GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Mechanical, Manufacturing, Production and Mechatronics
Subject Code: BE05000311
Subject Name: Manufacturing Technology

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

Prerequisite:	Nil
Rationale:	The *Manufacturing Technology* 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, and plastic processing ensures coverage of core manufacturing domains essential for producing a wide range of engineering components. 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. The syllabus also incorporates emerging areas such as microsystem fabrication (MEMS/NEMS), aligning with advancements in micro- and nano-scale manufacturing technologies. Plastic processing topics address the growing demand for lightweight, cost-effective, and high-performance materials in various industries. 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.

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	Explain microsystem fabrication techniques (MEMS/NEMS) and evaluate their applications in modern manufacturing systems.	20
CO-5	Evaluate plastic materials and processing techniques based on product requirements, cost, and performance criteria.	10

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/CA (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	**Foundry Technology:** 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 (CO_2) moulding. 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.	**10**
2	**Metal Joining Processes:** 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.	**10**

3	**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 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.	**10**
4	**Microsystems Fabrication Technology:** Microsystem Technology (MEMS/NEMS): Definition and classification of microsystems. Microfabrication techniques including photolithography (process steps and masks), etching processes such as wet etching and dry etching (plasma, reactive ion etching - RIE), and deposition techniques including Physical Vapour Deposition (PVD) and Chemical Vapour Deposition (CVD). Doping and ion implantation. Micromachining processes: bulk micromachining, surface micromachining, LIGA process, and laser micromachining. Recent trends and applications including basics of nanofabrication, 3D micro/nano printing, lab-on-chip systems, and industrial and biomedical applications.	**10**
5	**Plastic Technology:** 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.	**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**
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

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

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

Major Equipment:

1. Mechanical Press
2. Small foundry shop
3. Welding Machine: Arc welding machine, Gas welding machine, TIG, Spot welding 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 / Technical Writing / Research Writing	Assignment writing. Numerical based assignment is preferable.	5 assignments of 4 h each Total = 20h	Based on the correctness 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	Group Discussion on	Duration = 1h – 3h per	Based on performance in

	Discussion / Quiz / Simulation	emerging/trending technical topics based on subject	topic	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
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 **Manufacturing Technology compulsorily incorporates Mini Project and Seminar as PBL activities.**
   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.

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