing workflows for manufacturing applications.	PO3 (2), PO4 (3), PO5 (2)	3	3

MF25105	Computer Numerical Control and Adaptive Control	L	T	P	C
		2	0	2	3
Course objectives: This course provides a comprehensive understanding of CAM, CAE, and CIM systems in product realization and process planning, develops knowledge of CNC machines and their control systems, imparts skills in CNC programming with CAM software, and introduces IoT-enabled control systems for smart manufacturing and intelligent production management.					
Introduction to CAM, CAE, CIM; System configuration for CAM including hardware and software; Geometric tolerancing, ASME, ISO, DIN standards; Interpreting geometric specifications; Multiple part features and datum; Integration of CAD and CAM in CNC turning and machining centers. Activities: Interpret and apply geometric tolerancing (ASME/ISO standards) to sample parts, Demonstrate CAD-CAM integration by exporting a CAD model and generating a basic CAM toolpath.					
Process planning; Computer Aided Process Planning (CAPP); Product Life Cycle Management (PLM), Enterprise Resource Planning (ERP). Activities: Create a simple Computer Aided Process Plan (CAPP) for a given component, Discuss the role of PLM and ERP systems in managing manufacturing workflows.					
CNC machine building and structural details; Guide ways, friction, anti-friction, and other types; Rotary-to-linear motion conversion, screw and nut, recirculating ball screw; Spindle assembly; Torque transmission elements, gears, timing belts, flexible couplings; Bearings; Spindle drives and feed drives, Linear motors; Activities: Identify and explain the function of key CNC machine parts (e.g., ball screws, spindles), Compare open-loop vs closed-loop control systems using real CNC examples.					
Open-loop and closed-loop control; Axis measuring systems – grating, linear scale encoder, laser interferometer; Axes & spindle cooling system; Probing for zero offsets and first-off inspection; Tool breakage detecting system; In-process gauging system; Automatic Tool Changer (ATC) and Automatic Pallet Changer (APC). Activities: Write and simulate basic G-code for turning and milling operations (e.g., facing, drilling), Use CAM software to generate CNC code for a 3-axis machining operation.					
Structure of CNC program; Coordinate system; G and M codes; Cutter radius compensation; Tool nose radius compensation; Tool wear compensation; Canned cycles; Mirroring features; Manual part programming for CNC turning and machining centers; Macro programming; CNC programming using CAM software. Activities: Write and simulate a G-code program for a turning operation that includes: Facing, turning, and thread cutting, Use of canned cycles (e.g., G71, G76), Tool nose radius and wear compensation					

Use a CAM software package to, Generate CNC code for a 2.5D milling profile, Include mirroring, pocketing, and drilling operations, Post-process and simulate the toolpath

Practical:

1. Programming and simulation for turning, taper turning, circular interpolation, thread cutting, facing and parting operations using canned cycles for CNC Lathe.
2. Programming and simulation for 2D profile milling, drilling, tapping, circular & rectangular pocket milling and mirroring operations.
3. CNC code generation using CAM software package – CNC Lathe, 3 and 5 Axis Machining centre.
4. Programming for CNC Wire cut EDM.

Weightage: Continuous Assessment: 50%, End Semester Examinations: 50%

Assessment Methodology: Quiz (5%), Project (10%), Assignment (10%), Practical (25%), Review of Question papers (IES, SSC, GATE) (20%), Internal Examinations (30%)

References:

1. Radhakrishnan, P. (2014). Computer numerical control machines and computer aided manufacture. New Academic Science.
2. Nee, Y. C., Ong, K., & Wang, Y. G. (2012). Computer applications in near net-shape operations. Springer.
3. Zhang, Y., & Tao, F. (2017). Optimization of manufacturing systems using the Internet of Things. Academic Press.
4. Chang, T. C., Wysk, R. A., & Wang, H. P. (2006). Computer aided manufacturing. Pearson Prentice Hall.
5. HMT. (2005). Mechatronics. Tata McGraw-Hill Publishing Company Limited.
6. Rao, P. N. (2021). CAD/CAM. Tata McGraw-Hill Publishing Company Limited.

	Course Outcomes (COs)	Mapped POs	PSO1	PSO2
CO1	Explain CAM, CAE, CIM concepts, standards, and their role in product realization and process planning.	PO1 (3), PO2 (2)	3	–
CO2	Analyze CNC machine construction, drives, measuring systems, and adaptive control elements.	PO1 (3), PO2 (3), PO3 (2)	3	2
CO3	Develop CNC part programs using G/M codes, tool compensations, canned cycles, macros, and CAM software.	PO2 (3), PO3 (3), PO4 (2)	–	3
CO4	Apply IoT-enabled control, smart manufacturing, and PLM/ERP integration for intelligent production.	PO3 (2), PO4 (3), PO5 (2)	2	3

MF25106	Advances in Welding and Casting Technology	L	T	P	C
		3	0	0	3
Course objectives: This course provides knowledge on welding metallurgy, design, and special welding processes, explains gating system design and casting metallurgy with special casting processes, and introduces automation, environmental aspects, and standards.					
Welding Design: Heat Flow in Welding: Welding Thermal Cycle (WTC), Effect of WTC and Cooling Rate in Welding, Cooling Rate- Peak Temperature and Solidification Rate, Residual Stress, Residual Stress, Design of Weld Joints: Introduction to Design of Weld Joints, Types of Joints and Welds, Edge Preparation, Design for Static and Fatigue Loading, Fatigue Fracture of Weld Joints, Fatigue Fracture of Weld Joints, Understanding Weldability-Reactions in Weldment, Failure Analysis and Prevention Testing of Welding joints, Case Studies. Activities: Analyze a weld joint for residual stress and fatigue failure using a given thermal cycle, Design a welded structure under static and fatigue loading and propose suitable joint types.					
Special Welding Processes: Micro joining And Nano joining, Wire Bonding; Fundamentals and Types of Laser Welding Including Hybrid Processes, Laser Properties; Stud Welding And Mechanical Fasteners; Magnetically Impelled Arc Welding; Advanced Gas Tungsten Arc Welding; Flux Cored Arc Welding; Electron Beam Welding; Cold Pressure Welding; Ultrasonic Welding; Explosive Welding; Diffusion Bonding; Friction Stir Welding; Electromagnetic Pulse Welding; High Velocity Projectile Impact Welding-Under water welding-Diffusion bonding. Activities: Compare various advanced welding techniques (e.g., laser, friction stir, ultrasonic) based on application, material, and heat input, Case study analysis: Identify the best welding method for a lightweight aerospace component.					
Casting Design and Solidification: Introduction, Pattern allowances, Introduction of gating design, Types of gate-Pouring time calculation, Aspiration effects in gating system, Problem solving on gating design, Solidification analysis-Risering methods-Shape factor, Feeding & Chills effect-Problem related to riser design, Design of thin and unequal sections, mechanism of solidification, Rapid solidification processing (RSP), Melt spinning, Roll quenching, Vibratory solidification, Splat cooling, Thixoforming, Rheocasting, Single crystal growing, Casting defects, inspection, diagnosis and rectification, Case studies. Activities: Solve problems on gating and riser design, including pouring time and solidification analysis, Analyze a casting defect scenario, identify root causes, and suggest rectification measures.					

Special Casting Processes: Evaporative Pattern Casting Process and full mould process, Vacuum sealed moulding, vacuum casting, Magnetic Moulding, Squeeze Casting-types, Mega Casting-Plaster mould casting, Ceramic mould casting.

Activities: Compare traditional and special casting methods (e.g., vacuum casting, squeeze casting) with respect to quality and cost, Research-based presentation: Benefits and challenges of mega casting in automotive industries.

Automation Environmental Aspects, Specification and Standards: Fundamentals of Foundry automation:- Sand Plant, Material Handling, Mould and Core Making- Pollution control, energy and waste management in foundries. Fundamentals of welding automation, Principles of robotic welding, Welding robots, Positioners and Manipulators, Welding sensors and data acquisition Arc sensing, Weld Seam Tracking-Vision system, Microprocessor based control, Effects of welding fumes on environment. Codes, Specifications and Standards: American Society of Mechanical Engineers (ASME), American Petroleum Institute, American Society for Testing Materials (ASTM).

Activities: Simulate or analyze automation flow in a foundry: material handling, mould/core making, and pollution control, Review and interpret welding codes and standards (ASME, ASTM, AWS) for a specific application.

Weightage: Continuous Assessment: 40%, End Semester Examinations: 60%

Assessment Methodology: Quiz (5%), Project (10%), Assignment (10%), Practical (25%), Review of Question papers (IES, SSC, GATE) (20%), Internal Examinations (30%):

References:

1. American Welding Society. (2019). Welding handbook .
2. Radaj, D. (1990). Design and analysis of fatigue resistant welded structures. Woodhead Publishing.
3. Campbell, J. (2015). Complete casting handbook: Metal casting processes, metallurgy, techniques and design. Butterworth-Heinemann.
4. Sahoo, M., & Sahu, S. (2017). Principles of metal casting. McGraw-Hill Education.
5. Tuttle, R. B. (2012). Foundry engineering: The metallurgy and design of castings. CreateSpace Independent Publishing Platform.
6. Singh, R. (2012). Applied welding engineering: Processes, codes and standards. Elsevier.

	Course Outcomes (COs)	Mapped POs	PSO1	PSO2
CO1	Apply welding metallurgy concepts to analyze weld thermal cycles, stresses, joint design, and failures.	PO1 (3), PO2 (2), PO3 (2)	3	–
CO2	Evaluate advanced welding processes, their principles, applications, and suitability for modern industries.	PO1 (3), PO3 (3)	3	2
CO3	Design and analyze gating, risering, and solidification behavior in casting systems including special processes.	PO1 (3), PO2 (3), PO3 (2)	3	2
CO4	Assess automation, environmental aspects, codes, and standards in welding and foundry practices.	PO3 (2), PO4 (3), PO6 (2)	2	3

MF25107	Advanced Manufacturing Laboratory	L	T	P	C
		0	0	4	2
Course objectives: The course aims to familiarize students with manual part programming and CAM-based program generation, provide knowledge of robot programming, traditional and non-traditional micromachining processes, and composite material fabrication, while also introducing them to additive manufacturing technologies.					
LIST OF EXPERIMENTS: 1. CNC Machining Experiment: Perform a machining operation using a CNC (Computer Numerical Control) machine, such as milling or turning. 2. Surface Roughness Measurement: Measure the surface roughness of machined components using instruments like a profilometer or surface roughness tester. 3. Tool Wear Analysis: Analyze the wear characteristics of cutting tools used in machining operations. 4. Metal Forming Experiment: Perform a metal forming operation, such as bending, deep drawing, incremental forming and superplastic forming. 5. EDM (Electrical Discharge Machining) and WEDM (Wire Electrical Discharge Machining): Perform EDM experiments to understand the principles of material removal through electrical discharges. 6. Additive Manufacturing: Explore additive manufacturing processes using 3D printing machines. 7. Laser Processing Experiments – Laser cutting, laser drilling, laser engraving, laser surface hardening, laser cladding, laser welding, laser marking. 8. Cutting of different materials during abrasive water jet machining 9. Manufacturing of Polymer based composites using Resin Transfer Moulding Machine (RTM) Fabrication of metal matrix composite using stir casting setup 10. Topology optimisation and fabrication of components using additive manufacturing process 11. Experiments on incremental forming					
Weightage: Continuous Assessment: 60%, End Semester Examinations: 40%					
Assessment Methodology: Quiz (5%), Project (10%), Assignment (10%), Practical (25%), Review of Question papers (IES, SSC, GATE) (20%), Internal Examinations (30%)					

	Description of CO	Mapped POs	PSO1	PSO2
CO1	Develop and execute CNC part programs, CAM-based machining, and evaluate tool wear and surface roughness.	PO1 (3), PO2 (3), PO3 (2)	3	–
CO2	Apply non-traditional and hybrid processes (EDM, WEDM, AWJM, laser processing, incremental forming) for advanced manufacturing.	PO1 (3), PO2 (2), PO3 (3)	3	2
CO3	Fabricate polymer/metal matrix composites and additive manufactured parts, integrating design optimization and automation concepts.	PO3 (3), PO4 (2), PO5 (2)	2	3
CO4	Develop and execute CNC part programs, CAM-based machining, and evaluate tool wear and surface roughness.	PO1 (3), PO2 (3), PO3 (2)	3	–