GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
IV – Semester

Course Title: **Manufacturing Engineering Processes-III**
(Course Code: 4346501)

Diploma programmer in which this course is offered	Semester in which offered
Mechanical Engineering (CAD-CAM)	four

1. RATIONALE

This subject of Manufacturing Engineering Processes -III provides knowledge and embeds skill to students to develop different products using various machining process, rapid prototyping, and non-conventional machining process. Manufacturing processes are the most important element in any engineering industry. Large numbers of industrial parts have features like teeth, threads, slots, splines, surfaces etc. Quality of these parts depends on parameters aspects such as accuracy of profile, dimension & surface finish controls. Correct selection of process & its parameters on such machines; plays a vital role in obtaining required quality product at optimum cost. This course will make student familiar with fundamentals of cutting mechanics, kinematics, constructional features and selection criterion for various basic machine tools, rapid prototyping and advance machining process Developing strong domestic manufacturing base is vital for our country to accomplish the nation's vision "Make in India''.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different type of skills so that students are able to acquire at least following competencies:

- **Produce the part as per given drawing/specifications by adopting conventional machine tools and/or non-conventional machining processes using optimum process parameters, safe working procedures, suitable work & tool holding devices and appropriate cutting tools.**
- **Plan and supervise manufacturing operations at a shop floor of machine tools based manufacturing industries.**

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:

CO-1	Identify effect of machining parameter on quality of products.
CO-2	Produce the job with appropriate process, cutting tools, machine tools and cutting parameters for given work piece like gear, mechanical job with thread.
CO-3	Expose the students to different types of Rapid prototyping processes, materials used in RP systems.
C0-4	Select appropriate non – conventional machining method for different machining operations.
CO-5	Outline the role of computer and automation in manufacturing.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	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

Following practical outcomes (PrOs) are the sub-components of the Course Outcomes (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** (Includes Home Assignments)**:** Demonstrate various cutting parameters, carbide inserts with ISO designation system and explain the steps to calculate cutting speeds. Student will prepare the report on following. a. Tabulate various cutting tools materials with main elements, properties and applications. b. Calculate RPM for lathe, milling cutter and drill spindle strokes/minute for shaping/planning; based on given data. Use equations. Each student should be given different data for diameters and cutting speeds.	1 & 2	04
2	**Kinematics and motion transmission systems:** Demonstrate motion and power transmission path, transmission systems, work mounting systems, tool mounting systems and tool holders/holding. System of lathe, gear hobbing, gear milling, gear shaping, threading on lathe, drilling machine. **a.** Sketch and label main elements of machine kinematics. **b.** Write specification of Machine **c.** Sketch cutting tools with nomenclature, Sketch tool holders.	2, 4	02

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
3	**Produce job with various machining methods:** **a.** Sketch the production drawing of the part. Part should include plain/taper turning, step turning, cylindrical/surface grinding, etc. **b.** Outline the processes. **c.** Calculate/select, set, observe and record the cutting parameters for each process. **d.** List the cutting tools you have used. Also state specifications of each. **e.** List the work holding devices you have used. Also state specifications of each. **f.** Produce the part.	1, 2, 4	08
4	**Gear cutting:** Prepare a simple spur gear using milling operations including use of indexing head .Student will also prepare report including: **a.** Drawing of the job Gear. **b.** State equations to find module, pitch circle diameter, outside diameter, circular pitch and number of teeth. **c.** Produce spur gear on milling machine using indexing head. Calculate/select, set, observe and record the cutting parameters. **d.** List the cutting tools and work holding device you have used. Also state specifications of each.	2	06
5	**Thread cutting:** Prepare a job having threaded surfaces on lathe machine **a.** Sketch the production drawing of the part. **b.** Prepare a multi start/square threaded bolt and nut. Calculate/select, set, observe and record the cutting parameters for the process. **c.** List the cutting tools you have used. Also state specifications of each. **d.** List the work holding devices you have used. Also state specifications of each.	4	04
6	**Rapid prototyping machine(3D printer) (Demonstration)** To study the part builds mechanism of a Rapid prototyping machine. **a.** To develop CAD models using 3D Scanner/Software for 3D printer. **b.** To select a specific material for the given application. **c.** To produce a simple product using 3D printing or Additive Manufacturing (AM)	3	02

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
7	**Presentation:** **a.** Teacher will assign any one topic to each batch student from Unit number V &VI. Each student will have different topic. **b.** Using power point presentation, each student will present the topic. Presentation must include related Videos/images. **c.** Present the topic and submit the report of same.	1,3,6	02
8	**Technical visit/participation:** Visit manufacturing related industries (one must be having non-conventional manufacturing facilities) and prepare industry wise technical report. Hint: Before visit, faculty will remind student regarding portion of subject content (especially practice) not covered within institution premises (due to non-availability of resources). Faculty will also direct student's attention towards all possibility/scope available at the industries to be visited. Student will observe and record all such details like Specifications, Operating procedure, Selection of operational parameters, Details about tool/work holders used, Machine setting, Product details being manufactured for each method/machine like gear forming/generating, honing/lapping/buffing machine, Non-conventional machine, Jig boring machine, Broaching machine etc.	All	
		Total	**28**

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. Care must be taken in assigning and assessing study report as it is a third-year study report. Study report, data collection and analysis report must be assigned in a group. Teacher has to discuss about type of data (which and why) before group start their market survey.

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 machine tools & their equipment's (Knowledge)	10
2	Able to operate, set the machine and select machining parameters. (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

These major equipments with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practical in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1.	Hacksaw machine.	3 to 6
2.	Lathe with standard and special accessories.	3
3.	Milling machines-Vertical /horizontal with standard accessories and indexing/dividing head.	4
4.	Column drilling or Radial Drilling machine	4
5.	Shaper machine.	4
6.	Rapid Prototyping Machine	6
7.	HSS cutting tool and their tool holders	3 to 5
8.	Carbide inserts and their tool holders	4 ,5
9.	Drill bit and their tool holder	4

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 course competency.

a) Work as a leader/a team member.
b) Follow safety practices.
c) Follow ethical practices
d) Maintain tools and equipment
e) Practice environment friendly methods and processes. (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 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. Introduction to Manufacturing Engineering-III.	1a. Importance of Manufacturing engineering III	1.1 Introduction of process used in Industries like Gear manufacturing, thread production, Rapid Prototyping, Computer integrated manufacturing. Non-conventional and advance Methods of machining.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
	1b. Machine shop supervisor skill. 1c. the effect of different machining parameters on quality and cost of product.	1.2 Need of attitude, knowledge & skill required for shop floor supervision in Machine tools based industries for quality and cost effective production. 1.3 Importance of processes and required parameters (like material removal rate, cutting power, cutting time, cutting speed, feed, depth of cut, number of cuts, tool signature, tool life etc) on quality and cost of product.,
Unit– II **Gear manufacturing and finishing processes.**	2a. List types of gears 2b. Assimilate the Gear manufacturing & finishing processes. 2c. Describe constructional features and working of various gear manufacturing machines. 2d. Select appropriate gear manufacturing machine as per the given situation.	2.1 Types of gears and application, nomenclature of spur gear. 2.2 Gear generating and forming processes-concept, differences and applications. 2.3 Classification, constructional features, working and application of gear milling, gear hobbing and gear shaping machines. 2.4 Nomenclature and sketch of gear hob and gear shaping cutter.
	2e. Select gear cutting parameters for given materials and work- piece 2f. Gear finishing process	2.5 Gear Cutting parameters for commonly used materials and work-piece. 2.6 Gear finishing methods, requirement of gear finishing.
Unit– III **Rapid Prototyping**	3a. Explain Introduction, classification, application of rapid prototyping.	3.1 Fundamentals of Rapid Prototyping, advantages and limitations. 3.2 Classification of Rapid prototyping methods 3.3 Applications of rapid prototyping methods
	3b. Rapid prototyping methods, working principle, detail of process	3.4 Working principle, process detail of Stereo lithography apparatus, selective laser sintering, laminate object manufacturing & fused deposition modeling (3D printing).

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit– IV **Thread production Methods.**	4a. Explain thread production processes.	4.1 Thread nomenclature and important terminologies used in threads. 4.2 Various threads production processes like turning, rolling, grinding, taping, etc. their applications, advantages and limitations.
	4b. Describe constructional features and working of Various thread production machines. 4c. Select appropriate thread production machine as per the given situation. 4d. Explain different steps for producing thread on thread production machine.	4.3 Constructional features including coolant and lubrication systems, motion and power transmission path, working and application of various threads production machines/ processes like lathe, rolling, grinding, taping, etc. 4.4 Thread cutting parameters for commonly used materials and work-piece. 4.5 Tool mounting methods on thread production processes.
Unit-V **Computer integrated Manufacturing (CIM)**	5a. Concept and scope of Computer integrated Manufacturing (CIM) 5b. Role of management in CIM 5c. Role Manufacturing engineers in CIM 5d.introduction to automation	5.1 Introduction to CIM Concepts & scope of CIM, 5.2 Nature & type of manufacturing system. 5.3 Evolution, Benefits of CIM. 5.4 Role of management in CIM, Expert system & participate management. 5.5 Impact of CIM on personnel, Role of manufacturing engineers, CIM Wheel. 5.6 Introduction Automation in production system. Types of automation(fixed automation, programmable automation, flexible automation and integrated automation), Reasons for automation
Unit-VI **Non-conventional and advance methods of Machining.**	6.a Overview and requirement of Non- conventional Machining methods. 6.b Explain working principles and working parameters of non-conventional machining methods. 6.c Selection of nonconventional machining methods	6.1 Need of nonconventional machining and comparison between conventional & non-conventional machining methods. 6.2 Classification, working principles, application and working parameters of following non-conventional machining methods: i. Electro chemical machining (ECM). ii. Electro discharge machining (EDM) including wire cut and dies sinking. iii. Ultrasonic machining (USM).

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
		iv. Laser beam machining (LBM). v. Abrasive jet machining (AJM). vi. Plasma arc machining (PAM) vii. Water jet machining (WJM) 6.3 Criterion for selection of non-Conventional machining methods. 6.4 Introduction and application of MEMS.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	**Introduction to Manufacturing Engineering- III.**	**4**	**1**	**3**	**0**	**4**
2	**Gear manufacturing and finishing processes.**	**8**	**4**	**6**	**4**	**14**
3	**Rapid Prototyping**	**8**	**4**	**6**	**4**	**14**
4	**Thread production Methods.**	**6**	**2**	**4**	**4**	**10**
5	**Computer integrated Manufacturing (CIM)**	**6**	**4**	**5**	**3**	**12**
6	**Non-conventional and advance methods of Machining.**	**10**	**5**	**6**	**5**	**16**
Total		**42**	**20**	**30**	**20**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*

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 perform following activities in group and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

1. Prepare a report on at least one industrial component/product with its complete technical details covering the points like design criterion, features included with Dimensional/Geometric constraints, manufacturing resource requirements, challenges in controlling its quality and cost, etc.
2. Prepare report on product manufactured by rapid prototyping.
3. Collect the technical details about all production facilities available at nearby industry/industries.
4. Visit or participate in the technical events, exhibition, conference, seminar etc.
5. Collect/download at least four different machine tool catalogues including at least one special purpose, non-conventional or advance machine.

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:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) To acquire knowledge of basic machine, tool and their operation arrange two or more **industrial visit** of production industry. After visit student must be submit their industrial visit report.
c) Guide student(s) in undertaking micro-projects.
d) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
e) 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.
f) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.

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. However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed six.***

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 contribution 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 like various machining parts assembly/gear box/rapid prototyping model/useful thread assembly /small laboratory equipment/set-up utilizing laboratory resources.
b) Prepare a model for types of gear / types of different thread.
c) Design and manufacture various die or Jigs studied in Tool engineering subject
d) Prepare a report on product manufactured with various non-conventional process (design, machining methods, specification, parameters..)
e) Using Drafting software, prepare machining products drawing with tolerances, quality measure with operation sheets for manufacturing.

f) Survey nearby vendor for rapid prototyping, non-conventional machining, and gear and thread manufacturing etc. machining process and prepare report on products manufacture to reduce rejection, quality improvement, production rate etc..

g) Maintenance of available infrastructure related to Machining.

13. SUGGESTED LEARNING RESOURCES

Sr. No	Title of Book	Author	Publication with place, year and ISBN
1	Production Technology (Manufacturing Process)	Dr. P C Sharma	S Chand
2	Elements of Workshop Technology Volume No. II Machine Tools	Hajra Choudhary, Bose S. K., Roy Nirjhar	Media promotors and publishers pvt. Limited
3	Workshop Technology I & II	Raghuwanshi	Dhanpat Rai and Company(P) Limited
4	Machine tools technology	G. S. Kandasami	Khanna publisher
5	Fundamentals of Metal Machining and Machine Tools	W. A. Knight and Geoffrey Boothroyd	CRC Press
6	Modern Machining Processes	P. C. Pandey	Tata McGraw Hill, New Delhi
7	M.E.M.S.: Fundamental Technology and Application	VikasChoudhary, Krzysztof Iniewski	CRC Press
8	Production Technology	R. K. Jain and S. C. Gupta	Khanna Publishers
9	Production Technology	HMT	Tata Mcgraw-Hill Publishing Co.
10	All about Machine Tools	HEINRICH GERLING	New Age International Private Limited
11	Computer integrated manufacturing	S. Kant Vajpayee	Prentice Hall of India

14. SOFTWARE/LEARNING WEBSITES

1. https://nptel.ac.in/courses/112/105/112105126/
2. https://nptel.ac.in/content/storage2/courses/112105127/pdf/LM-32.pdf
3. https://nptel.ac.in/content/storage2/courses/112105127/pdf/LM-31.pdf
4. https://nptel.ac.in/courses/112/104/112104028/
5. https://archive.nptel.ac.in/courses/112/104/112104289/
6. https://www.me.iitb.ac.in/~ramesh/courses/ME338/non_trad.pdf
7. http://home.iitk.ac.in/~nsinha/Non-traditional-machining.pdf
8. http://www.youtube.com/watch?v=bmooEZyivxo
9. http://www.youtube.com/watch?v=mWy9awGv6so
10. http://www.youtube.com/watch?v=mKES5Fyz9l0
11. http://www.youtube.com/watch?v=BgGXQUeYNKw
12. ihttp://www.youtube.com/watch?v=eaeEn1Gs4aQ
13. http://www.youtube.com/watch?v=49GpJ7yhecg
14. http://www.youtube.com/watch?v=XfYXelZ4IaY

15. http://www.youtube.com/watch?v=SNWF_4jQ2pU
16. http://www.youtube.com/watch?v=pI1QGpmKqow
17. https://www.youtube.com/watch?v=NkC8TNts4B4
18. https://www.youtube.com/watch?v=KJj8CfnC0Ek
19. https://onlinecourses.nptel.ac.in/noc21_me115/p

15. PO-COMPETENCY-CO MAPPING

Semester IV	Manufacturing Engineering Processes-III (4346501)						
	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
Competency	**Make a part/component as per given specification using appropriate machine tools, work holding devices, cutting tools & tool holders by employing optimum process parameters and safe working procedures.**						
CO 1. Identify effect of machining parameter on quality of products.	3	2					
CO 2. Produce the job with appropriate process, cutting tools, machine tools and cutting parameters for given work piece like gear, mechanical job with thread.	3			2	3	2	2
CO 3. Expose the students to different types of Rapid prototyping processes, materials used in RP systems.	3	2		2	2		
CO 4. Select appropriate non – conventional machining method for different machining operations.	3			3	2		2
CO 5. Explain the knowledge about role of computer and automation in manufacturing.	3			2		2	

*Legend: '**3**' for high, '**2**' for medium, '**1**' for low and '**-**' for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

Sr. No	Name and Designation	Institute	Contact No.	Email
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