GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: THERMAL ENGINEERING-II
(COURSE CODE: 3351901)

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

1. RATIONALE.

Subject knowledge of thermal engineering is required in many industries. The objective of this course is to establish basic fundamental and practical knowledge in the field of internal combustion engine, refrigeration, air conditioning, eco-friendly fuels, etc. These are major fields of mechanical engineering. Student will be able to understand different systems and apply its competencies in major fields in related industries. Knowledge of alternate fuels is required as emerging field and today's need of society which will be provided by the course content.

2. LIST OF 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 competencies:

- **Apply concepts, laws and principles of thermal engineering to operate & maintain the machines/ equipment/ devices.**

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 outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Analyze performance of ICEs by operating them and observing changes in thermodynamic properties during each stroke of ICEs (and by using thermodynamic diagrams.)
ii. List characteristics and properties of alternate fuels used for ICEs.
iii. Analyse the performance of Vapour Compression Refrigeration System (VCRS), by operating them and observing the changes in properties of refrigerant during each process on VCRS (and using thermodynamic charts/diagrams.)
iv. Explain working of various air-conditioning equipments and aids including ducts and fans
v. Carryout maintenance task by using suitable tools and equipment

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 Theory Practice; **P** -Practical; **C** – Credit, **ESE** -End Semester Examination; **PA** - Progressive Assessment.

5. COURSE DETAILS.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I **Internal combustion engines.**	1a. Classify ICEs 1b. Compare ICE with External Combustion engine- ECE 1c. Explain the working principle of the ICEs 1d. Describe ICEs with classification. 1e. Explain terminology used in ICEs. 1f. Describe working of ICEs with functions of each element. 1g. Describe combustion process in CI & SI engines. 1h. List the steps to perform testing of ICEs.	1.1 IC Engine-concept (comparison with External Combustion engine- EC), classification, working principle and terminology used. 1.2 Main components of IC engine and their functions. 1.3 Petrol engines (Spark Ignition-SI) & diesel engines (Compression Ignition-CI)-two strokes and four strokes both: i) Working principles. ii) Cycles on P-V and T-s diagram. iii) Elements-sketch, working and functions. iv) Various systems- cooling, fuel injection (includes carburetion, fuel pump, fuel injectors, Multi Point Fuel Injection (MPFI), etc.), ignition, governing (quality, quantity and hit and miss governing), exhaust, etc. v) Comparison between SI & CI Engines. vi) Theoretical and actual valve timing diagrams. 1.4 MPFI- need and working. 1.5 Concept of scavenging and turbocharger.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		turbocharger. 1.6 Concept of Common Rail Direct Injection System-(CRDI) for diesel engine. 1.7 Performance testing of IC engines and its heat balance sheet (Simple numerical examples) with familiarization with testing as per BIS.
Unit– II **Alternate fuels.**	2a. List characteristics and properties of fuels used for ICEs. 2b. Explain needs and types of alternate fuels & their applications. 2c. Explain system requirements for alternate fuels with suitable diagrams.	2.1 Alternatives fuels: Types, properties, compositions, advantages, disadvantages and implementation issues- includes mainly Compressed Natural Gas (CNG), Liquefied Petroleum Gas (LPG) and Biodiesel. Effect of these fuels from pollution point of view. 2.2 Supply system requirement for CNG and LPG as alternate fuel in vehicle. 2.3 Conversion devices/ kits for SI Engines- vaporizer/ PRV for fuel compatibility, piping and allied needs.
Unit– III **Refrigeration.**	3a. Describe the processes and elements of VCRS with functions of each element. 3b. Operate VCRSs, observe the changes in properties of refrigerant during each process on VCRS and calculate / analysis the performance using thermodynamic charts/ diagrams. 3c. List characteristics of refrigerants used for VCRSs. 3d. Explain thermodynamic cycles based on second law of thermodynamics by using thermodynamic diagrams. 3e. Detect the leakages in VCRS by using appropriate tools and equipment. 3f. Evacuate and recharge the refrigerant in VCRS.	3.1 Introduction to refrigeration. 3.2 Reversed Carnot cycle & Bell column cycle. (No numerical) 3.3 Unit of refrigeration & basic terminology. 3.4 Vapor compression refrigeration cycle (VCRS), working with the help of P-V, T-s & P-h diagrams. 3.5 VCRS components, types, their construction, working, applications, (components include compressor- Reciprocating, Rotary, Screw and scroll; condensers- Air cooled and water cooled; evaporators- Dx type, flooded, shell and tube type; expansion devices -Automatic, thermostatic expansion valve and capillary tube, High side float valve).

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	3g. Perform various refrigerant tubing operations.	3.6 Performance of VCRS based on coefficient of performance (COP), simple numerical. 3.7 Effect of change in operating conditions (condenser pressure, evaporator pressure, sub cooling, superheating) on performance of VCRS & its representation on P-h diagram (with suitable numerical examples). 3.8 Application of VCRS: Ice Plant, cold storage, water cooler, domestic refrigerator, deep freezer- block diagram, components, working. 3.9 Basic concept of Vapor absorption refrigeration system. 3.10 Refrigerant classification, Desirable properties of refrigerants, and properties & applications of commonly used refrigerants including R22, R134a, Hydro Carbon-HC and R717 (Ammonia), need of new refrigerants.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit–IV **Air-Conditioning**	4a. Plot and interpret various air conditioning processes on psychometric chart. 4b. Measure various air properties. 4c. Explain working of various air-conditioning equipment.	4.1 Introduction to air conditioning. 4.2 Air conditioning- types and its applications. 4.3 Psychrometry- properties of air. 4.4 Representation of psychrometry properties on chart (simple numerical using chart). 4.5 Various air conditioning processes on psychometric charts. 4.6 Dessert cooler, window and split air conditioners- components and working. 4.7 Ducts- need, types with applications, constructional materials, and installation, common troubles with their remedies. 4.8 Air conditioning fans-types, constructional features, applications and common troubles with their remedies.

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

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Internal Combustion (I. C.) Engines.	11	10	8	8	26
II	Alternate Fuels.	02	4	2	0	6
III	Refrigeration.	10	8	8	8	24
IV	Air-Conditioning.	05	4	4	6	14
	Total	**28**	**26**	**22**	**22**	**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.

NOTES:

1. This specification table shall be treated as only general guideline for students and Teachers. The actual distribution of marks in the question paper may vary from above Table.

2. 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.
3. If midsem test is part of continuous evaluation, unit numbers I (Up to 1.3 only) and III (Up to 3.8 only) are to be considered.
4. In the optional numerical question, numerical of same chapter should be asked.

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**)**	Approx. Hours. required
1	ALL	**Preparatory Activity:** a. Student will recall and write basic thermodynamic units. b. Teacher will demonstrate working of I.C. Engine. i) Demonstrate and explain working and function of I.C. Engine. ii) Demonstrate working of two stroke and four stroke engine.	02
2	I	**Demonstration of IC engine parts:** a. Demonstrate and explain dismantling, assembling, working and inspection of fuel pump, fuel injector, carburetor and multipoint fuel injection system. b. Sketch and explain working of fuel pump, fuel injector, carburetor and multipoint fuel injection system. c. List dismantling and assembling methods/ steps in logical sequence. d. Record observations during inspection.	04
3	I	**Valve timing diagram:** a. Write specifications of IC engine undertaken for valve timing diagram.	02

		b. Perform and record angles and strokes. c. Prepare valve timing diagram. d. Interpret valve timing diagram.	
4	I	**Perform test and prepare heat balance sheet of IC Engine. (Petrol and Diesel-both separately);** a. Write specifications of IC engine undertaken for test. b. Demonstrate and perform test on IC engine. c. Observe and record test parameters. d. Derive required parameters- Indicated Power (IP), Break Power (BP), fuel consumption for varying load, efficiency, etc. e. Observe and record parameters required for heat balance sheet (For full load conditions). f. Prepare heat balance sheet. g. Interpret test results and heat balance sheet.	04
5	III	**Refrigeration tubing operations:** a. Demonstrate VCRS on any car/Bus from tubing point of view. b. Demonstrate various tubing tools and tubing operations. c. Perform various tubing operations. d. Sketch and explain VCRS demonstrated on any vehicle. e. Sketch and explain various tools used for refrigeration tubing. f. Describe tubing operations with neat sketches. Also state applications of each.	02
6	III	**Leak detection, evacuation and refilling of the refrigerant:** a. Demonstrate leak detection, evacuation and refilling of refrigerant. b. Demonstrate working of equipment / tools / instruments / devices used to demonstrate leak detection, evacuation and refilling of refrigerant. c. Explain various leak detection techniques. d. Sketch and explain working of equipment / tools / instruments / devices used to demonstrate leak detection, evacuation and refilling of refrigerant. e. List and explain the steps followed to perform leak detection, evacuation and refilling of refrigerant. f. Conclude your observations.	04
7	III	**COP of VCRS:** a. Sketch block diagram of VCRS. b. Write specifications of each component of VCRS taken for performance. (Of compressor, condenser, expansion device and evaporator). c. Perform, observe and record the parameters required to determine refrigeration effect (RE), work done (WD), mass flow rate and COP.	02

		d. Determination RE, WD, mass flow rate and COP. e. Plot the actual VCRS cycle on P-h chart and T-s diagram. f. Interpret the performance.	
8	III	**Determination of properties of air:** a. List and define various properties of air. b. List, sketch, demonstrate and explain working of various psychometric instruments. c. Perform, observe and record the properties. d. Calculate properties (Teacher will assign) of air from the readings taken. e. Given the data (Teacher will assign the data for four to five processes.), plot the processes on psychometric chart.	02
9	III	**Determination of capacity of window / split air-conditioner**. a. Sketch block diagram of setup. b. Perform, observe and record the parameters required to determine the capacity. c. Determine the capacity. d. Thumb rules to estimate the capacity.	02
10	IV	**Industrial visit: (ANY TWO)** a. Visit cold storage plant, ice plant and air-conditioning plant to observe VCRS, different kinds of ducting. b. Visit any Industry working on I C Engine manufacturing/ running or power plant working on I C Engine. (D.G. Power Plant.) c. Visit any petrol/ diesel/ CNG/ LPG station and study different fuel filling systems along with different parameters affected. d. Student will visit and prepare industrial visit report.	04
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.PA component of practical marks is dependent on continuous and timely evaluation of exercises.
b. Term work report must not include any photocopy/ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only.
c. Student activities are compulsory and are part of term work.
d. Term work content of industrial visit report should also include following.
    i. Brief details of industry/ site visited.
    ii. Type, location, processes / products, rough layout, human resource, etc of industry.
    iii. Details, description and broad specifications of machineries/ processes observed.
    iv. Safety norms and precautions observed.

v. Student's own observation on industrial environment, productivity concepts, quality consciousness and quality standards, cost effectiveness, culture and attitude.
vi. Any other details / observations asked by accompanying faculty.

e. For practical ESE part, students are to be assessed for competencies achieved. They should be assigned the necessary data and should be given to:
i. Any one performance type experience to perform.
ii. Identify the locations of parts on VCRS and ICEs and to explain functions of them.

8. SUGGESTED LIST OF STUDENT ACTIVITIES

SR.NO.	ACTIVITY
1	Enlist I C Engine specifications at your institute.
2	Prepare Charts of ICE systems.
3	Prepare chart of CNG/LPG/Diesel/ Petrol engine fuelling system.
4	Search different ICE components from scrap and identify type of defect/ failure.
5	Visit any Industry working on I C Engine manufacturing/ running or power plant working on I C Engine.
6	Visit any petrol/ diesel/ CNG/ LPG station and study different fuel filling systems along with different parameters affected.
7	Enlist VCRS system specifications at your institute.
8	Prepare chart VCRS/ VARS.
9	Visit cold storage plant, ice plant and air-conditioning Plant to observe VCRS or VARS, different kinds of ducting. After visit, student should submit detail industrial report of his understanding.
10	Preparation of small model of VCRS.
11	Built up/ evacuate VCRS available at your institute.
12	Prepare property table for different types of refrigerants/ alternate fuels.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any):

Sr. No.	Unit	Unit Name	Strategies
1	I	Internal Combustion (I.C.) Engines.	Movies, power point presentations, live demonstration, performance with IC engines.
2	II	Alternate Fuels.	Physical demonstration of properties of fuels, movies, lives examples.
3	III	Refrigeration.	Movies, power point presentations, live demonstration, performance with VCRS, industrial visits, Visit of cold storage/ice plants.
4	IV	Air-Conditioning.	Movies, power point presentations, live demonstration, performance of air conditioners, industrial visits.

10. SUGGESTED LEARNING RESOURCES

A) List of Books

S. No.	Title of Book	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.	Thermal Engineering.	R K Rajput.	Laxmi. Publications
5.	A Text book of Thermal Engineering.	R S Khurmi& J.K. Gupta.	S Chand & Co.
6.	I C Engine	Domkundwar	
7.	I C Engine	Mathur and Sharma.	DhanpatRaiPubli.
8.	Principles of Refrigeration	Dossat	Pearson Education
9.	Refrigeration and air conditioning	Arora & Domkundwar	Khanna publication.
10.	AText Book of Refrigeration and Air Conditioning	R S Khurmi	Eurasia Publishing House
11.	Thermal engineering	P.L.Ballaney	Khanna Publication
12.	Thermal Science and Engineering	Dr. D.S.Kumar	S.K.Kataria & Sons.
13.	Refrigeration & Air-Conditioning.	R.K.Rajput	S.K.Kataria& Sons.

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

SR.NO.	EQUIPMENT	BROAD SPECIFICATION
1	I C Engine test rig- petrol and diesel – both.	Single cylinder/ multi stage- 4 stroke- Petrol and diesel engine test rig with hydraulic / eddy current dynamometers, 3kW or higher capacity- sensors on appropriate places for temperature measurement, arrangement of cam shaft to measure valve timing, flow measuring device at inlet and outlet with computerized data acquisition system and MPFI system (Petrol test rig is preferable with CNG kit fitted).
2	VCRS test rig.	Hermetically sealed compressor of at least half HP with HP/LP cut out, air cooled condenser, expansion valve, evaporator, flow meter/ rotameter for measuring refrigerant flow, solenoid valves/ temperature sensors at compressor in/out, condenser in/ out, expansion in/out, evaporator in/out, pressure gauge at in out of compressor, withMulti-channel digital

		temperature indicator, digital volt meter and ammeter, R-134a refrigerant.
3	Psychrometer& Thermometer-wet bulb and dry bulb.	Digital temperature and Humidity measurement, temperature range of -25 degree C to 60 degree C or higher.
4	Anemometer.	Digital air flow measuring device with flow range measurement of 0.4m/s up to 25m/s with a resolution of 0.1m/s.
5	Refrigeration tool kit.	Standard refrigeration tool kit
6	Tool kit for tubing operations for Refrigeration.	Flaring tool set, single type for tube 4.7mm to 16mm O.D., Swaging tool set, single type for tube 4.7mm to 16mm O.D., Bending spring external type, for copper tube 3mm to 16mm dia., Tube bender of 3 mm to 16 mm DIA, Pipe cutter miniature for copper tube 3mm to 16mm DIA, Pinch of tool, for copper tube, 6mm to 18mm DIA, Ratchet spanner of 6.4 sq.mm reversible, Capillary plague gauge, Pinch of plier/crimping plier tool 6mm – 18mm DIA, Piercing plier 6-18mm & reversing valve with access fitting.
7	I C Engine tool kit.	Standard Engine maintenance tool kit available at workshops.
8	Leak detector.	Electronic refrigerant leak detector with microprocessor control. Gas leak detector for halogen gas
9	Refrigerant evacuation pump / vacuum pump.	Two stage rotary vacuum pump capacity approx. 60 – 10rmp capable of evacuating to 50 microns of Hg and fitted with gas ballast, anti such back valve and single phase motor
	Optional Items for evacuation pump/ vacuum pump.	Evacuating and refrigerant charging station, compression a) Rotary two stage vacuum pump and motor (with gas ballast and anti such back) manifold with gauges and valves and capable of pulling vacuum up to 50 microns of Hg and with provision of connecting to a microns level vacuum gauge b) Graduated charging cylinder with provision for temperature correction and all necessary isolating valves II) Evacuating and charging station as above but fitted with weighing scale (up to 2 kg. In lieu of (b) above and with accuracy of +/-1 g for charging hydrocarbons)
10	Window/ split air conditioner test set up.	Test rig containing air conditioner of 1.5 tons- in open condition.
11	Air washer/ cooler.	Air washer test rig.
12	Various fans for demonstration.	Models of fans- includes radial, backward, forward curve blades etc.
13	Brazing kit	Brazing tool kit with suitable Silver and

		copper brazing alloy rods for ¼" to 7/8" tubes – Cu to cu, cu to steel, cu to brass and appropriate flux
14	Pressure gauge and gauge manifold for charging	Pressure guage diameter 63mm with recalibration set, Compound gauge, diameter 63mm, with recalibration set screw, scale vacuum 76mm. Pressure 15 Kg/sq.cm, Two way manifold with gauges and charging pipe
15	Refrigerants	Hc refrigerant in cylinders/disposable containers, 134 A refrigerant in cylinders
16	I C Engine parts	Fuel pump, different types of carburetors, different types of injectors- distributors.
17	I C Engine cut section/ models	Cut model of 4 stroke petrol and diesel engine, cut model of 2 stroke petrol engine, cut model of fuel pump

C) List of Software/Learning Websites

i. http://nptel.ac.in/courses/112105128/
ii. http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Ref%20and%20Air%20Cond/New_index1.html
iii. http://www.youtube.com/playlist?list=PLE2DA184A2E479885
iv. http://www.kolpak.com/asset/?id=tuqvr

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. S. R. Pareek,** Head of Department, Mechanical Engineering, Tolani F. G. Polytechnic, Adipur.
- **Dr. Shah Atul S.,** Lecturer in Mechanical Engineering, Dr. S & SS Ghandhy Collage of Engineering and Technology, Surat.
- **Shri M. N. Patel,** Lecturer in Mechanical Engg, Government Polytechnic, ChhotaUdepur.
- **Shri Haresh G Ranipa**, Lecturer in Mechanical Engineering, Shri N M Gopani Polytechnic, Ranpur.
- **Shri H.R.Sapramer,** Lecturer in Mechanical Engineering, Sir B.P.T.I., Bhavanagar.
- **Shri U.O. Khant** . Lecturer in Mechanical Engg, Government Polytechnic,Rajkot.
- **Shri A. A. Lohia**, Lecturer in Mechanical Engg, Government Polytechnic,Rajkot.

Coordinator and Faculty Members from NITTTR Bhopal

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

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: DESIGN OF MACHINE ELEMENTS
(COURSE CODE: 3351902)

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

1. RATIONALE

For production of machine parts and components it is required that specific shape and size of machine parts are determined and their drawings are prepared. We also have to select specific material for that product. This process is called as design. In designing a machine component it is necessary to have a good knowledge of many subjects such as Mathematics, Engineering Mechanics, Strength of Materials, Theory of Machines, Workshop Processes and Engineering Drawing. Students have learnt these subjects in previous semesters. This course curriculum provides the students' knowledge of design process, as well as familiarity with design of components subjected to various stresses and moments like direct stress, bending stress, twisting moment and combined stresses. In this course students will learn design of machine components/elements like cotter joint, knuckle joint, power screw, levers, helical and leaf springs, couplings, pressure vessels, bearings, etc.

2. LIST OF 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 competencies:

- **Design a simple machine element with appropriate material for given user defined boundary and loading conditions.**

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 objectives in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Identify various failures and calculate resisting areas of machine elements.
ii. Use preferred numbers and standardization to select element/element dimension.
iii. Design machine element subjected to:
    a: Direct stresses.
    b: Bending stresses.
    c: Twisting stresses.
    d: Combined stress.
iv. Design of thin and thick cylinder pressure vessel.
v. Select appropriate bearing for given situation/application.
vi. Calculate important bearing characteristics.

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	5	70	30	20	30	150

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

5. COURSE DETAILS.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I. **Introduction.**	1a. List various factors to be considered for design process. 1b. Identify and select materials that can be used for design of machine elements. 1c. Explain loads, stresses, stress concentration factor and factor of safety. 1d. List Types of loads, types of stresses 1e. Select standard items and preferred numbers for designing simple machine elements.	1.1 General consideration and factors influencing the design of machine elements and design process. 1.2 Various materials used in manufacturing of machine elements and their properties. 1.3 Types of loads, types of stresses, concept of stress concentration and factor of safety. 1.4 Standardization and preferred numbers, numeric examples on preferred numbers.
Unit– II **Design of machine elements subjected to direct stresses.**	2a. Describe the design process of simple elements like linkages, etc. 2b. Calculate resisting area of simple machine element subjected to direct independent stress. 2c. Explain the design of cotter joint and knuckle joint. 2d. Explain the design process of riveted joint, welded joint and	2.1 Illustration of simple machine elements subjected to direct stresses-independently and identification of resisting areas (simple numeric examples). 2.2 Design of simple machine elements subjected to uni-axial direct stresses-independently. 2.3 Design procedure (with numeric examples), steps, identification of resisting areas and design of: i. Knuckle joint. ii. Cotter joint. iii. Riveted joints. iv. Welded joint-fillet & lap joint .

	threaded fasteners.	v. Threaded fasteners & screw jack.
Unit– III **Design of machine elements subjected to bending stresses.**	3a. State the fundamental bending equation. 3b. State modulus of various sections subjected to pure bending like levers, beams and axles 3c. List types of levers. 3d. Design simple lever based on given input. 3e. Design leaf spring.	3.1 Principle of bending and its fundamental equation. 3.2 Modulus of various sections, example of pure bending like levers, beams, axle, etc. 3.3 Types of levers. 3.4 Design procedure (with numeric example) of levers including cross section of arms, bosses and pins. 3.5 Design procedure (with numeric example) of leaf spring.

Unit–IV **Design of machine elements subjected to direct and twisting moments.**	4a. State fundamental equation of twisting moment. 4b. List types of shafts with important features of each. 4c. List types of keys, couplings, spring & applications of each 4d. Explain the design procedure of shafts, keys and couplings. 4e. Define helical spring terminology and its applications. 4f. Calculate numerical on the design procedure of machine elements subjected to twisting moment.	4.1 Fundamental equation of twisting moment with design procedure. 4.2 Types of shafts with important features of each. 4.3 Design of shafts (with numeric examples). 4.4 Types of keys, applications of each and design procedure (with numeric examples). 4.5 Types of couplings and applications. 4.6 Design of muff and flange couplings (with numeric examples). 4.7 Types of spring, terminology related to helical spring and applications of helical spring.
Unit-V **Design of machine elements subjected to direct and bending stresses.**	5a. Define eccentric loading. 5b. Draw frame-clamp, Bracket, Foundation bolt, Bolts in flange, etc. 5c. Design machine components subjected to eccentric loading.	5.1. Eccentric loading- i. Concept. ii. Illustrations like frame, C-clamp, Bracket, Foundation bolt, Bolts in flange, etc. iii. Design of machine element like C-Clamp, bracket, foundation bolt and bolts in flange.(with numeric examples).
Unit-VI **Design of pressure vessels.**	6a. Define pressure vessels 6b. State types of pressure vessels with range of pressure. 6c. Design simple thick and thin cylinder pressure vessels. 6d. Design simple thin spherical shell.	6.1 Types and applications of pressure vessels used in industries. State Range of pressure also. 6.2 Design of thick and thin cylinders (with numeric examples). 6.3 Design of thin spherical shell (with numeric examples).
Unit-VII **Selection procedure for bearings.**	7a. Classify bearings. 7b. Explain designation of bearings. 7c. Select appropriate anti-friction bearings from manufacturer's catalogue. 7d. Calculate the load on the bearings.	7.1 Classification of bearings. 7.2 Bearing designation as per IS. 7.3 Antifriction bearings: types, advantages, applications. 7.4 Selection procedure of anti-friction bearings. 7.5 Calculation for anti-friction bearings: basic dynamic load, load rating, equivalent load, bearing life.

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

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction.	8	3	7	4	14
II	Design of machine elements subjected to direct stresses.	9	3	4	7	14
III	Design of machine elements subjected to bending stresses.	5	0	0	7	7
IV	Design of machine elements subjected to direct and twisting moments.	8	4	3	7	14
V	Design of machine elements subjected to direct and bending stresses.	4	0	3	4	7
VI	Design of pressure vessels.	4	0	3	4	7
VII	Selection procedure for bearings.	4	4	3	0	7
	Total	**42**	**14**	**23**	**33**	**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 2.3(ii) only, which are Knuckle and cotter joints only), VI and VII 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)	Approx Hours. required
1	ALL	**Preparatory Activity :** a. Interpret and write various course related SI units and their conversions. b. Write normal values of ultimate tensile strength, yield strength, density, modulus of elasticity and Poisson's ratio of commonly used materials. c. List normal values of factor of safety for different situations. d. Recall area, volume, section modulus, moment of inertia, radius of gyration, etc. for commonly used various section and shapes. e. Draw orthographic projections symbols. f. Draw symbols of threads, surface roughness, geometrical tolerances symbols, section lines, etc. g. Recall by sketching the general systems for limits, fits and tolerances.	02
2	II,III, IV and V.	**Design of simple components:** a. A C15 rod is subjected to tensile load of ….kN. Determine diameter of rod if factor of safety is…… b. Teacher will assign the sketch of a component/s with loading that induces tensile/compression and shear stresses. Teacher will also assign material, load, and factor of safety. Students are asked to determine the dimensions. c. Teacher will assign the sketch of a component/s with loading that induces bending stress in addition to two more types of stresses (from tensile, compression, shear, crushing or other.). Teacher will also assign material, load, factor of safety and other data if required. Students are asked to determine specified dimensions. If required, additional data may be given. d. Teacher will assign the sketch of a component/s with loading that induces twisting moment. This may have additional one or two types of stress/es. Teacher will also assign material, factor of safety and other required data.(Like kW, rpm, Torque, etc.). Students are asked to determine the specified dimensions. e. Student will also prepare the report on this, which will include calculations, sketches in A4 size drawing papers with identification of areas subjected to induced stresses. (Note: Each student of the batch must have different values of data. Use design data book	04

		wherever is necessary. Also assume suitable data if required. State the assumptions.)	
3	II,IV	**Design of assemblies:** a. Take load =…….kN, b. Take material as…….. c. Factor of safety =…….. d. Design following showing other assumptions, steps and final dimensions. i. Knuckle joint. ii. Cotter joint. iii. Screw jack. iv. Flange coupling. (Note: Each student of the batch must have different values of data. However problem may be same. Students are also expected to solve these as partial assignments at home. Use design data book wherever is necessary. Also assume suitable data if required. State the assumptions.)	06
4	II,IV	**Sketches and drawings of design assemblies:** a. Sketch production drawings of details (individual parts). Show dimensions calculated above at experience number 3. Use A4 size paper only. b. Prepare assembly drawings with dimensions and scale (if required). Use A4 size paper only. **c.** Show areas under various stresses induced using color codes. (Students are also expected to solve these as partial assignments at home.)	02
5	II,IV	**Modeling:** a. Create 3D Models of all parts and assemblies (In group of 4 students. Each student will perform one) with dimensions designed at experience number 3 and drawn at experience number 4 using any parametric CAD software (like Creo, Solid Edge, and Inventor). b. Take printout of the 3D models and orthographic views (with dimensions) of all parts and assemblies. Attach all prints with term work.	06
6	III and VII	**Tutorials:** a. Tutorial on bell crank lever design.(Teacher will assign the data- one problem). b. Tutorial on bearing. (Teacher will assign the data- one problems). (Students are also expected to solve these as partial assignments at home.)	02
7	ALL	**Mini project:** a. Assign simple mechanical assembly (preferably from real life or thought by batch teacher. Students will be provided with a sketch having 5-6 machined/mechanical components (exclude gears,	06

		cotter, knuckle or other book oriented solved assemblies. Also ensure that such assembly can be manufactured at institute's workshop).Also give load conditions and other necessary information in a batch. b. Batch students will design this assembly with dimensions. Show calculations and steps. c. Sketch production drawings (details and assembly) in A4 size drawing paper manually. d. Present this mini project with photos/movies of mini project execution and with work distribution executed. Use power point presentation.	
			Total Hours **28**

Note:

a) Students should bring any one reference design book (preferably English) and one design data book (By PSG Coimbatore) during theory and practical/exercises sessions.

b) 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. PA component of practical marks is dependent on continuous and timely evaluation of exercises.

c) 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.

d) For 20 marks ESE, students are to be assessed for competencies achieved. They should be given following type of tasks:
   i. Design some elements of cotter joint/knuckle joint/ power screw.
   ii. Design of some mechanical elements subjected to three to four types of stresses.
   iii. Design of flange coupling.
   iv. Design of leaf spring/ lever.
   v. Problems on bearing, equivalent load, rating, etc.

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8. SUGGESTED LIST OF STUDENT ACTIVITIES.

SR.NO.	ACTIVITY
1	Download and present various presentations related to stresses in machine elements.
2	Download and present various presentations related to failure of machine elements.
3	Download and present various presentations related to design of machine elements.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any).

Sr. No.	Unit	Unit Name	Strategies
1	I	Introduction.	Power point presentations, live examples, demonstration of BIS on preferred numbers and standardizations,
2	II	Design of machine elements subjected to direct stresses.	Movies/ animations/ educational charts, videos & model of different machine elements subjected to various stresses, live demonstration of failed components,
3	III	Design of machine elements subjected to bending stresses.	Movies/ animations/ educational charts, videos & model of different machine elements subjected to bending, live demonstration of bending and induced stresses.
4	IV	Design of machine elements subjected to direct and twisting moments.	Movies/ animations/ educational charts, videos & model of different machine elements subjected to twisting, live demonstration of twisting.
5	V	Design of machine elements subjected to direct and bending stresses.	Movies/ animations/ educational charts, videos & model of different machine elements subjected to direct and bending stresses.
6	VI	Design of pressure vessels.	Movies/ animations/ educational charts, videos, demonstration of live pressure vessels.
7	VII	Selection procedure for bearings.	Movies/ animations/ educational charts, videos, live demonstration of bearings, demonstration of BIS catalogues.

10. SUGGESTED LEARNING RESOURCES

A) List of Books

S.No.	Title of Book	Author	Publication
1.	Machine Design.	R.K.Jain.	Khanna Publishers.
2.	Machine Design	TVS Murthy and N.Shanmugam.	Anuradha publications.
3.	Machine Design	Pandya and Shah.	Charotar Publishing House Pvt. Limited.
4.	Machine Design	R.C.Patel and A.D.Pandya	Acharya Book Depot, 1959.
5.	Design of Machine Elements	Shigley.	Tata McGraw-Hill Education.
6.	Design Data Book	P.S.G. College of Technology, Coimbatore.	P.S.G. Publication.
7.	Design Data Book	K. Mahadevan & Balveera Reddy.	S. Chand.
8.	A Text book of Machine Design	R.S.Khurmi and J.K.Gupta	S. Chand.

9.	Design of machine elements.	V.B.Bhandari.	McGraw-Hill.

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

Sr.No.	Major Equipment/ Instrument	Broad Specifications
1	Wooden models (with cut sections) of knuckle joint, cotter joint, riveted joints, welded joints, screw jacks,	Two sets of each with design dimensions.
2	Assorted bearings.	As per BIS.
3	Miniature pressure vessels.	As per standards / design dimensions.
4	Assorted levers, shafts, couplings, flanges, keys, C-clamps, frames, other machine components.	Used as machine elements.
5	Assorted failed components.	Used as machine elements.

C) List of Software/Learning Websites

a. Chp:1 Introduction.
   i. http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Machine%20design1/left_home.html
b. Chp:2 Design of Machine elements subjected to direct stresses.
   i. http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Machine%20design1/left_mod4.html
c. Chp: 3 Design of Machine elements subjected to Bending stresses.
   i. http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Machine%20design1/left_mod7.html.
d. Chp:4 Design of Machine elements subjected to direct and twisting moments.
   i. http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Machine%20design1/left_mod4.html
   ii. http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Machine%20design1/left_mod5.html
   iii. http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Machine%20design1/left_mod8.html
e. Chp: 5 Design of Machine elements subjected to direct and bending stresses.
   i. http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Machine%20design1/left_mod11.html
f. chp: 6 Design of Pressure vessels.
   i. http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Machine%20design1/left_mod9.html
g. Chp:7 Selection Procedure for bearings**.**
   i. http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Machine%20design1/left_mod14.html
h. Chp:ALL
   i. https://www.machinedesignonline.com/MDO_Portal/design_component.html

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE.

Faculty Members from Polytechnics:

- **Prof. M.P.Jakhaniya**, Lecturer in Mechanical Engineering, C.U.Shah Govt.Poly., Surendranagar.
- **Prof. D.R.Katariya**, Lecturer in Mechanical Engineering, Government Polytechnic, Bhuj.
- **Prof.V.N.Patadiya,** Lecturer in Mechanical Engineering,N.M.Gopani Polytechnic, Ranpur.

Coordinator and Faculty Members from NITTTR Bhopal:

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

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

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

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

1. RATIONALE

Large numbers of industrial parts have features like teeth, threads, slots, splines, surfaces etc. Quality of these parts depends on parameters aspects such as accuracy of profile, dimension & surface finish controls. These parameters are specified on the product drawing and require suitable machines & cutting tools for its manufacturing. Nano-parts largely used in control systems require specialised manufacturing approach due to their miniature size. Correct selection of process & its parameters on such machines; plays a vital role in obtaining required quality product at optimum cost. This course will make students familiar with fundamentals of such conventional & advance processes on various machines like grinding machines, super-finishing machines, broaching machines, jig boring machines, non-conventional machining processes, Micro Electro Mechanical Systems (MEMS) etc.

2. LIST OF COMPETENCY

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

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

3. COURSE OUTCOMES

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

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

4. TEACHING AND EXAMINATION SCHEME

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

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

5. COURSE DETAILS.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I. **Introduction to Manufacturing Engineering-III.**	1a. Explain Need, Scope & importance of Manufacturing Engineering.	1.1 Need, Scope & importance of Manufacturing Engineering-III in the industries-----various grinding and super-finishing machines, thread production, broaching machines, electro-mechanical systems (MEMS). Non-conventional and advance methods of machining.
	1b. Define machining parameters 1c. Explain the effect of different machining parameters on quality and cost of product.	1.2 Definitions of machine tool, cutting speed, feed, depth of cut, metal removal rate, surface finish symbols and values, cutting tools and their geometry. 1.3 Need of attitude, knowledge & skill required for shop floor supervision in Machine tools based industries for quality and cost effective production. 1.4 Importance of processes and required parameters (like material removal rate, cutting power, cutting time, cutting speed, feed, depth of cut, number of cuts, tool signature, tool life etc) on quality and cost of product.

Unit– II **Grinding and super finishing processes.**	2a. Classify grinding machines 2b. Describe constructional features and working of various grinding and super-finishing machines. Gear manufacturing, 2c. Select appropriate finishing operation and grinding machine as per production drawing of the component.	2.1 Classification, Constructional features including coolant and lubrication systems, motion and power transmission path, working, application and cutting parameters of following grinding machines with "commonly used grinding wheels and work piece materials" : i. Cylindrical (centre less, internal and external) grinding machines. ii. Bench and portable grinder. iii. Tool and cutter grinding machine. iv. Profile grinding machine. 2.2 Methods of mounting work piece on cylindrical grinding machines (Including chuck and mandrel).
	2d. Explain Honing, lapping, buffing & super-finishing processes with their applications.	2.3 Honing, lapping, buffing and other super finishing processes and their applications.
	2e. Explain Cutting action of grinding wheel. 2f. Define Terms associated with grinding wheel operations including loading, glazing, dressing and truing. 2g. Select grinding wheel. 2h. Maintain grinding wheel for effective grinding.	2.4 Cutting action of grinding wheel. 2.5 Terms associated with grinding wheel operations including loading, glazing, dressing and truing. 2.6 Grinding wheels: i. Nomenclature. ii. Types and shapes. iii. Designation system and its interpretation. iv. Selection criteria and applications. 2.7 Static and dynamic balancing of grinding wheels - need and methods. 2.8 Methods of mounting grinding wheel.
Unit– III **Gear manufacturing and finishing processes.**	3a. List types of gears 3b. Assimilate the Gear manufacturing & finishing processes. 3c. Describe constructional features and working of various gear manufacturing machines. 3d. Select appropriate	3.1 Types of gears, nomenclature of spur and helical gears. 3.2 Gear generating and forming processes-concept, differences and applications. 3.3 Classification, constructional features including coolant and lubrication systems, motion and power transmission path, working and application of gear milling, gear hobbing and gear shaping machines.

	gear manufacturing machine as per the given situation.	3.4 Nomenclature and sketch of gear hob and gear shaping cutter.
	3e. Select gear cutting parameters for given materials and work-piece 3f. Explain procedural steps for producing accurate gears using gear milling, gear hobbing and gear shaping machines.	3.5 Gear Cutting parameters for commonly used materials and work-piece 3.6 Tool mounting methods on gear milling, gear shaping and gear hobbing machines. 3.7 Gear finishing processes- shaving & grinding.
Unit–IV **Thread production methods.**	4a. Explain thread production processes.	4.1 Thread nomenclature and important terminologies used in thread production. 4.2 Various threads production processes like turning, rolling, grinding, taping, etc. their applications, advantages and limitations.
	4b. Describe constructional featuresand working of various thread producti machines. 4c. Select appropriate thread production machine as per the given situation. 4d. Explain different steps for producing thread on thread production machine.	4.3 Constructional features including coolant and lubrication systems, motion and power transmission path, working and application of various threads production machines/ processes like lathe, rolling, grinding, taping, etc. 4.4 Thread cutting parameters for commonly used material s and work-piece. 4.5 Tool mounting methods on thread production processes.
Unit-V **Broaching, jig boring and special purpose machine (SPM) tools.**	5a. Explain constructional features, working and applications of broaching machines. 5b. List types of broaching machines. 5c. Select appropriate broaching machine as per the given situation.	5.1 Types, constructional features including coolant and lubrication systems, motion and power transmission path, working and applications of broaching machines. 5.2 Different Shapes that can be produced by broaching process. 5.3 Nomenclature and sketch of a simple broach

	5d. Explain constructional features and working of jig boring machines.	5.4 Types, constructional features including coolant and lubrication systems, motion and power transmission path,, working and application of jig boring machines.
	5e. Identify SPM to produce a given complicated job.	5.5 Various SPM (Only names) and their areas of application. 5.6 Parts fit for SPM. 5.7 Comparison of SPM with other automates.
Unit-VI **Non-conventional and advance methods of machining.**	6a. Appreciate use of Non-conventional machining methods. 6b. Explain working principles and working parameters of non-conventional machining methods. 6c. Select a non-conventional machine as per requirement	6.1 Need of nonconventional machining and comparison between conventional & non-conventional machining methods. 6.2 Classification, working principles, application and working parameters of following non-conventional machining methods: i. Electro chemical machining (ECM). ii. Electro discharge machining (EDM) including wire cut and dies sinking. iii. Ultrasonic machining (USM). iv. Laser beam machining (LBM). v. Abrasive jet machining (AJM). 6.3 Criterion for selection of non-conventional machining methods.
	6d. Explain micro electro-mechanical systems (MEMS). 6e. List materials used for MEMS. 6f. Explain working principle and applications of various MEMS fabrication techniques.	6.4 Need of micro electro-mechanical systems (MEMS). 6.5 Materials and their properties used for MEMS manufacturing. 6.6 Working principle and applications of MEMS fabrication techniques: i. Chemical vapour deposition. ii. Lithography. iii. Photolithography. iv. Dry & wet etching.

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

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

Legends: R = Remember U = Understand; A = Apply and above levels (Bloom's revised taxonomy).
Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

General Notes:

a. If mid semester test is part of continuous evaluation, unit no I, II, III & VI (Up to 6.3 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 psycho-motor and affective domain)** so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.
***Note**: Here only outcomes in psycho-motor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes (**as given in a common list at the beginning of curriculum document for this programme) would be assured. Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.*

S. No.	Unit No.	**Practical Exercises** (outcomes in psycho-motor Domain**)**	**Approx. Hours. required**
1	I	**Preparatory activity (Includes Home Assignments):** Demonstrate various cutting parameters, carbide inserts with ISO designation system and explain the steps to calculate cutting speeds. Student will prepare the report on following. a. Tabulate various cutting tools materials with main elements, properties and applications. b. Calculate RPM for lathe, milling cutter and drill spindle; based on given data. Use equations. Each student should be given different data for diameters and cutting speeds. c. Calculate strokes/minute for shaping/planning machine based on given data. Use equations. Each student should be given different data for cutting speeds and length of jobs.	02
2	All	**Mini Project:** Manufacture the assembly which has been designed in the course Design of Machine Elements. Keep the same batch. Student will prepare the report on following. a. Prepare production drawings of the assembly and details. b. Manufacture the parts. c. Note down work holding devices, cutting tools and cutting parameters used for each part and each operations. Summarised this in tabular form. d. On completion, present and share the experience of this mini project with photos/videos of mini project execution and with work distribution executed. Use power point presentation.	08
3	II, III,IV & V	**Kinematics and motion transmission systems:** Demonstrate motion and power transmission path, transmission systems, work mounting systems, tool mounting systems and tool holders/holding systems of cylindrical/surface grinding, tool and cutter grinding, gear hobbing, gear milling, gear shaping, threading and broaching machines. Student will prepare the machine wise report on all machines included here. a. Sketch and label main elements of machine kinematics. b. Demonstrate and explain machining process with position/motion of work piece and tool. Video may	08

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

		indexing head. Calculate/select, set, observe and record the cutting parameters. d. List the cutting tools you have used. Also state specifications of each. e. List the work holding devices you have used. Also state specifications of each.	
8	IV	**Thread cutting::** a. Sketch the production drawing of the part. b. Prepare a multi start/square threaded bolt and nut. Calculate/select, set, observe and record the cutting parameters for the process. c. List the cutting tools you have used. Also state specifications of each. d. List the work holding devices you have used. Also state specifications of each.	06
9	V &VI	**Presentation:** a. Teacher will assign any one topic to each batch student from Unit number V &VI. Each student will have different topic. b. Using power point presentation, each student will present the topic. Presentation must include related movie/s. c. Teacher will assign the topic on cutting tools/work holding devices/machine tools(Unit II to V). Each student will have different topic. Student will download the content, preferably videos/catalogues and will present the same.	06
10	All	**Technical visit/participation:** a. Visit at least three related industries (one must be having non-conventional manufacturing facilities) and prepare industry wise technical report. Hint: Before visit, faculty will remind student regarding portion of subject content (especially practice) not covered within institution premises (due to non-availability of resources). Faculty will also direct student's attention towards all possibility/scope available at the industries to be visited. Student will observe and record all such details like Specifications, Operating procedure, Selection of operational parameters, Details about tool/work holders used, Machine setting, Product details being manufactured for each method/machine like gear forming/generating, honing/lapping/buffing machine, Non-conventional machine, Jig boring machine, Broaching machine etc.	--

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

Notes:

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

8. SUGGESTED LIST OF STUDENT ACTIVITIES.

SR.NO.	ACTIVITY.
1	Prepare a report on at least one industrial component with its complete technical details covering the points like design criterion, features included with Dimensional/Geometric constraints, manufacturing resource requirements, challenges in controlling its quality and cost, etc.
2	Collect the technical details about all production facilities available at nearby industry/industries.
3	Visit or participate in the technical events, exhibition, conference, seminar etc.
4	Collect/download at least four different machine tool catalogues including at least one special purpose, non-conventional or advance machine.
5	Collect/download at least one catalogue each of cutting tool, work holding device and tool holder.

9. SPECIAL INSTRUCTIONAL STRATEGIES.

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

10. SUGGESTED LEARNING RESOURCES.

A) List of Books.

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

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

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

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

C) List of Software/Learning Websites:

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

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

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

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

Coordinator and Faculty Members from NITTTR Bhopal

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

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: INDUSTRIAL ENGINEERING
(COURSE CODE: 3351904)

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

1. RATIONALE

Prosperity of nation in general depends on the productivity of industries and quality of production. Technical managers, engineers, plant operators, machine operators, supervisors and workers working in industries have to compulsorily meet set standards of production in terms of quality, quantity and productivity so as to compete domestic and international market. This is possible for them only when they employ and exploit the principles of industrial engineering. Industrial engineering always aims to achieve higher productivity and better standards of quality through its constant endeavor in design, improvements and installation of integrated systems of human resource, machines and methods.

2. LIST OF 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 competencies:

- **Improve productivity and quality by applying industrial engineering, quality control and cost reduction/saving techniques.**

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 outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Improve productivity using work study and method study techniques.
ii. Analyze work content and calculate standard time in a given situation.
iii. Apply Statistical Quality Control tools in a given situation.
iv. Select material handling equipment.
v. Apply Ergonomics for human comfort at work place.
vi. Appreciate the emerging trends in industrial engineering.

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	5	70	30	20	30	150

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

5. COURSE DETAILS.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit-1 **Introduction to Industrial Engineering.**	1a. Appreciate importance of industrial engineering, productivity and work study. 1b. Describe ways to enhance productivity for given simple cases. 1c. Explain concept and importance of SQC	1.1 Industrial engineering-definition, objectives and techniques. 1.2 Scope, importance and applications of industrial engineering. 1.3 Methodology and approach of Industrial engineering. 1.4 Productivity – concept, definition, importance and ways to enhance it, numeric examples. 1.5 Introduction to work study. 1.6 Introduction to statistical quality control (SQC).
Unit-2 **Work Study.**	2a. Define work study, method study and work measurement. 2b. State the basic procedure of work study, method study and work measurement. 2c. Prepare in the standard formats the outline process chart, flow process chart, flow diagrams, man machine chart and process plan for given data. 2d. Modify given process plan and flow diagram for improvements. 2e. State principles of motion economy. 2f. Analyze work content and calculate standard time in a given situation.	2.1 Work study-Definition, techniques and role to enhance productivity. 2.2 Importance of human factors in application of work study techniques. 2.3 Basic procedure of method study. 2.4 Methods of recording data for method study using standard symbols, process charts and diagrams. 2.5 Preparation of operation (outline) process chart for given mechanical assembly having 6-8 components. 2.6 Process planning-concept, meaning, importance, functions, procedure and forms used. 2.7 Information required for process planning and information available from process planning. 2.8 Prepare process plan for given mechanical components, take 2-3 components. 2.9 Preparation of flow process chart and flow diagram for given mechanical components having at least 6-8 major operations. 2.10 Given the process plan, operation process chart and flow diagram, develop questioning techniques in analyzing data for method study. Also develop and improve the method, based on analysis of given data. 2.11 Principles of motion economy

		applied in (a) use of human body, (b) design of work place layout (c) design of tools and equipment. 2.12 Principles of micro motion study, Therbligs and SIMO chart. 2.13 Man and machine chart. 2.14 Basic procedure of work measurement. 2.15 Equipment used in time study. 2.16 Job elements and their types. 2.17 Methods of measuring time-cumulative and fly back timing. 2.18 Concept of rating and rating scale. 2.19 Allowances-types, normal values and applications. 2.20 Calculation of basic time, standard time and work content. 2.21 Concept of work sampling/ activity sampling.
Unit-3 **Quality Assurance.**	3a. Appreciate importance of quality. 3b. Define quality, quality control (QC), quality assurance (QA), statistical quality control (SQC) and reliability 3c. Differentiate between inspection and quality control. 3d. Calculate mean, mode, median and standard deviation for simple data. 3e. Prepare suitable frequency distribution chart for a given data. 3f. Determine central tendency and dispersion in a given situation. 3g. Calculate probabilities using normal distribution. 3h. Define binomial and Poisson distribution.	3.1 Definition of quality, quality control (QC), quality assurance (QA), statistical quality control (SQC) and reliability. 3.2 Importance of quality. 3.3 Difference between reliability and quality control. 3.4 Factors affecting and improving reliability. 3.5 QA tools. 3.6 Concept of total quality cycle, quality of design, quality of performance, quality of conformity and total quality. 3.7 Difference between inspection and quality control. 3.8 Fundamentals of statistics-types of variations, frequency, class boundary and midpoint, frequency distribution, frequency histogram, frequency bar chart and polygon chart. 3.9 Frequency distribution curve, central tendency, spread or dispersion and range, mode, median and mean, standard deviation and variance with numeric examples. 3.10 Concept of probability and normal distribution. 3.11 Area under normal distribution and examples on normal distribution. 3.12 Introduction to binomial and Poisson distribution.

Unit-4 **Statistical Quality Control (SQC).**	4a. Explain various tools of SQC. 4b. Compare variables and attributes 4c. Calculate control limits, range / mean and prepare control charts. 4d. Calculate number/ percentage of items falling in and outside specifications limits from mean and standard deviation using normal distribution curve. 4e. State and explain various methods of acceptance of incoming materials 4f. Prepare and operate single and double sampling plans on the basis of given lot size, AQL and inspection level. 4g. Describe process capability. 4h. Explain consumers and producers risk. 4i. State the importance of OC curve and interpret OC curves in a given situation.	4.1 Concept of variability. 4.2 SQC tools and statistical fundamentals. 4.3 Concept and differences between variables and attributes. 4.4 Control charts for variable quality-types, objectives, applications, calculations of control limits and range/mean, methods to plot and interpretations (X bar-R chart) and examples. 4.5 Control charts for attribute quality-types, objectives, applications, calculations of control limits and range/mean, methods to plot and interpretations (p, np, 100p and c chart) and examples. 4.6 Process capability – meaning, definition and method to calculate, numeric examples. 4.7 Acceptance sampling: i. Quality control of incoming raw material and components. ii. Concepts of random sampling. iii. Sampling plans: definition, terminology, types (Single, double and multiple), implementing plans based on given input. iv. OC curve-concept, need, types and importance, interpretation of given OC curve.
Unit-5 **Plant layout and material handling equipments.**	5a. Explain various types of plant layouts with their merits, demerits and their application. 5b. Describe importance and applications of material handling equipment. 5c. Select material handling equipments for given situation.	5.1 Plant layout: Definition and concept. 5.2 Types of plant layout, their applications, advantages and limitations. 5.3 Role of material handling systems in industries. 5.4 Material handling equipment-Classification, types, specifications, applications and selection criteria.
Unit - 6 **Recent trends in industrial engineering.**	6a. Explain ISO and its role in industries and business. 6b. Explain TQC and TQM and its applications. 6c. Explain six sigma and Kaizen with their	6.1 International Organization for standardization and its role, ISO standard series and quality managements system. 6.2 Total Quality Control (TQC) and Total Quality Management (TQM)-philosophical concepts.

	applications. 6d. Define and explain ergonomics. 6e. Explain types of workloads and show normal and maximum work area. 6f. Explain environmental requirements of workplace area and working conditions.	6.3 Concept of six sigma and its applications. 6.4 Concept and applications of Kaizen. 6.5 Definition, objectives and applications of ergonomics. 6.6 Normal and maximum work area. 6.7 Environmental requirements of work place.

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

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Industrial Engineering.	4	4	0	2	6
II	Work study.	14	4	6	14	24
III	Quality assurance.	6	4	4	2	10
IV	Statistical Quality Control (SQC).	8	4	4	7	15
V	Plant layout and material handling equipment.	4	4	0	2	6
VI	Recent trends in industrial engineering.	6	7	2	0	9
	Total	**42**	**27**	**16**	**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 mid-semester test is part of continuous evaluation, unit numbers I, II (Up to 2.9 only), III and V 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**)**	**Approx Hours. required**
1.	I	**Preparatory Activity:** a. Prepare the table for values of surface finishes achieved in manufacturing processes. b. Give examples of enhancing productivity. c. Sketch drafting symbols. d. Given the readings, sketch how such can be shown using Vernier and micrometer.	02
2.	ALL	**Mini Project and presentation:** a. Sketch the parts taken in Design of Machine Elements (DME) under Mini project. The batch of DME is to be continued. b. Prepare process plans for each part. c. Prepare flow diagram for each part. Assume institute's workshop layout. d. Present the work including work distribution, photographs and movies of actual project work using power point presentation.	04
3.	II	**Operation process chart (OPC):** Given real mechanical assembly having 6-8 components, prepare operation process chart. (This has to be assigned by teacher). a. Sketch parts and assembly. b. Prepare OPC. c. Prepare process plans for all components. Use format given in Annexure-I.	06
4.	II	**Flow diagram(FD):** Given real mechanical component having minimum 6-8 mechanical operations, prepare FD. (This has to be assigned by teacher). a. Sketch component. b. Sketch institute workshop layout. c. Prepare FD.	02
5.	II	**Man and machine chart:** Prepare man and machine chart for given situation. Teacher will assign the real situation. This include: a. List objectives of preparing man and machine chart. b. Describe the situation assigned by the teacher. c. Prepare the man and machine chart. d. Interpret the chart and suggest if any further improvements can be made with respect to enhance productivity.	02
6.	II	**Performance rating:** Calculate co-efficient of co-relation for time study person	02

		using performance rating technique. Teacher will assign the situation. This include: a. Define performance rating. b. Describe the situation assigned by the teacher. c. List the steps followed to perform the exercise. d. Observe and record the observations. e. Plot, interpret and calculate the co-efficient of co-relation.	
7.	II	**Time study:** Calculate standard time for a given job using decimal minute stop watch techniques. Teacher will assign the situation/job/elements to be recorded. This include: a. Sketch the part undertaken for time study. b. List elements to be considered. c. Observe and record elements time. d. List and justify allowances to be taken with values. e. Calculate standard time.	02
8.	III	**Frequency distribution curve**: a. Take live problem (may be measured variable dimension, result analysis, etc. (Teacher has to assign the live problem) and summarize the data. b. Perform and prepare frequency table. c. Determine central tendency, spread or dispersion and range, mode, median and mean standard deviation and variance. d. Prepare frequency bar, frequency polygon and frequency curve. e. Plot the areas under normal curve. f. Given the data (Teacher will assign the data), determine numbers/probabilities of acceptance/ rejection using normal distribution table- 4 cases.	02
9.	IV	**Control charts for variables:** a. Define variable. Give five examples. b. For given live problem, determine subgroup size, measure the variable and record the observations. c. Perform necessary calculations and determine control limits. d. Plot $\overline{X}$ – R chart and interpret the same.	02
10.	IV	**Control charts for attributes:** a. Define attribute. Give five examples. b. Explain binomial and Poisson distributions. c. For given live problems (different for different charts), determine parameters, record the observations of attribute. d. Perform necessary calculations and determine control limits. e. Plot p and c charts and interpret the same.	02
11.	IV	**Acceptance sampling:** a. Show double sampling plan using block diagram. b. Prepare/ operate double sampling plans on the basis of given lot size, AQL, inspection level and other input for a given problems.	02

		c. Record the observations and conclude the outcome.	
12.	ALL	**Industrial Visit:** Visit at least two related industries. Prepare the report as guidelines provided in notes.	-
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.PA component of practical marks is dependent on continuous and timely evaluation of exercises.
b. Term work report must not include any photocopy/ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only.
c. Mini project and presentation topic/area has to be assigned to the students in the beginning of the term by batch teacher.
d. Student activities are compulsory and are part of term work.
e. Term work content of industrial visit report should also include following.
    i. Brief details of industry visited.
    ii. Type, location, products, rough layout, human resource, etc of industry.
    iii. Details, description and broad specifications of machineries/ processes observed.
    iv. Safety norms and precautions observed.
    v. Student's own observation on industrial environment, productivity concepts, quality consciousness and quality standards, cost effectiveness, culture and attitude.
    vi. Any other details / observations asked by accompanying faculty.
f. For practical ESE part, students are to be assessed for competencies achieved. They should be assigned the necessary data and should be given any one experience to perform.

8. SUGGESTED LIST OF STUDENT ACTIVITIES.

Sr. No.	ACTIVITY.
1	During Industrial visit for other subjects students should be made familiar with various types of material handling equipments used in the industry. They should be encouraged to write special reports on material handling equipments and type of plant layout in the industries they visited.

9. SPECIAL INSTRUCTIONAL STRATEGIES.

Sr. No.	Unit	Unit Name	Strategies
1	I	Introduction to Industrial Engineering.	Movies on productivity.
2	II	Work study.	Movies on work study, live explanation at workshop place, presentations.
3	III	Quality assurance.	Movies on QA, live cases during industrial visits, power point presentations, failure analysis with rejected live parts.
4	IV	Statistical quality control	Movies on SQC, performance, live cases

		(SQC).	during industrial visits, power point presentations.
5	V	Plant layout and material handling equipments.	Movies on material handling equipments, industrial visits, power point presentations.
6	VI	Recent trends in industrial engineering.	Movies on trends, presentations.

10. SUGGESTED LEARNING RESOURCES.

A) List of Books.

Sr.No.	Title of Book	Author	Publication
1.	Industrial Engineering (IE) and Management	C.Natha Muni Reddy	New age international Publishers.
2.	Handbook of IE: Technology and operations management.	Gavriel Salvendy	Institute of Industrial Engineers.
3.	Comprehensive Industrial Engineering.	M. J Manek	Laxmi Publications (P) Ltd., New Delhi.
4.	Introduction to Work-study. ISBN: 9221071081	George Kanawaty	International Labor Organisatioin, Geneva.
5.	Introduction to productivity	---	National Productivity Council (NPC).
6.	Method Study	---	NPC.
7.	Work Measurement	---	NPC.
8.	Introduction to Statistical quality control. 7th revised edition ISBN-13: 978-0078443541	Eugene Grant and Richard Leavenworth	McGraw-Hill Series in Industrial Engineering and Management

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

Sr.No.	Major equipment/ Instrument with Broad Specification.	
1	Decimal stopwatch (Non fly back type).	02 pcs.
2	Decimal stopwatch (Fly back type)	02 pcs.
3	Playing cards	2 sets.
4	M.S Pins 10mm dia X 15mm length with tolerance of ± 0.01mm.	100 pcs.
5	Buttons of 6 different colors.	100 of each color.
6	Sampling rack with 1000 washers	1 set.

C) List of Software/Learning Websites.

i. http://en.wikipedia.org/wiki/Industrial_engineering
ii. http://www.iiie-india.com/IIIE/industrial-engineering.php
iii. http://www.youtube.com/watch?v=3WmfSfNJr4w (How Receiver Operating Characteristic Curves Work ...)
iv. http://www.youtube.com/watch?v=J17SUDcrphw (How to construct an operating characteristic (OC) curve)

v. https://www.coursera.org/course/apstat (basics of statistics)
vi. http://www.youtube.com/view_play_list?p=299B5CC87110A6E7 (Lecture Series on Industrial engineering NPTEL)
vii. http://www.massey.ac.nz/~mbjones/Book/Chapter11.pdf (reading material on statistics)

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- R.R.MAHITCHA, Retired Lecturer in Mechanical Engineering, T.F.G Polytechnic, Adipur.
- P.V.JETHVA, Lecturer in Mechanical Engineering, L.E. College, Morbi.
- R.M. RAJYAGURU, Lecturer in Mechanical Engineering. GP,Porbandar.

Coordinator and Faculty Members from NITTTR Bhopal.

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

ANNEXURE-I

FORMAT FOR PROCESS PLANNING

NAME OF COMPONENT: ..... MATERIAL AND RAW MATERIAL SIZE: ..... QUANTITY / BATCH: .....

OP.NO.	DETAILS OF OPERATION	MACHINE	CUTTING TOOLS , HOLDING TOOLS, MEASURING TOOLS USED	CUTTING PARAMETERS			SETTING TIME	OPERATION TIME
				CUTTING SPEED	FEED	DEPTH OF CUT		
				RPM / NO. OF STROKES	(mm / rev OR mm / min)	mm	Min	Min

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: ESTIMATING, COSTING AND ENGINEERING CONTRACTING
(COURSE CODE: 3351905)

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

1. RATIONALE

This course is designed to develop the ability in the students to evaluate materials, consumables and process costs in the monetary units. Hence, it will help to increase the productivity of the organization and conservation of valuable resources. This course will also help in developing the skills required in the process of decision making and to plan, use, monitor and control resources optimally and economically. This will also be helpful in budgeting. The realm of this course is enlarged to estimate the process costs for fluid and thermal applications also.

2. LIST OF 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 competencies:

- Plan, use and control resources optimally and economically.
- Estimate production/operation cost for budgeting and analysis.

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 objectives in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Calculate material cost of given component/product.
ii. Identify and estimate elements of cost in various processes.
iii. Perform break even analysis to calculate break even quantity.
iv. Investigate the problem of cost and suggest their solution using cost reduction techniques.
v. Interpret given model of balance sheet and profit loss account.
vi. Prepare simple engineering contracts.

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 Theory Practice; **P** -Practical; **C** – Credit, **ESE** -End Semester Examination; **PA** - Progressive Assessment.

5. COURSE DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I **Introduction.**	1a. Explain the terminology of ECC- cost elements, overheads, selling price and catalogue price. 1b. Explain need, scope & importance of ECC in industries. 1c. Compare costing and estimating.	1.1 Need, Scope & importance of ECC in industries. 1.2 Difference between costing and estimating. 1.3 Terminology associated with various cost elements and their classification. 1.4 Terminology associated with overheads, their classification and allocation. 1.5 Determination of selling price and catalogue price.
	1d. Select appropriate method of depreciation and calculate it.	1.6 Depreciation and obsolescence: Definition, types, different methods of calculating depreciation, numeric examples.
	1e. Calculate machine hour rate (MHR) and process hour rate (PHR).	1.7 Concept of Machine Hour Rate (MHR) and process hour rate (PHR). 1.8 Method to calculate MHR for any machine/machine tool. 1.9 Method and example to calculate MHR of Lathe, Milling, Drilling, Grinding and Press tool. 1.10 Method to calculate PHR for any process. 1.11 Method and example to calculate PHR of running diesel generating set, running air conditioner, running refrigerator, welding and gas cutting.
Unit – II **Break even analysis.**	2a. Classify costs.	2.1 Classification of costs as fixed and variable costs. 2.2 Relationship between the costs and quantity of production.

	2b. Construct break even chart and determine break even quantity from given data.	2.3 Break Even Chart : i. Definition of Break Even Point (BEP) and its needs in industry. ii. Procedure of construction of Break Even Chart. iii. Assumptions made in constructing Break even chart. iv. Calculation of BEP analytically and graphically. v. Margin of safety, its importance and its derivation. vi. Effect of changing various parameters on BEP. vii. Numeric examples.
Unit –III **Cost estimation of welding.**	3a. List Factors effecting arc welding cost 3b. Estimate cost of consumables and production for gas cutting and welding of a given job.	3.1 Elements of cost in arc welding. 3.2 Factors effecting arc welding cost. 3.3 Estimating cost elements for: i. Consumables in arc welding and gas cutting. ii. Gas cutting. iii. Arc welding. 3.4 Estimation of production cost of given welding job for above methods.
Unit –IV **Cost estimation of forging and casting.**	4a. Estimate cost of material, forging dies and production cost for a forging component. 4b. Estimate cost of material, pattern and production for a casting component.	4.1 Cost terminology associated with forging shop. 4.2 The procedure of calculating material cost of a product for forging shop (including input weight, cut weight, forged weight etc.). 4.3 Procedure of estimating cost of forging dies. 4.4 Procedure of estimating forging cost. 4.5 Given the forged component, estimate forging cost. 4.6 Cost terminology associated with foundry shop. 4.7 The procedure of calculating material cost of a product for foundry shop. 4.8 Procedure of estimating cost of pattern making. 4.9 Procedure of estimating foundry cost. 4.10 Given the casting component, estimate foundry cost.

Unit –V **Cost estimation of machined part.**	5a. Estimate the machined part cost for lathe, drilling, milling and shaping operations.	5.1 The terminology associated with machine shop estimation. 5.2 Procedure to estimate material cost. 5.3 Procedure of estimating cost of machined part for following operations: i. Lathe operations (Facing, outside/inside turning, boring, drilling on lathe, grooving and out side threading). ii. Drilling operations (Drilling, reaming, tapping). iii. Shaping operations. iv. Milling operations (Face milling, side and face cutting, end milling, key way milling and gear forming). v. Cylindrical grinding operations (Plain cylindrical grinding). 5.4 For given machined part, estimate material cost and machining cost.
Unit – VI **Estimation of process cost.**	6a. Identify the elements required to estimate the process cost. 6b. Estimate the cost of processes required based on given set of input.	6.1 Understand importance of estimating various process costs. 6.2 Procedure and steps to estimate cost for following processes: i. Producing power using diesel generating set (cost per hour and cost per unit). ii. Power produced at thermal power plants. (Cost per unit). iii. Pouch packaging.(Cost per pouch). iv. Heat exchanger, cooling or heating.(Cost per hour). v. Ice plant.(Cost per unit weight). 6.3 Given the required set of input, estimate the cost of processes specified above.
Unit – VII **Budgeting and contracting.**	7a. Explain various budgetary and accounting terminologies. 7b. Prepare simple budget. 7c. Interpret given contract terms and conditions. 7d. Select parameters, terms and conditions to be	7.1. Define budget and budgetary control. 7.2. Purpose of budget. 7.3. Various types of budgets. 7.4. Benefits of budget. 7.5. With given example, interpret industrial budget. 7.6. Prepare simple budget given

	included in contract.	required input data. 7.7. Explain various accounting terminology like book value, Net Present Value, Work in progress, Gross Domestic Product (GDP),balance sheet terminology, etc. 7.8. Define contracts, its characteristics and advantages. 7.9. Types of contract. 7.10. Tendering, manual tendering and E-tendering. 7.11. Provision of different conditions in a contract. 7.12. Documents required in an engineering contract (explain). 7.13. Prepare a contract for a given input situation.

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

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction.	3	4	0	0	4
II	Break even analysis.	3	2	2	4	8
III	Cost estimation of welding.	3	2	2	4	8
IV	Cost estimation of forging and casting.	6	4	4	7	15
V	Cost estimation of machined part.	5	4	4	7	15
VI	Estimation of process cost.	4	3	3	4	10
VII	Budgeting and contracting.	4	3	3	4	10
		28	22	18	30	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 V 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)	Approx Hours. required
1.	I	**Preparatory activity:** a. Write various equations to calculate area and volume of commonly used shapes. b. List densities of commonly used materials. c. Machining process parameters of various manufacturing processes (Covered in this course) for commonly used materials. d. Collect market rates for various consumables like diesel, welding rods, gas, cutting tools, electricity rates, etc. to be used in this course.	02
2.	III, IV,V, VI	**Collection of parts:** a. Collect the finished parts from industries/market/scrap merchants consisting: i. Welded parts (Minimum THREE). ii. Casted parts (Minimum THREE). iii. Forged parts (Minimum TWO). iv. Parts having five to six machining operations like cutting, turning, threading, grinding, milling, shaping, drilling, etc.(Minimum FIVE). b. Measure and prepare production drawings of all the parts using A4 size paper (Manually). Note: Each student will be assigned to bring at least one specified part so that all varieties of about 13 parts get collected in a batch. All parts must be brought in first week duration only. After getting approval of part, each student will prepare production drawing of the part he/she has brought on an A4 size paper (manually) and then the batch will interchange these drawing so that all students will have drawing of all physical parts collected by	02

		the batch.	
3.	III	**Welding estimation:** a. Determine raw material volume for all welded parts. b. Select welding rod to be used. Estimate quantity of welding rod required. c. Determine material and consumables costs. d. For each part, estimate welding cost. Show the assumptions and steps followed to estimate welding cost. e. Derive total cost of the part.	02
4.	IV	**Casting estimation:** a. Determine raw material volume for all casted parts (calculate input weight, cut weight, net weight, losses etc.). b. Prepare pattern drawings (production drawings with all dimensions, surface finishes, allowances, etc.) for all parts. c. Estimate pattern cost. d. Determine material and consumables costs. e. For each part, estimate casting cost. Show the assumptions and steps followed to estimate casting cost. f. Derive total cost of the part.	04
5.	IV	**Forging estimation:** a. Determine raw material volume for all forged parts. b. Prepare die drawings (production drawings with all dimensions, surface finishes, allowances, etc.) for all parts. c. Estimate dies cost. d. Determine material and consumables costs. e. For each part, estimate forging cost. Show the assumptions and steps followed to estimate forging cost. f. Derive total cost of parts.	04
6.	V	**Machining estimation:** a. Determine raw material volume for all machined parts. b. For each part, tabulate operation, cutting tool/s to be used and cutting parameters (speed, feed and depth of cut) to be used. c. Estimate raw material cost. d. For each part, estimate machining cost. Show the assumptions and steps followed to estimate machining cost. e. Derive total cost of parts.	06
7.	VI	**Process estimation:** a. Teacher will assign the input data. Estimate hourly rate of running diesel generating set. Show the assumptions and steps followed to estimate the rate. b. Teacher will assign the input data. Estimate hourly rate of running ice plant. Also estimate the rate to	04

		produce a Ton of ice with same data. Show the assumptions and steps followed to estimate the rate. c. Teacher will assign the input data. Estimate hourly rate of running heat exchanger. Show the assumptions and steps followed to estimate the rate. d. Teacher will assign the input data. Estimate unit rate of thermal power plant. Show the assumptions and steps followed to estimate the rate.	
8.	ALL	**Mini Project and presentation:** a. Sketch the parts taken in Design of Machine Elements (DME) under Mini project. The batch constituted in DME course is to be continued. b. Prepare process plans for each part. c. Estimate the material, consumables and manufacturing process (May be welding, forging, casting, machining, etc.) costs (as applicable). Also prepare required pattern/die drawings and estimate cost of them (if applicable). d. Estimate cost of parts and assembly. Show the assumptions and steps followed to estimate the costs. e. Present the work including work distribution, photographs and movies of actual project work using power point presentation.	04
		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. PA component of practical marks is dependent on continuous and timely evaluation of exercises.
b. Term work report must not include any photocopy/ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student himself.
c. Mini project and presentation topic/area has to be assigned to the students in the beginning of the term by batch teacher.
d. Student activities are compulsory and are part of term work.
e. For practical ESE part, students are to be assessed for competencies achieved. They should be given physical part/s and should be asked to estimate the material and process cost.

8. SUGGESTED LIST OF STUDENT ACTIVITIES.

Sr.No.	ACTIVITY.
1	Do market survey and find prevailing hourly rates of lathe, milling and drilling machines.
2	Do market survey and find prevailing hourly rates of renting diesel generating sets. Specify output (HP or kW).
3	Do market survey and find prevailing rates of commonly used engineering materials like MS, brass, copper, stainless steel, Aluminum, etc.

9. SPECIAL INSTRUCTIONAL STRATEGIES.

Sr.No.	Unit	Unit Name	Strategies.
1	I	Introduction	Power point presentations, live examples.
2	II	Break even analysis	Demonstration of method to construct with live examples.
3	III	Cost estimation of welding	Demonstration of method to estimate cost taking live demonstration at work shop place, steps based handouts.
4	IV	Cost estimation of forging and casting	Demonstration of method to estimate cost taking live examples,, live demonstration at work shop place, steps based handouts.
5	V	Cost estimation of machined part	Demonstration of method to estimate cost taking live examples, live demonstration at work shop place, steps based handouts.
6	VI	Estimation of process cost	Live examples, demonstration at site, steps based hand out.
7	VII	Budgeting and contracting	Power point presentations, live examples.

10. SUGGESTED LEARNING RESOURCES.

A) List of Books.

Sr. No.	Title of Book	Author	Publication
1.	Mechanical estimating and costing.	Banga and Sharma	Khanna Publishers.
2.	Mechanical estimating and costing.	Shrimali and Jain	Khanna Publishers.
3.	Mechanical costing and estimation.	Singh and Khan	Khanna Publishers.
4.	Learning package in ECC.	NITTTR, Bhopal	NITTTR,Bhopal.

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

i. Vernier caliper, 150mm.
ii. Micrometer, 0-25mm and 25-50mm.
iii. Bevel protector.
iv. Thread gauges.

C) List of Software/Learning Websites.

i. http://calculatoredge.com/index.htm#mechanical

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics:

- A.M.TALSANIYA-Lecturer in Mechanical Engineering, Sir BPI, Bhavnagar.
- R.M. RAJYAGURU, Lecturer in Mechanical Engineering. GP, Porbandar.

Coordinator and Faculty Members from NITTTR Bhopal:

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

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: SELF EMPLOYEMENT AND ENTREPRENEURSHIP DEVELOPMENT
(COURSE CODE: 3351906)

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

1. RATIONALE.

The emerging concept of self-reliance at individual and national level - has significant impact on current developing economy. Future social expectations towards engineering professionals would be certainly as job creators and not as purely job seekers. Upgraded technological and changing economic environment has opened up wide horizons of business areas-including in service sectors too. This course deals with the key concern areas of self-employment and entrepreneurship development. This course is directed to help students to develop and shape their creativity and to understand peripheral influencing aspects. The content will certainly help students to think in a direction to establish a new enterprise using fundamental knowledge.

2. LIST OF 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 competencies:

- **Develop entrepreneurship and self-employment abilities to start any venture**
- **Plan, use, monitor and control resources optimally and economically.**

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 outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Identify entrepreneurial quality.
ii. Develop the ability to select potential areas for self-employment.
iii. Select appropriate agency / ies for technical and financial support.
iv. Prepare project setup planning and project report.
v. Explain SWOT analysis and strategies to achieve goals.
vi. Identify risk factors of project and their remedial measures.

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	5	70	30	20	30	150

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

5. COURSE DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I **Introduction to self-employment and entrepreneurship development.**	1a. Appreciate the need of self-employment and entrepreneurship development. 1b. Explore inner creativity and innovativeness in identifying areas for self-employment and entrepreneurship development.	1.1 Introduction of self-employment i. Concept and need in present Indian job market context. ii. Characteristics of self-employment areas for mechanical engineering field. iii. Broader ways to identify self-employment areas in mechanical engineering. 1.2 Creativity- concept, examples related to applications in mechanical engineering, ways to develop. 1.3 Innovativeness- concept, examples related to applications in mechanical engineering, ways to develop. 1.4 Entrepreneurship development: i. Concept and need. ii. Scope in local and global market. iii. Qualities of entrepreneur and Characteristics of Diploma holder as a self-employer like developing networking and personal contacts, communication skills, transferable work skills, positive work skills, conflict resolution, professional dress, workplace legal issues, work ethic, etc. 1.5 Concept and importance of productivity, quality, cost consciousness and customers' satisfaction. 1.6 Types of enterprise- i. Sole partnership. ii. Partnership firm. iii. Joint stock company. iv. Co-operative society.
Unit II **Entrepreneurial support agencies.**	2a. Know registration process/ procedure for enterprise. 2b. Explore the avenues for getting beneficial promotional schemes for establishment of new enterprise.	2.1. Definition – Micro, small and medium industries. 2.2. Registration process of an enterprise with Government agencies. 2.3. Name, type and role of state and national level support agencies for: i. Sources of information. ii. Financial assistance. iii. Technical assistance. iv. Training. 2.4 Current state & national level promotional schemes for establishment of new

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		enterprise
Unit – III **Project set up planning.**	3a. Understand process of product selection and stages of product development. 3b. Select appropriate process considering productivity. 3c. Determination of capacity based on identified product & process. 3d. Select proper location and prepare suitable plant layout.	3.1 Product (Physical and service both-having mechanical features) selection: i. Concept and importance ii. Product selection iii. Effect of competitive or similar types of products on product selection iv. Product development stages. 3.2 Process Selection: i. Concept and importance. ii. Factors affecting process selection. iii. Technology life cycle. iv. Productivity-concept & importance. v. Flexibility. 3.3 Process Conversion- Capacity Planning : i. Concept. ii. Importance. iii. Basic method to assess / estimate capacity. 3.4 Selection of location and layouts: i. Concept. ii. Factors affecting selection of location. iii. Objectives and types of plant layout. iv. Factors affecting plant layout.
Unit – IV **Project proposal planning.**	4a. Describe the Management of the critical resources. 4b. Define Marketing. 4c. Explain need for enterprise, 4Ps channels (product, price, place and promotion). 4d. Prepare preliminary and detailed project report.	4.1 7-M resources. 4.2 Marketing- definition, need for enterprise, 4Ps channels (product, price, place and promotion). 4.3 Market survey-concept, need and methods. 4.4 Managing finance : i. Terminology used in financial management. ii. Concept of financial statement and types (balance sheet, profit & loss statement and funds flow statement). 4.5 Project report preparation for mechanical feature based product: i. Meaning of project planning and report. ii. Feasibility study. iii. Details required for preparing project plan. iv. Project cost estimation. v. Cost, Volume and Profit (CVP) analysis. vi. Preliminary project report (PPR) and detailed project report (DPR).

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – V **Enterprise and risk management.**	5a. Know strategies to overcome risk areas.	5.1 Concept of risk in the context of enterprise / project. 5.2 Uncertainty and certainty of project elements. 5.3 Decision making under risk. 5.4 Methods of risk management. 5.5 Strength, Weakness, Opportunity and Threat (SWOT) analysis.
Unit – VI **Case studies.**	6a. Analyze success and failures of entrepreneur & self employer and integrate positive conclusions.	6.1 Case studies of entrepreneur and self employer. : (at least two for success and two for failure.) i. Important features. ii. Reasons for success and failures. iii. Analyzing success and failure criteria. iv. Integration of case analysis conclusions in enterprise management for improvement.

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

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to self-employment and entrepreneurship development.	8	8	2	4	14
II	Entrepreneurial support agencies	5	6	2	0	8
III	Project set up planning.	10	4	8	4	16
IV	Project proposal planning.	8	3	4	7	14
V	Enterprise and risk management.	5	2	4	2	8
VI	Case studies.	6	0	0	10	10
	Total	**42**	**23**	**20**	**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 mid semester test is part of continuous evaluation, unit numbers I, III (Up to 3.3 only) and IV are to be considered.
b. Ask the questions from each topic as per marks weight age. 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)	Approx Hours. required
1	ALL	**Preparatory activity:** a. List various types of industries. b. Narrate need of self employment. c. Anticipate importance of entrepreneurship development.	2
2	I	**Creativeness and innovativeness:** a. Teacher will assign any one mechanical feature based (in a group of not more than 5-6 students) item/product,(may be pen, gear, mouse, notebook, chair, table, fan, mobile, bicycle, etc.). List at least ten uses of this item/product other than pre-defined. Think out of box. b. Teacher will assign any one mechanical feature based (in a group of not more than 5-6 students) process, product or service, tangible or intangible, (may be milk packaging, service offers, camera, farm equipments, machine tools, automobiles, tools, travelling bags, material handling, logistics, construction, customer services, etc.), List at least ten innovations of assigned process, product or service. Imagine out of box. c. List at least ten mechanical engineering products which have passed through innovativeness.	4
3	I	**Identification of self-employment areas:** a. Teacher will assign this exercise in group of 5-6 students. b. List at least five mechanical feature based areas which have, in group's opinion, self-employment potential. Select any one promising area. c. Develop market survey format for the selected area. d. Perform market survey for self-employment	4

		opportunities. e. Describe the outcome. Also narrate the experience. f. It is compulsory to attach photographs of group conducting market survey.	
4	II	**Visit report:** a. Visit nearby : i. District Industries Centre (DIC). ii. Any one financial institution including bank. iii. Training institute / GITCO/EDI/ iNDEXTb/etc. b. Prepare the visit report which include followings: i. Brief history of organization. ii. Type and details of services /support/ assistance being given. iii. Any other information which are useful to be self-employer or entrepreneur. iv. Brochures/technical literature collected from agencies.	4
5	III and IV	**Preparing project feasibility report of assigned product:** a. Teacher will assign any one product (physical or service based having mechanical features) to the group of 5-6 students. b. Prepare project feasibility report (Technical and financial). Specifically include capacity requirement calculations and project set up planning details. Also present the same to whole batch.	8
6	VI	**Case analysis and presentations:** a. Teacher will assign one case of successful entrepreneur and one case of failed entrepreneur to the group of 5-6 students. Student will discuss in group, will analyze and will present the same to whole batch. Student will also prepare the report on analysis. Case may be put up with printed pages but analysis has to be hand written.	6
		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.PA component of practical marks is dependent on continuous and timely evaluation of exercises.
b. Term work report must not include any photocopy, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only.
c. For practical ESE part, students are to be assessed for competencies achieved.

8. SUGGESTED LIST OF STUDENT ACTIVITIES

The student activities are same as given in list of practical/exercises. Teacher may give more such activities to interested/bright students.

9. SPECIAL INSTRUCTIONAL STRATEGIES (IF Any)

During practical exercises teacher should not prescribe solutions to students and should motivate them to come out with different alternatives (even if they may not be feasible) and should allow them to try and learn on their own from their mistakes. Teacher should help students only when they are completely stuck.

10. SUGGESTED LEARNING RESOURCES

A) List of Books

S. No.	Title of Book	Author	Publication
1.	Developing Entrepreneurship		Pareek & Co. Learning systems,Delhi.
2.	Entrepreneurship & Venture - Management	Clifford and Bombak, Joseph R. Momanso.	
3.	Planning an Industrial unit	J. N. Vyas.	
4.	Small Industries management	Karmakar M.B.	
5.	Manual for the preparation of industrial - feasibility studies		UNIDO
6.	New project opportunities		GITCO
7.	Creativity	Pradeep Khandwala	
8.	Project profile for reserved - Development commissioner SSI,Items - VOl, I, II & III New Delhi. Small scale industry - Ministry of Industry Govt. of India. Policy & Perceptive,Dialogue with the Entrepreneur – GSFC, Import-Export Policy for SSI - Govt. of India.	GOVERNMENT PUBLICATIONS.	GOVERNMENT PUBLICATIONS.
9.	EDI STUDY MATERIAL	EDI, BHAT, Ahmedabad	Website : http://www.ediindia.org
10.	Entrepreneurship development and Management	R.K.Singal	S.K.Kataria and Sons.

B) List of Learning Websites.

i. http://www.ediindia.org
ii. http://niesbud.nic.in/docs/SelfEmploymentBook.pdf
iii. http://smallb.in/
iv. http://www.msme.gov.in/
v. http://nimsme.org/
vi. http://www.nsic.co.in/

vii. http://iie.nic.in/
viii. http://msme.gov.in/guidelines_pmegp_24092008.pdf
ix. http://www.gujagro.org/pdf/guidelines.pdf
x. http://www.entrepreneurshipsecret.com/8-factors-to-be-considered-in-products-selection/#sthash.goWj3LcV.dpbs

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics.

- **Prof. R.B.Patel**, Lecturer in Mechanical Engineering, RCTI,Ahmedabad.
- **Prof. A.M.Talsaniya**, Lecturer in Mechanical Engineering, Sir BPI, Bhavnagar.
- **Prof. Patel Kalpesh P**., Head of Mechanical Engineering, B.S.Patel Polytechnic, Kherava.
- **Prof. Patel Shailesh Kantilal**, Head of Mechanical Engineering, Swami Sachidanand Polytechnic College, Visnagar.

Coordinator and Faculty Members from NITTTR Bhopal.

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

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: OPERATIONS MANAGEMENT AND INFORMATION SYSTEMS
(COURSE CODE: 3351907)

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

1. RATIONALE

On one hand, the revolution of information technology has forced mechanical operations based. industries to integrate this technology in their day to day operations and on another hand, optimum utilisation of resources with quality objectives has become base for survival. This course will develop in the students the abilities to search for better solutions for any operating problems/situations by logical thinking and to develop analytical skill by learning important operation management techniques. The routine work and routine systems are being handled by the people at the operating level in industries with integration of computers and operations management philosophy. The stress is given on operations management, cost effectiveness and quality aspects with computer based information systems, which are required in day-to-day operations in industries for smooth and efficient operations. Proper and rapid flow of information improves the decision making process and the industrial relations as a consequence

2. LIST OF 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 competencies

- **Plan, use, and control resources optimally and economically.**
- **Interpret and operate simple information systems in a given situation.**

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 outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Perform various tasks like market survey, demand forecasting, shop floor and plant supervision, etc.
ii. Utilize resources optimally and efficiently.
iii. Implement and monitor data base management systems for mechanical based industries.

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	5	70	30	20	30	150

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

5. COURSE DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I. **Introduction.**	1a. Describe operations management and information system in mechanical based industries. 1b. Explain Optimization: concept need and scope. 1c. List types of production, their merits and demerits. 1d. List types of operations layouts: - types, features, applications. 1e. Explain concept and importance of information systems. 1f. List types of resources (7M).	1.1 Operations management: concept, meaning, definition, scope and functions. 1.2 Optimization: concept, meaning, definition, need and scope. 1.3 Types of production, their merits and demerits. 1.4 Types of operations layouts: - types, features, applications. 1.5 Types of resources (7M). 1.6 Data-meaning and types. 1.7 Information-meaning and types. 1.8 Information system: need, concept, definition, features, objectives and examples. 1.9 Need to integrate information systems and optimum utilization of 7M resources.
Unit – II **Marketing.**	2a. Calculate future demand of the product. 2b. Survey market for given product. 2c. Show the attitude to work as service engineer. 2d. Explain Concept, need and maintenance of customers' data by using Customer Relationship Management	2.1 Demand forecasting- Definition, importance, types for new products and established products, and their features and applications. 2.2 Time series analysis: features, types (This includes simple average, simple moving average and weighted moving average) and examples. 2.3 Market survey-importance and methods. 2.4 Marketing channels-types and applications. 2.5 Service after sales-importance, need of technical know-how, ways and methods, attitude attributes as service engineer, examples of better sales and service set up. 2.6 Concept, need and maintenance of customers' data by using Customer

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	(CRM) method / technique.	Relationship Management (CRM) method / technique.
Unit – III **Supervision with cost & quality control**	3a. Develop the concept to optimize utilization of 7M resources at shop floor/plant level. 3b. Define quality and various quality fads. 3c. Familiarize with TQC, TQM, ISO 9000 and other quality systems in current use. 3d. Construct simple house of matrix using QFD. 3e. Explain pareto analysis. 3f. Establish relationship between cost and quality. 3g. Establish relationship between rejection, cost and quality.	3.1 Importance of productivity, quality and cost saving during shop floor and plant supervision. 3.2 Qualities of good supervision at shop floor and plant level to optimise 7M resources utilisation. 3.3 Quality- Evolution of various quality definitions. 3.4 Definitions of quality policy, quality systems, quality management, quality control, (QC) quality circle, quality assurance (QA), and SQC. 3.5 Quality circle-concept, methodology and benefits with example. 3.6 Philosophical concept, meaning, importance with respect to employee leadership, customer satisfaction, quality, and Total Quality Management (TQM). 3.7 Introduction to quality system standards (ISO9000, BS 14000 and current with its area of application. 3.8 Quality Function Deployment (QFD)-concept, method to construct house of quality, examples. 3.9 Correlation between rejection, rework, cost and quality. 3.10 Pareto analysis-concept and examples.
Unit – IV **Data base management system.**	4a. Develop familiarity with objectives and need of data base management systems and software available in the market. 4b. Prepare RDBMS using database management system software.	4.1 Data management-concept, need, basic terminology used. 4.2 Data base: definition, meaning, importance, approach and architecture. 4.3 Objectives of database organizations. 4.4 Data models: meaning, relationship and association, drawing schema, bubble chart &tree structure for suitable mechanical engineering application. 4.5 Data Base Management System (DBMS) - definition, scope, importance, awareness about current software packages & their features , 4.6 Relational Data Base Management System

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		(RDBMS) - concept, definition, features and applications. 4.7 Preparation steps/ procedure for creating, storing, editing & retrieval of database on latest available database management software package. (MS Access or other in current use).
Unit – V **Information systems.**	5a. Develop simple data base information system for given input. 5b. Demonstrate suitable communication media for implementation of data base management systems.	5.1 Role of computers in information systems. 5.2 Management Information System (MIS) ; concept, definition, need & applications. 5.3 Computer aided information systems :(such as inventory records, operation schedule, consumables issues, tools issues, inspection and quality control reports, failure frequencies with reasons, efficiency and utility reports, maintenance records, produced power units per day, temperature at certain interval, etc..) : need, importance, design considerations, software selection criteria, examples. 5.4 Information communication: - Communication process; computer networks and its types, structures, need and applications, protocols - types, features, applications. 5.5 Communication media – types, features, benefits for industrial environment, working (this includes Internet and Intranet, E-mail, etc.). 5.6 Basics of Enterprise Resource Planning (ERP)

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

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction.	6	4	6	0	10
II	Marketing.	8	6	4	4	14
III	Supervision with cost & quality control.	10	7	4	5	16
IV	Data base management systems.	10	7	4	5	16
V	Information systems.	8	0	4	10	14
	Total	**42**	**24**	**22**	**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 and III (Up to 3.7 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.

Sr. No.	**Unit No.**	**Practical Exercises** (outcomes in Psychomotor Domain**)**	**Approx Hours. required**
1	I	**Preparatory activities:** Student will practice and prepare the report on following. a. Importance of attitude and information systems in day to day operations of shop floor/plant. b. Objectives of learning this subject. c. Definitions and illustrations of system, data and information. d. Attitude dos and don'ts as supervisor on shop floor/plant.	2
2	II	**Forecasting:** Teacher will assign the data. Student will practice and prepare the report on solution steps of three forecasting problems, one each from simple average, simple moving average and weighted moving average.	2
3	II	**Market survey, sales and service:** Student will practice and will prepare report on following. a. Teacher will assign any one mechanical engineering product in the group of 3 to 4 students and will develop market survey form/steps. Student will carry out market survey and will conclude the results of market survey. Students will also present the conclusion. b. Teacher will assign any one mechanical engineering	6

		product in group of 3 to 4 students. Students will visit related shops/traders/industry and will get information on sales schemes and the service steps being executed.	
4	III	**Quality circle:** Teacher will assign the case to be solved in quality circle in the group of 3-4 students. Group will practice and prepare the report on following. a. Reproduce the case. b. List the objectives to be solved. c. Viewpoints of each member. d. Group discussion on view points of each member listing the merits and demerits of each. e. Suggestive outcome/s of the quality circle group. f. Benefits sought if suggestive outcome/s of group is /are implemented.	2
5	V	**Management information system:** Student will practice and will prepare report on following. a. Select and name data base management system software. b. List and explain features of selected data base management software. c. Explain how data entry, editing, sorting and retrieval are performed in selected data base management system software. d. Teacher will assign the input data. Based on this, prepare appropriate data model and develop the information system using selected data base management system software. Also sort, edit and retrieve the data as asked by teacher. Teacher will also assign the data for this. Also attach the print of data base and outcome of sorting/retrieval.	8
6	ALL	**Mini project and presentation:** a. A group of 5-6 students will visit one industry/organization (small scale/medium scale/shop based) and will study the system of handling the unit. Students will record following. i. How output planning is done? ii. How materials purchase quantities are decided? iii. What is the system of inventory control? iv. Whether computers are used in any way or not. If used, for what purpose, these are used. v. How they are optimizing utilization of resources? vi. How is the quality control system? vii. How rework and rejection records are kept? viii. What they do to reduce rejection and rework? ix. Do they keep record keeping systems for utilization of resources?(Human-man power, machines, equipment, devices, plants, etc.). If yes, how they	8

		are maintaining? If no, suggest any computer based system with details. x. How supervisors are performing? Take interviews of supervisors and ask them important aspects to be followed for developing good qualities to become successful supervisors. xi. Any other point/s suggested by teacher. b. Prepare power point presentation and present the work including photographs and movies of actual project work. (This may be flexi –time based work. It may not be necessary to exactly follow the time table slots.)	
		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.PA component of practical marks is dependent on continuous and timely evaluation and submission of exercises.
b. Term work report must not include any photocopy / ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only.
c. Mini project and presentation topic/area has to be assigned to the students in the beginning of the term by batch teacher.
d. For practical ESE part, students are to be assessed for competencies achieved. They should be given experience/part of experience to perform.

8. SUGGESTED LIST OF STUDENT ACTIVITIES

The student activities are same as given in list of practical/exercises. Teacher may give more such activities to interested/bright students.

9. SPECIAL INSTRUCTIONAL STRATEGIES (IF Any)

During practical exercises teacher should not prescribe solutions to students and should motivate them to come out with different alternatives (even if they may not be feasible) and should allow them to try and learn on their own from their mistakes. Teacher should help students only when they are completely stuck.

10. SUGGESTED LEARNING RESOURCES

A) List of Books

S. No.	Title of Book	Author	Publication
1.	Computer database organization.	Jame's Martin	PHI publication
2.	Production and operations management.	N.G.Nair	TMGH publication
3.	Production and operations management.	Chase/Aquiline, Irwinpublication	PHI publication

4.	Management information system.	S.Sadagopan	PHI publication
5.	Production and operations management.	S.N.Charry	TMGH publication
6.	Modern production & operations management.	Elwood S. Buffa and RakeshK. Sarin.	John willy & sons publication
7.	Introduction to Database Management	Madhulika Jain, Jain & Shashi Singh	BPB publication
8.	Quality planning and analysis.	J.M.Juran, Frank M.Gryna	TMGHpublication

B) List of Software/Learning Websites.

i. http://www.ftpress.com/articles/article.aspx?p=2167438&seqNum=2 (OM)
ii. http://en.wikipedia.org/wiki/Quality
iii. http://www.businessdictionary.com/definition/quality.html
iv. https://www.youtube.com/watch?v=ypZiSguq4jM
v. https://www.youtube.com/watch?v=LdhC4ziAhgY
vi. https://www.youtube.com/watch?v=jd8B0QK9_5g
vii. https://www.youtube.com/watch?v=tjQFtSmVppY (market survey)
viii. http://www.wikihow.com/Make-a-Market-Survey
ix. https://www.youtube.com/watch?v=IO4zrY2tdCY (information system)
x. https://www.youtube.com/watch?v=LiQMHqi3csI(information system)
xi. https://www.youtube.com/watch?v=DTWnQDAhp9k (methods of production)
xii. http://crl.du.ac.in/ical09/papers/index_files/ical-111_76_183_2_RV.pdf (quality circle)
xiii. http://www.slideshare.net/monikatoshika/quality-circle-7881239(quality circle)

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics.

- Shri K.H.Patel, Head of Mechanical Engineering Department, Dr. S.S. & S. Gandhi College of Engineering and Technology, Surat.
- Shri A.M Talsaniya, Lecturer in Mechanical Engineering, Sir B.P.I., Bhavnagar.
-

Coordinator and Faculty Members from NITTTR Bhopal.

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