GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: MANUFACTURING ENGINEERING - II
(Code: 3341901)

Diploma Programme in which this course is offered	Semester in which offered
Mechanical Engineering, Mechatronics Engineering	4th Semester

1. RATIONALE

Large number of industrial parts has to undergo various machining operations for conversion into finished products. Appropriate selection and usage of machine tool, work holding devices, cutting tools and process parameters plays very crucial role in obtaining good 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 and automates with some basic exposure to conventional work holding devices and cutting tools and tool holders used on the same machines.

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:

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.

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Explain mechanics of cutting.
ii. Classify and explain working of basic machine tools with kinematics.
iii. Observe and conclude the effect of varying tool materials, cutting parameters and work piece materials.
iv. Interpret and select tool and tool holder designation system.
v. Identify the machine tool and select cutting parameters for given job.
vi. Make the job as per given manufacturing drawing.

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 Student Activity; **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 and mechanics of cutting**	1a. Explain mechanics of cutting.	1.1 Need, scope & importance of manufacturing processes in industries. 1.2 Need of attitude, knowledge & skill required for shop floor supervisor in machine tools based industries. 1.3 Differentiate between forming and generating processes. 1.4 Mechanics of cutting action, orthogonal and oblique cutting. (Without derivation).
	1b. Explain the effect of varying cutting parameters.	1.5 Chip formation, types of chips. 1.6 Forces acting on tool and chip, methods to compute cutting force using dynamometer. 1.7 Concept and definition of cutting speed, feed and depth of cut. 1.8 Cutting fluid- basic need, types, properties and its applications. 1.9 Influence of cutting variables on surface finish, tool life, economy, and mass production. 1.10 Safety precautions in machine tools.
Unit – II **Basic machine tools-I**	2a. Explain classification, working principles, construction and operation of lathe and drilling machines. 2b. Describe mechanism & motion transmission in lathe and drilling machines. 2c. Explain work holding devices for lathe and drilling machines.	2.1 Define and classify basic machine tools. 2.2 Movements of tool, job, slides and work holding devices during cutting operation on various machine tools. 2.3 Lathe machine. i. Types. ii. Working principle (using block diagram). 2.4 All geared head stock centre lathe. i. Constructional features. ii. Kinematics-(drive, head stock, feedbox, carriage, cross slide, top slide, swivel, apron, tailstock,) constructional sketch, working, and use. iii. Detailed specifications. iv. Operations performed. v. Work holding devices-constructional sketch, working and applications. (3 jaw chuck, 4 jaw chuck, face plate, centers).

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		vi. Lead screw and feed rod mechanisms. vii. Thread cutting setting-concept methods and simple numerical. viii. Accessories- types, constructional sketch, working and applications. 2.5 Metal removal rate (MRR) – concept and method to calculate on lathe. 2.6 Drilling machine. i. Types. ii. Working principle (using block diagram). 2.7 Redial drilling machining. i. Constructional features. ii. Kinematics (drive, spindle speeds, feed mechanism, radial movement, etc.) constructional sketch, working, and use. iii. Detailed specifications. iv. Accessories- types, constructional sketch, working and applications. v. Tool holding and setting methods. vi. Operations performed. vii. Work holding devices- constructional sketch, working and applications. 2.8 Metal removal rate (MRR) –method to calculate on drilling machine.
Unit – III **Basic machine tools- II**	3a. Explain classification, working principles, construction and operation of milling machine. 3b Describe mechanism & motion transmission in milling machine.	3.1 Milling machine. i. Types. ii. Working principle (using block diagram). 3.2 Plain horizontal milling machining. i. Constructional features. ii. Kinematics (drive, spindle speeds, feed mechanism, table movement, etc.) constructional sketch, working, and use. iii. Detailed specifications. iv. Operations performed.
	3c. Select appropriate milling cutter for required milling	3.3 Milling cutters-types and applications. 3.4 Up milling and down milling- concept, advantages, disadvantages and

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	operation.	applications.
	3d.Calculate number of revolutions of indexing head for given requirements using appropriate indexing method.	3.5 Indexing-dividing head- constructional sketch, working, and use. 3.6 Simple, differential and compound indexing methods with simple numerical. 3.7 Work holding devices- constructional sketch, working and applications. 3.8 Metal removal rate (MRR) – concept and method to calculate on milling.
Unit – IV **Basic machine tools-III**	4a. Explain types, working principles, construction and operations of shaping, slotting and planning machines. 4b. Describe mechanisms & motion transmission in shaping, slotting and planning machines.	4.1 Shaping machine. i. Types. ii. Working principle (using block diagram). iii. Constructional features and detailed specifications. iv. Quick return mechanisms- kinematic sketch, working and advantages. v. Operations performed. vi. Work holding devices- constructional sketch, working and applications. 4.2 Slotting machine. i. Types. ii. Working principle (using block diagram). iii. Constructional features and detailed specifications. iv. Operations performed. v. Work holding devices- constructional sketch, working and applications. 4.3 Planning machine. i. Types. ii. Working principle (using block diagram). iii. Constructional features and detailed specifications of double column planner iv. Operations performed. v. Work holding devices- constructional sketch, working and applications.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – V **Cutting tools and tool holders**	5a. Select cutting tool material for given work piece material and machining operation. 5b. Describe various effect of alloying elements on tool properties.	5.1 Various cutting tool materials, their compositions and properties. 5.2 Alloying elements in tool materials and their effects.
	5c. Interpret carbide insert and tool holder designation system. 5d. Suggest suitable carbide inserts and tool holder for specified operation.	5.3 Carbide inserts: i. Designation method for turning, milling and drilling (As per ISO). ii. Need. iii. Benefits. 5.4 Tool holders for carbide inserts: i. Designation method for turning, milling and drilling (As per ISO). ii. Need. iii. Benefits. iv. Mounting and replacement methods of carbide insert. 5.5 General cutting parameters for various cutting tool materials (HSS and Carbide) and work piece materials.(low carbon steel, high carbon steel, stainless steel, gunmetal, cast iron and aluminum).
	5e. Explain tool angles of cutting tools and their importance.	5.6 Cutting tool angles and their functions. 5.7 Various cutting tools (with tool geometry, nomenclature, tool materials, sketch/drawing of each, ISO/BIS standards) used for various operations on lathe, milling and drilling machines. i. Single point cutting tool. ii. Plain milling cutter. iii. Side and face milling cutter. iv. Centre drill. v. Twist drill. 5.8 Functions and types of chip breakers.
	5f. Explain factors affecting tool life.	5.9 Tool life, tool wear and machinability, factors affecting them. 5.10 Re-sharpening of cutting tools specified at 5.7 above.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – VI **Automates**	6a. Explain classification, working principles, construction and operation of capstan lathe, turret lathe and automats. 6b. Outline the tool layout for Capstan & Turret Lathe	6.1 Capstan and turret lathe: i. Constructional features and working principle. ii. Functions and applications. iii. Difference between capstan and turret lathe. iv. Preparation of tool layout. v. Merits and demerits. vi. Turret lathe in comparison with basic centre lathe. vii. Work holding devices. 6.2 Single spindle Automats: i. Need. ii. Constructional features. iii. Working principle and applications. iv. Collets-constructional features and applications. 6.3 Introduction to multi spindle automates and special purpose automates.

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

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction and mechanics of cutting	06	6	2	2	10
II	Basic machine tools-I	10	3	6	7	16
III	Basic machine tools-II	08	2	6	6	14
IV	Basic machine tools-III	06	2	6	2	10
V	Cutting tools and tool holders	08	2	4	8	14
VI	Automates	04	0	4	2	06
Total		**42**	**15**	**28**	**27**	**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:

a. If midsem test is part of continuous evaluation, unit numbers I, II (Up to 2.5 only) and III are to be considered.

b. 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 psychomotor 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 psychomotor 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.

Sr. No.	Unit No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs. required
1	I	**Preparatory Activity:** a. For given work piece and tool material; select, set and observe cutting speed, feed and depth of cut on lathe machine. Also define these terms. b. Calculate metal removal rate (MRR) for above case. c. Identify various cutting tools, its geometry and material available at workshop. Sketch them. d. Identify various carbide inserts and ISO codification. e. Calculate revolution per minute (RPM) for lathe, milling cutter and drill spindle based on given data.	06
2	I	**Effect of Varying Cutting Parameters:** Demonstrate type of chips, surface finishes and tool life for varying cutting parameters for same work piece material and tool material. Tabulate the observations.	02
3	I	**Effect of Varying Work Piece Materials:** Demonstrate type of chips, surface finishes and tool life for varying work piece material with same cutting parameters. Tabulate the observations.	02
4	II	**Turning Job:** Prepare a job on centre lathe as per the given drawing. (Including plain turning, taper turning, knurling, threading, grooving, etc). Student will also prepare report including: a. Drawing of the job. b. Operation sequences including details of cutting parameters used. c. Sketch of cutting tools used. d. Specification of machines used. e. Machine settings for threading.	12

5	III	**Milling Job:** Prepare a job using milling operations including use of indexing head (Excluding gear tooth cutting). Student will also prepare report including: a. Drawing of the job. b. Operation sequences including details of cutting parameters used. c. Sketch of cutting tools used. d. Specification of machines used. e. Machine settings for indexing.	10
6	IV	**Shaping and Drilling Job:** Prepare a job having plain and inclined surfaces on shaping machine with minimum two holes as per given drawing. Student will also prepare report including: a. Drawing of the job. b. Operation sequences including details of cutting parameters used. c. Sketch of cutting tools used. d. Specification of machines used.	10
7	V	**Single Point Cutting Tool:** a. Sketch single point cutting tool(SPCT) with nomenclature. b. Grind SPCT as per given geometry. c. Sketch the set up to grind each angle of SPCT.	04
8	VI	**Tool Layout:** Prepare a tool lay-out of a given component for capstan and turret lathe.	02
9	ALL	**Industrial Visit:** Visit A Nearby Machine Shop And Prepare A Two Page Report Comprises Of List Of Machine Tools Including Automates, Its Technical Specification, Machining Parameters For Various Operations Being Performed, Cutting Tools And Work Holding Devices Used, Observation Of Skill And Safety Criteria.	02
10	ALL	**Mini Project and Presentation:** For a given product (different for each student) prepare complete report in suggested format including selection of raw material type & section, sequence of various manufacturing operations, selection of machine, machining parameters, work holding device, tool holder, etc. For each machining operation. Each student will also present the outcome.	06
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 teacher.

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 student in the beginning of the term by batch teacher. This has to be assigned individually to each student.
d. Student activities are compulsory and are also required to be performed and recorded in logbook.
e. For 40 marks ESE, students are to be assessed for competencies achieved. They should be given following tasks (minimum two):
    i. Sketch or explain tool geometry for a given cutting tool.
    ii. Prepare a job on lathe machine. (At least two operations).
    iii. Prepare a job on shaper and drilling machine. (At least two operations).
    iv. Prepare a job on milling machine.
    v. Prepare a tool lay out for a given component for capstan & turret lathe.

8. SUGGESTED LIST OF STUDENT ACTIVITIES

SR.NO.	ACTIVITY.
1	Select two industrial components (approved by teacher) and list various machine tools and operations used to produce these components. Use one component for mini project and presentation.
2	Prepare a list of household items which are prepared by machining processes.
3	Identify and list different cutting tools available in your institute's workshop.
4	Collect/download at least four different machine tool catalogues including at least one automate.
5	Collect/download at least one catalogue each of cutting tool, work holding device and tool holder.
6	Identify type of electric motor used in each type of machine tools in your college workshop.

9. SPECIAL INSTRUCTIONAL STRATEGIES

Sr. No.	Unit	Unit Name	Strategies
1	I	Introduction and mechanics of cutting	Chart, PPT, Demonstration, Video.
2	II	Basic machine tools-I	Chart, PPT, Demonstration, Video, Industrial/workshop visit, machine tool catalogues
3	III	Basic machine tools-II	Chart, PPT, Demonstration, Video, Industrial/workshop visit, machine tool catalogues
4	IV	Basic machine tools-III	Chart, PPT, Demonstration, Video, Industrial/workshop visit, machine tool catalogues
5	V	Cutting tools and tool holders	Chart, PPT, Demonstration, Video, Industrial/workshop visit, physical tools, cutting tool catalogues
6	VI	Automates	Chart, PPT, Demonstration, Video, Industrial/workshop visit, work & tool holding

			device catalogues

10. SUGGESTED LEARNING RESOURCES

(A). List of Books:

Sr no.	Title of Books	Author	Publication
1	Workshop Technology I &	J. A. Schey	McGraw-Hill
2	Workshop Technology I & II	Raghuwanshi	Dhanpat Rai and Company(P) Limited
3	Workshop Technology I, II & III	W. A. J. Chapman	Viva books
4	Manufacturing Processes	M. L. Begman	John Wiley and Son
5	Production Technology	R. K. Jain and S. C. Gupta	Khanna Publishers
6	Elements of Workshop Technology Volume No. II Machine Tools	Hajra Choudhary, Bose S. K., Roy Nirjhar	Media promotors and publishers pvt. Limited
7	Manufacturing Processes	S. E. Rusinoff	Times of India Press
8	Production Technology	H. H. Marshall	Pitman
9	Production Technology	HMT	Tata Mcgraw-Hill Publishing Co.
10	All about machine tools	Gerling	John Wiley & Sons Canada, Limited
11	Manufacturing processes – I	Bava	McGraw-Hill

(B) List of equipments:

i Following machine tools.
- a. Hacksaw.
- b. Lathe with standard and special accessories.
- c. Milling machines-Vertical and Horizontal with standard accessories and indexing/dividing head.
- d. Column drill.
- e. Radial Drill.
- f. Shaper.
- g. Slotting.
- h. Planning.
- i. Tool and cutter grinder.
- j. Automats-turret and capstan.

ii Required cutting tools-HSS and Carbides.

iii Required cutting tool holders.

(C) List of Software/Learning Websites:

i. http://nptel.iitm.ac.in/video.php?subjectId=112105126
ii. http://nptel.iitm.ac.in/courses/Webcoursecontents/IIT%20Kharagpur/Manuf%20Proc%20II/pdf/LM-01.pdf
iii. http://www.youtube.com/watch?v=H0AyVUfl8-k&list=PLEFE7D1579523C45D
iv. http://www.youtube.com/watch?v=FFzRIop5bpg&list=PL843C2A830C65E2EE
v. http://www.youtube.com/watch?v=81Fdif5e85c
vi. http://www.youtube.com/watch?v=A0dTvf_Q8BA&list=PL2C105C94D2955C8B
vii. http://www.youtube.com/watch?v=tDc0l9Gm8D4&list=PL3AFB507B668AF162
viii. http://www.youtube.com/watch?v=THVgkBnjLq0
ix. http://www.youtube.com/watch?v=6VpCBk7FahI
x. http://www.youtube.com/watch?v=7wC1u4WOV1o
xi. http://www.youtube.com/watch?v=VDIoUZuTunI
xii. http://www.youtube.com/watch?v=fGqc9mZS0YI
xiii. http://www.youtube.com/watch?v=Mn9jpqI8rao
xiv. http://www.youtube.com/watch?v=8SuoH5aL1SY
xv. http://www.youtube.com/watch?v=xxNZSQML_ZA
xvi. http://www.youtube.com/watch?v=XXUHZxweBcw&list=PLD07DE61CB871A0CB

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. R. M. Rajyaguru**, Lecturer in Mechanical Engineering, G. P. Rajkot.
- **Prof. M. K. Patel**, Lecturer in Mechanical Engineering, M. L. Institute of Diploma Studies, Bhandu.

Coordinator and Faculty Members from NITTTR Bhopal.

- **Prof. Sharad K. Pradhan**, Head, Department of Mechanical Engineering.
- **Dr. K.K. Jain,** Professor and Dean, Department of Mechanical Engineering

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: THERMAL ENGINEERING- I
(Code: 3341902)

Diploma Programme in which this course is offered	Semester in which offered
Mechanical Engineering	4th Semester

1. RATIONALE

In industry, the mechanical engineers are supposed to operate and maintain thermal equipment. This course will provide the basic knowledge of thermal engineering which will function as foundation in applications in major fields of mechanical engineering and technology notably in steam and nuclear power plants. This course would develop knowledge and skills related to boilers, boiler mountings and accessories, compressors, heat exchangers, steam turbines etc. This course is thus very important for mechanical engineers.

2. COMPETENCY

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

- **Apply basic concepts, laws and principles of thermal engineering to operate and maintain equipment, devices and machines working in mechanical engineering systems.**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Determine steam properties and dryness fractions.
ii. Classify and explain boilers, boiler mountings and accessories.
iii. Determine boiler performance based on given specific parameters.
iv. Explain working of steam prime movers.
v. Identify the elements and processes of steam condensers and cooling towers.
vi. Operate air compressors and observe the parameters affecting the performance.
vii. Calculate heat transfer for given heat transfer system.

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	2	3	70	30	20	30	150

Legends: L -Lecture; **T** -Tutorial/Teacher Guided Student Activity; **P** -Practical; **C** - Credit; **ESE**-End Semester Examination; **PA** -Progressive Assessment

5. COURSE DETAILS

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I **Two phase system**	1a. Describe steam formation process and terminology.	1.1 Concept of two phase system. 1.2 Formation of steam, its various phases, definition and representation of wet steam, dry steam, saturated steam and superheated steam on PV, T-s and H-s diagram. 1.3 Concept and determination of dryness fraction and degree of superheat. 1.4 Concept and determination of latent heat, sensible heat, enthalpy, entropy and specific volume of steam.
	1b. Use steam table and Mollier chart for determination of steam property.	1.5 Use of Steam tables and Mollier chart- (Heat Entropy Chart). 1.6 Numerical examples based on above.(1.1 to 1.5).
	1c. Determine dryness fraction of steam. 1d. Explain throttling process.	1.7 Throttling process. 1.8 Methods of measurement of steam quality, Calorimeters- Bucket, Separating, Throttling and Combined calorimeters. (No numerical Problems).
Unit – II **Boilers, mountings and accessories**	2a. Explain the working of boilers, mountings and accessories.	2.1 Steam boiler-concept, definition as per Indian Boilers Regulation (IBR), functions, features and classification. 2.2 Working, merits and demerits of following low pressure steam boilers: i. Simple vertical boiler. ii. Lancashire boiler. iii. Cornish boiler. iv. Cochran boiler. v. Babcock and Wilcox water tube boiler. vi. Packaged boiler. vii. Waste heat recovery boiler. 2.3 Boiler mountings and accessories- functions, working and location on boilers. 2.4 Boiler draught system-concept and classification.
	2b.Determine boiler performance.	2.5 Boiler performance – parameters, evaporative capacity, equivalent evaporation, efficiency, heat balance sheet, simple numerical examples based on these. 2.6 Concept of fluidized bed combustion

Unit	Major Learning Outcomes	Topics and Sub-topics
		boilers. 2.7 Maintenance, inspection and safety precautions in boiler house (As per IBR), check list in boilers.
Unit – III **Steam prime movers**	3a.Explain principle of working and construction of Steam turbine. 3b.Apply principle of steam nozzles to solve simple examples.	3.1 Concept and classification of prime movers. 3.2 Steam nozzles-types, working and applications. Mass and velocity of steam discharge through nozzle (No derivation). Simple examples. 3.3 Steam turbine – concept and classification. Impulse and reaction turbines (constructional and materials details.)-working and differences.
	3c.Describe compounding of steam turbine.	3.4 Compounding of steam turbine: i. Need. ii. Pressure compounding. iii. Velocity compounding. iv. Pressure velocity compounding.
Unit – IV **Steam condensers and cooling towers**	4a.Describe working of condensers.	4.1 Elements of a steam condensing plant, concept, function and classification of condensers. 4.2 Jet condensers and surface condensers- constructional sketch, working and differences.
	4b.Determine efficiency of condensers.	4.3 Vacuum efficiency and condenser efficiency of condensers- simple numerical example.
	4c.Describe working of cooling towers.	4.4 Classification, function and working of cooling towers.
Unit – IV **Air compressors**	5a.Explain principle, construction and working of air compressors.	5.1 Air compressor-concepts, functions, classification and applications. 5.2 Working of reciprocating air compressor and rotary air compressors. 5.3 Single stage air compressor and multistage air compressor: i. Working. ii. Inter-cooling & after cooling.
	5b.Calculate power requirement and volumetric efficiency of reciprocating air compressor.	5.4 Power required and efficiency of reciprocating air compressors-single and two stages, simple numerical examples. 5.5 Concept of screw compressors for oil free air.

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – V **Heat transfer**	6a.Explain modes of heat transfer. 6b.Determination of heat transfer through cylinder and wall.	6.1 Various modes of heat transfer. 6.2 Conduction heat transfer- Fourier's law- explanation (No Cartesian or other equation derivation), thermal conductivity, heat transfer through a plain wall, composite wall and cylinder. 6.3 Convection heat transfer, Newton's law of convection, Free and force convection, coefficient of convection. 6.4 Radiation heat transfer, Blackbody concept, emissivity, refractivity, absorptivity, Stefan and Boltzmann's law.
	6c.Explain types of insulations.	6.5 Define thermal conductivity. 6.6 Need, types, properties and applications of insulating materials in various industries. 6.7 Difference between hot and cold insulation.
	6d.Calculate overall heat transfer coefficient and LMTD.	6.8 Over all heat transfer coefficient. 6.9 Simple numerical examples based on above. 6.10Heat exchanger: introduction, types and applications- Logarithmic Mean Temperature Difference (LMTD) concept- (No derivation & no numerical examples).

6. SUGGESTED SPECIFICATIONTABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Two phase system	7	2	4	4	10
II	Boilers, mountings and accessories	10	7	4	4	15
III	Steam prime-movers	6	4	4	2	10
IV	Steam condenser & cooling towers	3	2	3	2	07
V	Air compressors	8	3	6	5	14
VI	Heat transfer	8	3	4	7	14
Total		**42**	**21**	**25**	**24**	**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:

a. If midsem test is part of continuous evaluation, unit numbers I, II (UP TO 2.4 ONLY) and VI are to be considered.

b. 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 psychomotor 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 psychomotor 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 Psychomotor Domain)	Hrs. required
1	I	**Preparatory Activity:** a. List and define thermodynamic properties. b. Tabulate thermodynamic SI units and their conversions. c. Explain thermodynamic processes and their examples. d. Given the data, determine properties of steam using steam table and Mollier chart.	02
2	II	**Demonstration:** (Video/ Movie/Cut Sections /Models may be used in absence of Required Machine/ Equipment/ Device.): a. Steam boilers. b. Boiler mountings and accessories.	04
3	II	**Boiler Performance:** Boiler trial- determination of boiler efficiency, equivalent evaporation and Heat balance sheet. (Based on in-house performance or from the data collected during industrial visit.).	04
4	III	**Demonstration:** (Video/ Movie/Cut Sections /Models may be used in absence of Required Machine/ Equipment/ Device.): a. Steam prime movers-impulse and reaction turbines. b. Working of nozzles.	02
5	IV	**Demonstration:** (Video/ Movie/Cut Sections /Models may be used in absence of Required Machine/ Equipment/ Device.):	02

		a. Steam condensers. b. Cooling towers.	
6	V	**Performance Test of Air Compressor:** Performance test on a reciprocating air compressor and determine its volumetric efficiency.	04
7	VI	**Performance Test of Heat Exchanger:** Determine overall heat transfer coefficient and LMTD of heat exchanger.	02
8	ALL	**Mini Project And Presentation:** (In the group of 3-5students- to be assigned in the beginning of the term). a. Identify any one thermal equipment/device/plant (which are included in syllabus) at nearby industry. Sketch the setup, write the specifications, and describe the working of that with process parameters and state applications of that. b. Downloaded photos/ videos, PPTs. Make one CD/DVD for a batch of students. Also prepare a chart or model on given topic. Prepare the seminar. Topics related to syllabus are to be given by teacher. Advancement in the topics areas may also be given. c. Present the seminar at least for 10 minutes for a and b above.This must include photographs / movies of group working on project.	08
		TOTAL	28

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 and signed by teacher.
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. Term work report content of each experience should also include following.
    i. Experience set up sketch and specifications of boilers, mountings, accessories, condensers, cooling towers, air compressors, heat exchangers, etc (as applicable).
    ii. Working for demonstration type experiences.
    iii. Steps / process description to execute experience for performance type experience.
    iv. Observation table, calculation and graphs if necessary.
d. Mini project and presentation topic/area has to be assigned to the student in the beginning of the term by batch teacher. This may be assigned individually or in the group of maximum 3 to 5students.
e. Student activities are compulsory and to be submitted along with term work.
e. For ESE, students are to be assessed for competencies achieved through suggested list of activities/ practical. They should be given following tasks:
    i. Identify the parts of equipment (Air compressor/ boiler/heat exchanger/ condenser).
    ii. Identify location and function of boiler mountings/ accessories (any two).

iii. Use of steam table/ Mollier chart, determine properties of steam for given pressure and temperature (two problems).
iv. Any one performance test (for one set of reading) on heat exchanger/ air compressor/ boiler (determine heat supplied and any one heat loss).

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Sr. No.	Activity
1	Prepare Mollier charts and show different regions.
2	Collect/ download product catalogues with specification of various types of energy conservation equipment/ devices and heat exchanger of recent trends.
3	At least one visit of any power plant/ industry where various items like boiler, air compressor, heat exchanger, cooling tower, condenser etc. can be shown to students.
4	Identify and list at least 10 equipments/devices which require heat transfer and prevention of heat transfer. Also state mode of heat transfer and methods used to prevent heat transfer.

9. INSTRUCTIONAL STRATEGIES

Sr. No.	Unit	Unit Title	Strategies
1	I	Two Phase system	Charts, PPTs, demonstration of the process.
2	II	Boilers, mountings and accessories	Models, Charts, Videos, PPTs, Industrial visit.
3	III	Steam prime-movers, condensers and cooling towers	Models, Charts, Videos, Cut sections, Industrial visit.
4	IV	Air compressors	Charts, Videos, PPTs.
5	V	Heat transfer	Charts, Videos, PPTs.

10. SUGGESTED LEARNING RESOURCES

(A) List of Books:

Sr.No.	Title of Books	Author	Publication
1.	Heat Engines	Pandya and Shah	Charotar Publishing House
2.	Thermodynamics and Heat power Engg.	Mathur and Mehta	Tata Mcgraw- Hill
3.	Heat Engines	D. A. Wrangham	Cambridge University Press
4.	Heat and mass transfer	D S Kumar	S K Kataria & Sons
6.	Thermal Engineering	P.L.Ballaney	Khanna.Publishers
7.	Thermal Engineering	A. S. Sarao	SatyaPrakashan

8.	Heat and mass transfer	R K Rajput	S. Chand
9.	Basic Boiler Attendant	M MDalchawal	New Popular Prakashan
10.	Thermal Engineering	R K Rajput	Laxmi.Publications
11.	Practical Thermodynamics	G D Rai	Khanna Publisher
12.	A Text book of Thermal Engineering	R S Khurmi& J K Gupta	S Chand & Co.

(B) List of major equipment/materials:

i. Working non IBR steam boiler of package type.
ii. Cut section/ models of boilers, boiler mountings and accessories.
iii. Cut section/ models of steam prime movers.
iv. Test rigs of condensers and cooling towers.
v. Test rig of reciprocating air compressor.
vi. Experimental setup of heat exchanger.
vii. Independently temperature and pressure measuring instruments.

(C) List of Software/Learning Websites

i. http://nptel.iitm.ac.in/courses/112101097/
ii. http://nptel.iitm.ac.in/courses/112106155/
iii. http://nptel.iitm.ac.in/courses/112101002/
http://www.thermaxindia.com/Large-Industrial-Boilers/Waste-Heat Recovery-Boiler.aspx
v. http://www.thermaxindia.com/Packaged-Boilers/Shell-Boiler/Oil-Gas-Fired/Shellmax.aspx
vi. http://www.thermaxindia.com/Large-Industrial-Boilers/solid-fuels-agro-wastes-biomass/Biomass-Fired-Boiler.aspx
vii. http://www.bhel.com/product_services/range.php?rangeid=146&productid=106&categoryid=141
viii. http://www.bhel.com/product_services/product.php?categoryid=62&link=Power

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics.

- **Prof. S. R. Pareek**, Head of Department, Mechanical Engineering, Tolani F. G. Polytechnic, Adipur.
- **Prof. Patel Ramanbhai Revabhai**, Lecturer in Mechanical Engineering, R. C. Technical Institute, Sola, Ahmedabad.
- **Dr. Shah Atul S.**, Lecturer in Mechanical Engineering, Government Polytechnic Waghai.
- **Prof. M. N. Patel**, Lecturer in Mechanical Engg, Government Polytechnic, Chhotaudepur.

- **Prof. Patadiya Virenkumar Natvarlal**, Lecturer in Mechanical Engineering, Shree N. M. Gopani Polytechnic Institute, Ranpur.
- **Prof. Ms. Prajapati KrutikaVinodchandra**, Lecturer in Mechanical Engineering, Parul Institute of Engineering & Technology (Diploma Studies), Limda, Waghodia.

Coordinator and Faculty Members from NITTTR Bhopal

1. **Dr. Vandana Somkuwar**, Associate Professor, Department of Mechanical Engineering.
2. **Prof. C.K. Chugh**, Professor, Department of Mechanical Engineering.

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: THEORY OF MACHINES
(Code: 3341903)

Diploma Programme in which this course is offered	Semester in which offered
Mechanical Engineering, Mechatronics Engineering	4th Semester

1. RATIONALE

In industries, the mechanical engineers/technicians are supposed to manage functioning of equipment with proper planning, operation and maintenance of equipment. Such a functional requirement needs knowledge and skills of various motion and force transforming mechanisms and devices, such as four bar mechanism, belt pulley, clutches, flywheel, etc. This course is included in the curriculum to provide such necessary knowledge and skills in the area of mechanical equipment and devices to help in understanding of kinematics & dynamics of different equipment being used in industry. Thus it is a key course for mechanical engineers/technicians.

2. COMPETENCY

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

- **Use principles of kinematics and dynamics in operation and maintenance of various mechanisms and equipments**.

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Draw inversions and determine velocity and acceleration of different mechanisms.
ii. Construct different types of cam profile for a given data.
iii. Calculate loss of power due to friction in various machine elements.
iv. Solve problems on power transmission.
v. Construct turning moment diagram.
vi. Calculate balancing mass and its position.
vii. Identify different types of vibration, their causes and remedies.

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	
4	0	2	6	70	30	20	30	150

Legends: L -Lecture; **T** -Tutorial/Teacher Guided Student Activity; **P** -Practical; **C** - Credit; **ESE**-End Semester Examination; **PA** -Progressive Assessment.

5. COURSE DETAILS

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I **Introduction**	1a. Define link, pairs, mechanisms, inversion, structure and machines. 1b. Explain various terminology associated with theory of machine.	1.1 Theory of machines: introduction, need, scope and importance in design and analysis. 1.2 Kinematics, kinetics and dynamics- concept and examples. 1.3 Basic terminology related to machines and mechanisms.
	1c. Draw inversions of different mechanisms	1.4 Development of different mechanisms and its inversions like four bar chain mechanism , slider crank mechanism, double slider crank mechanism, etc.
Unit – II **Velocity and acceleration diagram**	2a.Draw velocity and acceleration diagram for a given mechanism. 2b. Calculate velocity and acceleration from a given mechanism.	2.1 Basic concept used in solving velocity and acceleration problems. 2.2 Approach to solve velocity and acceleration related to mechanisms using Relative velocity method for single slider crank mechanism and Four bar chain mechanism. 2.3 Klein's construction for single slider cranks mechanism.
Unit – III **Cam and cam profile**	3a. Explain different types of cams and cam followers and their motions.	3.1 Introduction, functions and types of cams and cam followers. 3.2 Types of motions and displacement for different types of cam and cam followers.
	3b.Construct different types of cam profile from given data.	3.3 Construct different types of cam profiles.
Unit – IV **Friction**	4a.Explain laws of friction 4b. Calculate Power loss due to friction in bearings.	4.1 Concept and laws of friction. 4.2 Appreciate the role of friction in thrust bearing, pivot bearing and collars considering - Uniform pressure and Uniform wear condition.
	4c.Describe the working of different types of clutches, brakes and dynamometers.	4.3 Clutch: i. Functions. ii. Types with sketches and working. 4.4 Brakes: i. Functions. ii. Types with sketches and working. 4.5 Dynamometers- types and operational working principles.

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – V **Power transmission**	5a.Explain the need and modes of power transmission.	5.1 Introduction, need and modes of power transmission. 5.2 Types of power transmission.
	5b.Solve problems on flat belt drive.	5.3 Belt drive- types, terminology and standards/designation methods as per BIS/ISO. 5.4 Belt speed-co-efficient of friction, velocity ratios and slip. 5.5 Power transmitted by flat belt - tensions, centrifugal tensions, maximum tension, condition for transmitting maximum power and initial tension.(with derivations), numerical examples. 5.6 Merits and demerits of power transmission drives.
	5c.Solve simple problems on gear trains.	5.7 Gear trains-types, numerical examples and applications.
Unit – VI **Flywheel and governor**	6a.Construct Turning moment diagram.	6.1 Turning moment diagram: i. Concept. ii. Its use for different machines. iii. Fluctuations of energy. 6.2 Co-efficient of fluctuation of speed and energy. 6.3 Method to construct turning moment diagram, numerical examples.
	6b.Differentiate between flywheel and governor. 6c.Calculate mass of flywheel.	6.4 Flywheel: functions and types. 6.5 Moment of inertia and mass calculation of flywheel-numerical examples. 6.6 Governors: terminology, types & functions.
Unit – VI I **Balancing and vibrations**	7a.Calculate balancing mass and its position for masses revolving in same plane.	7.1 Concepts and types of balancing. 7.2 Effects of unbalanced masses. 7.3 Balancing of revolving masses in same plane: i. Analytical and graphical methods to find balancing mass. ii. Numeric examples. 7.4 Balancing of reciprocating masses. (No numerical examples).
	7b.Identify different types of vibration, its causes and remedies.	7.5 Vibration: i. Terminology. ii. Effects. iii. Causes. iv. Remedies.

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

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction	08	07	07	00	14
II	Velocity and acceleration diagram	07	02	00	05	07
III	Cam and cam profile	06	00	00	07	07
IV	Friction	12	02	05	07	14
V	Power transmission	12	00	07	07	14
VI	Flywheel and governor	06	02	05	00	07
VII	Balancing and vibrations	05	05	02	00	07
Total		**56**	**18**	**26**	**26**	**70**

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:

a. If midsem test is part of continuous evaluation, unit numbers I, II , III and IV (Up to 4.2 only) are to be considered.

b. 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 psychomotor 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 psychomotor 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 Psychomotor Domain)	Hrs. required
1	ALL	**Preperatory Activity:** a. Interpret and write various course related SI units and their conversions. b. Recall and write scalar and vector quantities.	02

		c. Demonstrate various mechanisms.	
2	II	**Velocity And Acceleration:** a. Prepare one sheet on velocity and acceleration diagram for given mechanisms by relative velocity method. This should include minimum four problems. b. Prepare one sheet on velocity and acceleration diagram for given mechanisms by Klein's construction method. Teacher will assign any one problem from sheet drawn with relative velocity method. (Above at a). c. Prepare report showing necessary calculations for above a and b.	06
3	III	**Cam Profile:** a. Demonstrate working of any type of cam and followers. b. Prepare one sheet on construction of cam profile for given data (without offset). This should include one problem of knife edge follower and another of roller follower. c. Prepare one sheet on construction of cam profile for given data (with offset). This should include one problem of knife edge follower and another of roller follower. d. Prepare report showing necessary calculations for above b and c.	06
4	IV	**Demonstration of Clutch:** Identify different parts of a single plate disc clutch through disassembly, observe wear and tear due to friction and prepare report based on inspection criteria.	02
5	V	**Demonstration Of Power Transmission Systems:** a. Identify various power transmission systems by observing different machines and equipments used in mechanical engineering laboratory/workshop. For example- IC Engine test rig, Compressors, Machine tools, Elevators, etc. Sketch at least four mechanisms with labeling on each. b. Demonstrate working of each.	02
6	VII	**Balancing:** Prepare one sheet on balancing using graphical and analytical method for a given data. Include minimum two problems.	02
7	IV,V and VI	**Tutorials:** a. Calculate power loss due to friction in bearings from given experimental data. b. Solve two problems of power transmission systems (one of belt drive and another of gear train) from given experimental data. c. Calculate and prepare turning moment diagram from given experimental data. d. Calculate mass of flywheel from given experimental data.	02
8	ALL	**Mini Project And Presentation:** a. Compile information from internet related to various mechanisms/elements like piston, crank, connecting rod, cam, clutch, brake, flywheel, governor, or animation of mechanism etc. along with functions of each. b. Select any one mechanism (preferably that which is NOT	06

		part of syllabus) from mechanical laboratory/workshop/real life. Sketch the same. Take photograph of the same. Also record the movie of its working. c. Prepare subject related mechanism simple model. This has to be proposed by student/s and has to be approved by teacher. d. Present the experience with power point presentation and model prepared at c above. This has to include: i. Compiled information as per a above. ii. Explain the mechanism selected at b above. Use photographs and movie recorded. iii. Explain the working of model prepared at c above. iv. Photographs/movie of students working on project. e. Present student activities also.	
		Total Hours	28

Notes:

a. Term work report must not include any photocopies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only. However teacher may allow related photographs/movie for experience number 8.
b. Term work report content of each experience should also include following.
   i. Sheets, reports and tutorials.
   ii. Mini project model, presentation and downloaded content.
   iii. Student activity.
c. Mini project and presentation topic/area has to be assigned to the student in the beginning of the term by batch teacher. This may be assigned individually or in the group of maximum 3-5 students.
d. For 20 marks ESE, students are to be assessed for competencies achieved. They should be given following tasks:
   i. Problems on velocity and acceleration on mechanism, cam profile power transmission, friction, flywheel and balancing.
   ii. Sketch of mechanism, cam and follower, clutches, brakes, dynamometer, gear trains, governor.

8. SUGGESTED LIST OF STUDENT ACTIVITIES

SR.NO.	ACTIVITY
1	List the mechanisms which you are using in your day to day life. Sketch any three from these.
2.	List the mechanism used in a typical car.
3.	Identify and measure the dimensions of Flywheel used in automobile.
4.	Identify the type of clutches used in different automobiles and also the type of brakes in automobile and bicycle.
5.	Visit the market and collect the data of items which are used in any mechanisms. Data includes specifications, cost, applications, etc. Also name the mechanism/s in which such item/s is/are used.

9. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)

Sr. No.	Unit	Unit Name	Strategies
1	I	Introduction	Model, Education charts & videos, Real life examples. Demonstration of real industrial parts used in different devices, Movies/Animations.
2	II	Velocity and acceleration diagram	Movies/Animations.
3	III	Cam and cam profile	Demonstration of cams, Movies/Animations.
4	IV	Friction	Model, Education charts & videos, Real life examples. Demonstration of real industrial parts used in different devices, Movies/Animations.
5	V	Power transmission	Demonstration of real industrial parts, Movies/Animations, Models of different power transmission elements
6	VI	Flywheel and governor	Industrial visit, Animations/movies, Models of different types of governors.
7	VII	Balancing and vibrations	Industrial visit, Animations/movies.

10. SUGGESTED LEARNING RESOURCES

(A) List of Books:

S. No.	Title of Books	Author	Publication
1.	Theory of Machines	Jagdishlal	Metropolitan Book New Delhi, Company, Daryaganj, Delhi.
2.	Theory of Machines	S.S.Ratan	Tata McGraw Hill , New Delhi.
3.	Theory of Machines	Abdulla Shariff	Dhanpatray and sons, New Delhi.
4.	Theory of Machines	Shah & Jadvani	Dhanpatray and sons, New Delhi.
5.	Theory of Machines	A Ghosh and AK Malik	East West Press (Pvt) Ltd., New Delhi.
6.	Theory of Machines	R.S.Khurmi	S.chand, New Delhi.
7.	Theory of Machines	P.L.Bellaney	Khanna publication, NewDelhi.
8	Theory of Machines	Joseph Edward Shigley	McGrawHill.
8	Theory of Machines	Thomas Bevan	CSB Publishers & Distributors

(B) List of Software/Learning Websites:

i. http://nptel.iitm.ac.in/video.php?subjectId=112104121
ii. http://www.technologystudent.com/gears1/gears7.htm
iii. http://kmoddl.library.cornell.edu/model.php?m=20
iv. http://www3.ul.ie/~kirwanp/whatisacamandfollowersyste.htm
v. http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-Delhi/Kinematics%20of%20Machine/index.htm
vi. http://elearning.vtu.ac.in/12/enotes/Des_Mac-Ele2/Unit6-RK.pdf
vii. en.wikipedia.org/.../Canadian_Committee_for_the_Theory_of_Machines...
viii. global.oup.com/.../theory-of-machines-and-mechanisms-978019537123...
ix. www.tecquipment.com/Theory_of_Machines.aspx
x. www.researchgate.net/.../0094-114X_Mechanism_and_Machine_Theory
xi. www.journals.elsevier.com/mechanism-and-machine-theory/
xii. journalseek.net/cgi-bin/journalseek/journalsearch.cgi?field=issn...
xiii. site.iugaza.edu.ps/wp-content/.../IUGAZA%20TOM2012_CH1-2.pdf
xiv. www.iftomm.org/
xv. www.wiziq.com/online-tests/44047-mechanical-theory-of-machine
xvi. www.cs.ubc.ca/~murphyk/Teaching/CS340-Fall07/infoTheory.pdf

(C) List of equipments:

i. Working Models / wooden/thermocol theoretical models of:
   a. Kinematic links and pairs.
   b. Single slider crank.
   c. Four bar chain.
ii. Types of cams, followers and cam/follower arrangements.
iii. Friction bearing- all types.
iv. Dynamometers - all types.
v. Friction clutches - all types.
vi. Friction brakes - all types.
vii. Rope/belt – All types of flat and vee.
viii. Gear trains - all types.(Simple, compound, reverted, epicyclical).
ix. Balancing machines -Revolving masses, Reciprocating masses.
x. Steam engine, internal combustion engine.
xi. Governors - all types.
xii. Vibration -spring and mass model.
xiii. Any machine having flywheel.

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics:

- **Prof. D. M. Trivedi**. Lecturer in Mechanical Engineering, K.J.Polytechnic , Bharuch.
- **Prof. M. P. Jakhaniya**, Lecturer in Mechanical Engineering, C.U.Shah.Polytechnic Surendranagar.
- **Prof. D. R. Katariya**, Lecturer in Mechanical Engineering, Government Polytechnic, Bhuj.

Coordinator and Faculty Members from NITTTR Bhopal.

- **Prof. Sharad K. Pradhan**, Head, Department of Mechanical Engineering,
- **Dr. K.K. Jain**, Professor and Dean, Department of Mechanical Engineering,

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: COMPUTER AIDED DESIGN
(Code: 3341904)

Diploma Programme in which this course is offered	Semester in which offered
Mechanical Engineering	4th Semester

1. RATIONALE

The students of mechanical engineering programme are mainly involved in modelling, designing, manufacturing, inspection and planning activities (such as preparing design and production drawing, process plans, preparing bill of materials, etc.) in industries. For all such activities, reference document is the modelling and drawing of component/assembly to be manufactured. In this context, it is of utmost importance to prepare, read and interpret these drawings correctly for production of components and assemblies accurately and precisely. The industrial practices of modelling and designing are also important for the students to make them aware of modelling and designing practices, symbols, codes, norms and standards generally used in industries.
This course has been introduced at Diploma level in order to develop the skills in student so that they can generate various modelling and digital production drawings as required by industry using appropriate CAD software.

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:

- **Develop production drawings and solid models using codes, norms, standards and CAD software**.

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Select configuration of CAD workstation.
ii. Select type of modeling technique for given part.
iii. Design, develop and model the given part using various CAD software like- Creo/Catia /Unigraphics/Solid edge/Inventor/ AutoCAD, etc.
iv. Prepare solid models & assembly of mechanical parts.

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	
2	0	2	4	70	30	20*	30	150

Legends: L -Lecture; **T** -Tutorial/Teacher Guided Student Activity; **P** -Practical; **C** - Credit; **ESE**-End Semester Examination; **PA** -Progressive Assessment
* WITH EXTERNAL EXAMINER.

5. COURSE DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I **Fundamentals of CAD**	1a. Appreciate the need of CAD and its application.	1.1 Computer graphics & its terminology. 1.2 CAD definition, concept & need. 1.3 CAD process. 1.4 Functional areas of CAD. 1.5 Coordinate systems.
	1b.Perform Geometric 2D transformation.	1.6 Geometric transformation-concept and types. 1.7 2 dimensional (2D) geometric transformation- translation, scaling, rotation and mirror with numeric examples.
Unit- II **CAD Hardware**	2a. Describe functions of CAD Workstation, its types, and configuration. 2b. Use input/output CAD devices.	2.1 CAD Workstation-types, functions and configuration. 2.2 Input and output devices (including voice, gesture, 3 dimensional (3D) printer, etc)-types, configuration and applications.
Unit – III **Geometric modeling**	3a.Explain types of solid modeling.	3.1 Difference between 2D & 3D models. 3.2 Geometric modeling – concept, types, features and applications. 3.3 Solid modeling methods like Constructive Solid Geometry, Pure primitives & Boundary Representation
	3b.Describe characteristics of features based CAD packages.	3.4 Feature base modeling-concept, illustrative examples.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	3c.Differentiate graphics packages used for modeling	3.5 Parametric & non parametric modeling-concept, differences and illustration.
Unit – IV **3D Modeling using AutoCAD**	4a. Use appropriate UCS for the given situation.	4.1 Introduction to AutoCAD-3D features and 2D commands overview. 4.2 3D primitives-types and defining parameters. 4.3 User coordinate system (UCS) and its options.
	4b. Prepare solid model of industrial parts and its assembly using Auto CAD.	4.4 3D draw commands. 4.5 3D modify and editing commands. 4.6 3D viewing & views generation.
	4c. Prepare simple surface model using AutoCAD.	4.7 Surface modeling commands.
Unit – V **3D parametric modeling**	5a Prepare solid model of industrial parts and its assembly using parametric modeling software.	5.1 Introduction to parametric modeling software. (Any one from Creo, Unigraphics, CATIA, Solid Edge, Inventor etc). 5.2 Sketching interfacing overview. 5.3 3D working plane introductions. 5.4 3D modeling. 5.5 Assembly modeling. 5.6 Views generation.

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

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fundamentals of CAD	4	5	5	0	10
II	CAD Hardware	2	2	3	0	5
III	Geometric modeling	4	2	4	4	10
IV	3D Modeling using AutoCAD	8	4	6	10	20
V	3D parametric modelling	10	5	6	14	25
	TOTAL	28	18	24	28	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:

a. If midsem test is part of continuous evaluation, unit numbers I, II, III and IV (Up to point number 4.2 only) are to be considered.

b. 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.

c. For theory paper, examiner has to give options of "Select and specify any one software from Creo, Unigraphics, CATIA, Solid Edge, Inventor etc" while asking the questions from Unit V.

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 psychomotor 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 psychomotor 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 Number	Practical/Exercises (Outcomes' in Psychomotor Domain)	Hrs. required
1	ALL	**Preperatory Activity** Prepare a 2D drawing using AutoCAD and 2D parametric sketcher environment.	02
2	IV	**3DSolid Modeling-I** Prepare 3D solid models using AutoCAD (Three mechanical components).	04
3	IV	**3D Surface Model** Prepare simple surface model using AutoCAD (Two mechanical components).	02
4	V	**3D Solid Modeling-II:** Prepare 3D solid model using any one (from Creo, Unigraphics, CATIA, Solid Edge, Inventor etc) parametric software. (Three models that includes base features, Extrude/Protrude/Revolve).	05

5	V	**3D Solid Modeling-III:** Prepare 3D solid models using any one (from Creo, Unigraphics, CATIA, Solid Edge, Inventor etc) parametric software. (Four models that includes engineering features).	05
6	V	**Mini Project And Presentation Using Any One (From CREO, Unigraphics, CATIA, Solid Edge, Inventor) Parametric Software.** a. Prepare solid models of dismantled parts of an assembly (selected as student activity 1). b. Assemble the parts. c. Get orthographic production drawings of solid models prepared at "a" above. d. Get orthographic production drawings of assembly model prepared at "b" above. e. Prepare the bill of material (BOM) . f. Present the project.	10
Total Hours			**28**

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 teacher.
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. Printouts of actually modelled parts/assemblies are to be permitted.
c. Term work report content of each experience should include following.
    i. Sketches of parts/assemblies.
    ii. Steps followed with commands, its options with numeric values, position of UCS (in case of AutoCAD), planes selected, etc.
    iii. Printouts of modelled parts/assemblies.
d. Mini project and presentation topic/area has to be assigned to the student in the beginning of the term by batch teacher. This may be assigned individually or in the group of maximum 2 to 3 students.
e. For 80 marks ESE, students are to be assessed for competencies achieved. They should be given following tasks:
    i. Prepare solid models and assembly using AutoCAD and any one software (Creo, Unigraphics, CATIA, Solid Edge, Inventor etc).

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Sr. No.	Activity
1	Bring Actual mechanical assembly from industry/real life/scrap shop/garage/etc. (made up of at least 4 to 5 mechanical components), dismantle the same, measure dimensions and sketch it to use the same for exercise no.6).
2	Visit design section of different industry and observe various hardware and software, procedure, standards they are following for designing a product.

9. SPECIAL INSTRUCTIONAL STRATEGIES (If any)

Sr. No.	Unit	Strategies
1	I & II	a. Explain various configurations for CAD workstation and different peripherals. b. Demonstrate various Input/output devices and its connections and how to use it. c. Demonstrate the procedure of loading the CAD software on a computer system.
2	III	Bring actual industrial production drawings from nearby industry and distribute them among group of students for self study and interpretation. Ask students to practice these drawings using CAD software.
3	IV & V	a. Bring small real components/assemblies like nuts, bolts, washers, cotter-knuckle joints, couplings, pulleys, shafts, gears, tool post, tool holders, etc. in the class. b. Demonstrate various features of such components. c. Show the steps to create solid models and assemblies of such parts/assembly using CAD softwares. d. Take the students for industrial visit.

10. SUGGESTED LEARNING RESOURCES

A. List of Books:

Sr. No.	Title of Books	Author	Publication
1.	Creo 2.0 for designer and engineers	Sham Tickoo	Dreamtech press
2.	Designing with Creo Parametric 2.0	Dr. Michel J Rider	SDC Publications
3.	Pro/Engineer wildfire 5.0 instructor	David S. Kelley	McGraw-hill
4.	Unigraphics for designer & engineers	Sham Tickoo	Dreamtech press
5.	AutoCAD for engineers and Designers	Sham Tickoo	Dreamtech press
6.	Machine design	K.C.Jhon	PHI
7.	Production drawing	K.L.Narayan	New age publication
8.	Fundamental of Geometric dimensioning & tolerancing	Alex kruleski	Cengage publication
9.	CAD/CAM & Automation	Farzak haidaree	Nirali
10.	Machine drawing including AutoCAD	Ajeet singh	McGraw-hill

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

i. CAD Workstations.
ii. Laser printer-A3 size.
iii. AutoCad.

iv. Latest educational network version of Creo, Unigraphics, CATIA, Solid Edge, Inventor, software (Any one).

C. List of Software/Learning Websites:

i. https://www.youtube.com/watch?v=WY0YuCkJWdw
ii. https://www.youtube.com/watch?v=OIYrkF_FId8
iii. https://www.youtube.com/watch?v=zoMW_usjaJo
iv. https://www.youtube.com/watch?v=fx6kt9djIpc
v. https://www.youtube.com/watcAh?v=8wdOIHxICxw
vi. https://www.youtube.com/watch?v=srnm--IKtl4
vii. https://www.youtube.com/watch?v=rtjDfZXscrI

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics:

- **Prof. K. H. Patel**, Head of Mechanical Engineering, Dr.S.S.& S. Gandhi College of Engineering and Technology, Surat.
- **Prof. A. A. Lohia**, Lecturer in Mechanical Engineering, Government Polytechnic, Rajkot.
- **Prof. S. H. Sundrani**, Lecturer in Mechanical Engineering, Government Polytechnic Ahmedabad.
- **Prof. Hitesh J. Yadav**, Lecturer in Mechanical Engineering, RCTI, Ahmedabad.
- **Prof. B.D. Parmar**, Lecturer in Mechanical Engineering, Government Polytechnic, Porbandar.
- **Prof. J. B. Patel,** Lecturer in Mechanical Engineering, Sir BPI, Bhavnagar.
- **Prof. Jignesh M. Patel,** Lecturer in Mechanical Engineering, BSP Polytechnic, Kherva.

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. Sharad K. Pradhan**, Head, Department of Mechanical Engineering
- **Dr. K.K. Jain,** Professor and Dean, Department of Mechanical Engineering

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: METROLOGY & INSTRUMENTATION
(Code: 3341905)

Diploma Programme in which this course is offered	Semester in which offered
Mechanical Engineering, Mechatronics Engineering	**4th Semester**

1. RATIONALE

The students of Mechanical Engineering branch are basically concerned with manufacturing various machine components in shops as per given drawing. Today the industrial processing and manufacturing techniques have become complex and complicated and their control is very much difficult by human judgment only. Therefore, the exact and precise measurements are the basic need of the industries. This course of Metrology & Instrumentation, therefore, provides required knowledge and skills and creates self confidence in students so that they can work on shop floor independently for accurate and precise measurements and manufacturing.

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:

- **Select and use appropriate analog and digital measuring and gauging instruments for a given manufacturing situation**

3. COURSE OUTCOMEs (COs)

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Measure the given mechanical elements and assemblies using linear and angular analog /digital measuring instruments.
ii. Check geometrical accuracy of given application.
iii. Explain surface roughness checking instruments.
iv. Measure and derive important dimensions of various thread forms and gears.
v. Select and use non destructive testing methods.
vi. Check the dimensions using the gauges.
vii. Select and measure variables using appropriate sensors and transducers.

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	
4	0	4	8	70	30	40	60	200

Legends: L -Lecture; **T -**Tutorial/Teacher Guided Student Activity; **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 **Linear and angular measurement**	1a. Distinguish between accuracy, precision and error. 1b.Determine least count of given measuring instrument	1.1 Inspection, quality and quality control-definitions and differences. 1.2 Define accuracy, precision and error. 1.3 Principle of vernier scale and least count. 1.4 Surface plates-types, important features, standards/important sizes, applications and precautions in use.
	1c. Select suitable linear measurement instrument and measure the linear dimension of given component.	1.5 Types, constructional sketch, major parts and their functions, least count , measuring methods and measurement illustration (for e.g. 12.48mm)of: i. Vernier caliper. ii. Micrometer. iii. Telescopic gauge. iv. Height gauge. v. Depth gauge.
	1d. Describe the procedure for wring the slip gauge and set given dimension.	1.6 Slip gauge-types, applications, and wringing method.
	1e.Select suitable angular measurement instrument 1f. Describe the measurement procedure for the angular dimension of given component.	1.7 Sketch, major parts and their functions, least count , measuring methods and measurement illustration of: i. Bevel Protector. ii. Sine bar. iii. Angle gauges. iv. Angle Dekkor. v. Spirit level. vi. Clinometers. vii. Auto collimator. 1.8 Calibration – concept and need.
Unit – II	2a. Explain working of dial indicators.	2.1 Dial indicators/gauge-types, constructional sketch and applications.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Measurement of geometrical tolerances	2b.Select the measuring method and describe the measurement procedure for geometrical tolerance of given part/assembly.	2.2 Definition, symbol and measuring methods of: i. Straightness. ii. Flatness. iii. Squareness. iv. Parallism. v. Perpendicularity. vi. Roundness. vii. Concentricity. viii. Cylindricity. ix. Run out and ovality.
Unit – III **Measurement of surface roughness**	3a. Define various terminology used for surface roughness. 3b. Explain working of direct instrument methods.	3.1 Terminology used in connection with surface finish. 3.2 Comparison methods to inspect surface finish-concept and applications. 3.3 Direct instrument measurement methods-types and concepts. 3.4 Construction, working and applications of Talysurf surface roughness tester and Tomlinson tester.
	3c. Determine surface roughness of given data.	3.5 Centre line average and Root Mean Square systems of surface texture evaluation-terminology used, concept, equations and numerical examples. 3.6 Indication of various surface roughness characteristics with surface roughness symbols-interpretation.
Unit – IV **Gear and thread measurement**	4a. Define various terms used for gear nomenclature. 4b.Use gear tooth vernier to measure gear tooth thickness.	4.1 Types of gears. 4.2 Forms of gear teeth-types and concept. 4.3 Gear tooth Terminology. 4.4 Sketch, major parts and their functions, least count, measuring methods and measurement illustration of gear tooth vernier. 4.5 Derivation and numerical example to measure gear tooth thickness using: i Gear tooth vernier. ii Constant chord method. iii Base tangent method.
	4c. Explain working of profile projector.	4.6 Gear tooth profile measurement.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	4d. Define various terms used for thread nomenclature. 4e.Determine best wire size. 4f. Use two and three wire methods to determine effective diameter of thread. 4g.Describe method for measuring the pitch of given thread.	4.7 Threads-classification, elements, specifications and forms. 4.8 Measurement of major and minor diameters. 4.9 Three and two wire method of measuring effective diameter of external thread-concept, terminology used, best wire size, derivation of equation and numerical example. 4.10 Thread micrometer-sketch, method to use and determination of dimension. 4.11 Pitch measurement methods.
Unit – V **Limit gauges, Transducers and sensors**	5a. Select and check the given dimension using limit gauge.	5.1 Limit gauges-classification, sketch and applications. 5.2 Comparators-concept, types and applications.
	5b. Define static characteristics of instruments.	5.3 Instrumentation-introduction, performance characteristics. 5.4 Static characteristics of instruments.
	5c. Explain various transducers and sensors.	5.5 Transducers-concept, classifications, physical quantities which can be measured, advantages and disadvantages. 5.6 Electrical transducers-types, working principles and applications. i Linear Variable Differential Transformer (LVDT) type pressure gauge. ii Resistance type. iii Capacitance type. iv Inductance type (LVDT). v Piezo-electric. 5.7 Sensors- classification and applications.
Unit – VI **Non destructive testing**	6a. Explain various non destructive testing methods.	6.1 Non destructive testing (NDT) - concept, need and advantages. 6.2 NDT- important methods, working with sketch and applications.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – VII **Temperature, pressure and flow measurement**	7a. Select and describe the method for using appropriate temperature measuring device to measure temperature of given hot body.	7.1 Introduction. 7.2 Classification, working principle, construction, working, advantages, limitations and applications of temperature measuring devices: i. Mercury in glass thermometer. ii. Bimetallic thermometer. iii. Resistance thermometer. iv. Thermister. v. Thermocouple. vi. Radiation pyrometers. vii. Optical pyrometers.
	7b.Select and describe the method for using appropriate pressure and flow measuring device to measure pressure/flow.	7.3 Pressure measurement scales. 7.4 Types and applications of manometers (only list and applications). 7.5 Working principle, construction, working, advantages, limitations and applications of pressure measuring devices: i. Bellows type pressure gauge. ii. Diaphragm type pressure gauge. iii. Bourdon tube pressure gauge. iv. Dead weight piston gauge. 7.6 Concept of transducer based pressure measuring devices- resistance type, capacitance type and inductance type. 7.7 Classification of flow measuring devices. 7.8 Working principle, construction, working, advantages, limitations and applications of volumetric flow measuring devices: i. Bellows type. ii. Rotating impeller. iii. Rotating lobs. iv. Nutating Disc. v. Reciprocating piston. vi. Obstruction. 7.9 Working principle, construction, working, advantages, limitations and applications of velocity measuring

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		devices: i. Pitot tube. ii. Orifice meter. iii. Rota meter.

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

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Linear and angular measurement	10	06	04	04	14
II	Measurement of geometrical tolerances	06	02	02	03	07
III	Measurement of surface roughness	06	02	02	03	07
IV	Gear and Thread measurement	12	04	04	06	14
V	Limit gauges, transducers and sensors	08	02	04	05	11
VI	Non destructive testing	06	02	02	03	07
VII	Temperature, pressure and flow measurement	08	03	03	04	10
Total		**56**	**21**	**21**	**28**	**70**

Legends: R = Remembrance; 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:

a. If midsem test is part of continuous evaluation, unit numbers I (Up to 1.6 only), II, III and VII (Up to point number 7.6 only) are to be considered.

b. 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 psychomotor 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 psychomotor 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 Psychomotor Domain)	Hrs. required
1	I	**Preperatory Activity:** a. S.I. basic, supplementary and derived units and their conversions. Convert given length, area and volume from one unit to another. (From mm to cm and m, from mm to inch, from m to yard and foot, from mm^2 to $inch^2$ and vice-versa, mm^3 to $inch^3$ and vice-versa ,etc.). b. Convert given degree to radian and vice-versa. c. Various drafting, surface finish and geometrical symbols. d. Define axis, axes, centre, angles, plane, solid angle.	02
2	I	**Linear And Angular Measurement:** Each student will select and bring at least such five mechanical components which will have use of instruments specified below. Same are to be approved by teacher. After approval, student will: a. Sketch each component. b. Sketch and label main parts of instruments to be used. c. Calculate least count of the instrument/s to be used. d. Measure and record applicable dimensions of each component using: i. Vernier calliper. ii. Inside micrometer. iii. Outside micrometer. iv. Telescopic gauge. v. Height gauge. vi. Depth gauge. vii. Bevel protector. viii. Clinometers.	14
3	I	**Sine Bar:** Measure angle between two planes with the help of sine bar and slip gauges.	02
4	II	**Straightness:** a. Sketch the part and setup, list the instruments used, list the steps followed and record the observations for checking straightness. b. Plot straightness observations on graph paper.	02
5	II	**Flatness:** Sketch the part and setup, list the instruments used, list the steps followed and record the observations for checking flatness.	02

6	II	**Squareness, Perpendicularity And Parallity:** Sketch the part and setup, list the instruments used, list the steps followed and record the observations for checking following. a. Squareness. b. Perpendicularity and Parallity.	02
7	II	**Roundness, Cylindricity, Concentricity, Run Out And Ovality:** a. Sketch the part and setup, list the instruments used, list the steps followed and record the observations for checking roundness, cylindricity, concentricity, run out and ovality. b. Prepare polar graph for roundness observations.	02
8	III	**Surface Roughness:** a. Tabulate machining processes, and roughness values (Ra , mm),roughness grade number and roughness symbol. b. Demonstrate various surfaces having different roughness values. c. For given component, sketch the component, judge the roughness of surfaces and show surface roughness symbols on applicable surfaces. d. Measure surface roughness value of given machined surface.	04
9	IV	**Gear Measurement:** a. Sketch gear tooth nomenclature. b. Sketch gear tooth vernier and label each part. c. Calculate chordal thickness and height of given gear. d. Determine tooth height. e. Measure and compare chordal thickness of given spurs gear using gear tooth vernier.	02
10	IV	**Thread Measurement:** For given external threaded part: a. Draw nomenclature for ISO screw threads (Internal and external both). b. Explain and derive best wire size. c. Sketch the part and show the dimensions to be measured. d. Sketch the set up and instruments used to measure/derive major diameter, minor diameter and effective diameter using two wire and three wire methods. e. Measure the pitch. f. Use threaded ring gauge. g. Record observations.	04
11	V	**Limit Gauges:** a. Demonstrate use of various limit gauges. b. Select appropriate limit gauge for given dimension/part and check the dimension with gauge. c. Record your observations.	02
12	V	**Demonstration of Transducers and Sensors:** a. Demonstrate electrical (LVDT type, resistance type, capacitance type, inductance type and piezo-electric.) transducers and various sensors. b. Sketch each demonstrated transducers and sensors and tabulate specifications, range, resolution and applications of each.	04

13	VI	**Non Destructive Testing:** a. Demonstrate ultrasonic testing of NDT. b. Observe and interpret X ray test of any weld joint.	02
14	VII	**Temperature Measurement:** a. Sketch the set up and constructional sketch of thermocouple used to measure temperature. b. Measure the temperature of hot body/hot liquid with thermocouple. c. Record the observation.	02
15	VII	**Pressure Measurement:** a. Sketch the set up and constructional sketch of pressure gauge used to measure pressure. b. Measure the pressure with pressure gauge. c. Record the observation.	02
16	VII	**Flow Measurement:** a. Sketch the set up and venture meter used to measure flow. b. Measure the flow with venture meter. c. Record the observation.	02
17	ALL	**Mini Project and Presentation:** a. Select actual mechanical assembly from industry/real life/scrap shop/garage/etc. (made up of at least 4 to 5 mechanical components) and get it approved by teacher. b. Measure geometrical tolerances. Sketch setup drawing to measure geometrical tolerances. Measure geometrical tolerances and record the observations. c. Dismantle the assembly, sketch the parts and measure dimensions. Record your observations. d. Present the work including photographs and movies of actual project work.	06
		TOTAL	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 teacher.

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. Photographs/movies of group members actually working on mini project should be allowed.

c. Term work report content of each experience should also include following.
   i. Reports.
   ii. Student activities.

d. Mini project and presentation topic/area has to be assigned to the student in the beginning of the term by batch teacher. This may be assigned individually or in the group of maximum 2 to 3 students.

e. For 40 marks ESE, students are to be assessed for competencies achieved. They should be given following tasks. (i and any one from ii, iii and iv.)
   i. Measure the linear/angular dimensions and geometrical tolerances of given part/assembly.
   ii. Measure tooth thickness using gear tooth vernier.
   iii. Measure effective diameter of given thread.
   iv. Explain working of transducers and sensors.

8. SUGGESTED LIST OF STUDENT ACTIVITIES

SR.NO.	ACTIVITY
1	Visit the workshop and identify the machines and arrangements which require geometrical tolerances.
2	Visit any industry / tool room and observe the working of inspection and testing department. Also prepare the report.

9. SPECIAL INSTRUCTIONAL STRATEGIES

Sr. No.	Unit No.	Unit Title	Strategies
1	I	Linear and angular measurement	Demonstrate actual instrument, video movies of measuring methods.
2	II	Measurement of geometrical tolerances	Show actual assemblies require geometrical tolerance, show measuring methods movies.
3	III	Measurement of surface roughness	Show various samples of surface textures, videos,
4	IV	Gear and thread measurement	Demonstrate use of gear tooth vernier, videos. Show various forms of threads, show measuring methods movies
5	V	Limit gauges, Transducers and Sensors	Demonstrate limit gauges usage. Demonstrate actual transducers and sensors, movies, industrial visits.
6	VI	Non destructive testing	Videos, PPTs, industrial visits.
7	VII	Temperature, pressure and flow measurement	Demonstrate actual instruments, movies, industrial visits.

10. SUGGESTED LEARNING RESOURCES

(A) List of Books:

Sr no.	Title of Books	Author	Publication
1	Mechanical measurements and instrumentation	R.K.Rajput	KATSON
2	Metrology and Instrumentation	Tahir	
3	Mechanical Measurement	Sirohi R.S., Radha Krishnan H.C.	New Age International
4	Practical Engineering Metrology	K.W.B.Sdarp	Pitman
5	Engineering Metrology	R.K.Jain	Khanna Publications.
6	Industrial Instrumentation	Donald A. Eckman	
7	Industrial Instrumentation & Control	S K Singh	Tata McGrawHill

8	Mechanical Measurement	Beckwith & Buck	Narosa publishing House
9	Mechanical Measurement and Control	D.S.Kumar	Metropolitan Book Pub.
10	Practical Engineering Metrology	K.W.B.Sdarp	Pitman
11	Mechatronics	W.Bolten	PEARSON
12	Gear Metrology	C.A.Scoks	

(B) List of equipments:

1. Surface plate, 500 x 500 mm.
2. Vernier calliper, 100 to 200mm, least count 0.01mm.
3. Vernier calliper, 100 to 200mm, least count 0.01mm, digital.
4. Inside micrometers, least count 0.01mm, 0-25mm, 25-50mm, 50-75mm.
5. Outside micrometer, least count 0.01mm, 0-25mm, 25-50mm, 50-75mm.
6. Outside micrometer, least count 0.001mm, 0-25mm.
7. Telescopic gauge- 10-100mm.
8. Height gauge- 300mm with least count 0.01mm.
9. Depth gauge- 100 mm with least count 0.01mm.
10. Bevel protector with least count 5'.
11. Clinometers.
12. Slip gauge box-
13. Sine bar- 150mm, 200mm.
14. Straight edge, 500mm.
15. Feeler gauge, radius gauge, thread pitch gauge.
16. Dial indicators magnetic stand.
17. Dial indicators, least count 0.01mm.
18. V blocks.
19. Samples of various surface textures and different surface roughness.
20. Microprocessor- stylus-probe based surface roughness testing machine.
21. Microscope to compare various textures and surface roughness.
22. Gear tooth vernier.
23. Profile projector.
24. Set of best wires to measure thread dimensions.
25. Thread micrometers.
26. Thread pitch measuring machine.
27. Thread
28. Set of limit gauges- sorted sizes, plug gauges, thread ring gauges and snap gauges.
29. LVDT type, resistance type, capacitance type, inductance type and piezo-electric type transducers.
30. Sensors, position, proximate, velocity, force/strain,
31. Thermocouple.
32. Bourdon pressure gauge.
33. Venturimeter.

(C) List of softwares/ learning websites:

a. http://en.wikipedia.org/wiki/Metrology (metrology).
b. https://www.youtube.com/watch?v=4hlNi0jdoeQ (vernier).
c. https://www.youtube.com/watch?v=FNdkYIVJ3Vc(vernier).
d. https://www.youtube.com/watch?v=O8vMFFYNIfo (micrometer)
e. https://www.youtube.com/watch?v=h98HPVuWjLA (depth micrometer)
f. https://www.youtube.com/watch?v=SmXfGan_NXQ (telescopic gauge)
g. http://www.authorstream.com/Presentation/007sandeepks-1858141-angular-measurment/ (angular measurement).
h. http://askguru.net/t-Angular-Measurement-ppt
i. https://www.youtube.com/watch?v=aBzh6i5fQ70 (surface roughness)
j. https://www.youtube.com/watch?v=S7SXD6sKQ-I(surface roughness)
k. https://www.youtube.com/watch?v=eVpoJzLJa0U(surface roughness)
l. https://www.youtube.com/watch?v=3Od7vnoMwGg(surface roughness)
m. https://www.youtube.com/watch?v=XnLiTPGE6pk (three wire thread measurement)
n. https://www.youtube.com/watch?v=Gdvtw0pTAOs (thread pitch).
o. https://www.youtube.com/watch?v=qMgXGedDffw (dial indicator)
p. http://www.authorstream.com/Presentation/donzvasanth-1501139-unit-2-linear-angular-measurement/
q. http://en.wikipedia.org/wiki/List_of_gear_nomenclature#Addendum (gear nomenclature).
r. https://www.google.co.in/search?q=gear+tooth+vernier+caliper&tbm=isch&tbo=u&source=univ&sa=X&ei=MIuEUsqSOsiKrQeywIFQ&ved=0CCgQsAQ&biw=1600&bih=804 (gear tooth vernier).
s. http://www.youtube.com/watch?v=lc4dsNvm2Ks (principle of mech. meas).
t. http://www.youtube.com/watch?v=nv3GuJArjNU (Transducers).
u. http://www.youtube.com/watch?v=iMIzApq1CQ0 (pressure measurement).
v. http://www.youtube.com/watch?v=JKuoQ5FV2c8 (temperature meas.).
w. http://www.youtube.com/watch?v=GNOI_7ftbQ0(temperature meas.) .
x. http://www.youtube.com/watch?v=7xUdPVpafyI (flow measurement).
y. http://www.ignou.ac.in/upload/Unit-4-62.pdf (limit gauges).
z. http://www.scribd.com/doc/55242715/8/Types-of-limit-gauges
aa. http://www.youtube.com/watch?v=v25PCV_IJCw (sensors)
bb. http://www.youtube.com/watch?v=QItuf6lNvmI(sensors)
cc. http://www.youtube.com/watch?v=pOvTyvBqzgM (displacement sensors)
dd. http://www.youtube.com/watch?v=inLkCOwVgyM (force sensors)
ee. http://www.youtube.com/watch?v=jxv0ITAr74A(force sensors)
ff. http://www.youtube.com/watch?v=0MP_9n08urA(force sensors)
gg. http://www.youtube.com/watch?v=zAddvPHfKnw(force sensors)
hh. http://www.youtube.com/watch?v=_fQSMVf3hdM (calibration).
ii. http://www.youtube.com/watch?v=HwSxBRaxn_4(calibration).
jj. http://www.youtube.com/watch?v=ZymDMUuVuyY (geometrical Tol.)
kk. http://www.gobookee.org/measurement-of-geometric-tolerances-in-manufacturing/
ll. http://www.me.metu.edu.tr/courses/me410/exp1/410exp1theory.pdf
mm. http://www.youtube.com/watch?v=5eaSkU6Ecik (flatness measurement)
nn. http://www.youtube.com/watch?v=1tBnpzyhVXU (measuring straightness)

oo. http://www.youtube.com/watch?v=1JNCe9fwRUw (measuring perpendicularity)
pp. http://www.youtube.com/watch?v=eJ8a0k8kQIE(Roundness and cylindricity)
qq. http://www.youtube.com/watch?v=V0R5GVCxBy4 (NDT)

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics:

- **Prof. A. M. Talsaniya**, Lecturer in Mechanical Engineering, Sir B.P.I., Bhavnagar.

Coordinator and Faculty Members from NITTTR Bhopal.

- **Dr. K.K. Jain**, Professor and Dean, Department of Mechanical Engineering.
- **Prof. C.K. Chugh**, Professor, Mechanical Engineering, NITTTR, Bhopal.

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: PLANT MAINTENANCE AND SAFETY
(Code: 3341906)

Diploma Programme in which this course is offered	Semester in which offered
Mechanical Engineering, **Mechatronics Engineering**	**4th Semester**

1. RATIONALE

Maintenance of equipment in industries is very critical issue to ensure quality and quantity of production. Industries are not able to survive and progress if proper maintenance of equipment is not done. In the absence of proper maintenance, industries are busy in every day fire fighting to repair the breakdowns and manage production in very unsafe manner. This course provides information about wear, corrosion, lubrication, preventive maintenance; decision tree to diagnose faults, important provisions of factory act, alignment of equipment etc. This course also provides basic knowledge and skills regarding maintenance problems, their causes and remedies in industries.

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:

- **Manage maintenance operations satisfactorily by following safety rules.**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

- Recognize troubles in mechanical elements.
- Assemble, dismantle and align mechanisms in sequential order.
- Carry out plant maintenance using tri-bology, corrosion and preventive maintenance.

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**	**150**
3	0	2	5	70	30	20	30	

Legends: L -Lecture; **T** -Tutorial/Teacher Guided Student Activity; **P** -Practical; **C** -Credit; **ESE**-End Semester Examination; **PA** -Progressive Assessment

5. COURSE DETAILS

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I **Fundamentals of maintenance engineering**	1a. Appreciate the need of maintenance in industry 1b. Describe functions of maintenance department	1.1 Definition and aim of maintenance engineering. 1.2 Primary and secondary functions and responsibility of maintenance department. 1.3 Types of maintenance. 1.4 Types and applications of tools used for maintenance.
	1a. Calculate service life of equipment	1.5 Maintenance cost & its relation with replacement economy. 1.6 Service life of equipment.
Unit – II **Wear and Corrosion and their prevention**	2a. Explain causes, effects and reduction methods of wear.	2.1 Wear- types, causes , effects 2.2 Wear reduction methods
	2b. Select appropriate lubricants and lubrication method.	2.3 Lubricants-types and applications. 2.4 Lubrication methods –General sketch, working and applications. i. Screw down grease cup. ii. Pressure grease gun. iii. Splash lubrication. iv. Gravity lubrication. v. Wick feed lubrication. vi. Side feed lubrication. vii. Ring lubrication.
	2c. Describe reasons of corrosion for given case.	2.5 Definition, principle and factors affecting the corrosion. 2.6 Types of corrosion.
	2d. Explain methods of corrosion prevention.	2.7 Corrosion prevention methods.
Unit – III **Fault tracing**	3a. Develop decision trees to diagnose faults in equipment.	3.1 Fault tracing-concept and importance. 3.2 Decision tree-concept, need and applications. 3.3 Sequence of fault finding activities, show as decision tree. 3.4 Draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipments like: i. Any one machine tool. ii. Pump iii. Air compressor. iv. Internal Combustion engine. v. Boiler. vi. Electrical motors. 3.5 Types of faults in machine tools and

Unit	Major Learning Outcomes	Topics and Sub-topics
		their general causes.
Unit – IV **Periodic and preventive maintenance**	4a. Carry out periodic inspection in mechanical systems.	4.1 Periodic inspection-concept and need. 4.2 Degreasing, cleaning and repairing schemes.
	4b. Overhaul of mechanical components and electrical motor.	4.3 Overhauling of mechanical components. 4.4 Overhauling of electrical motor. 4.5 Common troubles and remedies of Electric motor. 4.6 Repair complexities and its use.
	4c. Plan preventive maintenance of major mechanical systems.	4.7 Definition, need, steps and advantages of preventive maintenance. 4.8 Steps/procedure for periodic and preventive maintenance of: i. Machine tools. ii. Pumps. iii. Air compressors. iv. Diesel generating (DG) sets. 4.9 Program and schedule of preventive maintenance of mechanical and electrical equipments. 4.10 Advantages of Preventive maintenance. 4.11 Repair cycle-concept and importance.
Unit – V **Industrial safety**	5a. Describe different types of accidents and hazards.	5.1 Accident - causes, types, results and control. 5.2 Mechanical and electrical hazards-types, causes and preventive steps/procedure.
	5b. Describe salient points of Factories act 1948.for health, and safety. 5c. Describe Fire prevention and fire fighting, equipment and methods.	5.3 Describe salient points of Factories act 1948.for health and safety-, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc. 5.4 Safety colour codes. 5.5 Fire prevention and fire fighting, equipment and methods.
Unit – VI **Recovery, reconditioning and**	6a. Select appropriate recovery method for machine elements	6.1 Definition of recovery, reconditioning and retrofitting. 6.2 Methods of recovery and their applications. 6.3 Selection criteria of recovery methods.

Unit	Major Learning Outcomes	Topics and Sub-topics
retrofitting	6b. Explain reconditioning and retrofitting process.	6.4 Reconditioning - process, features and advantages. 6.5 Retrofitting - concept, need and applications.
Unit – VII **Installation, erection and commissioning of equipments**	7a. Explain foundation and erection of equipment in plant. 7b. Prepare test chart of given equipment	7.1 Design and planning of foundation. 7.2 Erection and commissioning of equipment. 7.3 Alignment and testing of equipment.

6 SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fundamentals of maintenance engineering	4	3	4	0	7
II	Wear and Corrosion and their prevention.	8	4	4	6	14
III	Fault tracing	6	2	2	6	10
IV	Periodic and preventive maintenance	10	3	3	8	14
V	Industrial safety	5	3	3	3	9
VI	Recovery, reconditioning and retrofitting	5	2	3	4	9
VII	Installation, erection and commissioning of equipments	4	2	3	2	7
Total		**42**	**19**	**22**	**29**	**70**

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:

a. If mid semester test is part of continuous evaluation, unit numbers I, II, III, and IV (Up to point number 4.6 only) are to be considered.

b. 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 psychomotor 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 psychomotor 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 Number	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs. required
1	I	**Preparatory Activity:** Study and demonstrate use of various types of tools. (Fix spanners, box spanners, ring spanners, allen keys, types of pliers, screw drivers, bearing puller, etc.).	02
2	II	**Measurement of Wear:** Measure wears of anyone of the following. a. Machine guide ways. b. Shaft –sleeve. c. Piston –cylinder. d. Bearing.	02
3	II	**Corrosion:** Each student will collect corroded component from field and identify the types of corrosion and possible causes. Student will also suggest prevention methods.	02
4	III	**Fault Tracing and Decision Tree:** Develop decision tree for location of fault for **any two** items from following- a. Internal combustion (IC) engine. b. Boiler. c. Pump. d. Machine tool. e. Air compressor. f. Electric motor.	04
5	IV	**Maintenance of Mechanical Based Equipment/Device/Machine.** Maintenance of **any two** from following. Batch may be divided in to two groups and each group may be given one case. a. Head stock. b. Tail stock. c. Feed box. d. Indexing head. g. Internal combustion (IC) engine. h. Pump. (Dismantle of given case, observe rules, follow sequence of dismantling operations, cleaning, inspection, measuring deviations , recovery methods, testing and assembling).	08

6	IV	**Preventive Maintenance:** Prepare a preventive maintenance schedule of any workshop having- air compressors, car washing pumps, tyre changer, lifts, welding machines, and wheel alignment.	02
7	V	**Safety:** Demonstrate use of fire fighting and safety related equipments.	02
8	VII	**Test Chart:** Prepare test chart of newly installed or repaired machine tool.	02
9	ALL	**Mini Project And Presentation:** a. Identify mechanical based any one equipment / device / machine at institute level which requires maintenance. b. Prepare general sketch. c. Perform fault tracing and prepare the decision tree. d. Dismantle. Write the sequence of dismantling. Also describe the steps. List the tools used for this activity. e. Attend necessary maintenance tasks. Write the tasks performed. f. Assemble, test and if necessary, modify. Write the steps. g. Prepare power point presentation. Present the project. This must include photographs / movies of group working on project.	04
10	ALL	**Industrial Visit:** Arrange visit to nearby automobile workshop/machine shop.	-
		Total Hours	28

Notes:

a. Term work report must not include any photocopies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only. However photographs/movies of actual performance by batch students and photographs of device/s undertaken for maintenance may be allowed by teacher.

b. Term work report content of each experience should also include following.
   i. The specifications of machines / equipments / devices / tools /instruments / items/ elements which is / are used to carry out and to check experience.
   ii. Sequence of dismantling and assembling.
   iii. Steps / process description to execute experience.
   iv. Observations.

c. Mini project and presentation topic/area has to be assigned to the student in the beginning of the term by batch teacher. This may be assigned individually or in the group of maximum 4 to 6 students.

e. For 20 marks ESE, students are to be assessed for competencies achieved. They should be given following tasks:

i. Identify different tools.
ii. Make decision tree for given case.
iii. Assemble and dismantle parts of given device.

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Sr. No.	Activity
1	Monitor functionality of machine element and try to judge fault in it.
2.	Visit nearby Industry/plant/workshop/hospital and collect samples of periodic & preventive maintenance format.

9. SPECIAL INSTRUCTIONAL STRATEGIES (If any)

Sr. No.	Unit	Unit Name	Strategies
1	I	Fundamentals of maintenance engineering	Demonstrate and explain use of tools.
2	II	Wear and Corrosion and their prevention	Show worn out parts. Also discuss reasons. Show corroded parts. Also discuss reasons.
3	III	Fault tracing	Show movie. Demonstrate the steps.
4	IV	Periodic and preventive maintenance	Show movie. Demonstrate the steps. Show some sample formats.
5	V	Industrial safety	Demonstrate and explain use of safety equipments. Industrial visit.
6	VI	Recovery, reconditioning and retrofitting	Show movie. Demonstrate the steps. Industrial visit.
7	VII	Installation, erection and commissioning of equipments	Show movie. Demonstrate the steps. Industrial visit.

10. SUGGESTED LEARNING RESOURCES

(A) List of Books:

Sr no.	Title of Books	Author	Publication
1.	Maintenance Engineering Handbook	Higgins & Morrow	DA Information Services
2.	Maintenance Engineering	H.P.Garg	S. Chand and Company.
3.	Maintenance of Machine Tools	Gilbirg & Morrow	
4.	Pump-hydraulic Compressors	Audels.	McGrew Hill Publication.
5.	Foundation Engineering Handbook	Winterkorn, Hans.	Chapman & Hall London

6.	Manuals Of Machine Tool And Auto mobile Vehicles	-	-
7.	Corrosion handbook	-	-

(B) List of Software/Learning Websites:

i. www.mt-online.com
ii. www.pmxpert.com
iii. www.nptel.iitm.ac.in
iv. en.wikipedia.org
v. webstore.ansi.org/preventive-maintenance
vi. www.mapcon.com

(C) List of equipments:

i. Tool kit.
ii. Fire extinguishers.
iii. Lubricants.
iv. Cotton waste.
v. Kerosene.
vi. Measuring instruments.

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics:

- **Prof. R B Patel**, Lecturer in Mechanical Engineering,Govt. Polytechnic, Himatnagar.
- **Prof. A M Patel**, Lecturer in Mechanical Engineering,B.S.Patel Polytechnic, Kherva.
- **Prof. K.P.Patel**, Head of Mechanical Engineering Department,B.S.Patel Polytechnic, Kherva.

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Vandana Somkuwar**, Associate Professor, Department of Mechanical Engineering,
- **Prof. C.K. Chugh**, Professor, Department of Mechanical Engineering