



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Automobile

Subject Code: BE05002041

Subject Name: Advance Manufacturing Technology

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	Professional Elective Course - 1

Prerequisite:	Basic knowledge of manufacturing Processes
Rationale:	<p>The <i>Advance Manufacturing Technology</i> syllabus is designed to provide mechanical engineering students with a comprehensive understanding of fundamental and advanced manufacturing processes required in modern industries. The inclusion of casting, welding, metal forming, un conventional manufacturing and plastic processing ensures coverage of core manufacturing domains essential for producing a wide range of engineering components.</p> <p>The study of foundry practices, including pattern making, gating and riser design, and casting defect analysis, enables students to understand process optimization and quality control in manufacturing. Metal joining processes such as welding and brazing develop essential fabrication skills, while metal forming processes build knowledge of material behavior under deformation, which is critical for component design and manufacturing.</p> <p>Unconventional manufacturing processes addresses difficult to hard metal machining and advances in material processing. Plastic processing topics address the growing demand for lightweight, cost-effective, and high-performance materials in various industries.</p> <p>Overall, the syllabus is structured to bridge the gap between theoretical knowledge and industrial practice, enabling students to select appropriate manufacturing processes, improve product quality, and adapt to evolving technological and industrial requirements.</p>

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Apply principles of foundry technology, including pattern design, moulding practices, and casting techniques to produce quality cast components and minimize defects.	25
CO-2	Analyze metal joining processes such as welding, brazing, and soldering, and select suitable methods for different engineering applications.	25
CO-3	Apply knowledge of metal forming processes to interpret material behavior under hot and cold working conditions and identify forming defects.	20
CO-4	Analyze and compare various advanced manufacturing processes based on their working principles, process parameters, machining characteristics, and suitability for engineering applications.	20
CO-5	Evaluate plastic materials and processing techniques based on product requirements, cost, and performance criteria.	10



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Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
L	T	P	PBL	Total no of hours per semester		Theory		Tutorial / Practical			
						ESE (E)	PA / CA (M)	PA/C A (I)	PBL (I)	ESE (V)	
45	0	30	15	90	3	70	30	20	30	50	200

* *Problem-Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.*

Content:

Sr. No.	Content	Total Hrs
1	<p>Foundry Technology:</p> <p>Pattern Practices: Types of patterns, pattern allowances, and materials used for patterns. Moulding materials and moulding sands, properties of moulding sand, and sand testing methods such as grain fineness, moisture content, clay content, and permeability. Core materials and core making, core prints, core boxes, and chaplets. Moulding practices including green sand, dry sand, and loam sand moulding; pit and floor moulding; shell moulding; permanent moulding; and carbon dioxide (CO₂) moulding.</p> <p>Casting Practices: Fundamentals of metal casting; sand casting; shell mould casting; plaster and ceramic mould casting; investment casting; vacuum casting; permanent mould casting; and slush casting. Pressure casting and die casting; centrifugal casting; continuous casting; and squeeze casting. Casting alloys, casting defects, and design of castings including gating system and riser design. Melting furnaces such as rotary, pit electric, tilting, and cupola furnaces.</p>	10
2	<p>Metal Joining Processes:</p> <p>Principles of welding, soldering, brazing, and adhesive bonding. Classification of welding and allied processes. Gas welding and gas cutting, including oxy-acetylene welding equipment. Arc welding, power sources, and consumables. Resistance welding processes such as spot, projection, and seam welding. Advanced welding processes including atomic hydrogen, ultrasonic, plasma arc, laser beam, and electron beam welding. Special welding processes such as TIG, MIG, friction, and explosive welding. Welding of cast iron (C.I.) and aluminium (Al). Welding defects, electrodes and electrode coatings, and welding positions.</p>	10
3	<p>Forming and Shaping Processes: Metal working; elastic and plastic deformation; hot and cold working; concept of strain hardening. Cold working processes such as shearing, drawing, squeezing, blanking, piercing, deep drawing, coining, and embossing. Rolling: principle and operations, and roll pass sequence. Extrusion, and</p>	10



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	wire and tube drawing processes. Forging: methods of forging, forging hammers and presses, and principles of forging tool design. Metal working defects, cold heading, riveting, thread rolling, bending, and forming operations.	
4	<p>Unconventional Machining Processes:</p> <p>Mechanical Energy Based Processes: Abrasive Jet Machining (AJM), Water Jet Machining (WJM), Ultrasonic Machining (USM). Working Principles – equipment used – Process parameters – MRR- Applications.</p> <p>Electrical Energy Based Processes: Electric Discharge Machining (EDM)- working Principle- equipment used -Process Parameters - Surface Finish and MRR - electrode / Tool – Power and control Circuits-Tool Wear – Dielectric – Flushing – Wire cut EDM – Applications.</p> <p>Chemical and Electro-Chemical Energy Based Processes: Chemical machining and Electro - Chemical machining (CHM and ECM) - Etchants – Maskant - techniques of applying maskants - Process Parameters – Surface finish and MRR - Applications. Principles of ECM - equipments-Surface Roughness and MRR Electrical circuit-Process Parameters- ECG and ECH - Applications.</p> <p>Thermal Energy Based Processes: Laser Beam machining (LBM), Plasma Arc machining (PAM) and Electron Beam Machining (EBM). Principles – Equipment – Types - Beam control techniques – Applications.</p>	10
5	<p>Plastic Technology:</p> <p>Introduction; classification of plastics; ingredients of moulding compounds; general properties of plastics; plastic part manufacturing processes such as compression moulding, transfer moulding, injection moulding, extrusion moulding, blow moulding, calendaring, thermoforming, slush moulding, and laminating.</p>	5
TOTAL		45

Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	20	25	15	10	10

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom’s Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

The syllabus of Manufacturing Technology directly contributes to

SDG 3	Good Health and Well-being
SDG 7	Affordable and Clean Energy
SDG 8	Decent Work and Economic Growth
SDG 9	Industry, Innovation and Infrastructure



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SDG 12	Responsible Consumption and Production
SDG 13	Climate Action

Reference Book

1. Kalpakjian, S., Schmid, S. (2019). Manufacturing Engineering and Technology. United States: Pearson Education.
2. Manufacturing technology. Volume 1, Foundry, forming and welding, 5th Edition by P N Rao, Tata McGraw-Hill
3. A textbook of production technology by P.C. Sharma, S. Chand Publishing (2022)
4. Manufacturing Processes and Systems, 9th Ed. (2008). by Phillip F., Ostwald, Jairo Munoz, India: Wiley India Pvt. Limited.
5. Castings Practice: The Ten Rules of Castings by John Campbell, Elsevier/Butterworth- Heinemann, 2004.
6. Welding Engineering and Technology, 2nd Edition by Dr. R.S. Parmar, Khanna Publisher, 2013
7. A textbook of welding technology by O. P. Khanna, Dhanpat Rai
8. Welding Process Technology by P. T. Houldcroft, Cambridge University Press
9. Fundamentals of Microfabrication and Nanotechnology, Marc J. Madou , Publisher: CRC Press (Taylor & Francis), 3rd Edition
10. Microsystem Design, Stephen D. Senturia, Publisher: Springer, 1st Edition
11. MEMS and Microsystems: Design and Manufacture, Tai-Ran Hsu, Publisher: McGraw-Hill Education, 2nd Edition
12. Introduction to Microelectromechanical Systems Engineering, Nadim Maluf & Kirt Williams, Publisher: Artech House, 2nd Edition
13. Silicon VLSI Technology: Fundamentals, Practice and Modelling, James D. Plummer, Michael D. Deal, Peter B. Griffin, Publisher: Pearson, 1st Edition
14. Microfabrication for Industrial Applications, Regina Luttge, Publisher: William Andrew (Elsevier), Edition: 1st Edition
15. Unconventional Machining process, Dr. Senthil, A R S Publishers
16. Modern Machining Processes, P. C. Pandey, H. S. Shan, Tata McGraw-Hill

Standards and Act:

1. **Foundry:** IS 1528, IS 210 ,IS 1918,
2. **Welding:** IS 813, IS 816-1969 , IS 814
3. **Forming:** IS 1608, IS 1500
4. **Plastics:** IS 13360
5. **General Manufacturing:** IS 696
6. **Forged components:** IS 3469
7. Factories Act 1948 – Safety in foundry operations, Welding safety and ventilation, Machine safety, press operations
8. Environment Protection Act 1986 – Emissions, waste disposal
9. Air (Prevention and Control of Pollution) Act 1981 – Furnace emissions control
10. Indian Electricity Act 2003 – Electrical safety in arc welding
11. Gas Cylinders Rules 2016 – Handling of oxygen/acetylene cylinders
12. Environment Protection Act 1986 – Noise, waste, emissions



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List of Experiments:

Experiments based on syllabus contents including workshop job of:

1. Casting Processes
2. Welding Processes
3. Sheet metal working
4. Plastic processes
5. Unconventional Manufacturing processes

Major Equipment:

1. Mechanical Press
2. Small foundry shop
3. Welding Machine: Arc welding machine, Gas welding machine, TIG, Spot welding etc..
4. EDM, wire cut EDM, ECM, etc

List of Open Source Software

1. Scilab
2. FreeCAD, PrePoMax, CalculiX, ParaView
3. OpenFOAM, CalculiX, ParaView (+ PoligonSoft Free for easy learning)

List of learning website:

1. <http://nptel.ac.in/courses/>

List of suggested activities for Problem-based Learning (PBL):

Sr. No	PBL category	Name of the activity	No. of hours	Evaluation Criteria
1.	Complex Problem-Solving targeting relevant SDGs / Mini Project	Mini Project	15h (need to be changed as per total PBL hours)	Based on the novelty of project, technical understanding, report quality and presentation
2.	Case Study Analysis / Seminar	Seminar	15h (need to be changed as per total PBL hours)	Based on the quality of report and presentation, technical understanding
3.	Micro project	Micro project	8h (need to be changed as per total PBL hours)	Based on the novelty of project, technical understanding, quality of report and demonstration
4.	Industry/Research laboratory visit	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
5.	Video Based Learning	Technical video-based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
6.	Assignment /	Assignment writing.	5 assignments of 4 h	Based on the correctness



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	Technical Writing / Research Writing	Numerical based assignment is preferable.	each Total = 20h	of submitted assignment
7.	Group Discussion / Quiz / Simulation	Problem solving/Coding using C, C++, MATLAB, Python, SCILAB, modeling and Analysis software or any other software	5 small coding-based assignment of 2h each Total = 10h	Based on the coding solution submitted.
8.	Video Based Learning	Self-learning online course	Minimum duration of the course should be 10h	Examination based assessment at the end of course. Based on the certificate produced.
9.	Complex Problem- Solving targeting relevant SDGs / Mini Project	Identification and solution of Complex problem	Maximum 2 problems. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
10.	Video Based Learning	Videos on Industrial safety/Disaster Management aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
11.	Research Paper Review / Analysis	Technical paper reading and summarization of research papers based on relevant subject	5 research papers = 20h	Summarize research paper and evaluation critical parameters
12.	Poster / Chart / PowerPoint presentation	Poster/chart/power point preparation on technical topics	Duration = 6h	Based on poster/chart preparation and presentation skills
13.	Industry/Research laboratory visit	Industrial exposure for 2- 3 days to observe and provide tentative solutions on society/environment/health/sustainability/any other issue	Duration = 15h for industrial exposure Problem identification and tentative solution = 10h Total = 20h	Based on evaluation of critical problems and solutions
14.	Group Discussion / Quiz / Simulation	Group Discussion on emerging/trending technical topics based on subject	Duration = 1h – 3h per topic	Based on performance in group discussion, technical depth, knowledge etc.
15.	Case Study Analysis / Seminar	Real world case studies- based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
16.	Group Discussion / Quiz / Simulation	Application/Software development	Duration = 10h	Depending on the complexity of the Application/Software



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17.	Assignment / Technical Writing / Research Writing	Research paper publication	Duration = 10h	Based on submission of proof of publication
18.	Micro project	Upgradation/Reverse engineering studies of existing equipment of the laboratory	Duration 10h	Based on the performance of the equipment
19.	Industry/Research laboratory visit	Expert lecture/session	Duration 3h For attending the lecture/session– 2h and for report writing 1h	Based on the proof of attendance and report submitted
20.	Video Based Learning	Annotated Video Explanation of Concept/Problem	10h (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
21.	Assignment / Technical Writing / Research Writing	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.
22.	Assignment / Technical Writing / Research Writing	Preparation of a report on Indian Standard(s)	10h (study of Indian Standard(s) + report	Based on report quality and understanding of the relevant Indian Standard(s).

Note:

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject **Advance Manufacturing Technology compulsorily incorporates Micro Project and 5 marks as PBL activities for PEC.**

These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.

2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.
3. All the suggested activity should be related to the subject.
4. The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
5. Rubrics for the evaluation can be prepared by the faculty.
6. Subject teacher can add the relevant activities other than those listed above, with the consent of head of the department and DQAC.
