

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2022 (COGC-2022) Semester-II

Course Title: Manufacturing Engineering Processes-I
(Course Code: C4326501)

Diploma programme in which this course is offered	Semester in which offered
Mechanical Engineering (CAD/CAM)	Second Semester

1. RATIONALE

This subject of Manufacturing Engineering Processes-I provides knowledge and embeds skill to students to produce various products using metal forming, metal casting, metal joining plastic moulding processes and Heat treatment processes. Materials and Manufacturing processes are the most important element in any engineering industry. Mechanical Engineer is a key person for shop floor activities related to manufacturing. He/she should have knowledge and associated skill of manufacturing processes. Hence emphasis is given on skill development by adding practices in all topics in this Manufacturing Engineering Processes-I subject. Developing strong domestic manufacturing base is vital for our country to accomplish the nation's vision "Make in India".

Metal forming processes, Casting processes, Plastic moulding process and Welding processes are essential components of many industries such as the automotive industry, machines and equipment industry, construction industry, aviation industry, and more.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency.

- **Produce the job as per given specification by selecting and applying appropriate manufacturing processes like Casting, Forming, Moulding and Joining.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

- Classify various mechanical manufacturing processes.
- Recommend heat treatment process to improve mechanical properties.
- Select appropriate casting process to produce mechanical components.
- Select appropriate metal forming process to produce mechanical components.
- Select appropriate moulding method to produce plastic components.
- Select appropriate metal joining process for various applications.

4. TEACHING AND EXAMINATION SCHEME

Examination Scheme		

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	4	5	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: **L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. Some of the **PrOs** marked ‘*’ are compulsory, as they are crucial for that particular CO at the ‘Precision Level’ of Dave’s Taxonomy related to ‘Psychomotor Domain’.

Sr. No	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Preparatory activity a. Recall Mechanical properties of materials. b. Safety Practices to be followed in metal forming, casting, non-metal moulding, metal joining processes and heat treatment processes.	ALL	02
2	Examine the given specimen by use of Metallurgical Microscope.	II	02
3	Perform hardening process on ferrous material. Measure the hardness before and after hardening.	II	04
4	Prepare a pattern for the given components/drawings, considering pattern allowances.	III	06
5	Prepare a sand mould using prepared pattern. Also pour molten metal and get the casting. (Use wax in place of molten metal for the purpose of demonstration.)	III	06
6	Prepare a job using hot/cold forging/smithy process.	IV	06
7	Study of Plastic moulding processes. (Demonstration of processes shall be carried out compulsory during industrial visit)	V	02
8	Prepare a job using arc welding. Highlight effect of process parameters	VI	06
9	Prepare a job using gas welding. Highlight effect of process parameters	VI	04
10	Prepare a job using spot/seam resistance welding.	VI	04
11	Prepare two jobs, one using soldering and another using brazing.	VI	02
12	Visit nearby Rolling mill/Hot-Cold material processes, foundry, plastic processing industry, fabrication industry and prepare a two page report comprises of types of item produced, quantities, different sections, equipments used with specification and materials.	ALL	–
13	Micro Project as suggested in section no. 4	ALL	10

14	SCHOOL WITHIN SCHOOL: Each student will prepare and present report on: a. His/her observation for the jobs made. b. PPT on topic assigned by teacher.	ALL	02
Total hours		56 Hrs.	

Note

- i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.
- ii. The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Identify components (Knowledge)	10
2	Prepare experimental setup. (Procedure followed)	20
3	Perform the experiment with accuracy. (Quality of job)	40
4	Follow safety practices. (Safety followed)	10
5	Submit the report. (Timely submission / Quality of report)	20
Total		100

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

Sr. No.	Major Equipments	PrO s. No.
1	Material Science and metallurgy 1. Metallurgical Microscope with standard specimen 2. Heat treatment Furnace 3. hardness tester	2,3
2	Pattern Making: Wood cutting planer machine/Wood jack plane, Carpentry vice, Flat file, Hammer, Steel rule, Right angle, Saw	4
3	Molding Cope and drag Boxes, Molding sand with additives and binder, Vent wire, Furnace or Oven, Consumable (Wax)	5
4	Smith forging Anvil, Furnace, Hammers, Tong, Steel rule, Air blower, Swage block	6

5	Arc welding Arc welding Machine with electrode holder, Tong, Chipping hammer, Wire brush, Hand gloves, Welding Face Shield, Safety goggles	8
6	Gas welding Oxy acetylene gas cylinders with regulators, Welding torch, Tong, Chipping Hammer, Steel rule, Hand gloves, Safety goggles	9
7	Spot/Resistance welding Spot welding machine, Plier cutter, Hammer, Steel rule	10
8	Soldering/ Brazing Brazing torch, Consumables, Tong, Hammer, Anvil, Wire brush, Soldering iron & lead wire	11

7. AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned COs and PrOs. More could be added to fulfill the development of this competency.

- a) Work as a leader/a team member.
- b) Follow safety practices while using equipment.
- c) Realize the importance of green energy. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below: i. 'Valuing Level' in 1st year ii. 'Organization Level' in 2nd year. iii. 'Characterization Level' in 3rd year

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – I Engineering Materials and Manufacturing Processes	1.a Define various properties of materials. 1.b Classify and describe various Engineering Materials. 1.c Classify various manufacturing processes.	1.1 Define Physical, Mechanical, electrical, electromagnetic and thermal properties of materials. 1.2 Engineering Materials: Classifications, properties and Applications. 1.3 Classification of various Manufacturing Engineering processes.

Unit – II Material Science and Metallurgy	2.a Draw and Interpret TTT curves and Iron carbon diagram. 2.b Explain various heat treatment processes. 2.c Recommend heat treatment process to improve mechanical properties 2.d Examine specimens using microscope.	2.1 Time Temperature Transformation curve- (TTT curve). i. Need and application. 2.2 Iron carbon equilibrium diagram. i. Need and application. 2.3 Heat treatment processes: Procedure and properties changes in Hardening, Annealing, Normalizing, Case hardening, Tempering, Nitriding). 2.4 Types of quenching mediums and their applications. 2.5 Powder metallurgy : Basic concept of powder metallurgy and its applications, Process steps.
Unit – III Metal Casting Processes	3.a Identify various metal casting processes. 3.b. Select appropriate casting processes to produce mechanical components. 3.c. Identify casting defects, their causes and suggest remedies.	3.1 Basic concept, advantages, Limitations and applications of Casting process. 3.2 Steps of sand moulding process. 3.3 Pattern: Definition, Types, Applications and allowances 3.4 Cores: Definition, Types, Applications 3.4 Mould making equipment's and their applications. 3.5 Special Casting processes: Basic principle and applications Of i. Centrifugal casting. ii. Die casting. iii. Investment casting 3.6 Casting defects - types, causes, effects and remedies. 3.7 Safety precautions in Casting processes.
Unit – IV Metal Forming Processes	4.a Compare hot and cold working Processes. 4.b Identify various metal forming processes. 4.c Select the appropriate metal forming process to produce a given mechanical component.	4.1 Concept of hot and cold working processes. 4.2 Classification of metal forming processes. 4.3 Working principle and applications of Forging, Rolling, Drawing, and Extrusion. 4.4 Safety precautions in metal forming processes.
Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit– V Plastic Moulding processes	5. a Classify plastic materials 5. b Suggest appropriate moulding method for a given Plastic component. 5.c Identify injection mould parts	5.1 Plastic materials: Types and applications of commonly used i.e. PP, HDPE, LDPE, PS, PCE, ABS etc 5.2 Construction, Working and Applications: i. Injection moulding ii. Blow moulding iii. Extrusion moulding iv. Rotational moulding 5.3 Construction of Injection mould with nomenclature.

Unit- VI Metal Joining Processes	6.a Explain different welding processes. 6.b Identify the area of applications of a particular joining process. 6.c Select metal joining methods for various applications. 6.d Practice standard safety norms during any joining process.	6.1 Classification of metal joining processes. 6.2 Working principle, equipments, consumables, advantages, limitations and applications of following metal joining processes. (i) Arc welding: Metal Arc Welding, MIG (Metal Inert Gas), TIG (Tungsten Inert Gas), Submerged arc welding. (ii) Gas welding: Oxy-acetylene Gas welding, cutting, Types of flames. (iii) Resistance welding: spot welding set up and working. 6.3 Types of weld joints 6.4 Soldering: Procedure and Applications 6.5 Brazing: Procedure and Applications 6.6 Comparison of Welding, Brazing and Soldering. 6.7 Safety precautions in metal joining processes.
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9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Engineering Materials and Manufacturing Processes	04	4	0	0	04
II	Material Science and Metallurgy	08	4	10	0	14
III	Metal Casting Processes	10	4	10	4	18
IV	Metal Forming Processes	06	4	6	4	14
V	Plastic Moulding Processes	06	0	3	3	06
VI	Metal Joining Processes	08	3	7	4	14
Total		42	19	36	15	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy) **Note:** This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table. **At Least 3 CO'S should be met to achieve in the Mid Sem Exam.**

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related **co-curricular** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

Sr. No.	Activity.
1	Select four industrial components (approved by teacher) and list various methods of manufacturing used to produce these components.
2	Select at least two components which are made by casting only. Also state the type of casting method used.
3	Prepare a list of industries/workshops in the nearby area which are producing components by casting/forming/moulding/Joining.
4	Prepare a list of plastic items which are produced using different types of molding methods. Name the process used.
5	Prepare a list of household items which are prepared by joining processes.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- Massive open online courses (**MOOCs**) may be used to teach various topics/subtopics.
- Guide student(s) in undertaking micro-projects.
- 'L' in section No. 4** : Use different types of teaching methods that are to be employed by teachers to develop the outcomes.
- About **20% of the topics/sub-topics** which are relatively simpler or descriptive in nature is to be given to the students for **self-learning**, but to be assessed using different assessment methods.
- With respect to **section No.10**, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- Guide students on how to address issues on environment and sustainability.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PROs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contributions in the project work and give a seminar presentation of it before submission. The duration of the micro-project should be about **10-16 (ten to sixteen)**

student engagement hours during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects can be added by the concerned course teacher:

- a) Prepare a small useful product like flower pot / stool / table / bench / laboratory equipment/set-up utilizing laboratory resources.
- b) Using Drafting software, prepare a pattern drawing/forged component drawing.
- c) Survey/Visit nearby vendor, prepare sample specifications of manual metal arc welding machine, injection moulding machine, forging and casting equipments.
- d) Maintenance of available infrastructure related to fabrication i.e. benches, stool, table, doors, grills, solar structure, etc.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1.	Material Science	GBS Narang	Khanna Publishers New Delhi
2.	Material Science and Metallurgy	D S Nutt	S K Kataria and Sons Delhi
3.	Physical Metallurgy	Sydney Avenor	Tata MacGraw Hill Education
4.	Workshop Technology I & II	J. A. Schey	Tata MacGraw Hill Education
5.	Workshop Technology I & II	Raghuwanshi	Dhanpat Rai and Sons
6.	Workshop Technology I, II &	W. A. J. Chapman	Arnold
7.	Manufacturing Processes	M. L. Begman	Wiley India
8.	Production Technology	R.K. Jain and S.C. Gupta	Khanna publication
9.	Injection Mould Design	Pye R G W	East-West Press
10.	Audles Welding Guide	F.D. Graham	Wiley India
11.	Foundry Engineering	P.L. Jain	Tata MacGraw Hill Education
12.	Principle of Foundry	Jain & Gupta	National Book Trust, India
13.	Production Technology	H.H. Marshall	Machinery Publishing Company
14.	Elements of Workshop Technology (Vol I & II)	Hajra Chowdhary & Bhattacharya	Media Promoters

14. SOFTWARE/LEARNING WEBSITES

1. <https://www.youtube.com/watch?v=1oZnxZj6-Ig> (Green Sand moulding- animation)
2. <https://www.youtube.com/watch?v=2ClcvB72dmk> (metal casting Basics)
3. <https://www.youtube.com/watch?v=EIBDp6U8bHo> (Sand Casting)
4. <http://www.youtube.com/watch?v=Yk1JOYzwrP4> (Loose piece Pattern)
5. <http://www.youtube.com/watch?v=khEvjhj SM> (Foundry Pattern making)

6. <http://www.youtube.com/watch?v=f7FXtnXVqzY> (Aluminium Casting)
7. <http://www.youtube.com/watch?v=bzSSfBgkWfc&NR=1&feature=endscreen> (Die Casting)
8. <http://www.youtube.com/watch?v=pTTap4WiEAU> (Gravity Die Casting)
9. <http://www.flamingfurnace.com/> (Casting projects)
10. <https://www.youtube.com/watch?v=3UNhaBOmLjM> (Hand Forging)
11. <https://www.youtube.com/watch?v=MyMTkLqZyEE> (Press forging-Squeezing)
12. https://thelibraryofmanufacturing.com/forming_basics.html
13. https://www.youtube.com/watch?v=6xnKmt_gsLs (Rolling)
14. https://www.youtube.com/watch?v=9MU0vSN_w-A (Cold roll forming)
15. <http://www.sme.org>
16. http://www.youtube.com/watch?v=6xnKmt_gsLs (Hot Rolling)
17. <https://www.youtube.com/watch?v=b1U9W4iNDiQ> (Plastic Injection Moulding)
18. <https://www.youtube.com/watch?v=Eyfd4ilCUM4> (Injection moulding Machine)
19. <https://www.youtube.com/watch?v=sDJpf6pKyuE> (Rotational moulding machine)
20. <https://olimy.com/technical/usual-mold-parts-and-their-function.html> (Injection mould)
21. <https://www.youtube.com/watch?v=pMtqDWUpJds> (Arc welding Basics)
22. <http://www.youtube.com/watch?v=CJ42scaWFnw> (Brazing video)
23. <https://www.youtube.com/watch?v=s9ouyi7h8zA> (MIG welding)
24. https://www.youtube.com/watch?v=tNYmo2_DI6c (TIG welding)
25. <https://www.youtube.com/watch?v=8fdVgj5pTPY&t=4s> (SAW)

15. PO-COMPETENCY-CO MAPPING

Semester II	Manufacturing Engineering-1 (Course Code:)						
	POs						
	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation & Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency & Course Outcomes							
<u>Competency</u>	Produce the job as per given specifications by selecting and applying appropriate manufacturing processes like Casting, Forming ,Moulding and Joining.						
(1) Classify various mechanical manufacturing processes.	3						
(2) Recommend heat treatment process to improve mechanical properties	3	2		2			
(3) Select appropriate casting process to produce mechanical components.	3		2	3			
(4) Select appropriate metal forming process to produce mechanical components.	3			3			
(5) Select appropriate moulding method to produce Plastic components.	3			2			

(6) Select metal joining process for various applications	2			2			
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16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	R.A. Prajapati, L.M.E.	GP, AHMEDABAD	9429435748	rap1432000@yahoo.com
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BOS Resource Persons

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