

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

**COURSE CURRICULUM
COURSE TITLE: MANUFACTURING ENGINEERING-III
(COURSE CODE: 3351903)**

Diploma Programme in which this course is offered	Semester in which offered
Mechanical Engineering/Mechatronics Engineering	5 th Semester

1. RATIONALE

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. These parameters are specified on the product drawing and require suitable machines & cutting tools for its manufacturing. Nano-parts largely used in control systems require specialised manufacturing approach due to their miniature size. 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 students familiar with fundamentals of such conventional & advance processes on various machines like grinding machines, super-finishing machines, broaching machines, jig boring machines, non-conventional machining processes, Micro Electro Mechanical Systems (MEMS) etc.

2. LIST OF 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

The theory should be taught and practical should be carried out in such a manner that students are able to acquire at least following learning outcomes in cognitive, psycho-motor and affective domain on the content specified in this subject.

- i.** Explain working of grinding, super finishing, gear cutting, broaching, threading, non-conventional and advance machining methods with kinematics and coolant/ lubrication systems stating functions of each element.
- ii.** Interpret designation system / method of cutting tools and tool holders used on machine tools.
- iii.** Set the machine and mount the job, cutting tools and tool holders correctly.
- iv.** Select appropriate cutting tools, work holding devices and cutting parameters for the given work piece.
- v.** Outline the process and produce the job/product as per given drawing/ specification.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
3	0	4	7	70	30	40	60	200

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

5. COURSE DETAILS.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I. Introduction to Manufacturing Engineering- III.	1a. Explain Need, Scope & importance of Manufacturing Engineering.	1.1 Need, Scope & importance of Manufacturing Engineering-III in the industries-----various grinding and super-finishing machines, thread production, broaching machines, electro-mechanical systems (MEMS). Non-conventional and advance methods of machining.
	1b. Define machining parameters 1c. Explain the effect of different machining parameters on quality and cost of product.	1.2 Definitions of machine tool, cutting speed, feed, depth of cut, metal removal rate, surface finish symbols and values, cutting tools and their geometry. 1.3 Need of attitude, knowledge & skill required for shop floor supervision in Machine tools based industries for quality and cost effective production. 1.4 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 Grinding and super finishing processes.	2a. Classify grinding machines 2b. Describe constructional features and working of various grinding and super-finishing machines. Gear manufacturing, 2c. Select appropriate finishing operation and grinding machine as per production drawing of the component.	2.1 Classification, Constructional features including coolant and lubrication systems, motion and power transmission path, working, application and cutting parameters of following grinding machines with “commonly used grinding wheels and work piece materials” : i. Cylindrical (centre less, internal and external) grinding machines. ii. Bench and portable grinder. iii. Tool and cutter grinding machine. iv. Profile grinding machine. 2.2 Methods of mounting work piece on cylindrical grinding machines (Including chuck and mandrel).
	2d. Explain Honing, lapping, buffing & super-finishing processes with their applications.	2.3 Honing, lapping, buffing and other super finishing processes and their applications.
	2e. Explain Cutting action of grinding wheel. 2f. Define Terms associated with grinding wheel operations including loading, glazing, dressing and truing. 2g. Select grinding wheel. 2h. Maintain grinding wheel for effective grinding.	2.4 Cutting action of grinding wheel. 2.5 Terms associated with grinding wheel operations including loading, glazing, dressing and truing. 2.6 Grinding wheels: i. Nomenclature. ii. Types and shapes. iii. Designation system and its interpretation. iv. Selection criteria and applications. 2.7 Static and dynamic balancing of grinding wheels - need and methods. 2.8 Methods of mounting grinding wheel.
Unit- III Gear manufacturing and finishing processes.	3a. List types of gears 3b. Assimilate the Gear manufacturing & finishing processes. 3c. Describe constructional features and working of various gear manufacturing machines. 3d. Select appropriate	3.1 Types of gears, nomenclature of spur and helical gears. 3.2 Gear generating and forming processes-concept, differences and applications. 3.3 Classification, constructional features including coolant and lubrication systems, motion and power transmission path, working and application of gear milling, gear hobbing and gear shaping machines.

	gear manufacturing machine as per the given situation.	3.4 Nomenclature and sketch of gear hob and gear shaping cutter.
	3e. Select gear cutting parameters for given materials and work-piece 3f. Explain procedural steps for producing accurate gears using gear milling, gear hobbing and gear shaping machines.	3.5 Gear Cutting parameters for commonly used materials and work-piece 3.6 Tool mounting methods on gear milling, gear shaping and gear hobbing machines. 3.7 Gear finishing processes- shaving & grinding.
Unit-IV Thread production methods.	4a. Explain thread production processes.	4.1 Thread nomenclature and important terminologies used in thread production. 4.2 Various threads production processes like turning, rolling, grinding, tapping, 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, tapping, etc. 4.4 Thread cutting parameters for commonly used materials and work-piece. 4.5 Tool mounting methods on thread production processes.
Unit-V Broaching, jig boring and special purpose machine (SPM) tools.	5a. Explain constructional features, working and applications of broaching machines. 5b. List types of broaching machines. 5c. Select appropriate broaching machine as per the given situation.	5.1 Types, constructional features including coolant and lubrication systems, motion and power transmission path, working and applications of broaching machines. 5.2 Different Shapes that can be produced by broaching process. 5.3 Nomenclature and sketch of a simple broach

	5d. Explain constructional features and working of jig boring machines.	5.4 Types, constructional features including coolant and lubrication systems, motion and power transmission path,, working and application of jig boring machines.
	5e. Identify SPM to produce a given complicated job.	5.5 Various SPM (Only names) and their areas of application. 5.6 Parts fit for SPM. 5.7 Comparison of SPM with other automates.
Unit-VI Non-conventional and advance methods of machining.	6a. Appreciate use of Non-conventional machining methods. 6b. Explain working principles and working parameters of non-conventional machining methods. 6c. Select a non-conventional machine as per requirement	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). iv. Laser beam machining (LBM). v. Abrasive jet machining (AJM). 6.3 Criterion for selection of non-conventional machining methods.
	6d. Explain micro electro-mechanical systems (MEMS). 6e. List materials used for MEMS. 6f. Explain working principle and applications of various MEMS fabrication techniques.	6.4 Need of micro electro-mechanical systems (MEMS). 6.5 Materials and their properties used for MEMS manufacturing. 6.6 Working principle and applications of MEMS fabrication techniques: i. Chemical vapour deposition. ii. Lithography. iii. Photolithography. iv. Dry & wet etching.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS AND MARKS (THEORY).

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to manufacturing engineering-III.	03	00	04	00	04
II	Grinding and super finishing processes.	09	07	07	04	18
III	Gear manufacturing and finishing processes.	08	04	05	03	12
IV	Thread production methods.	05	02	04	04	10
V	Broaching, jig boring and special purpose machine tools.	08	05	04	03	12
VI	Non-conventional and advance methods of machining.	09	05	06	03	14
	Total	42	23	30	17	70

Legends: R = Remember U = Understand; A = Apply and above levels (Bloom's revised 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.

General Notes:

- If mid semester test is part of continuous evaluation, unit no I, II, III & VI (Up to 6.3 only) are to be considered.
- Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.

7. SUGGESTED LIST OF EXERCISES/PRACTICALS.

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills (**outcomes in psycho-motor and affective domain**) so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

Note: Here only outcomes in psycho-motor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured. Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical Exercises (outcomes in psycho-motor Domain)	Approx. Hours. required
1	I	<p>Preparatory activity (Includes Home Assignments):</p> <p>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.</p> <ol style="list-style-type: none"> Tabulate various cutting tools materials with main elements, properties and applications. Calculate RPM for lathe, milling cutter and drill spindle; based on given data. Use equations. Each student should be given different data for diameters and cutting speeds. Calculate strokes/minute for shaping/planning machine based on given data. Use equations. Each student should be given different data for cutting speeds and length of jobs. 	02
2	All	<p>Mini Project:</p> <p>Manufacture the assembly which has been designed in the course Design of Machine Elements. Keep the same batch. Student will prepare the report on following.</p> <ol style="list-style-type: none"> Prepare production drawings of the assembly and details. Manufacture the parts. Note down work holding devices, cutting tools and cutting parameters used for each part and each operations. Summarised this in tabular form. On completion, present and share the experience of this mini project with photos/videos of mini project execution and with work distribution executed. Use power point presentation. 	08
3	II, III,IV & V	<p>Kinematics and motion transmission systems:</p> <p>Demonstrate motion and power transmission path, transmission systems, work mounting systems, tool mounting systems and tool holders/holding systems of cylindrical/surface grinding, tool and cutter grinding, gear hobbing, gear milling, gear shaping, threading and broaching machines. Student will prepare the machine wise report on all machines included here.</p> <ol style="list-style-type: none"> Sketch and label main elements of machine kinematics. Demonstrate and explain machining process with position/motion of work piece and tool. Video may 	08

		<p>also be used.</p> <p>c. Sketch cutting tools with nomenclature.</p> <p>d. Sketch tool holders.</p> <p>e. Explain methods of work and tool mounting systems.</p> <p>f. Tabulate cutting parameters for commonly used tool materials and work piece materials.</p>	
4	I	<p>Grinding various cutting tool angles:</p> <p>a. Sketch single point cutting tool.</p> <p>b. List various angles on single point cutting tool and state importance of each.</p> <p>c. Sketch set up to grind each angle on tool and cutter grinder.</p> <p>d. Grind the single point cutting tool on tool and cutter grinder.</p>	02
5	II	<p>Produce job with various machining methods:</p> <p>a. Sketch the production drawing of the part. Part should include plain/taper turning, knurling, threading, cylindrical/surface grinding, etc.</p> <p>b. Outline the processes.</p> <p>c. Calculate/select, set, observe and record the cutting parameters for each process.</p> <p>d. List the cutting tools you have used. Also state specifications of each.</p> <p>e. List the work holding devices you have used. Also state specifications of each.</p> <p>f. Produce the part.</p>	08
6	II, &IV	<p>Produce complex job:</p> <p>a. Sketch the production drawing of the part. Part should include shaping, milling, drilling, tapping, boring, slotting, surface grinding, etc.</p> <p>b. Outline the processes. Prepare process plan for the same.</p> <p>c. Prepare workshop layout and route sheet.</p> <p>d. Produce the part, Calculate/select, set, observe and record the cutting parameters for each process.</p> <p>e. List the cutting tools you have used. Also state specifications of each.</p> <p>f. List the work holding devices you have used. Also state specifications of each.</p>	10
7	III	<p>Gear cutting:</p> <p>a. Sketch the production drawing of the part.</p> <p>b. State equations to find module, pitch circle diameter, outside diameter, circular pitch and number of teeth.</p> <p>c. Produce spur gear on milling machine using</p>	06

		<p>indexing head. Calculate/select, set, observe and record the cutting parameters.</p> <p>d. List the cutting tools you have used. Also state specifications of each.</p> <p>e. List the work holding devices you have used. Also state specifications of each.</p>	
8	IV	<p>Thread cutting::</p> <p>a. Sketch the production drawing of the part.</p> <p>b. Prepare a multi start/square threaded bolt and nut. Calculate/select, set, observe and record the cutting parameters for the process.</p> <p>c. List the cutting tools you have used. Also state specifications of each.</p> <p>d. List the work holding devices you have used. Also state specifications of each.</p>	06
9	V &VI	<p>Presentation:</p> <p>a. Teacher will assign any one topic to each batch student from Unit number V &VI. Each student will have different topic.</p> <p>b. Using power point presentation, each student will present the topic. Presentation must include related movie/s.</p> <p>c. Teacher will assign the topic on cutting tools/work holding devices/machine tools(Unit II to V). Each student will have different topic. Student will download the content, preferably videos/catalogues and will present the same.</p>	06
10	All	<p>Technical visit/participation:</p> <p>a. Visit at least three 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.</p>	--

		b. Prepare a technical report on latest technical events, exhibition, seminar visited.	
		Total Hours	56

Notes:

- a. It is compulsory to prepare log book of exercises. It is also required to get each exercise recorded in logbook, checked and duly dated signed by faculty. PA component of practical marks is dependent on continuous and timely evaluation of exercises.
- b. Term work report must not include any photocopy/ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only.
- c. Mini project and presentation topic/area has to be assigned to the students in the beginning of the term by faculty.
- d. Student activities are compulsory to perform.
- e. Term work content of industrial visit report should also include following in addition to content of experience number 10. Duplication may be avoided.
 - i. Brief details of industry visited.
 - ii. Type, location, products, rough layout, human resource, etc of industry.
 - iii. Details, description and broad specifications of machineries/ processes observed.
 - iv. Safety norms and precautions observed.
 - v. Student's own observation on industrial environment, productivity concepts, quality consciousness and quality standards, cost effectiveness, culture and attitude.
 - vi. Any other details / observations suggested by the accompanying faculty.
- f. For practical ESE part, students are to be assessed for competencies achieved. They should be assigned production drawing of part to be produced at workshop. Due weightage should be given to Knowledge, skill, approach and safety practices demonstrated by an individual in producing the given part/exercise.

8. SUGGESTED LIST OF STUDENT ACTIVITIES.

SR.NO.	ACTIVITY.
1	Prepare a report on at least one industrial component 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	Collect the technical details about all production facilities available at nearby industry/industries.
3	Visit or participate in the technical events, exhibition, conference, seminar etc.
4	Collect/download at least four different machine tool catalogues including at least one special purpose, non-conventional or advance machine.
5	Collect/download at least one catalogue each of cutting tool, work holding device and tool holder.

9. SPECIAL INSTRUCTIONAL STRATEGIES.

Sr. No.	Unit	Unit Name	Strategies
1	I	Introduction to manufacturing engineering-III.	Demonstration on machine, Power point presentations.
2	II	Grinding and super finishing processes.	Demonstration on machines, videos, live explanation at workshop place, presentations, industrial visits.
3	III	Gear manufacturing and finishing processes.	Demonstration on machines, videos, live explanation at workshop place, presentations, industrial visits.
4	IV	Thread production methods.	Demonstration on machines, videos, live explanation at workshop place, presentations, industrial visits.
5	V	Broaching, jig boring and special purpose machine tools.	Demonstration on machines, videos, live explanation at workshop place, presentations, industrial visits.
6	VI	Non-conventional and advance methods of machining.	Videos on trends, presentations.

10. SUGGESTED LEARNING RESOURCES.

A) List of Books.

Sr.No.	Title	Author	Publisher
1	Machine tools technology	G. S. Kandasami	Khanna publisher
2	All about machine tools	Gerling	John Wiley & Sons Canada, Limited
3	Machine tools	B. Chennov	
4	Machine tool design Vol.-I to IV	N. Acherkan	Mir publisher
5	Metal cutting technology & Experiments	K. G. Chandiramani	Tata McGraw Hill, New Delhi
6	Engineering Productivity Vol.1 & 2	W F Walker	Crosby Lockwood & Son LTD
7	Principles of Engineering Production (Higher techniques)	A. Lissaman and S. Martin	Hodder Arnold
8	Production Engineering Sciences	Dr. P. C. Pande & C. K. Singh	Standard Publishers Distributors
9	Fundamentals of Metal Machining and Machine Tools	W. A. Knight and Geoffrey Boothroyd	CRC Press
10	The Art of Tool & Cutter Grinding	S. P. Narang	S. Chand
11	Production Technology ISBN: 9780070964433	HMT	Tata McGraw Hill, New Delhi
12	Advanced Machining	V.K.Jain	Allied Publishers,

	Processes		New Delhi
13	Modern Machining Processes	P. C. Pandey	Tata McGraw Hill, New Delhi
14	M.E.M.S. and microsystems: design and manufacturing.	Tai-Ran Hsu	McGraw-Hill
15	M.E.M.S.: Fundamental Technology and Application	VikasChoudhary, Krzysztof Iniewski	CRC Press
16	Manufacturing Technoligy	Kalpak Jian	

B) List of Major Equipment/ Instrument with Broad Specifications:

SR.NO.	Resource with brief specification.
1	Centre lathe, minimum 500 mm between centre, with required set of work holding devices, cutting tools, accessories and tool holders. Cutting tools to include carbide inserts and related tool holders for carbide inserts.
2	Horizontal milling machine, minimum 500 mm longitudinal traverse, with required set of work holding devices, cutting tools, accessories and tool holders. Cutting tools to include carbide inserts and related tool holders for carbide inserts. Should also include indexing head.
3	Drilling (Column and radial both), minimum 25 mm capacity, with required set of work holding devices, cutting tools, accessories and tool holders.
4	Tool and cutter grinding machine, with required set of work holding devices, cutting tools, accessories and tool holders.
5	Cylindrical grinding machine, minimum 50 mm outside diameter can be ground, minimum work piece length to be ground should be 500 mm, with required set of work holding devices, cutting tools, accessories and tool holders. Or Surface grinding machine.

C) List of Software/Learning Websites:

- i. <http://nptel.ac.in/video.php?subjectId=112105126>
- ii. <http://nptel.ac.in/courses.php?disciplineId=112>
- iii. <http://nptel.ac.in/courses/112104028/>
- iv. <http://nptel.ac.in/courses/112105126/27>
- v. <http://www.youtube.com/watch?v=bmooEZYivxo>
- vi. <http://www.youtube.com/watch?v=mWy9awGv6so>
- vii. <http://www.youtube.com/watch?v=mKES5Fyz9l0>
- viii. <http://www.youtube.com/watch?v=BgGXQUeYNKw>
- ix. <http://www.youtube.com/watch?v=eaeEn1Gs4aQ>
- x. <http://www.youtube.com/watch?v=49GpJ7yhecg>
- xi. <http://www.youtube.com/watch?v=XfYXelZ4IaY>
- xii. http://www.youtube.com/watch?v=SNWF_4jQ2pU
- xiii. <http://www.youtube.com/watch?v=pI1QGpmKqow>

- xiv. <http://www.youtube.com/watch?v=N7NofmHWWPQ>
- xv. http://en.wikipedia.org/wiki/Microelectromechanical_systems
- xvi. <http://www.engineersgarage.com/articles/mems-technology>

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. M. M. Jikar**, HOD, Mechanical Engineering, N. G. Patel Polytechnic, Bardoli.
- **Prof. J. P. Parmar**, Lecturer in Mechanical Engineering, C. U. Shah Polytechnic, Surendranagar.
- **Prof. P. M. Rojasra**, Lecturer in Mechanical Engineering, Sir B. P. T. I., Bhavnagar.

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. S.K.Pradhan**, Associate Professor, Mechanical Engg. NITTTR, Bhopal
- **Dr. A.K.Sarathe**, Associate Professor, Mechanical Engg. NITTTR, Bhopal