

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Manufacturing Engineering-1 (Course Code: 4331903)

Diploma programme in which this course is offered	Semester in which offered
Mechanical Engineering, Mining Engineering , Mechatronics Engineering	Third Semester

1. RATIONALE

This subject of Manufacturing Engineering -1 provides knowledge and also embed skill to students to produce various products using metal forming, metal casting, metal joining and plastic moulding processes. Manufacturing Engineer is a key person in engineering industries and 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-I subject. Manufacturing processes are the most important element in any engineering industry. 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, Joining, using safe working procedures.**

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:

- a) Classify various mechanical manufacturing processes.
- b) Select appropriate metal working processes to produce mechanical components.
- c) Select appropriate casting processes to produce mechanical components.
- d) Select moulding methods suitable for non-metal components.
- e) Select metal joining methods for various applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			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 material. b. Safety Practices to be followed in metal forming, casting, non-metal moulding and joining processes.	ALL	02
2	Prepare a job using hot/cold forging/hot smithy process. This includes cutting of raw material and preparation of pre forged parts.	II	06
3	Prepare a pattern for the given components/drawings, considering pattern allowance.	III	06
4	Prepare a mould using a prepared pattern, and moulding sand. Also pour molten metal and get the casting. (Use wax in place of molten metal for the purpose of demonstration.)	III	06
5	Prepare a job using arc welding. This includes cutting of raw material and edge preparation.	V	06
6	Prepare a job using gas welding. This includes cutting of raw material and preparation of pre-weld parts	V	04
7	Prepare a job using spot/seam resistance welding. This also includes cutting of raw material and preparation of pre-weld parts.	V	04
8	Prepare two jobs, one using soldering and another using brazing.	V	04
9	Study of Non- metal moulding processes. (Demonstration of processes shall be carried out during industrial visit)	IV	02
10	Visit nearby Rolling mill/Hot-Cold material processes, foundry, plastic processing industry, fabrication industry and prepare a two-page report comprises of types of items produced, quantities, different sections, equipments used with specification and consumables.	ALL	–

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
11	Micro Project as suggested in section no. 4	ALL	14
12	SCHOOL WITHIN SCHOOL: Each student will present and will prepare report on: a. His/her observation for the jobs made. b. His/her experience during industrial visits. Process parameters and their effects.	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.	Equipment Name with Broad Specifications	PrO. No.
1	Pattern Making: 1. Wood cutting planer machine/Wood jack plane 2. Carpentry vice 3. Flat file 4. Hammer 5. Steel rule 6. Right angle 7. Saw	3
2	Molding 1. Cope and drag Boxes 2. Molding sand with additives and binder 3. Vent wire 4. Furnace or Oven	4

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
	5. Consumable (Wax)	
3	Smith forging <ol style="list-style-type: none"> 1. Anvil 2. Furnace 3. Hammer 4. Tong 5. Steel rule 6. Air blower 7. Swage block 	2
4	Spot/Resistance welding <ol style="list-style-type: none"> 1. Spot welding machine 2. Plier cutter 3. Hammer 4. Steel rule 5. Anvil 	7
5	Arc welding <ol style="list-style-type: none"> 1. Arc welding Machine with electrode holder 2. Tong 3. Chipping hammer 4. Wire brush 5. Hand gloves 6. Hand screen 7. Safety goggles 	5
6	Gas welding <ol style="list-style-type: none"> 1. Oxy acetylene gas cylinders with regulators 2. Welding torch 3. Tong 4. Chipping Hammer 5. Steel rule 6. Hand gloves 7. Safety goggles 	6
7	Soldering/ Brazing <ol style="list-style-type: none"> a. Brazing torch ii. Consumables iii. Tong iv. Hammer v. Anvil vi. Wire brush vii. Soldering iron & lead wire 	8

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) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit – I INTRODUCTION	1.a Define Manufacturing processes. 1.b Classify various Manufacturing processes. 1.c Define various mechanical properties of material.	1.1 Introduction of mechanical manufacturing processes. 1.2 Classification of various Manufacturing processes. 1.3 Recall mechanical properties of material.
Unit – II METAL FORMING PROCESS	2.a Recall residual stresses and recrystallization temperature. 2.b Compare the principles of hot and cold working Processes. 2.c Identify various metal working processes. 2.d Select the appropriate metal working process to produce a given mechanical component.	2.1 Effect of residual stresses and recrystallization temperature on metals. 2.2 Concept and differences of hot and cold working processes. 2.3 Classification of metal forming processes. 2.4 Types, working principle, equipments used and applications of Forging, Rolling, Drawing, Extrusion. 2.5 Press working operations 2.6 Safety Precautions in metal forming processes.
Unit – III Metal casting processes	3.a Identify various metal casting processes. 3.b Calculate pattern allowances. 3.c Interpret the standard color coding on pattern.	3.1 Basic concept, advantages, Limitations and Applications of Casting process. 3.2 Pattern: i. Definition, Types and materials of construction.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	<p>3.d Select appropriate casting processes to produce mechanical components.</p> <p>3.e Identify casting defects, their causes and suggest remedies.</p>	<p>ii. Allowances, their needs and normal values.</p> <p>iii. Drawings and color codes.</p> <p>iv. Making process.</p> <p>v. Applications.</p> <p>3.3 Cores:</p> <p>i. Need.</p> <p>ii. Types</p> <p>3.4 Molding sand:</p> <p>i. Sand properties</p> <p>ii. Types</p> <p>iii. Sand binders</p> <p>3.5 Recovery of sand for control of environment pollution.</p> <p>3.6 Mould making equipments, and their applications.</p> <p>3.7 Moulding processes.</p> <p>3.8 Furnace: Types, working and applications.</p> <p>i. Crucible furnace</p> <p>ii. Pit furnace</p> <p>iii. Electric furnace</p> <p>iv. Cupola</p> <p>3.9 Casting processes: basic principle, working, and applications.</p> <p>i. Centrifugal.</p> <p>ii. Die.</p> <p>iii. Investment.</p> <p>3.10 Casting defects -types, causes, effects and remedies.</p> <p>3.11 Safety precautions in Casting processes.</p> <p>3.12 Pollution prevention in metal casting industry.</p>
<p>Unit– IV</p> <p>Non-metal moulding processes</p>	<p>4.a Suggest appropriate moulding method suitable for a given non-metal component.</p> <p>4.b Classify plastic materials.</p>	<p>4.1 Construction, Working and Applications.</p> <p>i. Injection moulding process.</p> <p>ii. Blow moulding process.</p> <p>iii. Extrusion moulding process.</p> <p>4.2 Plastic materials: Types (commonly used i.e PP, HDPE, LDPE, PS, PCE, ABS etc.), applications.</p> <p>4.3 Construction of Injection mould.</p> <p>4.4 Safety precautions in plastic processing.</p>
<p>Unit– V</p> <p>Metal Joining Processes</p>	<p>5.a Explain different welding processes.</p> <p>5.b Identify the area of applications of a particular joining</p>	<p>5.1 Classification of metal joining processes.</p> <p>5.2: Working principle, setup sketch, equipment and consumables, Applications, advantages, limitations of following metal joining processes.</p>

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	process. 5.c Select metal joining methods for various applications. 5.d Practice standard safety norms during any joining process.	(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, seam, Projection welding. (iv) Thermit welding 5.3 Welding defects -types, causes, effects and remedies. 5.4 Arc welding Electrodes selection. 5.5 Types of weld joints 5.6 Soldering: Procedure and Application 5.7 Brazing: Procedure and Application 5.8 Comparison of Welding, Brazing and Soldering. 5.9 Safety precautions in metal joining processes.

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	Introduction	02	0	4	0	04
II	Metal Forming Processes	12	4	12	4	20
III	Metal Casting Processes	12	4	12	4	20
IV	Non Metal Moulding Processes	04	0	3	3	06
V	Metal Joining Processes	12	4	12	4	20
Total		42	12	43	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 household items which are prepared by joining processes.
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 industries/workshops in the nearby area which are producing components by casting/forming/moulding/Joining.
6	Identify the types of manufacturing processes used in making the main component of a car engine.

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-project 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 **14-16 (fourteen 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 could be added by the concerned course teacher:

- a) Prepare a small useful product (approved by teacher) 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.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Workshop Technology I & II	J. A. Schley	Tata McGraw Hill Education
2	Workshop Technology I & II	Raghuvanshi	Dhanpat Rai and Sons
3	Workshop Technology I, II &	W. A. J. Chapman	Arnold
4	Manufacturing Processes	M. L. Bagman	Wiley India
5	Production Technology	R.K. Jain and S.C. Gupta	Khanna publication
6	Welding Engineering	B.E. Rossi	Jefferson Publications
7	Audles Welding Guide	F.D. Graham	Wiley India
8	Foundry Engineering	P.L. Jain	Tata McGraw Hill Education
9	Principle of Foundry	Jain & Gupta	National Book Trust, India
10	Manufacturing Processes	S.E. Rusinoft	Times of India Press
11	Production Technology	H.H. Marshall	Machinery Publishing Company
12	Production Technology	HMT	Tata McGraw Hill Education
13	Elements of Workshop Technology (Vol I & II)	Hajra Chowdhary & Bhattacharya	Media Promoters

14. SOFTWARE/LEARNING WEBSITES

- a. www.youtube.com/watch?v=k6iODHla6qY
- b. http://web.iitd.ac.in/~pmpandey/MEL120_html/Metal%20Forming%20Processes.pdf
- c. http://thelibraryofmanufacturing.com/forming_basics.html
- d. http://www3.nd.edu/~manufact/MPEM%20pdf_files/Ch07.pdf
- e. www.ielm.ust.hk/dfaculty/ajay/courses/ieem215/lecs/3_forming.pdf
- f. www.youtube.com/watch?v=HkjdMdp9KVU
- g. <http://www-old.me.gatech.edu/jonathan.colton/me4210/casting.pdf>
- h. <http://www.mccannsales.com/book/sandcasting.pdf>
- i. <http://me.emu.edu.tr/me364/2.pdf>
- j. http://www.ielm.ust.hk/dfaculty/ajay/courses/ieem215/lecs/8_joining.pdf
- k. http://www.tech.plym.ac.uk/sme/mats116/Materialsjoiningprocesseslecturenotes_docx.pdf
- l. <http://www.aws.org/w/a/>
- m. www.youtube.com/watch?v=H3Qb9I03FCK
- n. www.youtube.com/watch?v=JqFp5kCeTA0
- o. www.youtube.com/watch?v=7F0ypF6ldrU
- p. <http://www.flamingfurnace.com/>
- q. <http://www.sme.org>
- r. <http://www.youtube.com/watch?v=IrcNSgLZuFs>(Metal Casting)
- s. <http://www.youtube.com/watch?v=Yk1JOYzWRP4>(Loose piece Pattern)
- t. http://www.youtube.com/watch?v=khEvjh_SM (Foundry Pattern making)
- u. <http://www.youtube.com/watch?v=f7FXtnXVqzY>(Aluminium Casting)
- v. <http://www.youtube.com/watch?v=dOw624I9FDQ>(Investment Casting)
- w. w:
<http://www.youtube.com/watch?v=bzSSfBkgWfc&NR=1&feature=endscreen>(Hot Chamber Die Casting Process)
- x. <http://www.youtube.com/watch?v=pTTap4WiEAU>(Gravity Die Casting)
- y. <http://www.youtube.com/watch?v=eUthHS3MTdA>(Plastic Injection Moulding)
- z. http://www.youtube.com/watch?v=6xnKmt_gsLs(Hot Rolling)
- aa. http://www.youtube.com/watch?v=9MU0vSN_w-A(Cold roll forming)
- bb. <http://www.youtube.com/user/IGEJohannesen?feature=watch>(Channel For welding videos)
- cc. <http://www.youtube.com/watch?v=SDJdiNeDXto>(Introduction to Welding)
- dd. <http://www.youtube.com/watch?v=CJ42scaWFnw>(Brazing video)

15. PO-COMPETENCY-CO MAPPING

Semester II	Manufacturing Engineering-1 (Course Code:)						
	POs						
Competency & Course Outcomes	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
<u>Competency</u>	Produce the job as per given specifications by selecting and applying appropriate manufacturing processes like Casting, Forming and Joining using safe working procedures.						
(a) Classify various mechanical manufacturing processes.	3						
(b) Select appropriate metal working processes to produce mechanical components.	3	2		3	2		2
(c) Select appropriate casting processes to produce mechanical components.	3	2		3	2		2
(d) Select moulding methods suitable for non metal components.	3	2			2		2
(e) Select metal joining methods for various applications.	3	2		3	2		2

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No.	Name and Designation	Institute	Contact No.	Email
1.	Shri C.J. SHAH, L.M.E.	SSGP, SURAT	9426526465	chiragshah72@rediffmail.com
2.	Shri N.G. PARMAR, L.M.E.	RCTI, AHMEDABAD	9426333054	ng_parmar@yahoo.co.in
3.	Shri B.V. PATEL, L.M.E.	BBIT, V.V. NAGAR	9925232822	bhaveshpatel1908@gmail.com
4.	Shri I.R. MOMIN, L.M.E.	RCTI, AHMEDABAD	9586970802	lqbal.momin786@gmail.com