

# GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

## DIPLOMA MECHANICAL ENGINEERING

BRANCH CODE:19 DIPLOMA PROGRAMME IN MECHANICAL ENGINEERING										
SEMESTER - I										
COURSE CODE	COURSE TITLE	TEACHING SCHEME/WEEK			CREDITS (L+T+P)	EXAMINATION SCHEME				GRAND TOTAL
		L	T	P		THEORY		PRACTICAL		
						ESE	PA	ESE	PA	
<a href="#">3300001</a>	BASIC MATHEMATICS	2	2	0	4	70	30	0	0	100
<a href="#">3300002</a>	ENGLISH	3	2	0	5	70	30	20	30	150
<a href="#">3300003</a>	ENVIRONMENT CONSERVATION & HAZARD MANAGEMENT	4	0	0	4	70	30	0	0	100
<a href="#">3300004</a>	ENGINEERING PHYSICS (GROUP-1)	3	0	2	5	70	30	20	30	150
<a href="#">3300007</a>	BASIC ENGINEERING DRAWING	2	0	4	6	70	30	40	60	200
<a href="#">3301901</a>	ENGINEERING WORKSHOP PRACTICE	0	0	4	4	0	0	40	60	100
		14	4	10						
TOTAL					28	350	150	120	180	800

BRANCH CODE:19 DIPLOMA PROGRAMME IN MECHANICAL ENGINEERING										
SEMESTER - II										
COURSE CODE	COURSE TITLE	TEACHING			CREDITS (L+T+P)	EXAMINATION SCHEME				GRAND TOTAL
		L	T	P		THEORY		PRACTICAL		
						ESE	PA	ESE	PA	
<a href="#">1990001</a>	CONTRIBUTOR PERSONALITY DEVELOPMENET	4	0	0	4	70	30	20	30	150
<a href="#">3320003</a>	ADVANCED MATHEMATICS (GROUP-2)	2	2	0	4	70	30	0	0	100
<a href="#">3300008</a>	APPLIED MECHANICS	3	0	2	5	70	30	20	30	150
<a href="#">3321902</a>	MATERIAL SCIENCE & METALLURGY	3	0	2	5	70	30	20	30	150
<a href="#">3321901</a>	MECHANICAL DRAFTING	2	0	6	8	70	30	40	60	200
<a href="#">3320004</a>	BASIC OF CIVIL ENGINEERING	0	1	2	3	0	0	20	30	50
		14	3	12						
TOTAL					29	350	150	120	180	800

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## DIPLOMA MECHANICAL ENGINEERING

BRANCH CODE:19		DIPLOMA PROGRAMME IN MECHANICAL ENGINEERING								
SEMESTER - III										
COURSE CODE	COURSE TITLE	TEACHING SCHEME				EXAMINATION SCHEME				GRAND TOTAL
		L	T	P	CREDITS (L+T+P)	THEORY MARKS		PRACTICAL MARKS		
						ESE	PA	ESE	PA	
<a href="#">3331901</a>	MANUFACTURING ENGINEERING-I	3	0	4	7	70	30	40	60	200
<a href="#">3331902</a>	THERMODYNAMICS	3	0	0	3	70	30	0	0	100
<a href="#">3331903</a>	FLUID MECHANICS AND HYDRAULIC MACHINES	4	0	2	6	70	30	20	30	150
<a href="#">3331904</a>	STRENGTH OF MATERIALS	3	0	2	5	70	30	20	30	150
<a href="#">3331905</a>	APPLIED ELECTRICAL AND ELECTRONIC ENGINEERING	3	0	2	5	70	30	20	30	150
<a href="#">3331906</a>	COMPUTER AIDED MACHINE DRAWING	0	0	4	4	0	0	40	60	100
<a href="#">3330001</a>	HUMAN RESOURCE MANAGEMENT	2	0	0	2	70	30	0	0	100
<b>TOTAL</b>		<b>18</b>	<b>0</b>	<b>14</b>	<b>32</b>	<b>420</b>	<b>180</b>	<b>140</b>	<b>210</b>	<b>950</b>

BRANCH CODE:19		DIPLOMA PROGRAMME IN MECHANICAL ENGINEERING								
SEMESTER - IV										
COURSE CODE	COURSE TITLE	TEACHING SCHEME				EXAMINATION SCHEME				GRAND TOTAL
		L	T	P	CREDITS (L+T+P)	THEORY MARKS		PRACTICAL MARKS		
						ESE	PA	ESE	PA	
<a href="#">3341901</a>	MANUFACTURING ENGINEERING - II	3	0	4	7	70	30	40	60	200
<a href="#">3341902</a>	THERMAL ENGINEERING-I	3	0	2	5	70	30	20	30	150
<a href="#">3341903</a>	THEORY OF MACHINES	4	0	2	6	70	30	20	30	150
<a href="#">3341904</a>	COMPUTER AIDED DESIGN	2	0	2	4	70	30	20	30	150
<a href="#">3341905</a>	METROLOGY & INSTRUMENTATION	4	0	4	8	70	30	40	60	200
<a href="#">3341906</a>	PLANT MAINTENANCE AND SAFETY	3	0	2	5	70	30	20	30	150
<b>TOTAL</b>		<b>19</b>	<b>0</b>	<b>16</b>	<b>35</b>	<b>420</b>	<b>180</b>	<b>160</b>	<b>240</b>	<b>1000</b>

# GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

## DIPLOMA MECHANICAL ENGINEERING

BRANCH CODE:19 DIPLOMA PROGRAMME IN MECHANICAL ENGINEERING										
SEMESTER - V										
COURSE CODE	COURSE TITLE	TEACHING SCHEME				EXAMINATION SCHEME				GRAND TOTAL
		L	T	P	CREDITS (L+T+P)	THEORY MARKS		PRACTICAL MARKS		
						ESE	PA	ESE	PA	
<a href="#">3351901</a>	THERMAL ENGINEERING-II	2	0	2	4	70	30	20	30	150
<a href="#">3351902</a>	DESIGN OF MACHINE ELEMENTS	3	0	2	5	70	30	20	30	150
<a href="#">3351903</a>	MANUFACTURING ENGINEERING-III	3	0	4	7	70	30	40	60	200
<a href="#">3351904</a>	INDUSTRIAL ENGINEERING	3	0	2	5	70	30	20	30	150
<a href="#">3351905</a>	ESTIMATING, COSTING AND ENGINEERING CONTRACTING	2	0	2	4	70	30	20	30	150
	ELECTIVE-I [ANY ONE ELECTIVE FROM ANY ONE GROUP]	3	0	2	5	70	30	20	30	150
<a href="#">3351908</a>	PROJECT-I	0	1	3	4	0	0	40	60	100
<b>TOTAL</b>		<b>16</b>	<b>1</b>	<b>17</b>	<b>34</b>	<b>420</b>	<b>180</b>	<b>180</b>	<b>270</b>	<b>1050</b>

ELECTIVE- I	
GROUP 1-MANUFACTURING ENGINEERING	
<a href="#">3351906</a>	SELF EMPLOYEMENT AND ENTREPRENEURSHIP DEVELOPMENT OR
<a href="#">3351907</a>	OPERATIONS MANAGEMENT AND INFORMATION SYSTEMS
GROUP 2-THERMAL ENGINEERING	
<a href="#">3351906</a>	SELF EMPLOYEMENT AND ENTREPRENEURSHIP DEVELOPMENT OR
<a href="#">3351907</a>	OPERATIONS MANAGEMENT AND INFORMATION SYSTEMS
GROUP 3-FLUID ENGINEERING	
<a href="#">3351906</a>	SELF EMPLOYEMENT AND ENTREPRENEURSHIP DEVELOPMENT OR
<a href="#">3351907</a>	OPERATIONS MANAGEMENT AND INFORMATION SYSTEMS

BRANCH CODE:19 DIPLOMA PROGRAMME IN MECHANICAL ENGINEERING										
SEMESTER - VI										
COURSE CODE	COURSE TITLE	TEACHING SCHEME				EXAMINATION SCHEME				GRAND TOTAL
		L	T	P	CREDITS (L+T+P)	THEORY MARKS		PRACTICAL MARKS		
						ESE	PA	ESE	PA	
<a href="#">3361901</a>	COMPUTER AIDED MANUFACTURING(CAM)	2	0	2	4	70	30	20	30	150
<a href="#">3361902</a>	TOOL ENGINEERING	3	0	2	5	70	30	20	30	150
<a href="#">3361903</a>	INDUSTRIAL MANAGEMENT	3	0	0	3	70	30	0	0	100
	ELECTIVE-II (FIRST SUBJECT FROM ANY ONE GROUP)	3	0	2	5	70	30	20	30	150
	ELECTIVE-III (SECOND SUBJECT FROM ANY SAME GROUP)	3	0	2	5	70	30	20	30	150
<a href="#">3361910</a>	PROJECT-II	0	0	6	6	0	0	60	90	150
<b>TOTAL</b>		<b>14</b>	<b>0</b>	<b>14</b>	<b>28</b>	<b>350</b>	<b>150</b>	<b>540</b>	<b>210</b>	<b>850</b>

ELECTIVE- II,III	
GROUP-1 MANUFACTURING ENGINEERING	
<a href="#">3361904</a>	MANUFACTURING SYSTEMS.
<a href="#">3361905</a>	FABRICATION TECHNOLOGY.
GROUP-2 THERMAL ENGINEERING	
<a href="#">3361906</a>	POWER PLANT ENGINEERING
<a href="#">3361907</a>	THERMAL SYSTEMS AND ENERGY EFFICIENCY
GROUP-3 FLUID ENGINEERING	
<a href="#">3361908</a>	HYDRAULIC SYSTEMS
<a href="#">3361909</a>	PNEUMATIC SYSTEMS

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**  
**COURSE CURRICULUM**

Course Title: Basics Mathematics  
(Code: 3300001)

Diploma Programmes in which this course is offered	Semester in which offered
Automobile Engineering, Biomedical Engineering, Ceramic Engineering, Chemical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, Electronics & Communication Engineering, Environment Engineering, Fabrication Technology, Information Technology, Instrumentation & Control Engineering, Mechanical Engineering, Mechatronics Engineering, Metallurgy Engineering, Mining Engineering, Plastic Engineering, Power Electronics Engineering, Printing Technology, Textile Manufacturing Technology, Textile Processing Technology, Transportation Engineering	<b>First Semester</b>

### 1. RATIONALE

The subject is classified under Basic Sciences and students are intended to know about the basic concepts and principles of Mathematics as a tool to analyze the Engineering problems. Mathematics has the potential to understand the Core Technological studies.

### 2. LIST OF COMPETENCIES

The course content should be taught so as to understand and perform the Engineering concepts and computations. Aim to develop the different types of Mathematical skills leading to the achievement of the following competencies:

- i. **Apply the concepts and principles of mathematics to solve simple engineering problems**

### 3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	100
2	2	0	4	70	30	0	0	

#### Legends:

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

#### 4. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes	Topics and Sub-topics
<b>Unit – I Logarithm</b>	1.1 Solve simple problems using concepts of Logarithms	Concept ,Rules and related Examples
<b>Unit– II Determinants and Matrices</b>	2.1 Solve simultaneous equations using concepts of Determinants and Matrices	Idea of Determinant and Matrix, Addition/Subtraction, Product, Inverse up to 3X3 matrix, Solution of Simultaneous Equations(up to three variables)
<b>Unit– III Trigonometry</b>	3.1 Solve simple problems using concepts of Trigonometry	Units of Angles(degree and radian), Allied & Compound Angles, Multiple –Submultiples angles, Graph of Sine and Cosine, Periodic function, sum and factor formulae, Inverse trigonometric function
<b>Unit– IV Vectors</b>	4.1 Solve simple problems using concepts of Vectors	Basic concept of Vector and Scalar, addition & subtraction, Product of Vectors, Geometric meaning of Scalar and Vector Product. Angle between two vectors, Applications of Dot (scalar) and Cross (vector) Product, Work Done and Moment of Force.
<b>Unit-V Menstruation</b>	5.1 Calculate the surface area and volume of different shapes and bodies.	Area of Triangle, Square, Rectangle, Trapezium, Parallelogram, Rhombus and Circle Surface & Volume of Cuboids, Cone, Cylinder and Sphere.

#### 5. 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
1.	Logarithms	03	4	4	2	10
2.	Determinants and Matrices	08	6	8	4	18
3.	Trigonometry	08	8	6	4	18
4.	Vectors	06	5	5	4	14
5.	Mensuration	03	3	3	4	10
<b>Total</b>		<b>28</b>	<b>26</b>	<b>26</b>	<b>18</b>	<b>70</b>

#### Legends:

R = Remembrance; U= Understanding; A= Application and above levels (Revised Bloom's Taxonomy)

## 6. SUGGESTED LIST OF EXERCISES (During tutorial hours)

The exercises should be properly designed and implemented with an attempt to develop different types of skills leading to the achievement of the competency.

S. No.	Unit No.	Exercises/Tutorial
1	1	Logarithms-Simple Examples related Definition and Rules
2		Examples on various types and Graphs
3	2	Determinants, Simple Examples on Matrix Addition/Subtraction and Product
4		Co-factors, Adjoint and Inverse of Matrix
5	2	Solution of Simultaneous Equation using 3X3 Matrix and its Applications
6	3	Practice Examples: Allied & Compound Angles
7		Practice Examples: Periodic functions, Sum/Diff and factor formulae, Inverse Trigonometric function etc.
8		Simple Graphs of Sine and Cosine Functions(Explain Spherical Trigonometry, if possible, for Applications)
9	4	Practice Simple Examples Vectors
10		Example related to Dot and Cross Products and Applications
11	5	Examples on Area
12		Surface Area & Volume and its Applications

Note: The above Tutor sessions are for guideline only. The remaining Tutorial hours are for revision and practice.

## 7. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities like: course/topic based seminars, internet based assignments, teacher guided self learning activities, course/library/internet/lab based Mini-Projects etc. These could be individual or group-based.

1. Applications to solve identified Engineering problems and use of Internet.
2. Learn MathCAD to use Mathematical Tools and solve the problems of Calculus.
3. Learn MATLAB and use to solve the identified problems.

## 8. SUGGESTED LEARNING RESOURCES

### A. List of Books

S.No.	Author	Title of Books	Publication
1	Anthony croft and others	Engineering Mathematics (third edition)	Pearson Education
2	W R Neelkanth	Applied Mathematics-I	Sapna Publication
3	S P Deshpande	Polytechnic Mathematics	Pune Vidyarthi Gruh Prakashan
4	Rudra Pratap	Getting Started with MATLAB-7	OXFORD University Press

**B. List of Major Equipment/ Instrument**

1. Simple Calculator
2. Computer System with Printer, Internet
3. LCD Projector

**C. List of Software/Learning Websites**

1. Excel
2. DPlot
3. MathCAD
4. MATLAB

You may use other Software like Mathematica and other Graph Plotting software. Use wikipedia.org, mathworld.wolfram.com Etc...

**9. COURSE CURRICULUM DEVELOPMENT COMMITTEE:****Faculty Members from Polytechnics**

- **Dr.N.R.Pandya**, HOD-General Dept. Govt. Polytechnic, Ahmedabad
- **Dr N. A. Dani**, Lecturer, Govt. Polytechnic, Junagadh.
- **Smt R. L. Wadhwa**, Lecturer, Govt. Polytechnic, Ahmedabad
- **Shri H. C. Suthar**, Lecturer, BPTI, Bhavnagar
- **Shri P. N. Joshi**, Lecturer, Govt. Polytechnic, Rajkot
- **Shri P. T. Polara**, Lecturer, Om Institute of Engg. And Tech, Junagadh,
- **Smt Ami C. Shah**, Lecturer, BBIT, V. V. Nagar.

**Coordinator and Faculty Member From NITTTR Bhopal**

- **Dr. P. K. Purohit**, Associate Professor, Dept. of Science, NITTTR, Bhopal

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**  
**COURSE CURRICULUM**

Course Title: English  
(Code: 3300002)

<b>Diploma Programmes in which this course is offered</b>	<b>Semester in which offered</b>
Architectural Assistanship, Automobile Engineering, Biomedical Engineering, Ceramic Engineering, Chemical Engineering, Civil Engineering, Computer Aided Costume Design & Dress Making, Computer Engineering, Electrical Engineering, Electronics & Communication Engineering, Environment Engineering, Fabrication Technology, Information Technology, Instrumentation & Control Engineering, Mechanical Engineering, Mechatronics Engineering, Metallurgy Engineering, Mining Engineering, Plastic Engineering, Power Elctronics Engineering, Printing Technology, Textile Designing, Textile Manufacturing Technology, Textile Processing Technology, Transportation Engineering	<b>First Semester</b>

## 1. RATIONALE

English language has become a dire need to deal successfully in the globalized and competitive market and hence this curriculum aims at developing the functional and communicative abilities of the students in English. Proficiency in English is one of the basic needs of technical students. A technician has to communicate all the time with peers, superiors, subordinates and clients in his professional life. Hence this course is being offered.

## 2. LIST OF COMPETENCIES

The course content should be taught and implemented with the aim to develop different types of skills leading to the achievement of the following competencies:

- i. **Communicate verbally and in writing in English.**
- ii. **Comprehend the given passages and summarize them.**



### 3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Tutorial Marks		
3	2	0	5	ESE	PA	ESE	PA	150
				70	30	20	30	

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

### 4. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes		Topics and Sub-topics
	Writing Skills	Speaking Skills	
<b>Unit – I Grammar</b>	1.1 Apply correct verb in the given sentence	1b. Use grammatically correct sentence in day to day communication	<b>1.1 Tenses</b> - Present Tense (Simple, Continuous, Perfect, Perfect Continuous) - Past Tense (Simple, Continuous, Perfect) - Future Tense (Simple)
	1.2 Distinguish among various Determiners	1d. Distinguish among determiners and apply correctly in communicative usage.	<b>1.2 Determiners</b> - Articles (A, An, The) Some, Any, Much, Many, All, Both, Few, A few, The few, Little, A little, The little, Each, Every.
	1.3 Use appropriate modal auxiliaries in a given expression	1f. Choose appropriate modals in situations where different modes of expressions are used.	<b>1.3 Modal Auxiliaries</b> Can, Could, May, Might, Shall, Should, Will, Would, Must, Have to, Need, Ought to
	1.4 Choose the correct verb for the given subject	1h. Use the correct verb depending on the subject in a sentence.	<b>1.4 Subject- Verb Agreement</b>
	1.5 Distinguish between Active and Passive structures. Apply correct model auxiliary in the given sentence.	1j. Apply the correct voice in formal communication	<b>1.5 The Passive Voice</b> Simple Tenses, Perfect Tenses And Modal Auxiliary Verbs
	1.6 Use appropriate preposition in a sentence	1l. Usage of correct preposition as per time, place and direction.	<b>1.6 Prepositions:</b> Time, Place and Direction
	1.7 Identify different connectors and their usage.	1n. Join words or sentences using connectors and bring out the desired meaning.	<b>1.7 Connectors:</b> And, But, Or, Nor, Though, Although, If, Unless, Otherwise, Because, as, Therefore, So, Who, Whom, Whose, Which, Where, When, Why.

Unit	Major Learning Outcomes		Topics and Sub-topics
	Writing Skills	Speaking Skills	
<b>Unit – II Comprehension Passages</b>	2.1 Formulate sentences using new words. 2.2 Enrich vocabulary through reading. 2.3 Write short as well as long answers to questions. 2.4 Express ideas in English in written form effectively	2e. Discuss the content of the passage/story in the class. 2f. Ask appropriate questions as well to answer them. 2g. Follow oral instructions and interpret them to others. 2h. Present topics effectively and clearly. 2i. Use dictionary, thesaurus and other reference books. 2j. Describe an object or product. 2k. Use correct pronunciations and intonations. 2l. Give instructions orally	<b>2.1 Comprehension Passages</b> <ul style="list-style-type: none"> <li>• Lincoln's Letter to His Son's Teacher (Abraham Lincoln)</li> <li>• What we must Learn from the West (Narayana Murthy)</li> <li>• Dabbawallas: Mumbai's Best Managed Business (Amberish K. Diwanji)</li> <li>• Internet (Jagdish Joshi)</li> </ul> <b>2.2 Vocabulary Items:</b> <ul style="list-style-type: none"> <li>- Matching items (word and its Meaning)</li> <li>- One word Substitution</li> <li>- Phrases and idioms</li> <li>- Synonyms and Antonyms from given MCQs</li> </ul>
<b>Unit – III Short Stories</b>		3a Express ideas and views on given topics. 3b. Speak briefly on a given topic fluently and clearly. 3c. Participate in formal and informal conversations 3d. Recapitulate orally the facts or ideas presented by the speaker	<ul style="list-style-type: none"> <li>• My Lost Dollar by Stephen Leacock</li> <li>• The Snake in the Grass by R K Narayan</li> <li>• A Day's Wait by Earnest Hemingway</li> </ul>
<b>Unit – IV Writing Skills</b>	4.1 Write letters and dialogues on given topics / situations.	4b. Face oral examinations and interviews	<b>4.1 Dialogue Writing</b> <b>4.2 Samples for Practice:</b> <ul style="list-style-type: none"> <li>- Meeting and Parting</li> <li>- Introducing and Influencing</li> <li>- Requests</li> <li>- Agreeing and Disagreeing</li> <li>- Inquiries and Information</li> </ul> <b>4.3 Letter:</b> <ul style="list-style-type: none"> <li>- Placing an order</li> <li>- Letter to Inquiry</li> <li>- Letter of Complaint</li> <li>- Letter of Adjustment</li> <li>- Letter seeking permission</li> </ul>
<b>Unit – V Speaking Skills</b>		5a. Follow correct pronunciation, stress and intonation in everyday conversation.	<b>For 28 hours of practical periods</b> , digital language laboratory is recommended to be established in every polytechnic. But as polytechnics currently do not have digital language laboratories practical periods will be engaged encouraging the students to speak as per the text taught in the class.

## 5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY )

Unit Title	Teaching Hours 42+28	Distribution of Theory Marks			
		R Level	U Level	A Level	Total
Unit – I Grammar	14	8	8	9	25
Unit – II Comprehension Passages	07	4	6	5	15
Unit – III Short Stories	07	4	5	5	14
Unit – IV Writing Skills	14	3	6	6	15
Unit – V Speaking Skills	28	1			01
<b>Total</b>	<b>70</b>	<b>20</b>	<b>25</b>	<b>25</b>	<b>70</b>

**Legends:** R = Remembrance; U = Understanding; A = Application and above levels (Revised Bloom's taxonomy )

## 6. SUGGESTED LIST OF TUTORIAL EXERCISES

The tutorial exercises should be properly designed and implemented with an attempt to develop different types of skills leading to the achievement of the above mentioned competencies.

S. No.	Unit No.	Experiment
1	I	<b>Conversation</b> <ol style="list-style-type: none"> <li>1. Introducing oneself</li> <li>2. Introduction about family</li> <li>3. Discussion about the weather</li> <li>4. Seeking Permission to do something</li> <li>5. Description about hobbies</li> <li>6. Seeking Information at Railway Station/ Airport</li> <li>7. Taking Appointments from superiors and industry personnel</li> <li>8. Conversation with the Cashier- College/ bank</li> <li>9. Discussing holiday plans</li> <li>10. Asking about products in a shopping mall</li> <li>11. Talking on the Telephonic</li> <li>12. Wishing Birthday to a Friend</li> <li>13. Talking about Favourite Sports</li> </ol>
2	II	<b>Presentation Skills</b> General Presentations pertaining to Unit I, II, III

## 7. SUGGESTED LIST OF PROPOSED STUDENT ACTIVITIES

Following is the list of proposed student activities like:

- course/topic based seminars,
- internet based assignments,
- teacher guided self learning activities,
- course/library/internet/lab based mini-projects etc.

These could be individual or group-based.

## 8. SUGGESTED LEARNING RESOURCES

### A. Text Book

Sr. No.	Author/s	Title of Books	Publication
1	Juneja & Qureshi	Active English	Macmillan

### B. List of Reference Books

Sr. No.	Author/s	Title of Books	Publication
1	Wren & Martin	High School English Grammar	S. Chand & Co. Ltd
2	M. Gnanamurali	English Grammar at Glance	S. Chand & Co. Ltd.
3	E. Suresh Kumar & Others	Effective English	Pearson
4	S. Chandrashekhar & Others	English Communication for Polytechnics	Orient BlackSwan
5	-	English Fluency Step 1 & 2	Macmillan
6	-	Active English Dictionary	Longman

### C. List of Major Equipment/ Instrument

- i. Digital English Language Laboratory
- ii. Computers for language laboratory software
- iii. Headphones with microphone
- iv. Computer furniture

### D. List of Software/Learning Websites

- i. <http://www.free-english-study.com/>
- ii. <http://www.english-online.org.uk/course.htm>
- iii. <http://www.english-online.org.uk/>
- iv. <http://www.talkenglish.com/>
- v. <http://www.learnenglish.de/>

## 9. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### Polytechnic Faculty Members

- **Prof. K. H. Talati**, Govt. Polytechnic, Gandhinagar (Convener)
- **Ms. Almas Juneja**, Gujarat Technological University, Ahmedabad.
- **Shri. D. M. Patel**, Govt. Polytechnic, Ahmedabad.
- **Dr. Sonal K. Mehta**, Govt. Girls Polytechnic, Ahmedabad.
- **Shri. Bhadresh J. Dave**, Govt. Polytechnic, Rajkot.
- **Dr. Peena Thanki**, Govt. Polytechnic, Jamnagar.
- **Dr. Chetan Trivedi**, Govt. Engineering College, Bhavnagar.
- **Dr. Raviraj Raval**, Govt. Polytechnic, Rajkot.
- **Shri Vaseem Qureshi**, Vishwakarma Govt. Engineering College, Chandkheda, Ahmedabad.

### NITTTR Bhopal Faculty and Co-ordinator

- **Dr. Joshua Earnest**, , NITTTR, Bhopal
- **Prof.(Mrs.) Susan S. Mathew**, NITTTR, Bhopal

## GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT COURSE CURRICULUM

Course Title: Environment Conservation & Hazard Management  
(Code: 3300003)

Diploma Programmes in which this course is offered	Semester in which offered
Biomedical Engineering, Ceramic Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, Environment Engineering, Fabrication Technology, Information Technology, Instrumentation & Control Engineering, Mechanical Engineering, Mining Engineering, Textile Design, Transportation Engineering	<b>First Semester</b>
Architecture Assistantship, Automobile Engineering, Chemical Engineering, Electronics & Communication, Mechatronics Engineering, Metallurgy Engineering, Plastic Engineering, Power Electronics, Printing Technology, Textile Manufacturing, Textile Processing	<b>Second Semester</b>

### 1. RATIONALE

For a country to progress, sustainable development is one of the key factors. Environment conservation and hazard management is of much importance to every citizen of India. The country has suffered a lot due to various natural disasters. Considerable amount of energy is being wasted. Energy saved is energy produced. Environmental pollution is on the rise due to rampant industrial mismanagement and indiscipline. Renewable energy is one of the answers to the energy crisis and also to reduce environmental pollution. Therefore this course has been designed to develop a general awareness of these and related issues so that the every student will start acting as a responsible citizen to make the country and the world a better place to live in.

### 2. COMPETENCIES

The course content should be taught and implemented with the aim to develop different types of skills leading to the achievement of the following competencies.

- i. **Take care of issues related to environment conservation and disaster management while working as diploma engineer.**

### 3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	100
4	0	0	4	70	30	0	0	

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

#### 4. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes	Topics and Sub-topics
<b>Unit – I Ecology and environment</b>	1.1 Enhance knowledge about engineering aspects of Environment 1.2 Correlate the facts of ecology and environment A 1.3 assess the effect of pollution 1.4 List the causes of environmental pollution 1.5 State the major causes of air, water and noise pollution 1.6 Describe how industrial waste contaminates the land 1.7 Describe the effects of radiation on vegetables, animals	1.1 Importance of environment and scope 1.2 Engineering and environment issues 1.3 The natural system, Biotic and a-Biotic components and processes of natural system 1.4 Eco system, food chain and webs and other biological Systems, 1.5 Causes of environmental pollution 1.6 Pollution due to solid waste 1.7 water pollution, air pollution, the Noise as pollution, 1.8 Pollution of land due to industrial and chemical waste 1.9 Radiation and its effects on vegetables and animals
<b>Unit– II Sustainable Development</b>	2.1 Explain the concept of sustainable development 2.2 Justify the need for renewable energy 2.3 Describe the growth of renewable energy in India 2.4 Explain the concepts of waste management and methods of recycling	2.1 Concept of sustainable development, 2.2 Natural resources, a-biotic and biotic resources 2.3 Principles of conservation of energy and management 2.4 Need of Renewable energy 2.5 Growth of renewable energy in India and the world 2.6 Concept of waste management and recycling
<b>Unit – III Wind Power</b>	3.1 Describe the growth of wind power in India 3.2 State the differences between VAWTs and HAWTs 3.3 Explain the differences between drag and lift type wind turbines 3.4 Describe the working of large wind turbines 3.5 List the types of aerodynamic control of large wind turbines 3.6 Name the generators used in large wind turbines	3.1 Growth of wind power in India 3.2 Types of wind turbines – Vertical axis wind turbines (VAWT) and horizontal axis wind turbines (HAWT) 3.3 Types of HAWTs – drag and lift types 3.4 Working of large wind turbines 3.5 Aerodynamic control of large and small wind turbines 3.6 Types of electrical generators used in small and large wind turbines
<b>Unit – IV Solar Power</b>	4.1 Describe the salient features of solar thermal and PV systems 4.2 Describe a solar cooker and solar water heater 4.3 Describe the working of solar PV system 4.4 State the salient features of polycrystalline, monocrystalline and thin film PV systems	4.1 Features of solar thermal and PV systems 4.2 Types of solar cookers and solar water heaters 4.3 Solar PV systems and its components and their working 4.4 Types of solar PV cells 4.5 Solar PV and solar water heaters, rating and costing
<b>Unit – V Biomass energy</b>	5.1 State the different types of biomass energy sources 5.2 Describe about the energy content in biomass 5.3 Describe the working of simple biogas plant	5.1 Types of Biomass Energy Sources 5.2 Energy content in biomass of different types 5.3 Types of Biomass conversion processes 5.4 Biogas production

Unit	Major Learning Outcomes	Topics and Sub-topics
<b>Unit – VI Seismic Engineering and disaster management</b>	6.1 Explain the principles of seismic Engineering in design of structure 6.2 State the appropriate actions to be taken during disasters	6.1 Introduction of seismic engineering and its application civil engineering designs 6.2 Features of disasters such as Floods, Earthquakes, Fires, Epidemics, Gas/radioactive leaks etc. 6.3 Management and mitigation of above disasters

## 5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1.	Ecology and Environment	8	4	4	0	8
2.	Sustainable Development	10	4	5	1	10
3.	Wind Power	10	4	6	4	14
4.	Solar Power	10	4	6	4	14
5.	Biomass energy	8	4	4	2	10
6.	Seismic Engineering and disaster	10	6	6	2	14
	<b>Total</b>	<b>56</b>	<b>26</b>	<b>31</b>	<b>13</b>	<b>70</b>

### Legends:

R = Remembrance; U = Understanding; A = Application and above levels (Revised Bloom's taxonomy)

## 6. SUGGESTED LIST OF EXPERIMENTS/PRACTICAL EXERCISES

Nil

## 7. SUGGESTED LIST OF STUDENT ACTIVITIES

- i. Prepare paper on various sustainable development
- ii. Make a report after gathering information the values of water, noise pollution and air pollution in your city/town and compare the values in other cities and towns in India with respect to environmentally acceptable levels
- iii. Prepare a paper on air and water pollution in an industry/institute
- iv. Undertake some small mini projects in any one of the renewable energies
- v. Visit an energy park and submit project on various sources of energy
- vi. Prepare powerpoint on clean and green technologies
- vii. Prepare a list of do's and don'ts applicable during disasters
- viii. Submit a report on garbage disposal system in your city/town.



## 8. SUGGESTED LEARNING RESOURCES

### A. List of Books

S. No.	Title of Book	Author	Publication/Year
1	Renewable Energy Technologies	Solanki, Chetan Singh	PHI Learning, New Delhi, 2010
2	Ecology and Control of the Natural Environment	Izrael, Y.A.	Kluwer Academic Publisher
3	Environment Engineering and Disaster Management	Sharma, Sanjay K.	Luxmi Publications, New Delhi
4	Environmental Noise Pollution and Its Control	Chhatwal, G.R.; Katyal, T.; Katyal,	Anmol Publications, New Delhi
5	Wind Power Plants and Project Development	Earnest, Joshua & Wizelius, Tore	PHI Learning, New Delhi, 2011
6	Renewable Energy Sources and Emerging Technologies	Kothari, D.P. Singal, K.C., Ranjan, Rakesh	PHI Learning, New Delhi, 2009
7	Environmental Studies	Anandita Basak	Pearson
8	Environmental Science and Engineering	Alka Debi	University Press
9	Coping With Natural Hazards, Indian Context	K. S. Valadia	Orient Longman
10	Engineering and Environment	Edward S. Rubin	Mc Graw Hill Publ.

### B. List of Major Equipment/ Instrument

- i. Digital sound level meters (to check noise pollution)
- ii. Digital air quality meter (to measure air pollution)
- iii. Digital handheld anemometer (to measure wind speeds)
- iv. Digital hand held pyranometer (to measure solar radiation levels)

### C. List of Software/Learning Websites

- i. [http://www1.eere.energy.gov/wind/wind\\_animation.html](http://www1.eere.energy.gov/wind/wind_animation.html)
- ii. [http://www.nrel.gov/learning/re\\_solar.html](http://www.nrel.gov/learning/re_solar.html)
- iii. [http://www.nrel.gov/learning/re\\_biomass.html](http://www.nrel.gov/learning/re_biomass.html)
- iv. <http://www.mnre.gov.in/schemes/grid-connected/solar-thermal-2/>
- v. <http://www.mnre.gov.in/schemes/grid-connected/biomass-powercogen/>

## 9. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### Faculty Members from Polytechnics

- Prof. H.L.Purohit , HOD, Civil Engg. Dept. L.E.College. Morbi
- Shri. P.A.Pandya, LCE, Civil Engg. Dept, G.P , Himatnagar

### Co-ordinator and Faculty Members from NITTTR Bhopal

- Dr. J.P.Tegar, Professor Dept of Civil and Environmental Engg, NITTTR, Bhopal.
- Dr. Joshua Earnest, Professor and Head, Dept. of Electrical & Electronics Engg, NITTTR, Bhopal

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**  
**COURSE CURRICULUM**

Course Title: Engineering Physics (Group-1)  
(Code: 3300004)

<b>Diploma Programmes in which this course is offered</b>	<b>Semester in which offered</b>
Automobile Engineering, Ceramic Engineering, Civil Engineering, Environment Engineering, Fabrication Technology, Mechanical Engineering, Mechatronics Engineering, Metallurgy Engineering, Mining Engineering, Plastic Engineering, Transportation Engineering	<b>First Semester</b>
Chemical Engineering, Textile Manufacturing Technology, Textile Processing Technology	<b>Second Semester</b>

### 1. RATIONALE

As Physics is the mother of all engineering disciplines, students must have some basic knowledge on physics to understand their core engineering subjects more comfortably. Accordingly, in reviewing the syllabus, emphasis has been given on the principles, laws, working formulae and basic ideas of physics to help them study the core subjects. Complicated derivations have been avoided because applications of the laws and principles of physics are more important for engineering students.

As Physics is considered as basic science its principles, laws, hypothesis, concepts, ideas are playing important role in reinforcing the knowledge of technology. Deep thought is given while selecting topics in physics. They are different for various branches of engineering. This will provide sound background for self-development in future to cope up with new innovations. Topics are relevant to particular program and students will be motivated to learn and can enjoy the course of Physics as if it is one of the subjects of their own stream.

Engineering, being the science of measurement and design, has been offspring of Physics that plays the primary role in all professional disciplines of engineering. The different streams of Physics like Optics, Acoustics, Dynamics, Semiconductor Physics, Surface Physics, Nuclear physics, Energy Studies, Materials Science, etc provide Fundamental Facts, Principles, Laws, and Proper Sequence of Events to streamline Engineering knowledge.

**Note:- Teachers should give examples of engineering/technology applications of various concepts and principles in each topic so that students are able to appreciate learning of these concepts and principles.**

**Laboratory experiments have been set up keeping consistency with the theory so that the students can understand the applications of the laws and principles of physics.**

## 2. LIST OF COMPETENCIES

The course content should be taught and implemented with the aim to develop different types of skills leading to the achievement of the following competencies.....

### i. Apply principles and concepts of Physics for solving various Engineering Problems

## 3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
3	0	2	5	70	30	20	30	

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

## 4. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes	Topics and Sub-topics
<b>Unit – I</b>	1.1 Explain Physical Quantities and their units. 1.2 Measure given dimensions by using appropriate instruments accurately. 1.3 Calculate error in the measurement 1.4 Solve numerical based on above outcomes	<b><u>SI Units &amp; Measurements</u></b> 1.1 Need of measurement and unit in engineering and science, definition of unit , requirements of standard unit, systems of units-CGS,MKS and SI, fundamental and derived quantities and their units 1.2 Least count and range of instrument, least count of vernier caliper, micrometer screw gauge 1.3 Definition of accuracy, precision and error, estimation of errors -absolute error, relative error and percentage error, rules and identification of significant figures. (Numerical on above topics)
<b>Unit– II</b>	2.1 List Newton’s laws of motion 2.2 Differentiate among various forces in nature 2.3 Define inertia, momentum and impulse of force 2.4 State Newton’s laws of motion 2.5 State law of conservation of momentum 2.6 Solve numerical problems based on above topics	<b><u>Force and Motion:</u></b> Recapitulation of equations of motion, Newton’s Ist law of motion, Force, basic forces in motion, gravitational force, electrostatic force, electromagnetic force, nuclear force, Inertia, types of inertia (inertia of rest, inertia of motion, inertia of direction ), Momentum, Newton’s IInd law of motion, measurement of force using second law, simple problems on $F = ma$ and equations of motion, Impulse of force, Impulse as the product of force and time, impulse as the difference of momentum, examples of impulse, simple problems on impulse, Newtons IIIrd law of motion and its examples. Law of conservation of momentum, Statement, simple problems  (Numerical on above topics)
<b>Unit– III</b>	3.1 Comprehend the concept of elasticity and Define Stress, Strain and Elastic limit.	<b><u>General properties of matter</u></b> <b>3.1 Elasticity</b> Deforming force, restoring force, elastic and plastic

Unit	Major Learning Outcomes	Topics and Sub-topics
	3.2 State Hooke's law. 3.3 Explain the term elastic fatigue. 3.4 Distinguish between Streamline and Turbulent flow 3.5 Define coefficient of viscosity. 3.6 Apply the principle of viscosity in solving problems. 3.7 State significance of Reynold's number 3.8 Explain terminal velocity. 3.9 Mention Stoke's formula. 3.10 Explain the effect of temperature on viscosity 3.11 Comprehend the phenomenon of surface tension and its applications. 3.12 Define surface tension. 3.13 Explain angle of contact and capillarity. 3.14 Solve problems related to surface tension.	body, stress and strain with their types. elastic limit, Hooke's law, Young's modulus, bulk modulus, modulus of rigidity and relation between them (no derivation), stress strain diagram. behavior of wire under continuously increasing load, yield point, ultimate stress, breaking stress, factor of safety. <b>3.2 Surface Tension.</b> Molecular force, cohesive and adhesive force, Molecular range, sphere of influence, Laplace's molecular theory, Definition of surface tension and its S.I. unit, angle of contact, capillary action with examples, shape of meniscus for water and mercury, relation between surface tension, capillary rise and radius of capillary (no derivation), effect of impurity and temperature on surface tension <b>3.3 Viscosity</b> Fluid friction, viscous force, Definition of viscosity, velocity gradient, Newton's law of viscosity, coefficient of viscosity and its S.I. unit, streamline and turbulent flow with examples, critical velocity, Reynolds's number and its significance, free fall of spherical body through viscous medium (no derivation), up thrust force, terminal velocity, Stokes law (statement and formula). (Numericals on Above topics)
<b>Unit- IV</b>	4.1 Distinguish between Heat and Temperature. 4.2 Explain modes of Transmission of heat and their applications. 4.3 Define heat capacity and specific heat of substances. 4.4 Explain temperature 4.5 List various temperature scales and convert among temperatures	<b>Heat Transfer</b> 4.1 Three modes of transmission of heat -conduction, convection and radiation, good and bad conductor of heat with examples, law of thermal conductivity, coefficient of thermal conductivity and its S.I. unit.  4.2 Heat capacity and specific heat of materials 4.3 Celsius, Fahrenheit and Kelvin temperature scales and their conversion formulae  (Numericals on above topics)
<b>Unit- V</b>	5.1 Comprehend the concept of wave motion 5.2 Distinguish between transverse and longitudinal waves. 5.3 Define period, frequency, amplitude and wavelength 5.4 Explain principle of superposition of waves 5.5 Define resonance 5.6 Explain resonance. 5.7 State Formula for velocity of sound in air 5.8 Comprehend the Importance of Reverberation 5.9 State Sabine's formula and Factors affecting Reverberation time 5.10 Explain ultrasonic waves. Mention applications of	<b>Waves and Sound</b> Definition of wave motion, amplitude, period, frequency, and wavelength, relation between velocity, frequency and wavelength, longitudinal and transverse wave, principle of superposition of waves, definition of resonance with examples, Formula for velocity of sound in air and various factors affecting it <b>Ultrasonic Waves</b> Definition, Properties of ultrasonic waves Uses of ultrasonic waves. <b>Acoustics Of Building</b> Importance of Reverberation, Reverberation time, Optimum time of Reverberation, Coefficient of absorption of Sound, Sabine's formula for Reverberation time, Factors affecting Reverberation time and acoustics of building.  (Numericals on above topics)

Unit	Major Learning Outcomes	Topics and Sub-topics
	ultrasonic waves	
<b>Unit– VI</b>	6.1 State Properties Of Light 6.2 Define various phenomena of light 6.3 State Snell’s law of refraction. 6.4 Explain importance and list applications of nanotechnology in engineering field	<b><u>Light and Nanotechnology</u></b> Properties Of Light, Electromagnetic spectrum, Reflection, refraction, snell’s law, diffraction, polarization, interference of light, constructive and destructive interference (Only definitions), physical significance of refractive index, dispersion of light  Introduction to Nanotechnology (Numericals on above topics)
<b>Unit – VII</b>	7.1 Define radio activity 7.2 Distinguish between Natural & Artificial radioactivity 7.3 State relation between Half Life, Average Life & Decay Constant. 7.4 Describe properties of Alpha, Beta and Gamma rays.	<b><u>Radioactivity</u></b> <b>7.1 Radioactivity</b> Definition, Natural & Artificial radioactivity, Units and Laws of Radioactivity, Half Life, Average Life & Decay Constant. <b>7.2 Radioactive Rays</b> Properties and uses of alpha particles, beta particles and gamma rays (Numericals on Above topics)

## 5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total
1.	SI Units & Measurements	05	03	02	05	10
2.	Force and Motion	05	02	02	04	08
3.	General Properties of Matter	10	04	06	08	18
4.	Heat Transfer	04	02	02	02	06
5.	Waves and sound	07	04	04	04	12
6.	Light and Nanotechnology	07	03	03	04	10
7.	Radioactivity	04	02	02	02	06
	<b>Total</b>	<b>42</b>	<b>20</b>	<b>21</b>	<b>29</b>	<b>70</b>

### Legends:

R = Remembrance; U = Understanding; A = Application and above levels (Revised Bloom’s taxonomy)

## 6. SUGGESTED LIST OF EXERCISES/PRACTICAL/EXPERIMENTS

The exercises/practical/experiments should be properly designed and implemented with an attempt to develop different types of skills leading to the achievement of the competency. Following is the list of exercises/practical/experiments for guidance.

S. No.	Unit No.	Experiment /Practical Exercises
1	1	Linear Measurement by Vernier calipers
2	1	Linear Measurement by Micrometer screw
3	3	Measurement of Surface tension
4	3	Measurement of Viscosity
5	3	Measurement of Young's Modulus
6	3	To determine Force constant with the help of periodic time of oscillations of spring
7	3	Measurement of specific gravity
8	6	To calculate refractive index of material of prism using spectrometer device.
9	4	Joule's mechanical equivalent of heat
10	4	Measurement of co-efficient of thermal conductivity
11	5	To study the relation between the length of a stretched string and the tension in it with the help of a sonometer.
12	6	To calculate SA/V ratio of simple objects to understand nanotechnology

Minimum 8 experiments/practical exercises should be performed from the above list

- Hours distribution for Physics Experiments :

Sr. No.	Description	Hours
1	An introduction to Physics laboratory and its experiments (for the set of first four experiments)	02
2	Set of first four experiments	08
3	An introduction to experiments (for the set of next four experiments)	02
4	Set of next four experiments	08
5	Mini project	06
6	Viva and Submission	02

## 7. SUGGESTED LIST OF PROPOSED STUDENT ACTIVITIES

Following is the list of proposed student activities like:

Laboratory based mini projects:

1. To calculate acoustics of given class room
2. To prepare models of Vernier calipers, micrometer screw gauge and travelling microscope

And many more Teacher guided self learning activities:

1. To prepare a chart of applications of nanotechnology in engineering field
2. To prepare models to explain different concepts

And many more Course/topic based seminars:

1. Seminar by student on any relevant topic

## 8. SUGGESTED LEARNING RESOURCES

### A. List of Books

Sr No.	Author	Title of Books	Publication
1	Sears And Zemansky	University Physics	Pearson Publication
2	Paul G Hewitt	Conceptual Physics	Pearson Publication
3	Halliday & Resnick	Physics	Wiley India
4	G Vijayakumari	Engineering Physics, 4e	Vikas-Gtu Students' Series
5	Arvind Kumar & Shrish Barve	How And Why In Basic Mechanics	Universities Press
6	Ncert	Physics Part 1 And 2	Ncert
7	Giancoli	Physics For Scientists And Engineers	
8	H C Verma	Concepts Of Physics	
9	Gomber & Gogia	Fundamentals Of Physics	Pradeep Publications, Jalandhar

### B. List of Major Equipment/ Instrument

- 1.Redwood's Viscometer
- 2.Digital Vernier Calipers And . Digital Micrometer Screw Guage
- 3.Digital Travelling Microscope
- 4.Joule's Calorimeter
- 5.Searle's Thermal Conductivity Apparatus
- 6.Visible Light Spectrometer

### C. List of Software/Learning Websites

1. [www.physicsclassroom.com](http://www.physicsclassroom.com)
2. [www.physics.org](http://www.physics.org)
3. [www.fearofphysics.com](http://www.fearofphysics.com)
4. [www.sciencejoywagon.com/physicszone](http://www.sciencejoywagon.com/physicszone)
5. [www.science.howstuffworks.com](http://www.science.howstuffworks.com)

## 9. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### Faculty Members from Polytechnics

- Dr. S. B. Chhag**, Lecturer in Physics, Science Deptt, Govt. Polytechnic, Rajkot
- Ku. B. K. Faldu**, Lecturer in Physics, Science Deptt, Govt. Polytechnic, Ahmedabad
- Shri D. V. Mehta**, Lecturer in Physics, Science Deptt, RCTI, Ahmedabad
- Shri S. B. Singhania**, Lecturer in Physics, Science Deptt, Govt. Polytechnic, Ahmedabad
- Dr. U. N. Trivedi**, Lecturer in Physics, Science Deptt, RCTI, Ahmedabad

### Coordinator and Faculty Members From NITTTR Bhopal

- Dr. P. K. Purohit**, Professor, Department of Applied Science, NITTTR, Bhopal

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**  
**COURSE CURRICULUM**

Course Title: Basics Engineering Drawing  
(Code: 3300007)

<b>Diploma Programmes in which this course is offered</b>	<b>Semester in which offered</b>
Automobile Engineering, Ceramic Engineering, Civil Engineering, Environment Engineering, Mechanical Engineering, Mechatronics Engineering, Metallurgy Engineering, Mining Engineering, Printing Technology, Textile Manufacturing Technology, Textile Processing, Transportation Engineering	<b>First Semester</b>
Chemical Engineering, Electrical Engineering, Fabrication Technology, Plastic Engineering	<b>Second Semester</b>

## 1 RATIONALE:

Engineering drawing is an effective language of engineers. It is the foundation block which strengthens the engineering & technological structure. Moreover, it is the transmitting link between ideas and realization. It is an attempt to develop fundamental understanding and application of engineering drawing. It covers knowledge & application of drawing instruments & also familiarizes the learner about Bureau of Indian standards. The curriculum aims at developing the ability to draw and read various drawings, curves & projections.

The subject mainly focuses on use of drawing instruments, developing imagination and translating ideas. Developing the sense of drawing sequence and use of drawing instruments effectively yields not only with productive preparation of computer aided graphics but also yields with effective industrial applications ranging from marking to performance of operations.

## 2 LIST OF COMPETENCIES:

The course content should be taught and implemented with the aim to develop different types of skills leading to the achievement of the following competencies:

- i. Prepare engineering drawings manually with given geometrical dimensions using prevailing drawing standards and drafting instruments. .**
- ii. Visualize the shape of simple object from orthographic views and vice versa.**



### 3. TEACHING AND EXAMINATION SCHEME:

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	
2	0	4	6	70	30	40	60	<b>200</b>

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

### 4. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes	Sub-topics
<b>Unit – 1</b> <b>ENGINEERING DRAWING AIDS</b>	1.1 Use drawing equipments, instruments and materials effectively.	1.1 Drawing equipments, instruments and materials. (a) Equipments-types, specifications, method to use them, applications. (b) Instruments-types, specifications, methods to use them and applications. (c) Pencils-grades, applications, types of points and applications. (d) Other materials-types and applications.
<b>Unit– 2</b> <b>PLANNING, LAYOUT AND SCALLING OF DRAWING</b>	2.1 Follow and apply standard practice as per bureau of I.S. for planning and layout 2.2 Choose appropriate scale factor for the drawing as per given situation	2.1 I.S. codes for planning and layout. 2.2 Scaling technique used in drawing.
<b>Unit– 3</b> <b>LINES, LETTERING AND DIMENSIONING</b>	3.1 Write annotations on a drawing where ever necessary. 3.2 Choose appropriate line and dimensioning style for a given geometrical entity.	3.1 Different types of lines. 3.2 Vertical capital and lower case letters. 3.3 Inclined capital and lower case letters. 3.4 Numerals and Greek alphabets. 3.5 Dimensioning methods. (a) Aligned method. (b) Unilateral with chain, parallel, progressive and combined dimensioning.

Unit	Major Learning Outcomes	Sub-topics
<b>Unit- 4</b>  <b>GEOMETRIC CONSTRUCTION</b>	4.1 Develop the ability to draw polygons, circles and lines with different geometric conditions.	4.2 Geometric construction related with line like bisecting a line, to draw perpendicular with a given line, divide a line, etc. 4.3 Geometric construction related with angle like bisect an angle, trisect an angle, etc. 4.4 To construct polygon. a: Triangle b: Square / Rectangle. c: Pentagon with special method. d: Hexagon with special method. 4.5 To draw tangents. 4.6 Geometric construction related with circle & arc.
<b>Unit-5</b>  <b>ENGINEERING CURVES</b>	5.1 Able to draw engineering curves with proficiency and speed as per given dimensions.	5.2 Conic sections. (a) Concept and understanding of focus, directrix, vertex and eccentricity and drawing of conic sections. (b) Using various methods, understand construction of : i. Ellipse. ii. Parabola. iii. Hyperbola. 5.3 Cycloidal Curves(Cycloid, Epicycloid, Hypocycloid) 5.4 Involutés. (a) Involutés of a circle (b) Involutés of a polygon 5.5 Spiral (Archimedean spiral only).
<b>Unit- 6</b>  <b>PROJECTION OF POINTS, LINES AND PLANES</b>	6.1 Draw the projection of points, lines and planes with different conditions. 6.2 Find out true shape and size of a inclined line or plane	6.1 Reference planes, orthographic projections. 6.2 Concept of quadrant. 6.3 1 <sup>st</sup> angle and 3 <sup>rd</sup> angle projection and their symbols. 6.4 Projection of points. 6.5 Projection of lines – determination of true length and inclinations for following cases. (a) Line parallel to one or both the plane. (b) Line perpendicular to one of the plane. (c) Line inclined to one plane and parallel to another. (d) Line inclined to both the planes. 6.6 Projection of Planes. (a) Types of planes. (b) Projection of planes parallel to one of the reference planes. (c) Projection of plane inclined to one reference plane and perpendicular to another. (d) Projection of planes inclined to both reference planes.  Note : Triangle, Square / rectangle, pentagon, hexagon and circle shape should be included in various plane problems.

Unit	Major Learning Outcomes	Sub-topics
<b>Unit- 7</b> <b>ORTHOGRAPHIC PROJECTIONS</b>	7.1 Draw the orthographic views of object containing lines, circles and arc geometry. 7.2 Interpret given orthographic views and to imagine the actual shape of the component.	7.1 Types of projections-orthographic, perspective, isometric and oblique: concept and applications. 7.2 Various term associated with orthographic projections. (a) Theory of projection. (b) Methods of projection. (c) Orthographic projection. (d) Planes of projection.  7.3 Conversion of simple pictorial views into Orthographic views. Illustrative problems on orthographic projection. 7.4 B.I.S. code of practice.  Note : (1) Problem should be restricted up to four views- Front view/Elevation, Top view/Plan and Side views only. (2) Use First Angle Method only.
<b>Unit- 8</b> <b>ISOMETRIC PROJECTIONS</b>	8.1 Draw the isometric view from orthographic views of object/s containing lines, circles and arcs.	8.2 Isometric axis, lines and planes. 8.3 Isometric scales. 8.4 Isometric view and isometric drawing. 8.5 Difference between isometric projection and isometric drawing. 8.6 Illustrative problems limited to objects containing lines, circles and arcs shape only.

## 5. SPECIFICATION TABLE WITH HOURS & MARKS (THEORY):

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total
1.	Engineering drawing aids.	0	00	00	02	02
2.	Planning, layout and scaling of drawing.	0	02	00	03	05
3.	Lines, lettering and dimensioning.	0	00	02	00	02
4.	Geometric construction.	3	00	03	07	10
5.	Engineering curves.	6	02	00	10	12
6.	Projection of points, lines and planes.	8	03	00	14	17
7.	Orthographic projections.	6	00	00	12	12
8.	Isometric projections.	5	00	02	08	10
	Total	<b>28</b>	<b>07</b>	<b>07</b>	<b>56</b>	<b>70</b>

### Legends:

R = Remembrance; U = Understanding; A = Application and above levels.

**NOTES:**

**a:** If midsem test is part of continuous evaluation, unit number 4, 5 and 6 (For Unit 6, except projections of planes) are to be considered.

**b:** Ask the questions from each topic as per weightage of marks. Choice of questions must be given from the same topic.

**6. SUGGESTED LIST OF EXERCISES/PRACTICAL/EXPERIMENTS**

The exercises/practical/experiments should be properly designed and implemented with an attempt to develop different types of skills leading to the achievement of the competency. Following is the list of exercises/practical/experiments for guidance.

Ex. No.	Unit No.	Practical Exercises	Hours
1	1,2,3	<p><b>USE OF DRAWING INSTRUMENTS:</b></p> <p>1. Teacher will demonstrate-</p> <p style="padding-left: 20px;">a: Use of drawing instruments.</p> <p style="padding-left: 20px;">b: Planning and layout as per IS.</p> <p style="padding-left: 20px;">c: Scaling technique.</p> <p>2. Draw following.</p> <p>Problem – 1 Drawing horizontal, vertical, 30 degree, 45 degree, 60 &amp; 75 degrees lines using Tee and Set squares/ drafter.</p> <p>Problem – 2 Types of lines.</p> <p>Problem – 3 Types of dimensioning.</p> <p>Problem – 4 Alphabets &amp; numerical ( Vertical &amp; inclined as Per I.S.).</p>	14
2	4	<p><b>GEOMETRIC CONSTRUCTION:</b></p> <p>Drawing of set of lines with different conditions. (Two problems)</p> <p>Drawing Polygons. (Three Problems)</p> <p>Drawing circles and arcs with different geometric conditions and with line constraints. (Three problems)</p>	06
3	5	<p><b>ENGINEERING CURVES – I:</b></p> <p>Problem –1: Construction of ellipse using any two methods from arc of circle method, four centre method, rectangular method, eccentricity method and concentric circle method.</p> <p>Problem –2: Construction of parabola with any one method from rectangular method, tangent method and eccentricity method.</p> <p>Problem –3: Construction of hyperbola with any one method from eccentricity method and rectangular method.</p> <p>Problem –4: Construction of spiral. (Refer note c for dimensions).</p>	04
4	5	<p><b>ENGINEERING CURVES – II:</b></p> <p>Problem – 1: Construction of cycloid.</p> <p>Problem – 2: Construction of hypocycloid &amp; epicycloids.</p> <p>Problem – 3: Construction of involute (circle).</p>	04

		Problem – 4: Construction of involute (polygon). (Refer note c for dimensions).	
5	6	<b>PROJECTIONS OF POINTS AND LINES:</b> Draw projection of points-For 10 various conditions.(One problem) Draw projection of lines with different conditions. (Four problems) (Refer note c for dimensions).	06
6	6	<b>PROJECTIONS OF PLANE:</b> Draw projection of different planes with different conditions. (triangle, square / rectangular, pentagonal / hexagonal, and circular -one for each). (Four problems) (Refer note c for dimensions).	04
7	7	<b>ORTHOGRAPHIC PROJECTIONS:</b> Draw Orthographic projections of different objects. (Two problems) (Draw four views of each object). (Refer note c for dimensions).	08
8	8	<b>ISOMETRIC DRAWINGS:</b> Draw isometric drawings from given orthographic views (Three problems) (Refer note c for dimensions).	10
9	All	<b>PROBLEM BASED LEARNING:</b> Given the orthographic views of at least three objects with few missing lines, the student will try to imagine the corresponding objects, complete the views and draw these views in sketch book.	-
10	All	<b>SCHOOL WITHIN SCHOOL:</b> <ul style="list-style-type: none"> <li>• Explain at least one problem for construction and method of drawing in sheet to all batch colleagues. Teacher will assign the problem of particular sheet to be explained to each batch student.</li> <li>• Each student will assess at least one sheet of other students (May be a group of 5-6 students identified by teacher can be taken) and will note down the mistakes committed by them. Student will also guide the students for correcting the mistakes, if any.</li> </ul>	-

**Notes :-**

- a: **Use both sides of sheet. For example, draw sheet number 2 on back side of sheet number 1, 4 on back of 3, and likewise.**
- b: Theory & practice should be in first angle projections and IS codes should be followed wherever applicable.
- c: The dimensions of line, axes, distances, angle, side of polygon, diameter, etc. must be varied for each student in batch so that each student will have same problems, but with different dimensions.
- d: The sketchbook has to contain data of all problems, solutions of all problems and student activities performed. Students' activities are compulsory to be performed.

- e: A hand out containing applicable standards from IS codes including title block as per IS standard should be given to each student by concerned teacher.
- f: For 40 marks Practical Marks ESE, students are to be assessed for competencies achieved. Students are to be given data for practical ESE to prepare drawings.

## 7. LIST OF STUDENT ACTIVITIES:

Following is the list of student activities to be performed by each student individually:

Activity No.	Details of student activity
1	Sketch the combinations of set squares to draw angles in step of $15^{\circ}$ . ( $15^{\circ}$ , $30^{\circ}$ , $45^{\circ}$ , $60^{\circ}$ , $75^{\circ}$ , $90^{\circ}$ , $105^{\circ}$ , $120^{\circ}$ , $135^{\circ}$ , $150^{\circ}$ , $165^{\circ}$ , $180^{\circ}$ ).
2	Solve all problems for all sheets number 1 to 8 in sketch book (with dimensions).
3	List the shapes you are observing around you in real life with place/item. (For ellipse, parabola and hyperbola).
4	Take two simple objects. Sketch isometric of them. Also draw orthographic projections of them (all views).
5	Take one circular shape. Assume one point on circumference and mark it. Roll that shape on flat and circular surface. Observe the path of point.
6	List at least two questions individually which you would like to ask for followings: a: Ellipse. b: Involute of circle. c: Perspective projections. d: Use of geometric constructions. e: Quadrants.

## 8. SUGGESTED LEARNING RESOURCES:

### A. List of Books

Sr.No	Title of Books	Author	Publication
1	Elements of Engineering Drawing.	N.D. Bhatt	Charotar Publishing House, Anand.
2	Engineering Drawing.	P.J.Shah	S.Chand, New Delhi.
3	Fundamentals of Engineering Drawing.	W.J.Luzzadar	Prentice-hall of India Pvt. Ltd.-New Delhi
4	Fundamentals of Drawing.	K.R.Gopalkrishna	Subhash Publications, Bangalore.
5	Engineering Drawing	M.B.Shah, B.C.Rana	Pearsons.
6	Machine Drawing.	V. Laxminarayan & M.L.Mathur	Jain Brother, New Delhi.
7	Fundamentals of Engineering Drawing.	French & Vierck	McGraw-Hill

### B. List of Major Equipments/ Instruments :

- Models- full and cut.
- Set of various industrial drawings being used by industries-up dated.
- Drawing equipments and instruments for class room teaching-large size.
- Drawing board-half imperial size.
- T-square or drafter (Drafting Machine).

- Set squares ( $45^0$  and  $30^0-60^0$ )
- Protector.
- Drawing instrument box (containing set of compasses and dividers).
- Drawing sheets.
- Drawing pencils.
- Eraser.
- Drawing pins / clips.
- Roller scale

### C. List of Software/Learning Websites:

- [rgpv-ed.blogspot.com/2009/02/engineering-curves.html](http://rgpv-ed.blogspot.com/2009/02/engineering-curves.html)
- <http://www.slideshare.net/sahilsahil992/conic-section-1819818>
- <http://www.technologystudent.com/designpro/drawdex.htm>
- [http://www.engineeringdrawing.org/engg\\_curves/problem-3-8-engineering-curves/490/](http://www.engineeringdrawing.org/engg_curves/problem-3-8-engineering-curves/490/)
- <http://web.iitd.ac.in/~hirani/mel110-part3.pdf>
- <http://www.studyvilla.com/ed.aspx>
- [http://www.youtube.com/watch?v=a703\\_xNeDao](http://www.youtube.com/watch?v=a703_xNeDao)
- [http://www.youtube.com/watch?v=TCxTP\\_8ggNc](http://www.youtube.com/watch?v=TCxTP_8ggNc)
- <http://www.youtube.com/watch?v=JpgFPZILTu8&feature=related>
- <http://www.youtube.com/watch?v=o1YPja2wCYQ&feature=related>
- <http://www.youtube.com/watch?v=dJyKV3Ay7vM&feature=fvwrel>
- E-learning package from KOROS.
- E-learning package from Cognifront.
- CD with book-Engineering drawing, M.B. Shah-B.S. Rana (Pearson).
- Computer based learning material published by KOROS.

## 9. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### Faculty Members from Polytechnics

- **Prof.K. H. Patel**, Head Dept.of Mech., Engg., Dr. S. & S. Gandhi College of Engineering and Technology, Surat,
- **Shri.H. R. Sapramer**, Lecturer in Mech. Engineering, Dr. J.N.Mehta Government Polytechnic, Amreli.
- **Prof.A.M. Talsaniya**, Lecturer in Mech. Engineering, Sir Bhavsinhji Polytechnic Institute, Bhavnagar.

### Co-ordinator and Faculty Member from NITTTR Bhopal

- **Prof. Sharad Pradhan**, Associate Professor, Dept. of Mech. Engg., NITTTR, Bhopal.

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**  
**COURSE CURRICULUM**

Course Title: Engineering Workshop Practice  
(Code: 3301901)

Diploma Programmes in which this course is offered	Semester in which offered
Automobile Engineering, Mechanical Engineering, Mechatronics Engineering, Metallurgy Engineering	<b>First Semester</b>
Ceramic Engineering, Fabrication Technology, Mining Engineering, Printing Technology, Textile Manufacturing Technology, Textile Processing Technology	<b>Second Semester</b>

### 1. RATIONALE

Workshop practice is the backbone of the real industrial environment which helps to develop and enhance relevant technical hand skills required by the technician working in the various engineering industries and workshops. This course intends to impart basic know-how of various hand tools and their use in different sections of manufacturing. Irrespective of branch, the use of workshop practices in day to day industrial as well domestic life helps to dissolve the problems.

The workshop experiences would help to build the understanding of the complexity of the industrial job, along with time and skills requirements of the job. Workshop curricula build the hands on experiences which would help to learn manufacturing processes and production technology courses in successive semesters. Workshop practice is also important since only practice can make the man perfect.

The students are advised to undergo each skill experience with remembrance, understanding and application with special emphasis on attitude of enquiry to know why and how for the various instructions and practices imparted to them in each shop.

### 2. LIST OF COMPETENCIES

The course content should be taught and implemented with the aim to develop different types of skills leading to the achievement of the following competencies.

- i. **Prepare simple jobs in fitting, carpentry, pipefitting and metal joining shop while following safe working and good housekeeping practices.**

### 3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	100
0	0	4	4	0	0	40	60	

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



#### 4. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes	Topics and Sub-topics
<b>UNIT – 1</b> <b>INTRODUCTION TO WORKSHOP</b>	1.1 Sketch general workshop layout. 1.2 Follow preliminary safety rules in workshop.	1.1 Workshop layout. 1.2 Importance of various sections/shops of workshop. 1.3 Types of jobs done in each shop. 1.4 General safety rules and work procedure in workshop.
<b>UNIT – 2</b> <b>FITTING</b>	2.1 Select appropriate fitting tools for the required application. 2.2 Prepare the simple jobs as per specification using fitting tools.	2.1 Sketch, specification and applications of fitting work holding tools-bench vise, V-block with clamp and C-clamp. 2.2 Sketch, specification, material, applications and methods of using fitting marking and measuring tools-marking table, surface plate, angle plate, universal scribing block, try-square, scriber, divider, centre punch, letter punch, calipers, vernier caliper, etc. 2.3 Types, sketch, specification, material, applications and methods of using of fitting cutting tools-hacksaw, chisels, twist drill, taps, files, dies. 2.4 Types, sketch, specification, material, applications and methods of using of fitting finishing tools-files, reamers. 2.5 Sketch, specification and applications of miscellaneous tools-hammer, spanners, screw drivers sliding screw wrench. 2.6 Demonstration of various fitting operations such as chipping, filing, scraping, grinding, sawing, marking, drilling, tapping. 2.7 Preparation of simple and male- female joints. 2.8 Safety precautions.  <i>Note: See List of Major Equipments/ Instruments at serial no. 8B.</i>
<b>UNIT – 3</b> <b>TIN SMITHY</b>	3.1 Select appropriate tin smithy tool for the required application. 3.2 Prepare the simple job as per specification using tin smithy tools.	3.1 Concept and conversions of SWG and other gauges in use.. 3.2 Use of wire gauge. 3.3 Types of sheet metal joints and applications. 3.4 Types, sketch, specification, material, applications and methods of using tin smithy tools-hammers, stakes, scissors/snips, etc. 3.5 Demonstration of various tin smithy tools and sheet metal operations such as shearing, bending and joining. 3.6 Preparation of tin smithy job. 3.7 Safety precautions.  <i>Note: See List of Major Equipments/ Instruments at serial no. 8B.</i>

<b>UNIT – 4</b>  <b>CARPENTRY</b>	4.1 Select appropriate carpentry tool for the required application. 4.2 Prepare the simple job as per specification using carpentry tools.	4.1 Types, sketch, specification, material, applications and methods of using of carpentry tools-saws, planner, chisels, hammers, pallet, marking gauge, vice, try square, rule, etc. 4.2 Types of woods and their applications. 4.3 Types of carpentry hardwares and their uses. 4.4 Demonstration of carpentry operations such as marking, sawing, planning, chiseling, grooving, boring, joining, etc. 4.5 Preparation of wooden joints. 4.6 Safety precautions.  <i>Note: See List of Major Equipments/ Instruments at serial no. 8B.</i>
<b>UNIT – 5</b>  <b>PIPE FITTING</b>	5.1 Select appropriate pipe fitting tool for the required application. 5.2 Prepare the simple job as per specification using pipe fitting tools.	5.1 Types, specification, material and applications of pipes. 5.2 Types, specification, material and applications of pipe fittings. 5.3 Types, specifications, material, applications and demonstration of pipe fitting tools. 5.4 Demonstration of pipe fitting operations such as marking, cutting, bending, threading, assembling, dismantling, etc. 5.5 Types and application of various spanners such as flat, fix, ring, box, adjustable, etc. 5.6 Preparation of pipe fitting jobs. 5.7 Safety precautions.  <i>Note: See List of Major Equipments/ Instruments at serial no. 8B.</i>
<b>UNIT – 6</b>  <b>METAL JOINING</b>	6.1 Select appropriate equipment and consumables for required application. 6.2 Prepare the simple jobs as per specification using proper metal joining and cutting method.	6.1 Types, specification, material and applications of arc welding transformers. 6.2 Types, specification, material and applications of arc welding accessories and consumables. 6.3 Demonstration of metal joining operations- arc welding, soldering and brazing. Show effect of current and speed. Also demonstrate various welding positions. 6.4 Demonstrate gas cutting operation. 6.5 Preparation of metal joints. 6.6 Safety precautions.  <i>Note: See List of Major Equipments/ Instruments at serial no. 8B.</i>

## 6. SUGGESTED LIST OF EXERCISES/PRACTICAL/EXPERIMENTS

The exercises/practical/experiments should be properly designed and implemented with an attempt to develop different types of skills leading to the achievement of the competency. Following is the list of exercises/practical/experiments for guidance.

S. No.	Unit No.	Practical Exercises	HOURS
1	I	Prepare carpentry and fitting shop layout.	02
2	II	Demonstrate use of different fitting tools –like work holding, marking, measuring, cutting, finishing and miscellaneous. Student will also prepare the report with sketch, specifications and applications of fitting tools demonstrated.	04
3	II	Prepare one simple and another male-female type fitting jobs as per given drawings- 2 jobs.	10
4	III	Demonstrate use of different tin smithy tools. Student will also prepare the report with sketch, specifications and applications of tin smithy tools demonstrated.	02
5	III	Prepare one tin smithy job as per drawing having shearing, bending, joining and riveting.	04
6	IV	Demonstrate use of different carpentry tools. Student will also prepare the report with sketch, specifications and applications of carpentry tools demonstrated.	04
7	IV	Prepare two wooden joints as per given drawings.	08
8	V	Demonstrate use of different pipe fitting tools. Student will also prepare the report with sketch, specifications and applications of pipe fitting tools demonstrated.	02
9	V	Prepare pipe fitting jobs as per drawings-two jobs.	04
10	VI	Demonstrate use of different welding transformers and consumables. Also demonstrate arc welding, gas cutting, soldering and brazing operations. Student will also prepare the report with sketch, specifications and applications of fitting tools demonstrated.	04
11	VI	Prepare jobs using arc welding, gas cutting, spot welding, brazing and soldering process- three jobs.	08
12	I to VI	<b>PROBLEM BASED LEARNING:</b> Group of 6 students will take rejected workpieces in workshop practice (at least two in each fitting, carpentry, tin smithy, pipe fitting and welding). Group will draw the workpieces, will identify type of defects and will discuss the reasons of such defects. Outcome of discussion has to be written in logbook and report.	02
13	I to VI	<b>SCHOOL WITHIN SCHOOL:</b> i: Each student will demonstrate and explain at least one tool (to be assigned by teacher) to all batch colleagues. ii: Each student will share his/her student activities outcome. He/she will also share the experience for the student activities he/she has carried out.	02

### NOTES:

- a: It is compulsory to follow safety norms of workshop.
- b: Workshop log-book is compulsory. Record of activities performed by student in each period is also compulsory and must be duly certified by concerned instructor and teacher in routine log book.
- c: Keep your all tools duly resharpened/ready.

- d: It is compulsory to submit reports, student activities and workshop logbook. Students activities are compulsory to perform.
- e: For 40 marks Practical marks ESE, students are to be examined for competencies achieved. Students are to be asked to prepare job/s.

## 7. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of student activities.

S. No.	STUDENT ACTIVITY
1	Prepare student reports as asked in experiments.
2	Visit the nearer timber merchant. Collect the information on types and appearance of wood being sold by them.
3	Visit the nearer plywood merchant. Collect the information on type and thickness being sold by them.
4	Visit nearer fabricator. Collect the information on welding electrodes, transformers and accessories being used by them.
5	Down load movies showing correct practices for fitting, carpentry and welding.
6	List at least two questions for each of following. Material of centre punch. Use of rough file. Metal joining by welding and adhesives. Shearing machine. Wooden joints.

## 8. SUGGESTED LEARNING RESOURCES

### A. List of Books:

Sr.No.	Title of Books	Author	Publication
1	Mechanical workshop practice.	K.C. John	PHI.
2	Workshop familiarization.	E.Wilkinson	Pitman engineering craft series.
3	Workshop Technology-I.	Hazra and Chaudhary	Media promoters & Publisher private limited.
4	Workshop Technology-I.	W.A. J. Chapman	Taylor & Francis.
5	Comprehensive Workshop Technology (Manufacturing Processes).	S.K. Garg	Laxmi publications.
6	I.T.B. Handbook.	-	Engineering industry Training Board.
7	Workshop practice manual.	K.Venkata Reddy	B.S.Publications.

### B. List of Major Equipments/ Instruments

#### FITTING:

- (i): Bench vices 50/100/150 mm.
- (ii): Hand vice, Machine vice
- (iii): Marking table.
- (iv): Surface plate.
- (v): Angle plate.
- (vi): Universal scribing block.
- (vii): Scriber.
- (viii): Marking gauge.
- (ix): Fitting tables.

- (x): Tri square.
- (xi): Right angle.
- (xii): Combination set.
- (xiii): V block with clamps.
- (xiv): C clamps.
- (xv): Set of needle files.
- (xvi): Ball pane Hammer - 750 Gms.
- (xvii): Pair of outside spring caliper- 250 mm.
- (xviii): Pair of Inside spring caliper 150 mm.
- (xix): Vernier caliper.
- (xx): Micrometer outside & inside
- (xxi): Bevel protractor
- (xxii): Odd leg caliper
- (xxiii): Files (smooth & rough)-round, flat, safe edge, square, knife edge, triangular, half round.
- (xxiv): One pair of divider.
- (xxv): Hacksaw frame with blade 12" \* 300 mm.
- (xxvi): Centre punch.
- (xxvii): Dot punch.
- (xxviii): Prick punch.
- (xxix): Letter punch-Number punch.
- (xxx): Flat chisel 20 mm.
- (xxxi): Set of sorted twist drills, taps and dies (with holders/wrench).
- (xxxii): Set of spanners-Fix, Ring, box, Allen and adjustable.
- (xxxiii): Set of screw drivers-sorted.
- (xxxiv): Scraping tool.
- (xxxv): Set of pliers.
- (xxxvi): Filler and radius gauge

### **TIN SMITHY:**

- (i): Tin cutter.
- (ii): Shearing machine
- (iii): Set of sorted hammers and pallets.
- (iv): Set of stakes.
- (v): Set of sorted scissors/snips.
- (vi): Tin smithy tables.
- (vii): Tin smithy vices.
- (viii): Marking table.
- (ix): Surface plate.
- (x): Angle plate.
- (xi): Marking gauge.
- (xii): Tri square.
- (xiii): Right angle.
- (xiv): Tong
- (xv): Square block
- (xvi): Set of chisels.
- (xvii): Scriber.
- (xviii): Punches-sorted including drift.
- (xix): Rivets-sorted.
- (xx): Sheet bending machine.
- (xxi): Trammels.
- (xxii): Wire gauge.
- (xxiii): Hand groover
- (xxiv): Anvil and swage block
- (xxv): Hollow mandrel
- (xxvi): Flatters and cone
- (xxvii): Set of Gouges
- (xxviii): Teflon sheet
- (xxix): Hollow punch set
- (xxx): Snip cutter round and flat

**CARPENTRY:**

- (i): Carpentry tables.
- (ii): Carpentry vices.
- (iii): Bar cramp.
- (iv): Plane machine-small ("Randha machine").
- (v): Wood and metal Jack planes- 45 mm.
- (vi): Set of sorted wooden jack planes.
- (vii): Smoothing plane.
- (viii): Rebate plane.
- (ix): Cross cut saw.
- (x): Compass saw.
- (xi): Set of sorted saws.
- (xii): Round hole saw
- (xiii): Tenon saw 350 mm.
- (xiv): Set of chisels-Firmer, Dovetail, Paring, Mortise.
- (xv): Adze tool
- (xvi): Auger bit.
- (xvii): Hand drill with set of sorted drill bits.
- (xviii): Gimlet.
- (xix): Small precision brace.
- (xx): Mallet.
- (xxi): Wood rasp file.
- (xxii): Claw hammer.
- (xxiii): Pincer.
- (xxiv): Marking gage 150 mm.
- (xxv): Steel rule 24"
- (xxvi): Measuring Tape 300mm
- (xxvii): C clamps.
- (xxviii): Tri square.
- (xxix): Right angle.
- (xxx): Compass and divider.
- (xxxi): Set of chisels.
- (xxxii): Ball pane Hammer - 750 Gms.
- (xxxiii): Hardwares- nails, screws,etc.
- (xxxiv): Set of screw drivers.
- (xxxv): Wood work punches
- (xxxvi): Set of Gouges

**PIPE FITTING:**

- (i): Various samples of pipe fittings-like joints, elbows, tees, unions, bend, nipples, couplers, reducers, four way etc. of Metal and PVC.
- (ii): Water taps,plug, farule
- (iii): Pipe bending machine manual/hydraulic
- (iv): Pipe vice
- (v): Pipe wrenches.
- (vi): Pipe spanners.
- (vii): Set of spanners-Fix, Ring, box, Allen and adjustable.
- (viii): Set of screw drivers-sorted.
- (ix): Set of chisels.
- (x): Hammers.
- (xi): Teflon taps, cotton thread
- (xii): Set of dies and holders.
- (xiii): Hacksaw, pipe cutter.
- (xiv): Adhesive for PVC pipe fittings.

**METAL JOINING:**

- (i): Arc welding transformers.
- (ii): Spot welding machine with necessary accessories, tools and consumables.
- (iii): Welding cables.
- (iv): Electrodes.
- (v): Electrode holders.
- (vi): Ground clamps.
- (vii): Chipping hammer.
- (viii): Wire brush.
- (ix): Oxygen-acetylene cylinders with pressure regulators-torch-hoses, trolley and accessories.
- (x): Filler rods.
- (xi): Solder filler material.
- (xii): Flux for soldering.
- (xiii): Soldering iron.
- (xiv): Brazing/welding torch.
- (xv): Try Square
- (xvi): Hammers, tongs, chisels and anvil
- (xvii): Screw Wrench
- (xviii): Tip Cleaner
- (xix): Swage block.
- (xx): Personal Protective Equipment like safety gloves, face shield /screen

**C. List of Software/Learning Websites:**

- <http://www.abmtools.com/downloads/Woodworking%20Carpentry%20Tools.pdf>
- <http://www.weldingtechnology.org>
- <http://www.newagepublishers.com/samplechapter/001469.pdf>
- <http://www.youtube.com/watch?v=TeBX6cKKHWY>
- <http://www.youtube.com/watch?v=QHF0sNHnttw&feature=related>
- <http://www.youtube.com/watch?v=Kv1zo9CAxt4&feature=relmfu>
- <http://www.piehtoolco.com>
- <http://sourcing.indiamart.com/engineering/articles/materials-used-hand-tools/>

**9 COURSE CURRICULUM DEVELOPMENT COMMITTEE****Faculty Members from Polytechnics**

- **Prof .K. S. Patel**, Lecturer, in Mechanical Engineering, Government Polytechnic, Himatnagar.
- **Prof. R. M. Rajaguru**, Lecturer in Mechanical Engineering, Government Polytechnic, Rajkot.

**Coordinator and Faculty Member From NITTTR Bhopal**

- **Dr. A.K. Sarathe**, Associate Professor, Dept. of Mechanical Engg., NITTTR, Bhopal.

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**  
**COURSE CURRICULUM**

Course Title: Applied Mechanics  
(Code: 3300008)

Diploma Programmes in which this course is offered	Semester in which offered
Automobile Engineering, Metallurgy Engineering	<b>First Semester</b>
Civil Engineering, Environment Engineering, Fabrication Technology, Mechanical Engineering, Mechatronics Engineering, Mining Engineering, Transportation Engineering	<b>Second Semester</b>

### 1. RATIONALE

Applied mechanics, as its name suggests, bridges the gap between physical theory and its application to technology. As such, applied mechanics is used in many fields of engineering, especially mechanical and Metallurgy Engineering. In this context, it is commonly referred to as engineering mechanics. To impart basic knowledge of Engineering Mechanics where in Laws of Physics are applied to Solve Engineering problems, this programme / course will help the student to develop basic know how & awareness of the various laws of physics & it's real life applications in the various fields of engineering

### 2. LIST OF COMPETENCIES

The course content leading to the achievement of the following competencies;

- i. **Apply the concepts of force, work and energy to calculate work done, power required & efficiency for various simple machines**

### 3. Teaching and Examination Scheme

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
				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.



#### 4. DETAILED COURSE CONTENT

Unit	Major Learning Outcomes	Topics and Sub-topics
<b>Unit – I</b> <b>Introduction</b>	1.1 Define scope of Engineering Mechanics 1.2 Classify Scalar & Vector quantity 1.3 Differentiate the systems of Units	Scalar & Vector Quantities – like force , pressure , velocity , acceleration  Static & Dynamic – Kinetics & Kinematics  MKS , CGS & SI units and its conversion along with FPI and Metric System
<b>Unit– II</b> <b>Coplanar Concurrent Forces</b>	2.1 Understand Co - planer Concurrent Force system 2.2 Compute resultant & Equilibrium forces for given coplanar concurrent force system	<b>Force</b> – units , elements , <b>Laws/Principles</b> of forces such as Principle of Superposition , Principle of transmissibility Composition & Resolution of Forces <b>Resultant &amp; Equilibrium</b> forces conditions of equilibrium <b>Analytical &amp; graphical method</b> for Law of Parallelogram , Law of Triangle , Lami's Theorems , Law of Polygon
<b>Unit– III</b> <b>Coplanar Non-Concurrent Forces</b>	3.1 Differentiate Co-planar , parallel and non - concurrent forces 3.2 Compute resultant & Equilibrium forces for given coplanar concurrent force system 3.3 Calculate Support reactions of the given simply supported beam	<b>Principal of Moment</b> Moment , Couple , , application , properties of couple , conditions of equilibrium <b>types of supports</b> , end conditions – Hinge , free end , roller , fix , <b>types of loads</b> like point load , U.D.L , U.V.L , Couple , <b>Analytical method</b> to Evaluate reactions in statically determinate beam subjected to point load and/ or U.D.L by analytical method of solving Statically determinate beams to
<b>Unit – IV</b> <b>Centroid &amp; Centre of Gravity</b>	4.1 Distinguish between Centroid and Centre of Gravity 4.2 Compute Centroid & centre of gravity in different shape and lamina	<b>First moment of area</b> ; to find Centroid –standard shapes of I , L , Channel & T sections , axis of symmetry <b>First moment of mass</b> ; to find C.G of standard solids sections , Axis of symmetry
<b>Unit – V</b> <b>Friction</b>	5.1 Appreciate Friction and its Engineering applications 5.2 Calculate coefficient of friction for different surfaces	<b>Friction</b> , Laws of Friction , Angle of Friction , Angle of Repose, types of friction <b>Application of Lami's</b> theory and theory of resolution of forces , examples on friction for a block resting on horizontal plane & on inclined plane
<b>Unit – VI</b> <b>Work, Power &amp; Energy</b>	6.1 Establish relation between Work, Power Energy 6.2 Calculate IHP and BHP in different conditions	<b>Work</b> – work done , force displacement diagram , torque , work done by torque <b>Power</b> – I.H.P and B.H.P of engine ,Equation of H.P in terms of Torque and R.P.M , Engineering Problems <b>Energy</b> – Kinetic & Potential energy and Engineering Problems
<b>Unit – VII</b> <b>Simple Machines</b>	7.1 Apply the principle & application of Simple Machines 7.2 Compare reversible & irreversible Machines, evaluate the efficiencies of various simple machines	<b>principles of machines</b> to evaluate Mechanical Advantage , Velocity Ratio of simple machine <b>pulley blocks</b> , Draw Line sketch of different systems of <b>Simple and compound levers</b> ,Problems , Laws of Machines , reversible & non reversible machines

## 5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1.	Introduction	02	04	00	00	04
2.	Coplanar Concurrent Forces	10	02	02	06	12
3.	Coplanar Non-Concurrent Forces	10	02	02	08	12
4.	Centroid and Centre of Gravity	04	02	02	06	10
5.	Friction	06	02	04	06	12
6.	Work, Power & Energy	04	02	02	06	10
7.	Simple Machines	06	02	02	08	12
	Total	42	16	14	40	70

### Legends:

R = Remembrance; U = Understanding; A = Application and above levels (Revised Bloom's taxonomy)

## 6. SUGGESTED LIST OF EXERCISES/PRACTICAL/EXPERIMENTS

The exercises/practical/experiments should be properly designed and implemented with an attempt to develop different types of skills leading to the achievement of the competency. Following is the list of exercises/practical/experiments for guidance.

S. No.	Unit No.	Practical Exercise/Experiment
1	01	----
2	02	Verify and calculate resultant force through Law of Parallelogram, Polygon Law of Forces, Lami's Theorem
3	03	Verify reactions in beam through Graphical & analytical method
4	04	Calculate Centroid of lamina and Centroid of different sections
5	05	Calculate Co efficient of Sliding Friction for different surfaces – Wood, Glass
6	06	----
7	07	Work-out M.A & Efficiency of Simple purchase crab, simple wheel and axle, simple screw jack

## 7. SUGGESTED LIST OF STUDENT ACTIVITIES

7.1 Students will prepare File/journal for the above mentioned Experiments.

7.2 Students may be given few exercises to calculate resultant/equilibrium force of the force system graphically & analytically verify the results. -unit 2

7.3 Student may be asked to collect photographs from internet which is related to field application of various topics.

## 8. SUGGESTED LEARNING ACTIVITIES

### A. List of Books

Sr. No.	Title of Book	Author	Publication
1.	Engineering Mechanics	R S Khurmi	S. Chand , New Delhi
2.	Engineering Mechanics	D S Kumar	S. K. Kataria & Sons,
3.	Engineering Mechanics 7 <sup>th</sup> edition	Bear & Jonstan	New media
4.	Applied Mechanics	H J Shah & Junarkar	CHAROTAR Publication

### B. List of Major Equipment/ Instrument

- 7.4 Apparatus for Law of Parallelogram , Lami's theorem & law of Polygon
- 7.5 Apparatus for determination of coefficient of friction
- 7.6 Apparatus to determine CG of Lamina
- 7.7 Beam apparatus to find reactions
- 7.8 Simple purchase crab , simple wheel and axle , simple screw jack

### C. List of Software/Learning Websites

Video Lectures on Applied Mechanics By Prof.SK. Gupta, Department of Applied Mechanics, IIT Delhi

[www.tut.fi/.../InstituteofAppliedMechanicsandOptimization/TME-51](http://www.tut.fi/.../InstituteofAppliedMechanicsandOptimization/TME-51)

[ocw.mit.edu > ... > Mechanics of Materials](http://ocw.mit.edu > ... > Mechanics of Materials)

[www.me.ust.hk/.../ME106-applied%20mechanics-lecture%201.pdf](http://www.me.ust.hk/.../ME106-applied%20mechanics-lecture%201.pdf)

## 9. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### Faculty Members from Polytechnics

- **Prof. B G RAJGOR** , HOD , Dept of Applied Mechanics, B & B Institute of Technology
- **Prof. J H GABRA** , I/C HOD , Dept of Applied Mechanics, G.P , Godhara

### Co-ordinator and Faculty Members from NITTTR Bhopal

- **Dr. J.P.Tegar**, Professor Dept. of Civil and Environmental Engg, NITTTR, Bhopal.

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**  
**COURSE CURRICULUM**

Course Title: Advance Mathematics (Group-2)  
(Code: 3320003)

Diploma Programmes in which this course is offered	Semester in which offered
Civil Engineering, Ceramic Engineering, Environment Engineering, Mechanical Engineering, Mining Engineering,	Second Semester

### 1. RATIONALE

The course is classified under Advance Mathematics and students are intended to understand the advance concepts and principles of Mathematics such as calculus, coordinate geometry and Statics. This knowledge is required to understand and solve engineering problems.

### 2. COMPETENCIES

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

- Use proper Mathematical tool to understand engineering principles and concepts.
- Apply concepts of calculus or suitable mathematical tool to solve given engineering problems.

### 3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			C	ESE	PA	ESE	PA	
2	2	0	4	70	30	0	0	100

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

**Note:** It is the responsibility of the institute heads that marks for **PA of theory & ESE and PA of practical** for each student are entered online into the GTU Portal at the end of each semester within the dates specified by GTU.

## 4. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes	Topics and Sub-topics
<b>Unit – I Co-ordinate Geometry</b>	<p><b>1a.</b> Find the distance between two points, use Mid-Point formula for quadrilateral</p> <p><b>1b.</b> Find the equation of locus using Distance Formula</p> <p><b>1c.</b> Find the equation of line using the different forms</p> <p><b>1d .</b> Find the equation of circle</p> <p><b>1e.</b> Find Tangent and Normal to the circle</p>	<p><b>1.1Point</b> : Distance Formula, Mid-point, Locus of a point</p> <p><b>1.2Straight Line</b> : Forms of Equation of St Lines : Slope Point Form, Two Point Form, Intercept Form, Parallel and Perpendicular lines</p> <p><b>1.3 Circle</b> : Equation of Circle, Centre and radius form, Tangent and Normal and related problems.</p>
<b>Unit– II Function &amp; Limit</b>	<p><b>2a .</b> Solve the problem using functions</p> <p><b>2b .</b> Solve the problem of function using the concept of Limit</p>	<p><b>2.1 Function</b> Concept and Examples</p> <p><b>2.2 Limit</b> Concept of Limit, Standard Formulae and related Examples.</p>
<b>Unit– III Differentiation &amp; its Applications</b>	<p><b>3a.</b> Differentiate the various function</p> <p><b>3b.</b> Apply the differentiation to Velocity, Acceleration and Maxima &amp; Minima</p>	<p><b>3.1Differentiation:</b> Definition, Rules of, Sum, Product, Quotient of Functions, Chain Rule, Derivative of Implicit functions and Parametric functions, Logarithmic Differentiation. Successive Differentiation up to second order</p> <p><b>3.2 Application:</b> Velocity, Acceleration, Maxima &amp; Minima.</p>
<b>Unit– IV Integration &amp; its application</b>	<p><b>4a .</b> Integrate the various function</p> <p><b>4b .</b> Apply the Integration for finding Area and Volume</p>	<p><b>4.1 Integration:</b> Concept, Integral of Standard Functions, Working Rules of Integration, Integration by Parts, Integration by Substitution Method, Definite Integral and its properties.</p> <p><b>4.2 Application:</b> Area and Volume.</p>
<b>Unit-V Statistics</b>	<p><b>5a .</b> Measure Central Tendency in given data</p> <p><b>5b.</b> Measure Dispersion in given data</p>	<p><b>5.1 Measures of Central Tendency</b> for Ungrouped and Grouped Data : Mean, Median and Mode</p> <p><b>5.2 Measure of Dispersion</b> for Grouped and Ungrouped data : Standard deviation</p>

### 5. 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
I	Co-ordinate Geometry	5	2	8	4	14
II	Function & Limit	4	3	5	4	12
III	Differentiation & its Application	8	4	8	6	18
IV	Integration & its Application	8	4	8	4	16
V	Statistics	3	2	5	3	10
<b>Total</b>		<b>28</b>	<b>15</b>	<b>34</b>	<b>21</b>	<b>70</b>

**Legends:** R = Remember; U= Understand; A= Application and above levels (Bloom's revised taxonomy)

**Note:** 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.

### 6. SUGGESTED LIST OF EXERCISES (During tutorial hours)

The exercises should be properly designed and implemented with an attempt to develop different types of mathematical skills so that students are able to acquire above mentioned competencies.

S. No.	Unit No.	Exercises/Tutorial
1	I	Co-ordinate Geometry, Practice Examples
2	I	Solve engineering problems using coordinate geometry
3	II	Practice Examples of Function & Limit
4	II	Use of Various Method/Techniques.
5	III	Differentiation and Related Examples
6	III	Solve problems related to various methods/techniques of differentiations
7	III	Identify the Engineering Applications from respective branches and solve the problems
8	IV	Integration & Related Examples.
9	IV	Solve problems Related to Various Methods/Techniques of integration
10	IV	Identify the Engineering Applications from respective branches and solve the problems
11	V	Statistics, Practice Examples
12	V	Use Excel and solve the problems

**Note:** The above Tutor sessions are for guideline only. The remaining Tutorial hours are may be used by teachers appropriately for revision and practice.

## 7. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities like: course/topic based seminars, internet based assignments, teacher guided self learning activities, course/library/internet/lab based Mini-Projects etc. These could be individual or group-based. Some of these may be as below:

1. Applications to solve identified Engineering problems and use of Internet.
2. Learn graphical softwares:EXCEL,DPLOT,GRAPH etc.
3. Learn MathCAD to use Mathematical Tools and solve the problems of Calculus.
4. Learn MATLAB and use it to solve the identified problems.

## 8. SUGGESTED LEARNING RESOURCES

### A. List of Books

S.No.	Author	Title of Books	Publication
1	Anthony croft and others	Engineering Mathematics (third edition)	Pearson Education,2012
2	Pandya N R	Advanced Mathematics for Polytechnic	Macmillan Publishers India Ltd.,2012
3	Deshpande S P	Polytechnic Mathematics	Pune Vidyarthi Gruh Prakashan,1984
4	Prakash D S	Polytechnic Mathematics	S Chand,1985

### B. List of Major Equipment/ Instrument

1. Simple Calculator
2. Computer System with Printer, Internet
3. LCD Projector

### C. List of Software/Learning Websites

1. Excel
2. DPlot
3. Graph
4. Math CAD
5. MATLAB

You may use other Software like Mathematica and other Graph Plotting software. Use wikipedia.org, mathworld.wolfram.com Etc...

**9. COURSE CURRICULUM DEVELOPMENT COMMITTEE:****Faculty Members from Polytechnics**

- **Dr. N. R. Pandya**, HOD-General Dept., Govt. Polytechnic, Ahmedabad
- **Dr N A Dani**, Lecturer, Govt. Polytechnic, Junagadh.
- **Prof. (Smt) R L Wadhwa**, Lect Govt Polytechnic, Ahmedabad
- **Prof. H C Suthar**, BPTI, Bhavnagar
- **Prof. P N Joshi**, Govt Polytechnic, Rajkot

**Coordinator and Faculty Member From NITTTR Bhopal**

- **Dr. P. K. Purohit**, Associate Professor, Dept. of Applied Science
- **Dr. Deepak Singh**, , Associate Professor, Dept. of Applied Science



**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**  
**COURSE CURRICULUM**

Course Title: Basic of Civil Engineering  
 (Code: 3320004)

Diploma Programmes in which this course is offered	Semester in which offered
Electrical Engineering ,Mechanical Engineering, Fabrication Technology	Second Semester

**1. RATIONALE:**

A mechanical or electrical technician is expected to look after many activities at work place, which may be interdisciplinary, for example if he/she has to mount a heavy machine, he should be able to supervise the preparation of foundation for it, which requires the knowledge of civil engg. Therefore he/she is supposed to be exposed to very basics of civil engineering. This course mainly encompasses the major and general areas of civil engineering, knowledge of which may be required by mechanical and electrical engineers/technicians.

**2. COMPETENCIES:**

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:

- To supervise the simple civil engineering tasks related to own branch's integrated tasks.

**3. TEACHING AND EXAMINATION SCHEME:**

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE	PA	ESE	PA	
0	1	2	3	0	0	20	30	<b>50</b>

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

**Note:** It is the responsibility of the institute heads that marks for PA of theory & ESE and PA of practical for each student are entered online into the GTU Portal at the end of each semester within the dates specified by GTU.

**4. DETAILED COURSE CONTENTS:**

<b>Unit</b>	<b>Major Learning Outcomes</b>	<b>Topics and Sub-topics</b>
<b>Unit –1</b> <b>CIVIL ENGG.</b> <b>SURVEYING</b>	<p><b>1a.</b> Use surveying tools and equipments for field survey, leveling and measurements</p> <p><b>1b.</b> Calculate different levels and angles</p> <p><b>1c.</b> Understand given contour map</p>	<p>1.1 Surveying &amp; leveling (its importance and types)</p> <p>1.2 Necessity for leveling</p> <p>1.3 Principals of surveying</p> <p>1.4 Instrument/ tools used for survey and level</p> <p>1.5 Various methods of finding the field survey measurements</p> <p>1.6 Chain and Compass Survey</p> <p>1.7 Preparations of contour sheets/ plan using survey data.</p> <p>1.8 Procedure of leveling</p>
<b>Unit – 2</b> <b>CIVIL ENGG.</b> <b>DRAWING</b>	<p><b>2a.</b> Read and Interpret the building drawing</p> <p><b>2b.</b> Plan lay out of a simple building</p>	<p>2.1 Types of building drawings</p> <p>2.2 Abbreviation, conventions &amp; symbols in civil drawing</p> <p>2.3 Building byelaws for planning of residential building and industrial building</p> <p>2.4 Planning of simple residential and industrial building</p>
<b>UNIT –3</b> <b>CONSTRUCTION</b> <b>MATERIALS</b>	<p>3a. Select different types of construction materials as per requirements</p> <p>3b. Test given construction materials for quality control</p> <p>3c. Prepare approximate cost estimates</p>	<p>3.1 Common construction materials such as cement, Brick, Stone, Timber, Steel and Concrete.</p> <p>3.2 Properties of each materials &amp; their acceptable standards</p> <p>3.3 Quality parameters of materials</p> <p>3.4 Estimations and costing for simple structure (only the material cost)</p>
<b>Unit –4</b> <b>MACHINE</b> <b>FOUNDATIONS</b>	<p>4a. Assess the typical requirements of foundations for medium sized electrical and Mechanical Machines.</p>	<p>4.1 Criteria for machine foundation</p> <p>4.2 Provisions for foundation design considerations in machine foundations.</p> <p>4.3 Factors to be considered while designing machine foundations such as type of soil</p> <p>4.4 Design foundations for simple machine like lathe, compression press, universal testing machine, electric power hammer etc.</p> <p>BIS CODE of practice for machine foundations I.S.- 2974 - Part –I&amp; II</p>

### 5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit No.	Unit Title	Tutorial Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total
I.	Civil engineering Surveying	04	NOT APPLICABLE			
II.	Civil engineering drawing	04				
III.	Construction materials	02				
IV.	Machine foundations	04				
Total		14				

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

**Note:** 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.

### 6. SUGGESTED LIST OF PRACTICAL/EXERCISES

The experiments should be properly designed and implemented with an attempt to develop different types of skills so that students are able to acquire above mentioned competency. This is the list of minimum experiments to be performed.

Ex. No.	Unit No.	Practical/Exercises	Approx Hours Required
1	I	Practice for linear measurements through ranging, chaining, taping offsetting, recording field book etc.	04
2	I	Practice for working on prismatic compass, dumpy Levels, for taking measurements and , recording length and angles.	04
3	II	Prepare surveying drawings using surveyed data	04
4	III	Test few construction materials such as cement, brick etc in laboratory	04
5	IV	Visit of industry to observe the machine foundation and study of foundation design	04
6	III	Market survey of construction materials and prepare of cost estimation	04
7	IV	Observe and draw machine foundation for some heavy machines.	04
Total			28

## 7. SUGGESTED LEARNING RESOURCES:

### A. List of Books.

Sr.No.	Title of Books	Author
1	Text book on Surveying&leveling	T.P.Kanitkar
2	Text hook on Surveying&leveling	B.C.Punmia
3	Civil Engineering Drawing	Shah Kalel&Patkil
4	Engineering Material	S.C.Rangwala
5	Properties of concrete	A.M.Neville

### B.List of Major Equipment/ Instrument.

- 1.Chain (10m, 20m, 30m, etc.)
- 2.Measure Tape, Ranging rods
- 3.Prismatic compass, Surveyor compass
- 4.Dumpy level, Tilting level
- 5.Compressive Testing Machine

### C. List of Software/Learning Websites: QE PRO for estimation, Autocad for drawings

## 9. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### Faculty Members from Polytechnics

- **Prof. Bhavesh Modi** Principal ,B V P I T (DS) Umrakh Ta. Bardoli
- **Mr. Krishnaraj A. Khatri** L C E, B V P I T (DS) Umrakh Ta. Bardoli
- **Mrs. A. N. Pamnani** L C E ,B B I T , V V Nagar
- **Mrs. Rina Chokshi** L C E, P I E T (DS) Limda Vadodara

### Co-ordinator and Faculty Members from NITTTR Bhopal

- **Dr. J.P.Tegar**, Professor Dept of Civil and Environmental Engg,

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**  
**COURSE CURRICULUM**

Course Title: Mechanical Drafting  
 (Code: 3321901)

Diploma Programmes in which this course is offered	Semester in which offered
Mechanical Engineering, Mechatronics Engineering	Second Semester

**1. RATIONALE:**

The students of mechanical engineering programme are mainly involved in drafting, manufacturing, inspection and planning activities (such as preparing process plans, preparing bill of materials, etc.) at industries. For all such activities, reference document is the drawing of components/assemblies to be manufactured. In this context, it is of utmost priority to prepare, read and interpret these drawings correctly for production of components and assemblies accurately and precisely. The industrial practices of drafting are also important for the students to make them aware of drafting practices, symbols, codes, norms and standards generally used in industries. Development of sketching ability also strengthens effective engineering communication & presentation.

**2. COMPETENCIES:**

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:

- i. **Prepare engineering drawings using codes, norms and standards.**
- ii. **Interpret basic engineering drawings for various planning, inspection and manufacturing activities.**

**3. TEACHING AND EXAMINATION SCHEME:**

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			C	ESE	PA	ESE	PA	
2	0	6	8	70	30	40	60	<b>200</b>

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

**Note:** It is the responsibility of the institute heads that marks for **PA of theory & ESE and PA of practical** for each student are entered online into the GTU Portal at the end of each semester within the dates specified by GTU.

**4. DETAILED COURSE CONTENTS:**

<b>Unit</b>	<b>Major Learning Outcomes</b>	<b>Sub-topics</b>
<b>Unit – I</b> <b>Multi views Representation</b>	1a. Draw isometric and multi views of an object. 1b. Interpret multi views drawings.	1.1 First & third angle projection methods and positions of six views. 1.2 Multi view drawings (all six views) from given isometric drawing / physical object. 1.3 Missing view drawings from given adequate orthographic views.
<b>Unit– II</b> <b>Sectional Orthographics</b>	2a. Draw sectional view/s of an object. 2b. Interpret sectional views.	2.1 Need of sections. 2.2 Section lines and cutting plane. 2.3 Rules for sectioning and section lines. 2.4 Types of sections- full, half, revolved, removed, partial, off-set, aligned. 2.5 Sectional view drawings from given isometrics drawing / physical object and cutting plane conditions.
<b>Unit– III</b> <b>Projections and Sections of Solids</b>	3a. Draw sectional views of different solids. 3b. Interpret sectional views of different solids.	3.1 Types and dimensional specifications of solids (prism, pyramid, cylinder, cone). 3.2 Projections of solids - in various positions with respect to the reference planes. (Parallel, perpendicular and inclined to HP and / or VP.) 3.3 Sectional views of different solids in given various positions. 3.4 True shape of section.
<b>Unit– IV</b> <b>Intersection and Penetration of Solids and Surfaces</b>	4a. Draw intersectional view/s of an object.	4.1 Importance and field use. 4.2 Intersection curve for Intersection / penetration of : i. Prism into prism. ii. Cylinder into cylinder. iii. Cylinder into prism. iv. Cone into cylinder.
<b>Unit– V</b> <b>Development of Surfaces</b>	5a. Develop the surface requirement of given application.	5.1 Importance of development of surfaces. 5.2 Drawing of development of surfaces of prism, pyramid, cylinder and cone – independent, sectioned and combination.
<b>Unit– VI</b> <b>Drafting Symbols</b>	6a. Use & Interpret drafting symbols.	6.1 Machining symbol and its interpretation. 6.2 Geometrical symbols and its interpretation. 6.3 Other drafting symbols like threading, dowels, pins, ribs, bearings, etc. 6.4 Notes in drawing like heat treatment conditions, surface conditions, assembly notes, etc. (All symbols as per BIS).
<b>Unit– VII</b> <b>Welded Joints, Piping &amp; Duct Layouts</b>	7a. Draw & interpret weld joints, piping layout and duct drawings. 7b. Interpret Process	7.1 Weld symbols as per BIS-813 / ASME (primary symbols & supplementary symbols). 7.2 Weld nomenclature. 7.3 Weld dimensions.

	flow diagram & piping isometrics	<p>7.4 Welding drawing interpretations. (like simple heat exchangers, pressure vessels, etc.)</p> <p>7.5 Pipe-types, standards and designation methods.</p> <p>7.6 Pipe line symbol as per passing fluid, air, gas, water etc.</p> <p>7.7 Piping fitting symbols.</p> <p>7.8 Pipe line diagram.</p> <p>7.9 Interpretation of Process flow diagram &amp; piping isometrics &amp; pipe schedule chart.</p> <p>7.10 Ducts-types and applications.</p> <p>7.11 Duct layout.</p>
<b>Unit– VIII</b> <b>Details &amp; Assembly</b>	<p>8a. Prepare and interpret detail and assembly drawing.</p> <p>8b. Workout material requirement from a given drawing.</p>	<p>8.1 Importance and difference of these drawings.</p> <p>8.2 Detail drawing from given assembly.</p> <p>8.3 Assembly drawings from given details.</p> <p>8.4 Preparing bill of material (part list).</p>
<b>Unit– IX</b> <b>Fasteners</b>	<p>9a. Use appropriate fasteners for given situations.</p> <p>b. Draw sketches for different types of fasteners.</p>	<p>9.1 Detachable &amp; permanent fasteners.</p> <p>9.2 Sketches of threads (square, acme, knuckle, Internal – external threads, Left hand – right hand threads, Single &amp; multi start threads).</p> <p>9.3 Sketches of studs (cap screws, machine screws, set screws).</p> <p>9.4 Sketches of bolts &amp; nut (hexagonal, square).</p> <p>9.5 Sketches of rivets (snap, pan, countersunk, conical).</p> <p>9.6 Sketches of keys.</p>

### 5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY):

Unit No.	Topic Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total
I.	Multiviews representation	3	0	0	07	07
II.	Sectional orthographics	3	0	0	07	07
III.	Projections and sections of solids	4	0	0	07	07
IV.	Intersection & penetration of solids & surfaces	6	0	5	07	12
V.	Development of surfaces	4	0	0	07	07
VI.	Drafting symbols	2	5	0	00	05
VII.	Welded joints and Piping Layouts	4	2	2	04	08
VIII.	Details & assembly	2	2	0	09	11
IX.	Fasteners	-	4	0	02	06
	<b>Total</b>	<b>28</b>	<b>13</b>	<b>7</b>	<b>50</b>	<b>70</b>

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

**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. If midsem test is part of continuous evaluation, unit numbers 1, 2, 3 and 5 are to be considered. It is also compulsory for student to complete ex.no.1 to 5 and 7 to eligible for midsem test.
3. Ask the questions from each topic as per marks weightage. Optional questions must be asked from the same topic. That is weightage of compulsory attendance part of questions will be equal to marks allotted to each topic.

**5. SUGGESTED LIST OF PRACTICAL/EXERCISES:**

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills leading to the achievement of the above mentioned expected competency. Following is the list of minimum sheets to be drawn.

Sheet No.	Unit No.	Practical/Exercises	Hours
1	I	<b>MULTIVIEWS:</b> a: Given the pictorial view, draw multi views.-Two problems. b: Select one object, measure it and draw multi views. The selected object has to be approved by Teacher.  (Multi views include Elevation, Plan, Rear view, Bottom view, Right hand side view and Left hand side view.	08
2	I	<b>MISSING VIEWS:</b> Given adequate number of minimum views, draw additional view/s as asked.-Three problems.	04
3	II	<b>SECTIONAL VIEWS:</b> a: Given the pictorial view with cutting plane/s, draw the views as asked including sectional view/s.-Two problems. b: Select one object, measure it and draw the views as asked including sectional view/s. The selected object has to be approved by Teacher.	06
4	III	<b>PROJECTIONS OF SOLIDS:</b> Draw the projection of solids- 4 problems.(1-Prism, 1-Pyramid, 1-Cylinder and 1-Cone.). (With varied dimensions. Refer Note d.)	06
5	III	<b>SECTIONS OF SOLIDS:</b> Draw the sections of solids. Also draw true shape of each sections-4 problems.(1-Prism,1-Pyramid,1-Cylinder and 1-Cone.)	08



		(With varied dimensions. Refer Note d.)	
6	IV	<b>PENETRATION AND INTERSECTION:</b> Draw the intersection curves- 4 problems.( Prism into prism, Cylinder into cylinder, Cylinder into prism, Cone into cylinder. (With varied dimensions. Refer Note d.)	08
7	V	<b>SURFACE DEVELOPMENT:</b> Draw development of surface of prism, pyramid, cylinder and cone – independent, sectioned and combination.-Total 4 problems. (With varied dimensions. Refer Note d.)	04
8	VII	<b>WELD JOINT ASSEMBLY:</b> Draw the weld joint drawing with weld symbols and nomenclature. Take minimum 3 parts for weld joint assembly.	08
9	VII	<b>PIPING LAYOUT:</b> Prepare piping layout for given application/situation with piping symbols and nomenclature. Also prepare isometric piping layout for the same problem.	08
10	VIII	<b>DETAILS:</b> Draw the details of all parts for the assembly selected and sketched as student activity.	12
11	VIII	<b>ASSEMBLY:</b> Draw the assembly of all parts drawn for Sheet No.8. This includes minimum one sectional view and also the parts list.	12
12	All	<b>PROBLEM BASED LEARNING:</b> Complete the given orthographic views with few missing lines of at least three objects. Also sketch (free hand) isometrics of them.	-
13	All	<b>SCHOOL WITHIN SCHOOL:</b> a: Explain at least one problem for construction and method of drawing in sheet to all batch colleagues. Teacher will assign the problem of particular sheet to be explained to each batch student. b: Each student will assess at least one sheet of other students (May be 5-6 students- to be assigned by teacher) and will note down the mistakes committed by them. Student will also guide the students for correcting the mistakes, if any.	-
<b>Total</b>			<b>84</b>

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

**Note:** 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.

**NOTES:**

- a: Use **both sides of sheet. For example, draw sheet number 2 on backside of sheet number 1.**
- b: It is compulsory to perform students' activities.
- c: Submission includes sheets, objects, parts/assembly, drawings got for interpretation, student activities performed and sketch book. (Term work must not include any photocopy/ies, printed manual/pages, litho, etc. It must be hand written/hand drawn by student only.)
- d: The dimensions of solids-like base dimension/diameter, height, number of sides (for prism and pyramid) must be varied for each student in batch so that each student will have same problem, but with different dimensions.
- e: Ask for 6-8 components assembly only.
- f: Keep "Westernmann Table" (Revised to Indian Standards, New Age International Publishers) during theory and practice periods.
- g: For 40 marks under Practical Marks ESE, students are to be assessed for competencies achieved. Students are to be given data for practical ESE to:
  - i. Prepare drawings.
  - ii. Interpret given drawing/s.
  - iii. Refer and interpret data from data book/codes/standards/ Westernmann Table.

**7. SUGGESTED LIST OF PROPOSED STUDENT ACTIVITIES:**

Following is the list of student activities.

S. No.	Activity No.	Details of student activity
1	1	Solve all problems for sheet number 1 to 7 in sketch book (with dimensions).
2	2	Select two objects. Student will measure and sketch* the same in sketchbook for the reference to draw in sheet. One for MULTIVIEW (Sheet No.1) and another for SECTIONAL VIEWS (Sheet No.3). (*Only freehand isometric sketch with dimensions).
3	3	Select one assembly having minimum 6-8 mechanical related components. Student will measure and sketch the same in sketchbook for the reference to draw details and assembly sheets. This may be in group of 3-4 students. (*Only freehand isometric sketch with dimensions).
4	4	Draw freehand sketches for sheet number 8 to 11 in sketch book.
5	5	Draw various drafting symbols in sketch book. This includes mainly: <ul style="list-style-type: none"> <li>a: Threading symbols.</li> <li>b: Machining symbols.</li> <li>c: Geometrical symbols</li> <li>d: Welding symbols.</li> <li>e: Piping symbols.</li> </ul>
6	6	Get <sup>+</sup> minimum one industrial drawing each for following , which are in use by industry: <ul style="list-style-type: none"> <li>a: Machined component.</li> <li>b: Machined part assembly-6-8 components.</li> <li>c: Welded joint based component /assembly.</li> </ul>

		d: Piping layout. Interpret above all drawings and write your conclusions in sketchbook. + Get by Industrial visits, internet search, reference book, etc.
7	7	Freehand sketches ( in sketch book) of various fasteners assigned by teacher.
8	8	List at least two questions each for following cases. List those questions you would like to ask to know / improve further. a: More than six views. b: Combination of different solids. c: Impact of ability of manual drafting on computer aided drafting. d: Intersection and duct layout. e: Correlation between details drawings and assembly drawings.

## 8. SUGGESTED LEARNING RESOURCES:

### A. List of Books.

S.No.	Title of Books	Author	Publication
1	Engineering Drawing.	N.D.Bhatt.	Charotar Publishing House, Anand.
2	Engineering Drawing.	K.R.Gopalakrishna.	Subhash Publications, Banglore.
3	Engineering Drawing.	P.J.Shah.	S.Chand, New Delhi.
4	Engineering Graphics.	M.B.Shah, B.C.Rana.	Pearsons.
5	Machine Drawing.	P. Sidheswar, P. Kannaiah & VVS Sastry.	Tata-McGraw Hill Publishing Co.Ltd.-New Delhi
6	Fundamentals of Engineering drawing.	Warren J. Luzadder	Prentice-hall of India Pvt. Ltd.- New Delhi
7	Westernmann Table, Revised to Indian Standards	Jutz, Scharkus.	New Age International Publishers

### B. List of Major Equipment/ Instrument.

1. Models and cut sections.
2. Various machined parts assemblies.
3. Various weld joints.
4. Set of various industrial updated drawings being used by industries-.
5. Large size drawing equipments and instruments for class room teaching-.
6. Half imperial size drawing board.
7. T-square or drafter (Drafting Machine).
8. Set squires ( $45^0$  and  $30^0-60^0$ ).
9. Protector.
10. Drawing instrument box (containing compasses and divider).
11. Drawing sheets.

12. Drawing pencils.
13. Eraser.
14. Drawing pins / clips.

### C. List of Software/Learning Websites.

1. <http://mvredp.blogspot.in/2010/04/sections-of-solids-introduction.html>
2. <http://www.youtube.com/watch?v=P5g5omLoDr8>
3. <http://enggraphics.wordpress.com/2012/04/10/an-advance-tamil-new-year-gift/>
4. <http://rgpv-ed.blogspot.in/2009/09/development-of-surfaces.html>
5. <https://sites.google.com/site/middleschooljghs/graphic-communication/geometric-drawing-and-surface-developments>
6. <http://www.techdrawingtools.com/12/11201.htm>
7. <http://www.weramac.org/documents/isometric.html>
8. <http://www.me.metu.edu.tr/courses/me114/Lectures/assembly.htm>
9. [http://metal.brightcookie.com/2\\_draw/draw\\_t1/hm/draw1\\_2\\_1.htm](http://metal.brightcookie.com/2_draw/draw_t1/hm/draw1_2_1.htm)
10. <http://www.ductedreversecycleairconditioning.com.au/category/37165122>
11. [http://www.affordablecomfort.org/images/Events/15/Courses/422/Proctor\\_TAM07.pdf](http://www.affordablecomfort.org/images/Events/15/Courses/422/Proctor_TAM07.pdf)
12. [http://en.wikipedia.org/wiki/Engineering\\_drawing](http://en.wikipedia.org/wiki/Engineering_drawing)
13. [http://www.sevenhills-h.schools.nsw.edu.au/Graphics\\_TG201/Orthographic/Drawortho.htm](http://www.sevenhills-h.schools.nsw.edu.au/Graphics_TG201/Orthographic/Drawortho.htm)
14. [www.design-technology.info](http://www.design-technology.info)
15. [www.studyvilla.com](http://www.studyvilla.com)
16. [www.authorstream.com](http://www.authorstream.com)
17. Computer based learning material published by KOROS.

## 9. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### Faculty Members from Polytechnics

1. **Prof. M. K. Dudharejiya**, Lecturer in Mechanical Engineering, Sir B.P.I., Bhavnagar.
2. **Shri A.M.Talsaniya**, Lecturer in Mechanical Engineering, Sir B.P.I., Bhavnagar.
3. **Shri P.L.Bhogayata**, Lecturer in Mechanical Engineering, Sir B.P.I., Bhavnagar.

### Co-ordinator and Faculty Member from NITTTR Bhopal

1. **Prof. Sharad Pradhan**, Associate Professor, Dept. of Mechanical Engineering,

## GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

### COURSE CURRICULUM

Course Title: Material Science and Metallurgy  
(Code: 3321902)

Diploma Programmes in which this course is offered	Semester in which offered
Mechanical Engineering, Automobile Engineering	Second Semester

#### 1. RATIONALE

Engineering Materials play an important role as the vital tool for solving the problems of material selection and application in the production and manufacturing of equipment/machines, devices, tools, etc. Therefore, an engineering diploma student must be conversant with the properties, composition and behavior of materials from the point of view of reliability and performance of the product.

Subject is concerned with the changes in structure and properties of matter. Many of the processes which are involved to bring out these changes, forms the basis of engineering activities. The study of basic concepts of material science and metallurgy will help the students understanding engineering subjects where the emphasis is laid on the application of these materials.

#### 2. LIST OF COMPETENCIES

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:

- i. **Select Engineering materials based on properties, behavior and environmental effect for given engineering application.**
- ii. **Examine microstructure and alloying elements of given engineering materials**

#### 3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
3	0	2	5	70	30	20	30	

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

**Note:** It is the responsibility of the institute heads that marks for **PA of theory & ESE and PA of practical** for each student are entered online into the GTU Portal at the end of each semester within the dates specified by GTU.

#### 4. DETAILED COURSE CONTENT

Unit	Major Learning Outcomes	Topics and Sub-topics
<b>Unit – I</b> <b>Engineering Materials</b>	1a. Explain different types of bonds material, its construction and characteristics	1.1 Types of bonds, construction and characteristics of electrovalent, covalent, coordinate, hydrogen and metallic
	1b. Draw molecular arrangement in solids, liquid and gases	1.2 Intermolecular force of attraction 1.3 Molecular arrangement in solids, liquid and gases 1.4 Structure of solids i. Concept of crystalline structure. ii. Structure of metal-unit cell, BCC, FCC and HCP. iii. Examples and properties of metallic structures
	1c. Describe various properties of material	1.5 Physical, chemical, electrical, electromagnetic and thermal properties of material
	1d. Explain effects of cooling rate, grain size on materials properties	1.6 Solidification of metals and digital transducers i. Concept. ii. Crystal, grain, grain boundaries and dendritic solidification. iii. Effect of cooling rate on material properties. iv. Effect of grain size on properties of metal
<b>Unit– II</b> <b>Phase Diagrams</b>	2a. Explain the concept of equilibrium diagram 2b. Plot cooling curves for pure metals and alloys	2.1 Equilibrium diagrams. i. Concept, definition and need. ii. Solid solution-definition, properties and examples. iii. Alloys-major elements, reasons to add and important effect on material properties. iv. Cooling curve-concept and method to plot. v. Cooling curve for pure metals and alloys.
	2c. Draw and Interpret TTT curves and Iron carbon diagram	2.2 Time Temperature Transformation curve- (TTT curve). i. Need and application. ii. Steps to construct TTT curve 2.3 Iron carbon equilibrium diagram. i. Concept, need & characteristics. ii. Definition of the terms used. iii. Plotting fundamentals. iv. Interpretation.
	2d. Explain various heat treatment processes	2.4 Heat treatment processes. i. Types of furnaces. ii. Heat treatment processes. (Annealing, normalizing, carburizing, case hardening, hardening, tempering, spheroidising, nitriding, tempering, stabilizing, etc.). Methods, parameters and changes in properties. iii. Types of quenching mediums, their properties and applications.

Unit	Major Learning Outcomes	Topics and Sub-topics
<b>Unit– III Metallurgical Microscope</b>	3a. Prepare specimens for microscopic examination 3b. Examine specimens using microscope	3.1 Metallographic examination and microstructures-need and importance 3.2 Principle & working of metallurgical microscope 3.3 Preparation of specimen for microscopic examinations
<b>Unit– IV Metals And Its Alloys</b>	4a. Identify various ferrous metals and alloys based on composition and properties for prescribed application 4b. Test material for alloying elements content 4c. Interpret material designations	4.1 Classification of metals. 4.2 Flow diagram for the production of iron and steel. 4.3 Ferrous metals i. Classification. ii. Steels-types, composition, properties, applications. (for Plain carbon steel, alloy steel including stainless steel and cast iron.) iii. Designation and coding methods according to BIS for plain & alloy steel and cast iron. iv. Designation and coding (as per BIS, ASME, EN, DIN,JIS)of plain & alloy steel and cast iron. v. Microstructure of mostly used ferrous materials-low carbon steel, alloy steel, cast iron.
	4d. Select various non-ferrous metals and alloys based on composition and properties for given application	4.4 Non ferrous metals i Classification. ii.Types, composition, properties and applications. (for Copper, copper alloys, Aluminum and Aluminum alloys.) iii.Designation and coding methods according to BIS . iv.Designation and coding (as per BIS, ASME, EN, DIN,JIS)of mostly used non ferrous materials. v.Microstructure of mostly used non ferrous materials-(Copper, Brass, Gunmetal, Aluminum).
<b>Unit– V Non Metallic Materials</b>	5a. Identify non-metallic material by judgment and lay-man tests 5b. Select the non metallic material for given simple machine elements	5.1 Introduction and classification of non metallic materials. 5.2 Classification of Polymers on basis of Thermal behavior (Thermoplastics & Thermosetting). 5.3 Properties and applications of polymers (like Polyethylene, Polypropylene, Polyvinyl chloride, Teflon, Polystyrene, Phenol formaldehyde, Acrylonitrile, Epoxy resin.) 5.4 Surface coating methods, setup, working parameters and applications using polymers. 5.5 Composites. i. Introduction of composite. ii.Characteristics of composites. iii.Constituents of composite. iv.Types and applications of composites. 5.6 Other non metallic materials-types, properties and applications.(like rubber, ceramics, refractories ,

Unit	Major Learning Outcomes	Topics and Sub-topics
		insulators, abrasives, adhesives, etc). 5.7 Designation and coding of important non metallic materials as per BIS.
<b>Unit- VI</b> <b>Electrolysis</b>	6a.Select proper electrolyte for specified application. 6b.Select proper electrolysis process for surface coating.	6.1 Introduction 6.2 Electrolytes and Non-electrolytes. i. Types of electrolytes. ii. Construction and working of electrochemical cell. iii. Standard conditions. iv. Standard hydrogen electrodes. v. Electrochemical series, galvanic series. vi. Faraday's Laws of Electrolysis. vii. Industrial applications of electrolysis. viii. Surface coating through electrolysis-setup and working. 6.3 Corrosion-types and reasons.
<b>Unit- VII</b> <b>Fluid And Powder Materials.</b>	7a.Select suitable cutting oil for given machining process 7b.Select suitable lubricants. 7c.Interpret designations of oils and paints. 7d.List areas of powder metallurgy applications.	7.1 Classification of fluid and powder materials. 7.2 Oils. i.Types and properties. ii.Designation methods as per BIS. iii.Applications in Mechanical engineering. 7.3Paints and varnishes. i. Definition and classifications. ii.Surface preparation and coating methods using paints and varnishes. 7.4Powder metallurgy. i. Basic concept of powder metallurgy and its applications, merits and demerits. ii.Manufacturing process of powder coating-setup, equipment used and working.

### 5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total
I.	Engineering Materials.	05	4	2	2	8
II.	Phase diagrams.	10	6	4	8	18
III.	Metallurgical Microscope	03	3	2	0	5
IV.	Metals and alloys.	10	6	4	6	16
V.	Non metallic materials.	06	3	2	4	09
VI.	Electrolysis.	04	3	0	4	7
VII.	Fluid and powder materials.	04	3	0	4	7
	<b>Total</b>	<b>42</b>	<b>28</b>	<b>14</b>	<b>28</b>	<b>70</b>

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



**Notes:**

- i) 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.
- ii) If midsem test is part of continuous evaluation, unit numbers I, II, III and VII are to be considered. It is also compulsory for student to complete ex.no.1 to 4 to eligible for midsem test.
- iii) Ask the questions from each topic as per marks weightage. Optional questions must be asked from the same topic. That is weightage of compulsory attendance part of questions will be equal to marks allotted to each topic.

**6. SUGGESTED LIST OF PRACTICAL/EXERCISES**

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills leading to the achievement of the above mentioned expected competencies.

S. No.	Unit No.	Practical/Exercises	Approx Hours. Required
1	I	a: State the criteria to identify any five (3 metallic and 2 non metallic) materials from the selected set of material b: List properties of each above identified materials. Also identify main alloying elements and reasons to add them.	2
2	II	Analyze content of ferrous/non ferrous material using photo spectrometer. (This may be covered during industrial visit).	2
3	II	a: Study various heat treatment furnaces. b: Perform hardening process on ferrous material. Measure the hardness before and after hardening.	4
4	III	Examine the given specimen by use of Metallurgical Microscope.	2
5	IV	Prepare ferrous micro specimens and examine them. Also prepare report on this. –Four specimens. (One of plain carbon steel, second of alloy steel, third of heat treated steel and fourth of cast iron.)	8
6	IV	Prepare non-ferrous micro specimens and examine them. Also prepare report on this. – Three specimens.(One of copper, second of brass and third of aluminium.)	4
7	VI	Study corrosive materials to identify different types of corrosion of metals.	2
8	ALL	Visit one relevant industry which has specifically heat treatment processes facilities and photo spectrometer.	-
9	All	<b>PROBLEM BASED LEARNING:</b> Group of 4-5 students will identify and collect five machine / product components which are made from different engineering materials and which are also failed in their applications. Students will measure and sketch the components (free hand-orthographic views) with dimensions. Students in group will also discuss the reasons of failure and will note down the discussion and outcome.	2
10	All	<b>SCHOOL WITHIN SCHOOL:</b>	2

S. No.	Unit No.	Practical/Exercises	Approx Hours. Required
		a. Each student will explain at least one diagram (assigned by teacher-may be part of iron-carbon diagram, TTT curve for specific material, etc ) to all batch colleagues. b. Each student will share experiences of the student activities he/she has carried out.	

**NOTES:**

1. 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.
2. Student activities are compulsory and are also required to be performed and noted in logbook.
3. Term work report includes term work, objects taken for identification for laboratory work, student activity; parts experimented in acid as student activity and log book along with student activities. Term work report is compulsory part to be submitted at the time of practical ESE.
4. Term work report must not include any photocopy/ies, printed manual/pages, lithos, etc. It must be hand written / hand drawn by student only.
5. For 20 marks ESE, students are to be assessed for competencies achieved. Students are to be asked to prepare specimens, interpret microstructure-iron-carbon diagram-TTT curves, identify materials, select proper materials, etc.

**7. SUGGESTED LIST OF PROPOSED STUDENT ACTIVITIES**

- 7.1 Select any five objects (3 metallic and 2 non metallic) which will be used in laboratory and list the material of selected objects.
- 7.2 Prepare the material list of given tools and commonly used items such as razor blade, knife, scissor, hacksaw blade, carpentry chisel, fix spanner, etc. Also give reason(s) for using such material and discuss your answers with the teacher.
- 7.3 Take dilute acid which is commonly used at our home for cleaning purpose and put one scrap iron piece and one non ferrous metal piece in it for minimum 12 hours. Take out these two pieces by following all safety norms/steps (without touching acid) and observe the changes. Discuss with your teacher.
- 7.4 Group of 3-5 students will visit institute's workshop and will identify at least 5 nonmetallic components for a given machine / assembly. Also list the material of identified machine / assembly components.
- 7.5 List at least three questions individually which you would like to ask for followings:
  - i. Comparison of iron and fiber reinforced plastic.
  - ii. Comparison for strength of wood and cast iron.
  - iii. Annealing-heat treatment process.
  - iv. Materials used for construction of any bike.
  - v. Materials used for construction of any home appliance, like mixer, washing machine, iron, etc.
- 7.6 Any other relevant activity added by teacher including preparing industrial visit report.

## 8. SUGGESTED LEARNING RESOURCES

### A. List of Books

S.No.	Author	Title of Books	Publication/Year
1.	GBS Narang	Materials science	Khanna Publishers, New Delhi.
2.	R.K.Rajpoot	Materials science	Laxmi Publication, Dariya ganj, New Delhi.
3.	R.S.Khurmi, R.S.Sedha	Materials science	S.Chand
4	D.S.Nutt	Materials science and metallurgy	S.K.Katariya and sons, Delhi.
5.	V.Raghavan	Materials science and Engineering	EEE Edition, Prentice Hill, New Delhi.
6.	Sidney Avner	Physical Metallurgy	Tata McGraw-Hill Education (2011).

### B. List of Major Equipment/ Instrument

1. Metallurgical Microscope.
2. Standard specimens.
3. Furnaces to perform heat treatment process.
4. Sorted/required quenching mediums.
5. Hardness tester-to check Rockwell hardness-scales A,B and C.
6. Other hardness testers like scleroscope, etc.
7. Polishing machine to prepare specimens with necessary consumables.
8. Hand grinder – specifically to prepare specimens and for spark testing.
9. Other consumables.

### C. List of Software/Learning Websites

1. <http://vimeo.com/32224002>
2. [http://www.substech.com/dokuwiki/doku.php?id=iron-carbon\\_phase\\_diagram](http://www.substech.com/dokuwiki/doku.php?id=iron-carbon_phase_diagram)
3. <http://www-g.eng.cam.ac.uk/mmg/teaching/typd/>
4. <http://www.ironcarbondiagram.com/>
5. <http://uk.ask.com/web?q=Who+Discovered+Carbon%3F&qsrc=14097&o=41647924&l=dir>
6. <http://www.youtube.com/watch?v=fHt0bOfj3T0&feature=related>
7. <http://www.youtube.com/watch?v=cN5YH0iEvTo>
8. <http://www.youtube.com/watch?v=m911tVXyFp8>
9. <http://www.youtube.com/watch?v=98lh5Q0M0cg>
10. <http://www.youtube.com/watch?v=KIyGr-1snMY>
11. [http://en.wikipedia.org/wiki/Materials\\_science](http://en.wikipedia.org/wiki/Materials_science)
12. <http://www.studyvilla.com/electrochem.aspx>

## 9. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### Faculty Members from Polytechnic

- **Prof. Y. R. Joshi**, TPO, B&B Institute of Technology, Vallabhvidyanagar.
- **Prof. D. A. Dave**, Head of Automobile Engineering Department, Sir B.P.I., Bhavnagar.
- **Prof. A. M. Talsaniya**, Lecturer in Mechanical Engineering, Sir B.P.I., Bhavnagar.
- **Prof. R. B. Dhruv**, Lecturer in Mechanical Engineering, R.C.T.I., Ahmedabad.

### Co-ordinator and Faculty Member from NITTTR Bhopal

- **Dr. K.K.Jain**, Professor and Head; Dept. of Mechanical Engg,
- **Dr. A.K.Sarathe**, Associate Professor; Dept. of Mechanical Engg,

# GUJARAT TECHNOLOGICAL UNIVERSITY

MCA Sem-2/ B.E. Sem-2 & 7 / B.Pharm. Sem-2 & 7/

Diploma Engineering Sem-2 & 5 (01-07-2013)

Subject Name: **Contributor Personality Development**

Subject Code: **1990001**

**Table-I -For MCA/B.E. / D.E**

<b>Table-I</b>						
<b>Teaching Scheme</b>				<b>Evaluation Scheme</b>		
<b>Theory (Hrs.)</b>	<b>Tutorial (Hrs.)</b>	<b>Practical (Hrs.)</b>	<b>Credit</b>	<b>University Exam (E)</b>	<b>Mid Sem Exam (Theory) (M)</b>	<b>Practical (Internal)</b>
4	0	0	4	70	30	50

**\*For the Evaluation Scheme of Diploma Engineering Sem – 2, please refer the link**

**[http://www.gtu.ac.in/Syllabus/New\\_Diploma/sem-2/Pdf/3990001.pdf](http://www.gtu.ac.in/Syllabus/New_Diploma/sem-2/Pdf/3990001.pdf)**

**Table-I –For B.Pharm only**

<b>Table-II</b>						
<b>Teaching Scheme</b>				<b>Evaluation Scheme</b>		
<b>Theory (Hrs.)</b>	<b>Tutorial (Hrs.)</b>	<b>Practical (Hrs.)</b>	<b>Credit</b>	<b>University Exam (E)</b>	<b>Mid Sem Exam (Theory) (M)</b>	<b>Practical (Internal)</b>
4	0	0	4	80	0	20

**Note:**

- 1. This subject is compulsory.**
- 2. 4 Credits will be over and above the existing credit structure.**
- 3. This subject will be taught by faculty of English. For B. Pharm., the institute will have to nominate one faculty member for the subject.**
- 4. In Institutes, where as the load is not managed by the lecturers of English only, please nominate the other faculty for teaching the course of Contributor Personality Development.**

## (A) Background

The Contributor Personality Program has been designed keeping in mind the following:

- 1.0 Technology students should not only be excellently trained in the technological field, they should acquire soft skills if they are to be successful. Every student must also learn about the techniques of effective participation in a group discussion. He/she must learn to prepare his/her resume and he/she should also be groomed for presenting himself/herself at an interview.
- 2.0 There is a great need to equip students with not only the right skill-sets but also the right mindsets.



- 3.0 The ‘mindsets’ needed in today’s environment must support both (i) effective action and (ii) values and service oriented behavior.

Effective action without human values can lead to personal benefits for individuals but a long-term cost to both nation and society. Human values without effective action can lead to an inability on the part of the individual to perform and flourish in today’s environment.

This combination of effectiveness with human values is crystallized in the concept of “contributor ship”.

- 4.0 Students who adopt and develop the right mindsets early in their professional career are able to bring about a positive and sustainable change in their overall personality.

They are able to grow the right approaches to their peers, seniors, industry, and their own future. They become more responsible and capable of shaping their own lives.

Therefore, the program may be rightly called a “Contributor Personality Development Program”.

5.0 Any program of this sort must, in order to be effective, be inspired and guided by a high ideal and principles/ practices flowing from that ideal.

The Contributor Personality Program is guided by the ideals and ideas of Swami Vivekananda – who represented in his leonine personality the highest ideals of human values combined with effective action.

**The Contributor Personality**



**Contributor**

- **Creates value - for self, for the organization, for society**
- **Takes charge and makes things happen, making a positive difference**
- **Creates opportunities and sees possibilities everywhere**
- **Is 'in demand' wherever he/she goes**
- **Seeks long-term career success and life-fulfillment**

**(B) Course Outline**

Topics 1-6 relate to the basic axioms or “mental models” that students carry about themselves, about success, careers, contribution, etc. The right mental models are a necessary prerequisite for developing into a Contributor.

Topics 7-12 are 6 core practices that will help a student manifest the ideal of contributor ship in one’s life.

Topics 13-15 relate to the students capability to connect into the job-market.

Topic	Course Title
1	<p><b>Who is a Contributor</b></p> <p>Student develops an appreciation of who the Contributors are and how they fundamentally differ from Non-contributors in their overall approach to work, to other human beings, to society as a whole.</p>

2	<p><b>The Contributor's identity</b></p> <p>Student develops his/ her own answer to the question “who am I?” The student becomes aware of the fact that Non-contributors usually define themselves in terms of what they have acquired in life (e.g. qualifications, position, years of experience, etc.) while Contributors define themselves in terms of what they will become or accomplish (e.g. capacity to deliver, commitment and ownership of the organization's purpose, etc.).</p>
3	<p><b>The Contributor's vision of success</b></p> <p>The student explores the meaning of success in his life. Through this exploration, the student is expected to recognize that Contributors have a wider definition of success than Non-contributors. While Non-contributors define success in terms of material success, achievement, external impact, etc., Contributors are able to widen this definition of success to include personal fulfillment, development of self-esteem, ongoing development of personal capabilities etc.</p>
4	<p><b>The Contributor's vision of career</b></p> <p>The student learns to distinguish between an “acquisitive career” and a “contributive career”. An acquisitive career is one in which the career-seeker is focused on acquiring higher position, higher salary, more benefits etc. This preoccupation with selfish interests often damages the individual's career, as well as, damages the organization and society. A contributive career is one where the career-seeker is focused on contributing, with rewards being a by-product of the contributions made.</p>
5	<p><b>The scope of contribution</b></p> <p>The student learns to perceive that in all type of work, every type of role, there is a possibility of contributing at multiple levels – contributing to self, contributing to organization, and contributing to society.</p> <p>The student also appreciates the difference between “acquisition for self” and “contribution to self” – the former being material acquisition and the latter being conscious development of oneself through the medium of one's career.</p>
6	<p><b>Embarking on the journey to contributor ship</b></p> <p>The student recognizes the fundamental “building blocks” for becoming a Contributor – the first building block being a shift from a “victim” to being a “creator of one's destiny”; the second building block being acceptance of the ideal of contributor ship; the third building block being the willingness to take full responsibility for one's own development; the fourth building block being the capacity to reflect on one's development and make appropriate modifications.</p>



7	<p><b>Design Solutions</b></p> <p>When faced with a challenge, the Contributor’s first response is: “Can we find a solution?” This is unlike a Non-contributor who may respond to the challenge by trying a little and giving up, blaming others, or finding excuses to cover up the issue.</p> <p>Whereas, the Contributor finds a solution. In other words, the Contributor develops the capacity to find solutions through continuous practice and learning from other Contributors.</p> <p>In this topic, students learn the importance of willingness and ability to find solutions.</p>
8	<p><b>Focus on value</b></p> <p>What does creating value mean? It means making a positive difference, a tangible impact, a specific contribution to any situation. This positive difference or impact can be in the form of achieving a specific goal, creating a product, creating ‘human touch’ in a particular interaction, or enhancing one’s own capacity, or the capacity of one’s colleagues and team- mates.</p> <p>Contributors are therefore extremely result-focused, but the result is measured in terms of value created.</p> <p>In this topic, students learn to clarify the meaning of the word “value” and how value is created in various situations.</p>
9	<p><b>Engage deeply</b></p> <p>Contributors are instantly distinguished by the way they approach work. They get involved. They are enthusiastic. They go deep into the subject. In short, Contributors love what they do.</p> <p>This is in direct contrast to Non-contributors who want to do only what they love - an approach that seems reasonable until you realize that life and workplaces have so much variety that you may very often be called upon to do tasks that seem unpleasant or boring until you get involved.</p> <p>In this topic, students learn the importance of engaging deeply with whatever work they do – at work, in study, in personal life.</p>
10	<p><b>Think in Enlightened Self-interest</b></p> <p>Contributors think in Enlightened Self-Interest. In every situation they get into, they find a way to create something good for self and for all at the same time – including team mates, bosses, customers and their organization.</p> <p>Contrasting to this is the mindset of a Non-Contributor. Such a person is only concerned with his/ her own self-interest in a situation. He/she is not concerned about the impact (positive or negative) on the other person. This leads to unpleasant</p>

	<p>situations, broken relationships, unhappy team-mates, subordinates, and bosses, and lower trust in any situation.</p> <p>Students are expected to learn to appreciate the importance of thinking win-win for all stakeholders and also in various situations.</p>
11	<p><b>Practice Imaginative Sympathy</b></p> <p>One of the unique qualities of Contributors is their ability to appreciate and understand others' life situation, others' mental condition, and others' point of view. How do they do this?</p> <p>They have consciously developed a 'way of thinking' called 'Imaginative Sympathy'. In this way of thinking, they are able to give due importance to the human aspects of a situation, and not just the technical or commercial aspects.</p> <p>But this is not all. Imaginative Sympathy goes beyond looking at the human aspects of the situation. It also means that Contributors are able to anticipate possible interactions or reactions, they are able to take a multi-dimensional view of a situation and they are able to bring about changes or results while taking everybody along with them.</p> <p>Imaginative Sympathy translates itself into active concern for others. Students will learn the importance and consequences of Imaginative Sympathy in a workplace situation.</p>
12	<p><b>Demonstrate Trust Behavior</b></p> <p>Contributors recognize that they are able to achieve results and make contributions with the help of other human beings. They receive this help if and only if they are trusted and, in turn, trust. Contributors practice trust behavior from very early in their career, thereby building a huge trust balance (like a bank balance) over their career and relationships.</p> <p>The term Trust Behavior may be described as character-in-action. This includes keeping one's word and commitments, staying with a task, acting with integrity in every situation, making sure that there is complete transparency in one's actions and interactions, etc.</p> <p>Students are expected to learn to develop a deep appreciation of trust behavior and how it is practiced.</p>
13	<p><b>Resume Building</b></p> <p>In this topic, students learn to develop a resume for the job-market. Students will learn to develop both a generic resume and resumes specific to some types of jobs. Students learn about best practices and common errors in developing their resume.</p>

	Most important, students learn to analyze the jobs offered and present themselves in terms of their potential / willingness to contribute to the job.
14	<p><b>Group Discussions (GDs)</b></p> <p>In this topic, students learn (i) how to participate in a group discussion from the contributor's view-point (i.e. how to speak) (ii) how to contribute to the development of the topic (i.e. what to speak) and (iii) to develop the Contributor's view-point on various GD topics (i.e. how to interpret a topic of discussion from the point of view of a contributor)</p>
15	<p><b>Interview Skills</b></p> <p>In this topic, students learn about (i) common interview questions and how to develop answers (ii) typical challenges faced in interviews beyond the questions (such as body language, grooming, presentation) (iii) most important, the student learns the importance of trust building and creating confidence in the interview.</p>

### (C) Course Plan

The course duration is 48 hours. It can be conducted in sessions of 1 hour each or some of the sessions can be combined as 2 hours each. The course plan is as follows –

<p><b>Topic 1: Who is a Contributor –</b></p> <ul style="list-style-type: none"> <li>– 2 hours Theory and practice exercises based on Contributor Personality Program Workbook (Vol I)</li> <li>– 1 hour Presentations and Projects</li> </ul>	<b>3 hours</b>
<p><b>Topic 2: The Contributor's identity –</b></p> <ul style="list-style-type: none"> <li>– 2 hours Theory and practice exercises based on Contributor Personality Program Workbook (Vol I)</li> <li>– 1 hour Presentations and Projects</li> </ul>	<b>3 hours</b>
<p><b>Topic 13: Resume Building</b></p> <ul style="list-style-type: none"> <li>– 2 hours for Concepts, Tools, and Techniques</li> <li>– 2 hours for Projects</li> </ul>	<b>4 hours</b>
<p><b>Topic 3: The Contributor's vision of success –</b></p> <ul style="list-style-type: none"> <li>– 2 hours Theory and practice exercises based on Contributor Personality Program Workbook (Vol I)</li> <li>– 1 hour Presentations and Projects</li> </ul>	<b>3 hours</b>
<p><b>Topic 4: The Contributor's vision of career –</b></p> <ul style="list-style-type: none"> <li>– 2 hours Theory and practice exercises based on Contributor Personality Program Workbook (Vol I)</li> <li>– 1 hour Presentations and Projects</li> </ul>	<b>3 hours</b>
<p><b>Topic 5: The scope of contribution –</b></p> <ul style="list-style-type: none"> <li>– 2 hours Theory and practice exercises based on Contributor Personality Program Workbook (Vol I)</li> <li>– 1 hour Presentations and Projects</li> </ul>	<b>3 hours</b>

<b>Topic 6: Embarking on the journey to contributorship –</b> – 2 hours Theory and practice exercises based on Contributor Personality Program Workbook (Vol I) – 1 hour Presentations and Projects	<b>3 hours</b>
<b>Topic 14: Group Discussions (GDs)</b> – 2 hours for Concepts, Tools, and Techniques – 2 hours for Projects and Practice	<b>4 hours</b>
<b>Topic 7: Design Solutions –</b> – 2 hours Theory and practice exercises based on Contributor Personality Program Workbook (Vol II) – 1 hour Presentations and Projects	<b>3 hours</b>
<b>Topic 8: Focus on value –</b> – 2 hours Theory and practice exercises based on Contributor Personality Program Workbook (Vol II) – 1 hour Presentations and Projects	<b>3 hours</b>
<b>Topic 9: Engage deeply –</b> – 2 hours Theory and practice exercises based on Contributor Personality Program Workbook (Vol II) – 1 hour Presentations and Projects	<b>3 hours</b>
<b>Topic 10: Think in Enlightened Self-interest –</b> – 2 hours Theory and practice exercises based on Contributor Personality Program Workbook (Vol II) – 1 hour Presentations and Projects	<b>3 hours</b>
<b>Topic 11: Practise Imaginative Sympathy –</b> – 2 hours Theory and practice exercises based on Contributor Personality Program Workbook (Vol II) – 1 hour Presentations and Projects	<b>3 hours</b>
<b>Topic 12: Demonstrate Trust Behavior –</b> – 2 hours Theory and practice exercises based on Contributor Personality Program Workbook (Vol II) – 1 hour Presentations and Projects	<b>3 hours</b>
<b>Topic 15: Interview Skills</b> – 2 hours for Concepts, Tools, and Techniques – 2 hours for Projects and Practice	<b>4 hours</b>
<b>TOTAL</b>	<b>48 hours</b>

### **(D) Examination Approach**

Total marks: 150. Break-up of marks -

- (i) Final exam : 70 marks (equal weightage for topics 1-15)
- (ii) Presentations and projects for topics 1-12: 30 marks
- (iii) Projects for topics 13-15: 50 marks

## **(E) Instructional Strategy**

1.0 The entire course will use a three-level instructional strategy

- Level I: Classroom Explorations
- Level II: Projects and Presentations
- Level III: Self-study by students

2.0 Level I: Classroom Explorations

1. The Classroom Explorations will be organized around the ‘Contributor Personality Program – Study Book’.

The Study Book may be downloaded by the student from the resource site produced by GTU.

2. The Classroom Explorations involves two kinds of explorations:
  - (i) Exploration of key concepts / frameworks such as “contributors vision of success” etc.
  - (ii) Exploration of the examples provided in the CPP Study Book.
3. The Classroom Explorations will be supported by Session Guide Sheets available online in the CPP ActivGuide.

3.0 Level II: Projects & Presentations

1. The entire Classroom Exploration process will be supplemented by projects and presentations.
2. Session Guides will provide sample topics for projects and presentations. Individual instructors will be free to develop their own projects/ presentation topics also.
3. This will not only enhance conceptual clarity but also build presentation, public-speaking, report writing, and group discussion skills of the students.

4.0 Level III: Self Study by students

1. Students will be given extensive learning support (upto 400 learning units) in the ActivGuide website. This will include videos, presentations, tests, etc.
2. Students can refer to ActivGuide on their own time through internet.

## (F) Reference Material

### Basic Study Material

SN	Author/s	Name of Reference	Publisher	Edition
1	Illumine Knowledge Resources Pvt. Ltd. (Downloadable from the internet)	Contributor Personality Program Workbook (Vols I & II)	Illumine Knowledge Resources Pvt. Ltd	Latest
2	Illumine Knowledge Resources Pvt. Ltd. (will be made available to all students on the Internet)	Contributor Personality Program ActivGuide	Illumine Knowledge Resources Pvt. Ltd	Latest

### Reference Books

Topic	Course Title	Reference
1	<b>Who is a Contributor</b>	1. On Contributors, Srinivas V.; Illumine Ideas, 2011 2. Enlightened Citizenship and Democracy; Swami Ranganathananda, Bharatiya Vidya Bhavan, 1989 3. Personality Development, Swami Vivekananda; Advaita Ashrama
2	<b>The Contributor's identity</b>	1. To have or to be, Erich Fromm; Continuum International Publishing Group, 2005 2. The art of being, Erich Fromm; Continuum International Publishing Group, 1992 3. Raja Yoga, Swami Vivekananda; Advaita Ashrama
3	<b>The Contributor's vision of success</b>	1. Eternal Values for a Changing Society – Vol IV (Ch 25, 35), Swami Ranganathananda; Bharatiya Vidya Bhavan, 1993 2. Karma Yoga, Swami Vivekananda; Advaita Ashrama
4	<b>The Contributor's vision of career</b>	1. Six Pillars of Self Esteem , Nathaniel Branden; Bantam, 1995 2. Mindset: The New Psychology of Success, Carol S. Dweck; Random House Publishing Group, 2007
5	<b>The scope of contribution</b>	1. Awakening India, Swami Vivekananda; Ramakrishna Mission, New Delhi, 2011 2. Eternal Values for a Changing Society – Vol IV

		<p>(Ch 35), Swami Ranganathananda; Bharatiya Vidya Bhavan, 1993</p> <p>3. Lasting Contribution: How to Think, Plan, and Act to Accomplish Meaningful Work, Tad Waddington; Agate Publishing, 2007</p>
6	<b>Embarking on the journey to contributor ship</b>	<p>1. Vivekananda: His Call to the Nation, Swami Vivekananda; Advaita Ashrama</p> <p>2. Eternal Values for a Changing Society – Vol IV (Ch 33), Vol III (Ch 19, 21, 30) Swami Ranganathananda; Bharatiya Vidya Bhavan, 1993</p> <p>3. Lectures from Colombo to Almora, Swami Vivekananda; Advaita Ashrama</p>
7	<b>Design Solutions</b>	<p>1. Why not?: how to use everyday ingenuity to solve problems big and small, Barry Nalebuff, Ian Ayres; Harvard Business School Press, 2003</p> <p>2. How to Have a Beautiful Mind, Edward De Bono; Vermilion, 2004</p>
8	<b>Focus on value</b>	<p>1. The value mindset: returning to the first principles of capitalist enterprise (Ch 8 &amp; 9); Erik Stern, Mike Hutchinson; John Wiley and Sons, 2004</p> <p>2. Managing for Results, Peter F. Drucker; HarperCollins, 2009</p>
9	<b>Engage deeply</b>	<p>1. The Power of Full Engagement: Managing Energy, Not Time, is the Key to High Performance and Personal Renewal, Jim Loehr, Tony Schwartz; Simon and Schuster, 2003</p>
10	<b>Think in Enlightened Self-interest</b>	<p>1. The 7 Habits of Highly Effective People, Stephen R. Covey; Simon and Schuster, 2004</p> <p>2. Creating Shared Value, Michael E. Porter and Mark R. Kramer; Harvard Business Review; Jan/Feb2011, Vol. 89 Issue 1/2</p>
11	<b>Practice Imaginative Sympathy</b>	<p>1. Eternal Values for a Changing Society – Vol IV (Ch 8, 10, 23, 35, 37), Swami Ranganathananda; Bharatiya Vidya Bhavan, 1993</p> <p>2. Eternal Values for a Changing Society – Vol III (Ch 18), Swami Ranganathananda; Bharatiya Vidya Bhavan, 1993</p>
12	<b>Demonstrate Trust Behavior</b>	<p>1. The Speed of Trust: The One Thing That Changes Everything, Stephen M. R. Covey, Rebecca R. Merrill, Stephen R. Covey; Free Press, 2008</p> <p>2. Integrity: The Courage to Meet the Demands of</p>

		Reality, Henry Cloud; HarperCollins, 2009 3. Responsibility at work: how leading professionals act (or don't act) responsibly, Howard Gardner; John Wiley & Sons, 2007
13	<b>Resume Building</b>	1. What Color Is Your Parachute? 2012: A Practical Manual for Job-Hunters and Career-Changers, Richard Nelson Bolles; Ten Speed Press, 2011 2. The what color is your parachute workbook: how to create a picture of your ideal job or next career, Richard Nelson Bolles; Ten Speed Press, 2011
14	<b>Group Discussions (GDs)</b>	1. Effective Group Discussion: Theory and Practice, Gloria J. Galanes, Katherine Adams; McGraw-Hill, 2004
15	<b>Interview Skills</b>	1. What Color Is Your Parachute? 2012: A Practical Manual for Job-Hunters and Career-Changers, Richard Nelson Bolles; Ten Speed Press, 2011 2. The what color is your parachute workbook: how to create a picture of your ideal job or next career, Richard Nelson Bolles; Ten Speed Press, 2011

### General References:-

SN	Author/s	Name of Book	Publisher	Edition
1	Swami Ranganathananda	Universal Message of the Bhagavad Gita (Vol 1-3)	Advaita Ashrama, Kolkata	Latest
2	Swami Ranganathananda	Eternal Values for a Changing Society (Vol 1-4)	Bharatiya Vidya Bhavan	Latest
3	Asim Chaudhuri	Vivekananda: A Born Leader	Advaita Ashrama, Kolkata	Latest
4	Swami Vivekananda	Complete Works of Swami Vivekananda (Vol 1-9)	Advaita Ashrama, Kolkata	Latest
5	Swami Vivekananda	Letters of Swami Vivekananda	Advaita Ashrama, Kolkata	Latest



## GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

### Course Curriculum

#### HUMAN RESOURCE MANAGEMENT (Code: 3330001)

Diploma Programmes in which this course is offered	Semester in which offered
Bio Medical Engg., Mechanical Engg., Mechatronics Engg., Metallurgy Engg., Power Electronics, Plastic Engg., Printing Technology, Ceramic Engg., Textile Manufacturing Technology, Textile Processing Tech., Textile Designing,	3 <sup>rd</sup> Semester

### 1. RATIONALE

Human resources are very crucial for effective achievement of changing goals of the organization. They have tremendous level of untapped potential which can be utilised by professional supervisor using human resource management abilities. In changing environment the role of the supervisor and people becomes crucial to success. Working conditions may create stress and conflict which could be managed effectively using various tools and techniques related to training, guidance, counselling, mentoring and coaching. In the present era of globalisation, human resource is considered as a dynamic asset which in turn contributes for achieving the excellence and delighting the customers.

This course aims at developing intra-personal, inter-personal and social competencies in the polytechnic students so as to enable them to perform their future role of supervisor effectively.

### 2. COMPETENCIES (Programme Outcomes according to NBA Terminology)

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.

- i. **Manage people effectively to achieve organizational goals**
- ii. **Foster values, positive attitude and interpersonal relations.**
- iii. **Facilitate employees for effective achievement of personal goals**

### 3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	100
2	0	0	2	70	30	0	0	

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

**4. COURSE DETAILS**

<b>Unit</b>	<b>Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)</b>	<b>Topics and Sub-topics</b>
<b>Unit I</b> <b>Introduction</b>	1.a Appreciate importance of human resource	1.1 Need and scope of human resource management in industrial environment. 1.2 Impact of human factors on productivity and industrial harmony. 1.3 Importance of providing need based training to the man power. 1.4 Qualities of a good supervisor.
<b>Unit II</b> <b>Human needs, relations and values</b>	2.a Identify human motivations.	2.1 Importance of human resources in Indian philosophy. 2.2 X and Y theory. 2.3 Maslow's hierarchy, its importance in managing human resources.
	2.b Appreciate values and ethics for relationships.	2.4 Need of human relations and human values in the industry, inter department and intra department. 2.5 Good relations with the suppliers and clients. 2.6 Desirable human values and their importance including ethics and morale values.
<b>Unit III</b> <b>Behavioural dynamics</b>	3.a Analyse self for interpersonal behaviour.	3.1 Need for interpersonal competence. 3.2 Determinants of interpersonal behaviour. 3.3 Concept of interpersonal orientation and attractions and its importance in human behaviour.
	3.b Develop team spirit and positive attitude.	3.4 Concept of group dynamics. 3.5 Dynamics of group formation. 3.6 Types of groups. 3.7 Role of teams in an organization. 3.8 Desirable characteristics of a team member. 3.9 Concept & importance of positive attitude and openness of mind. 3.10 Do's and don'ts for developing positive attitude. 3.11 Importance of mental health.
<b>Unit IV</b> <b>Leadership Development</b>	4.a Use leadership qualities. 4.b Develop subordinates by motivations & training. 4.c Develop decision	4.1 Various definitions of leadership. 4.2 Situational approach to leadership. 4.3 Quality of a good leader. 4.4 Power influence and compliance. 4.5 Influence of Leadership. 4.6 Techniques to deal people effectively. - case studies.

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
	making ability.	4.7 Importance of resource management (human, machine, material, method, money, time (moment), information (message)). 4.8 Need, importance & types of organisational training. 4.9 Need and importance of motivations. 4.10 Changing role of supervisor as facilitator & motivator. 4.11 Need, importance and use of guidance, mentoring, coaching and counselling. 4.12 Importance of problem solving and decision making in context of productivity, quality, cost consciousness, human relations and goal achievement. 4.13 Factors affecting decision making. 4.14 Types and process of decision making. 4.15 Make the decisions for given case/situation. - case studies.
<b>Unit V</b>  <b>Change and stress management.</b>	5.a Identify need for change and barriers to change. 5.b Suggest strategies for any change. 5.c Resolve conflicts.	5.1 Need for change. 5.2 Barriers to change. 5.3 Strategies and tools to manage change. (Effective implementation and management of change). - case studies. 5.4 Trade unions and their objectives. 5.5 Constructive role of trade unions in goal setting, achievement and change management. 5.6 Causes of conflicts and techniques to resolve conflicts - case studies.
	5d. Analyse stress situation 5e. Manage stress.	5.7 Concept of stress. 5.8 Causes of stress. 5.9 Stress measuring techniques. 5.10 Need for relieving stress. 5.11 Techniques to manage the stress- case studies. 5.12 Self-management techniques

## 5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction	02	02	03	00	05
II	Human needs, relations and values	04	05	05	00	10
III	Behavioural dynamics	08	06	07	07	20
IV	Leadership Development	08	05	05	10	20
V	Change and stress management	06	02	08	05	15
<b>Total</b>		<b>28</b>	<b>20</b>	<b>28</b>	<b>22</b>	<b>70</b>

**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.

## 6. LIST OF EXERCISES/PRACTICAL

**Not Applicable**

## 7. SUGGESTED LIST OF STUDENT ACTIVITIES

- a: Name the students with whom you have very good relations. Also list the reasons for that.
- b: Name the students with whom you have very bad relations. Also list the reasons for that.
- c: List the factors/situations which motivate you.
- d: Identify the situations which cause stress to you. Also state reasons for that.
- e: Visit institute's canteen, workshop and administration departments and identify the ways how people manage stress during peak hours.
- f: Visit nearby hotels, hospitals, malls, workshops, industries and draw the organisational structure followed in these organisations. Also prepare a list of documents that are commonly used by them for effective and smooth working of these organisations.
- g: Visit nearby hotels, hospitals, malls, workshops, industries and prepare a report on how they are dealing with day to day grievances and customer complaints.
- h: Visit different organisations and prepare a report on various unions exist in these.
- i: Each student should search the web and prepare biography of one leader from any field and try to identify the leadership traits he/she possesses.
- j: Participate in team building exercises
- k: Prepare a plan to develop yourself for achieving excellence

**8. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)**

Sr. No.	Unit	Strategies	Purpose
1	I	Live examples/movies on productivity and harmony.	Importance of productivity and harmony can be understood.
2	II	a: Group discussion for Maslow's hierarchy. b: Case study/ case movie which appreciate importance of values and ethics.	To identify human motivations and to appreciate values and ethics for relationships.
3	III	a: Presentation on self characteristics. b: Tasks assignments to deal in team. c: Case study/movie. d: Group discussion.	To analyse self for interpersonal behaviour and develop the ability to work in team. Also to develop self confidence and openness of the thoughts.
4	IV	a: Case study-leadership. b: Role play-leadership. c: Group discussion-case for decision making. d: Group discussion for the case which require solution.	To make students aware of the techniques to deal different types of people effectively. Also to develop the ability to identify the factors affecting decision making.
5	V	a: Case study/Movie. b: Group discussion.	To know the causes of conflicts and to find out the resolution techniques of conflicts. Also to know the techniques to manage the stress.

**9. SUGGESTED LEARNING RESOURCES****(A) List of Books:**

Sr. No.	Title of Books	Author	Publication
1.	Managing people at work.	Ahuja, Jain & Chhabra.	Dhanpatrai and Sons.
2.	Human Resource Management	D.R.Patel, Y.R.Joshi	Atul Prakashan.
3.	Human Resource Management	Biswajeet Pattanayak	PHI
4.	Human Resource Management	K. Aswathappa	Tata McGraw Hill
5.	Human Resource Management	V. S. P. Rao	
6.	Seven Habits of successful people	Stephen R. Covey	Free Press
7.	Competency Framework for HRM	B.L. Gupta	Concept Publishing Company, New Delhi, First Edition 2011
8.	Designing and Managing human resources systems.	Pareek, Udai and Rao T.V.	Oxford and TBH Publishing Co., New Delhi 1981
9.	Behavioural processes in organisation.	Pareek, Udai and Rao T.V.	Oxford and TBH Publishing Co., New Delhi 1981

**(B) List of Software/Learning Websites:**

- a. [www.cipd.co.uk/NR/rdonlyres/29D9D26D.../9781843982654\\_sc.pdf](http://www.cipd.co.uk/NR/rdonlyres/29D9D26D.../9781843982654_sc.pdf)
- b. [www.slideshare.net/kumaravinash23/chapter-12-2634971](http://www.slideshare.net/kumaravinash23/chapter-12-2634971)
- c. [www.tutor2u.net/business/people/motivation\\_theory\\_mcgregor.asp](http://www.tutor2u.net/business/people/motivation_theory_mcgregor.asp)
- d. [www.mindtools.com](http://www.mindtools.com)
- e. [kalyan-city.blogspot.com/.../maslow-hierarchy-of-needs-theory-of.html](http://kalyan-city.blogspot.com/.../maslow-hierarchy-of-needs-theory-of.html)
- f. [www.enotes.com](http://www.enotes.com) > Health
- g. [www.youtube.com/watch?v=RwZ4-GTSNUI](http://www.youtube.com/watch?v=RwZ4-GTSNUI)
- h. [www.entrepreneur.com/article/204248](http://www.entrepreneur.com/article/204248)
- i. [ceocommunity.ning.com/forum/attachment/download?id...](http://ceocommunity.ning.com/forum/attachment/download?id...)
- j. [www.facultyfocus.com/...leadership/improve-your-decision-making-skill...](http://www.facultyfocus.com/...leadership/improve-your-decision-making-skill...)
- k. [www.nap.edu/catalog.php?record\\_id=13188](http://www.nap.edu/catalog.php?record_id=13188)
- l. [nearyou.gwu.edu/hrdl-hr/hrd-ld-hr\\_brochure.pdf](http://nearyou.gwu.edu/hrdl-hr/hrd-ld-hr_brochure.pdf)
- m. [www.hrinz.org.nz/Site/Resources/...Base/.../Change\\_Management\\_.aspx](http://www.hrinz.org.nz/Site/Resources/...Base/.../Change_Management_.aspx)
- n. <http://www.youtube.com/watch?v=OD6-dBymmjk>
- o. <http://www.youtube.com/watch?v=SJR-MRVd1okhttp://www.youtube.com/watch?v=pbxpg6D4Hk8>

**10. COURSE CURRICULUM DEVELOPMENT COMMITTEE****Faculty Members from Polytechnics**

- **Prof. Shah Bhaskar K.** Lecturer in Mechanical Engineering, Butler Polytechnic, Vadodara.
- **Prof. A.M. Talsaniya**, Lecturer in Mechanical Engineering, Sir Bhavsinhji polytechnic institute, Bhavnagar.

**Coordinator and Faculty Members from NITTTR Bhopal**

- **Dr. B.L.Gupta**, Professor and Head, Department of Management.
- **Prof. Sharad Pradhan**, Associate Professor and Head Department of Mechanical Engineering.

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

**Course Curriculum**

**MANUFACTURING ENGINEERING - I  
(Code: 3331901)**

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
Mechanical Engineering	3 <sup>rd</sup> Semester

**1. RATIONALE**

This subject of Manufacturing Engineering provides knowledge regarding different types of manufacturing processes used to produce variety of metal products used in automobile and other machines and equipment. It also develops understanding that can be used to suggest and manipulate vital process parameters related to different manufacturing processes so that the high quality component may be produced at low cost and in minimum time, this is important if we want to compete in today's global market. It also provides information about behavior of metal and change in it during different manufacturing process.

As a technician the knowledge and practical skills in different manufacturing processes are essential and hence emphasis is also given in this course towards skills development. Further the technician should be able to handle machine, equipment, tools and accessories in the recommended manner and also follow safety precautions.

This subject is divided in two courses i.e. Manufacturing Engineering –I and Manufacturing Engineering-II. This course of Manufacturing-I deals with some of the above contents.

**2. COMPETENCY (Programme Outcome as per NBA Terminology)**

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

- **Produce the job as per given specification by selecting and applying appropriate manufacturing processes like Casting, Forming, Joining, using optimum process parameters and safe working procedures.**

**3. TEACHING AND EXAMINATION SCHEME**

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

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

#### 4. COURSE DETAILS

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA Terminology)	Topics and Sub-topics
<b>Unit – I Introduction to manufacturing processes</b>	1.a Explain the basic manufacturing processes. 1.b Describe various mechanical properties involved.	1.1 Nature, role and scope of manufacturing processes. 1.2 Role of machining, forming, casting and joining processes in manufacturing of industrial components. 1.3 Recall mechanical properties of material.
<b>Unit – II Metal working processes</b>	2.a Compare the principles of hot and cold working Process. 2.b Identify and explain various metal working processes. 2.c Suggest appropriate metal working process and basic parameters for a given industrial component.	2.1 Concept, principles and differences of hot and cold working processes. 2.2 Classification of forming processes. 2.3 Rolling, Forging, Spinning, Drawing, Extrusion, Swaging. <ol style="list-style-type: none"> <li>i. Types.</li> <li>ii. Working principle.</li> <li>iii. Equipments used and their specifications.</li> <li>iv. Major parts of equipments and their construction of materials and functions.</li> <li>v. Process parameters.</li> <li>vi. Applications.</li> </ol>
<b>Unit – III Metal casting processes</b>	3.a Appreciate the need of casting process. 3.b Calculate pattern allowances. 3.c Interpret the standard color coding on pattern as well as core. 3.d Suggest appropriate casting method suitable for a given industrial component. 3.e Identify casting defects, their causes and suggest remedies.	3.1 Basic concept of foundry process. 3.2 Types of foundries. 3.3 Pattern: <ol style="list-style-type: none"> <li>i. Importance.</li> <li>ii. Types and materials of construction.</li> <li>iii. Allowances, their need and normal values.</li> <li>iv. Drawings and color codes.</li> <li>v. Making process.</li> <li>vi. Applications.</li> </ol> 3.4 Cores: <ol style="list-style-type: none"> <li>i. Need.</li> <li>ii. Types.</li> <li>iii. Making materials and its properties.</li> <li>iv. Testing methods.</li> <li>v. Sintering.</li> <li>vi. Applications.</li> </ol> 3.5 Types, working and applications of furnaces. 3.6 Molding sand: <ol style="list-style-type: none"> <li>i. Sand properties.</li> <li>ii. Sand mixing.</li> <li>iii. Sand binders.</li> </ol>



Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA Terminology)	Topics and Sub-topics
		3.7 Molding equipments, their major specifications and applications. 3.8 Types of mould, mould making, mould sintering and applications of mould. 3.9 Salvage techniques. 3.10 Recovery of sand. 3.11 Casting processes: basic principle, working, process parameters and applications. <ol style="list-style-type: none"> <li>i. Centrifugal.</li> <li>ii. Die.</li> <li>iii. Investment.</li> <li>iv. Shell molding.</li> </ol> 3.12 Casting defects -types, causes, effects and remedies. 3.13 Safety precautions in foundry.
<b>Unit – IV</b>  <b>Non metal moulding processes</b>	4.a Suggest appropriate moulding method suitable for a given non metal industrial component.	4.1 Concept, basic principle, major parts, working and their materials of construction, process parameters and applications of: <ol style="list-style-type: none"> <li>i. Injection moulding.</li> <li>ii. Blow moulding.</li> <li>iii. Extrusion process.</li> </ol> 4.2 Safety precautions.
<b>Unit – V</b>  <b>Metal joining processes</b>	5.a Appreciate the need of joining process to reduce cost and time. 5.b Explain different welding processes. 5.c Identify the area of applications of a particular joining process. 5.d Suggest appropriate process and process parameters based on given joining situation. 5.e Practice standard safety norms during any joining process.	5.1 Introduction and classification. 5.2 Welding: working principle, setup sketch, specifications of equipment and consumables, functions of each element, process parameters for various materials, applications and safety precautions for: <ol style="list-style-type: none"> <li>i. Gas welding (Oxy-acetylene, Air-acetylene, oxy-hydrogen and LPG (Liquid Petroleum Gas)- oxygen.</li> <li>ii. Arc welding (Carbon arc, metal arc, MIG (Metal Inert Gas), TIG (Tungsten Inert Gas), flux coated arc and submerged arc).</li> <li>iii. Resistance welding (butt, spot, seam, projection and percussion).</li> <li>iv. Thermit welding.</li> <li>v. Forged welding.</li> </ol> 5.3 Welding defects -types, causes, effects and remedies. 5.4 Working principle, setup sketch, specifications of equipment, tools and consumables, functions of each element, process parameters for various materials, applications and safety precautions for:

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA Terminology)	Topics and Sub-topics
		i. Soldering. ii. Brazing. 5.5 Adhesive joining - process, applications. 5.6 Fastening process - process, applications.

## 5 SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to manufacturing processes.	03	03	02	00	05
II	Metal working processes.	12	05	07	08	20
III	Metal casting processes.	12	05	07	08	20
IV	Non metal moulding processes.	03	02	03	00	05
V	Metal Joining Processes.	12	05	07	08	20
<b>Total</b>		<b>42</b>	<b>20</b>	<b>26</b>	<b>24</b>	<b>70</b>

### Notes:

- 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.
- If midsem test is part of continuous evaluation, unit numbers I, II (2.1 and 2.2-only rolling, forging and spinning), III (Up to 3.6) and IV are to be considered. It is also compulsory for student to complete experiment.no.1 to 6 to eligible for midsem test.
- 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.

## 6. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of practical skills (**Course 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 course outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of **Programme Outcomes/Course Outcomes in affective domain** as given in a common list at the beginning of curriculum document for this programme. Faculty should refer to that common list and should ensure that students also acquire those programme outcomes/course outcomes related to affective domain.

S. No.	Unit Number	Practical/Exercise (Course Outcomes in Psychomotor Domain according to NBA Terminology)	Hours
1	II	Prepare two jobs using hot forging/hot smithy process. This includes cutting of raw material and preparation of pre forged parts.	06
2	II	Demonstration of spinning process with preparation of a job.	04
3	II	Visit a nearby Rolling mill/Hot-Cold material processes, allied manufacturing processes industry and prepare a two page report comprises of details(type, material, process, etc) of items produced, quantities, different sections, equipments used with specification, process parameters being used and consumables.	--
4	III	Demonstration of metal melting, metal pouring, metal casting and casting finishing. Also demonstrate and prepare a report on casting defects. (Use wax in place of molten metal for the purpose of demonstration.)	04
5	III	Prepare a pattern drawing, pattern and core from the given component/drawing.	06
6	III	Prepare a mould using prepared pattern, core and moulding sand. Also pour molten metal and get the casting.	06
7	III	Visit a nearby foundry and prepare a two page report comprises of details (type, material, process, etc) of items produced, quantities, different sections, equipments used with specification, process parameters being used and consumables.	--
8	IV	Prepare at least two jobs containing minimum 4 parts in each using arc welding. This includes cutting of raw material and preparation of pre-weld parts and use tacks and continuous welding in each job.	08
9	IV	Prepare at least two jobs using gas cutting and gas welding. This includes cutting of raw material and preparation of pre-weld parts. Minimum 3 parts for each job should be taken and should include tacks and continuous welding.	06
10	IV	Prepare a job using spot/seam resistance welding. This also includes cutting of raw material and preparation of pre-weld parts.	04
11	IV	Prepare two jobs, one using soldering and another using brazing. This also includes cutting of raw material and preparation of pre weld parts.	06
12	IV	Visit a nearby fabrication industry and prepare a two page report comprises of types of item produced, quantities, different sections, equipments used with specification and consumables.	--
13	ALL	SCHOOL WITHIN SCHOOL: Each student will present and will prepare report on: a. His/her observation for the jobs made. b. His/her experience during industrial visits. c. Process parameters and their effects.	06
<b>TOTAL</b>			<b>56</b>

**Notes:**

- a. It is compulsory to prepare log book of exercises. It is also required to get each exercise recorded in logbook, checked and duly dated signed by teacher.
- b. Student activities are compulsory and are also required to be performed and noted in logbook.
- c. Term work report must not include any photocopy/ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only.
- d. Term work report content of each experience should also include following.
  - i. Experience description / data and objectives.
  - ii. Drawing of experience / setup with labels/nomenclature to carry out the experience.
  - iii. The specifications of machines / equipments / devices / tools /instruments /items/elements which is / are used to carry out and to check experience.
  - iv. Process parameters / setup settings' values applied to carry out experience.
  - v. Steps / Process description to execute experience.
- e. For 40 marks ESE, students are to be assessed for competencies achieved. They should be given following tasks( minimum two):
  - ii. Prepare pattern drawing and pattern from given component/component drawing.
  - iii. Prepare weld joint job from given drawing.
  - iv. Prepare job from given drawing using gas welding/gas cutting.
  - v. Prepare job from given drawing using any one resistance welding method.
  - vi. Competency based questions and answers.

**7. SUGGESTED LIST OF STUDENT ACTIVITIES**

Sr. No.	Activity.
1	Select four industrial components (approved by teacher) and list various methods of manufacturing used to produce these components.
2	Select at least two components which are made by casting only. Also state the type of casting method used.
3	Prepare a list of household items which are prepared by joining processes.
4	Prepare a list of plastic items which are produced using different types of molding methods. Also name the process used.
5	Prepare a list of industries/workshops in the nearby area which are producing components by machining, casting and forming.
6	Identify the type of manufacturing process used in making main component of a car engine.

**8. SPECIAL INSTRUCTIONAL STRATEGIES (If ANY)**

Sr. No.	Unit	Unit Title	Strategies
1	I	Introduction to manufacturing processes.	Share the experience. Show various movies.
2	II	Metal working processes.	Demonstration. Movies. Live examples with suitable components. Industrial visits. Show effect of process parameters.
3	III	Metal casting processes.	
4	IV	Non metal casting processes.	
5	V	Metal Joining Processes.	

**9. SUGGESTED LEARNING RESOURCES****(A) List of Books:**

Sr no.	Title of Books	Author	Publication
1.	Workshop Technology I & II	J. A. Schey	Tata MacGraw Hill Education
2.	Workshop Technology I & II	Raghuwanshi	Dhanpat Rai and Sons
3.	Workshop Technology I, II & III	W. A. J. Chapman	Arnold
4.	Manufacturing Processes	M. L. Begman	Wiley India
5.	Production Technology	R.K. Jain and S.C. Gupta	Khanna publication
6.	Welding Engineering	B.E. Rossi	Jefferson Publications
7.	Audles Welding Guide	F.D. Graham	Wiley India
8.	Foundry Engineering	P.L. Jain	Tata MacGraw Hill Education
9.	Principle of Foundry	Jain & Gupta	National Book Trust, India
10.	Manufacturing Processes	S.E. Rusinoff	Times of India Press
11.	Production Technology	H.H. Marshall	Machinery Publishing Company

**(B) List of Software/Learning Websites:**

- a: [www.youtube.com/watch?v=k6iODHla6qY](http://www.youtube.com/watch?v=k6iODHla6qY)
- b: [http://web.iitd.ac.in/~pmpandey/MEL120\\_html/Metal%20Forming%20Processes.pdf](http://web.iitd.ac.in/~pmpandey/MEL120_html/Metal%20Forming%20Processes.pdf)
- c: [http://thelibraryofmanufacturing.com/forming\\_basics.html](http://thelibraryofmanufacturing.com/forming_basics.html)
- d: [http://www3.nd.edu/~manufact/MPEM%20pdf\\_files/Ch07.pdf](http://www3.nd.edu/~manufact/MPEM%20pdf_files/Ch07.pdf)
- e: [www.ielm.ust.hk/dfaculty/ajay/courses/ieem215/lecs/3\\_forming.pdf](http://www.ielm.ust.hk/dfaculty/ajay/courses/ieem215/lecs/3_forming.pdf)
- f: [www.youtube.com/watch?v=HkjMdp9KVU](http://www.youtube.com/watch?v=HkjMdp9KVU)
- g: <http://www-old.me.gatech.edu/jonathan.colton/me4210/casting.pdf>
- h: <http://www.mccannsales.com/book/sandcasting.pdf>
- i: <http://me.emu.edu.tr/me364/2.pdf>
- j: [http://www.ielm.ust.hk/dfaculty/ajay/courses/ieem215/lecs/8\\_joining.pdf](http://www.ielm.ust.hk/dfaculty/ajay/courses/ieem215/lecs/8_joining.pdf)
- k: [http://www.tech.plym.ac.uk/sme/mats116/Materialsjoiningprocesseslecturenotes\\_docx.pdf](http://www.tech.plym.ac.uk/sme/mats116/Materialsjoiningprocesseslecturenotes_docx.pdf)
- l: <http://www.aws.org/w/a/>
- m: [www.youtube.com/watch?v=H3Qb9I03FCk](http://www.youtube.com/watch?v=H3Qb9I03FCk)
- n: [www.youtube.com/watch?v=JqFp5kCeTA0](http://www.youtube.com/watch?v=JqFp5kCeTA0)

- o: [www.youtube.com/watch?v=7F0ypF6IdrU](http://www.youtube.com/watch?v=7F0ypF6IdrU)
- p: <http://www.flamingfurnace.com/>
- q: <http://www.sme.org>
- r: <http://www.youtube.com/watch?v=IrcNSgLZuFs> (Metal Casting)
- s: <http://www.youtube.com/watch?v=Yk1JOYzwRP4> (Loose piece Pattern)
- t: [http://www.youtube.com/watch?v=khEvhjhlh\\_SM](http://www.youtube.com/watch?v=khEvhjhlh_SM) (Foundry Pattern making)
- u: <http://www.youtube.com/watch?v=f7FXtnXVqzY> (Aluminium Casting)
- v: <http://www.youtube.com/watch?v=dOw624I9FDQ> (Investment Casting)
- w: <http://www.youtube.com/watch?v=bzSSfBgkWfc&NR=1&feature=endscreen> (Hot Chamber Die Casting Process)
- x: <http://www.youtube.com/watch?v=UI00-KoC1Oc> (Shell Moulding)
- y: <http://www.youtube.com/watch?v=pTTap4WiEAU> (Gravity Die Casting)
- z: <http://www.youtube.com/watch?v=eUthHS3MTdA> (Plastic Injection Moulding)
- aa: [http://www.youtube.com/watch?v=6xnKmt\\_gsLs](http://www.youtube.com/watch?v=6xnKmt_gsLs) (Hot Rolling)
- bb: [http://www.youtube.com/watch?v=9MU0vSN\\_w-A](http://www.youtube.com/watch?v=9MU0vSN_w-A) (Cold roll forming)
- cc: <http://www.youtube.com/user/IGEJohannesen?feature=watch> (Channel For welding videos)
- dd: <http://www.youtube.com/watch?v=SDJdiNeDXto> (Introduction to Welding)
- ee: <http://www.youtube.com/watch?v=CJ42scaWFnw> (Brazing video)

### (C) List of equipments:

- a. Pattern Making:
  - i. Wood cutting planer machine/Wood jack plane
  - ii. Carpentry vice
  - iii. Flat file
  - iv. Hammer
  - v. Steel rule
  - vi. Right angle
  - vii. Saw
- b. Molding
  - i. Cope and drag Boxes
  - ii. Molding sand with additives and binder
  - iii. Vent wire
  - iv. Furnace or Oven
  - v. Consumable (Wax)
- c. Smith forging
  - i. Anvil
  - ii. Furnace
  - iii. Hammer
  - iv. Tong
  - v. Steel rule
  - vi. Air blower
  - vii. Swage block
- d. Spot/Resistance welding
  - i. Spot welding machine
  - ii. Plier cutter
  - iii. Hammer
  - iv. Steel rule

- v. Anvil
- e. Arc welding
  - i. Arc welding Machine with electrode holder
  - ii. Tong
  - iii. Chipping hammer
  - iv. Wire brush
  - v. Hand gloves
  - vi. Hand screen
  - vii. Safety goggles
- f. Gas welding
  - i. Oxy acetylene gas cylinders with regulators
  - ii. Welding torch
  - iii. Tong
  - iv. Chipping Hammer
  - v. Steel rule
  - vi. Hand gloves
  - vii. Safety goggles
- g. Gas Cutting
  - i. Oxy acetylene gas cylinders
  - ii. Cutting torch
  - iii. Tong
  - iv. Steel rule
- h. Brazing
  - i. Brazing torch
  - ii. Consumables
  - iii. Tong
  - iv. Hammer
  - v. Anvil
  - vi. Wire brush
- i. Spinning
  - i. Hand shearing Machine/ cutter Plier
  - ii. Hammer
  - iii. Steel rule
  - iv. Lathe Machine
  - v. Spinning tool

## 10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### Faculty Members from Polytechnics

- **Prof. M. M. Jikar**, HOD, Department of Mechanical Engineering, N. G. Patel Polytechnic, Bardoli.
- **Prof. M. K. Patel**, Lecturer, Department of Mechanical Engineering, M. L. Institute of Diploma Studies, Bhandu.

### Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. S.K.Pradhan**, Associate Professor and Head Department of Mechanical Engineering
- **Dr. Vandana Somkuwar** Associate Professor, Department of Mechanical Engineering

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

**Course Curriculum**

**THERMODYNAMICS**

**(Code: 3331902)**

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
Mechanical Engineering	3 <sup>rd</sup> Semester

**1. RATIONALE**

Thermodynamics is a science of energy transfer and its effect on physical properties of substances. It is based upon observations of common experiences of energy (mainly heat) transfer. Thermodynamic laws have been formulated based on these experiences. In this course, work and heat transfer with changes in associated properties is studied based on laws of thermodynamics. This course will provide an understanding of the basic principles of thermodynamics which is must for understanding of major fields of mechanical engineering and technology notably in steam and nuclear power plants, internal combustion engines, gas turbines, air conditioning, refrigeration, gas dynamics, jet propulsion, compressors and energy conversion in different devices.

**2. COMPETENCY (Programme Outcome according to NBA Terminology):**

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

- **Apply basic concepts, laws and principles of thermodynamics to use and select equipments/devices/machines working on these basics.**

**3. TEACHING AND EXAMINATION SCHEME**

<b>Teaching Scheme (In Hours)</b>			<b>Total Credits (L+T+P)</b>	<b>Examination Scheme</b>				
<b>L</b>	<b>T</b>	<b>P</b>		<b>Theory Marks</b>		<b>Practical Marks</b>		<b>Total Marks</b>
<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>ESE</b>	<b>PA</b>	<b>ESE</b>	<b>PA</b>	
3	0	0	3	70	30*	00	00	<b>100</b>

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

\* 30 marks of Theory PA include two assignments each of 5 marks. First assignment must have total 12 numerical from Unit number I,II and III. Second assignment must be of 10 numerical from Unit number IV and V and report on student activities performed. Each numerical of each assignment must have different parameters for each student, that is each student will get total 22 numerical with same problem but with varied parameters. (Values of temperature, pressure, volume, etc may be different for each student.).



## 4. COURSE DETAILS

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
<b>Unit – I</b> <b>Basic concepts of thermodynamics</b>	1.a Identify a thermodynamic property and use it with appropriate units. 1.b Explain Zeroth law of thermodynamics.	1.1 Introduction. 1.2 Thermodynamic systems-concept, terminology associated, classification, concept of continuum. 1.3 Thermodynamics properties & their units. 1.4 Concept of energy, heat, work and power- types & simple numerical examples. 1.5 Zeroth law of thermodynamics and its application. 1.6 Name of various Temperature measurement devices/instruments used with related units.
<b>Unit – II</b> <b>First law of thermodynamics</b>	2.a Explain first law of thermodynamics. 2.b Apply first law of thermodynamics to real life situations.	2.1 Joule's experiment-set up & significance. 2.2 Law of conservation of energy. 2.3 First law of thermodynamics with reference to: i. Closed system. ii. System undergoing a change of state. iii. Open system. 2.4 Energy equation & its application to: i. Non flow process. ii. Open system. iii. Steady flow (Steady flow energy equation –SFEE) 2.5 Limitations of first law of thermodynamics. 2.6 Simple numerical examples based on above.
<b>Unit – III</b> <b>Ideal gases and thermodynamic processes</b>	3.a Explain various ideal gas laws & thermodynamic processes. 3.b Calculate amount of heat transfer, work transfer & internal energy associated with the process.	3.1 Various ideal gas laws. 3.2 Characteristic gas equation and Universal gas constant. 3.3 Specific heats & their relationship. 3.4 Different thermodynamic processes, their representation on P-V (Pressure-Volume) and T-s (Temperature-Entropy) diagram. 3.5 Equations for PVT relationship, work transfer, heat transfer internal energy (without derivations).

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
		3.6 Simple numerical examples based on above.
<b>Unit – IV Second law of thermodynamics</b>	4.a Describe second law of Thermodynamics. 4.b Apply second law of thermodynamics in real life problems. 4.c Appreciate importance of entropy.	4.1 Concept and real life examples of heat source, heat sink (reservoir), heat engine, heat pump and refrigerator. 4.2 Second law of thermodynamics. i. Kelvin-Planck statement ii. Clausius statement. iii. Equivalence of above two statements. iv. Corollary. 4.3 Concept of thermal efficiency and COP (Coefficient of Performance). 4.4 Concept, importance and examples of entropy. 4.5 Concept of reversibility and irreversibility of thermodynamic processes causes of irreversibility. 4.6 Carnot cycle, representation on P-V, T-s diagrams, derivation, examples.
<b>Unit – V Thermodynamic cycles</b>	5a. Identify thermodynamic processes in a cycle. 5b. Plot various cycles on property diagram 5c. Derive expression for efficiency. 5d. Solve simple examples of power producing cycle.	5.1 Concept of air standard efficiency. 5.2 Otto, Diesel & Dual Combustion cycle : i. Representation on P-V & T-s diagram, derivation for air standard efficiency & simple examples. ii. Limitations, applications & comparison of above cycles based on different parameters. 5.3 Refrigeration cycles: Reversed Carnot cycle, Reversed Brayton cycle: i. Representation on P-V & T-s diagram & expression for COP (without derivation).

**5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)**

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basic concepts of thermodynamics	06	04	03	03	10
II	First law of thermodynamics	06	03	03	04	10
III	Ideal gases and processes	10	04	06	06	16
IV	Second law of thermodynamics	10	04	07	05	16
V	Thermodynamic cycles	10	04	06	08	18
<b>Total</b>		<b>42</b>	<b>19</b>	<b>25</b>	<b>26</b>	<b>70</b>

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

**Notes:**

1. This specification table shall be treated as a general guideline for students and Teachers. The actual distribution of marks in the question paper may slightly vary from above Table.
2. If midsem test is part of continuous evaluation, unit numbers I, II and unit III up to 3.4 are to be considered.
3. 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.

**6. SUGGESTED LIST OF PRACTICAL/EXERCISES**

**Not Applicable**

**7. SUGGESTED LIST OF STUDENT ACTIVITIES**

Sr. No.	Activity.
1	Identify and list real situations which works on: a: Zeroth law. b: First law of thermodynamics. c: Second law of thermodynamics.
2	Prepare charts of diesel, dual and gasoline cycles. Tabulate main points of differences between them.
3	Write the specifications of domestic refrigerator available at your home and I.C.Engine of any two wheelers. Also draw & explain cycle on which domestic refrigerator and I.C.Engine works.
4	Prepare chart of p-v & p-h diagram for refrigeration cycle.
5	Prepare chart for different thermodynamics process with the help of p-v, t-s, h-s diagram.

**8. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)**

Sr. No.	Unit	Unit Title	Strategies
1	I	Basic concepts of thermodynamics.	Real life examples. Demonstration of real systems. Movies/Animations. Numerical.
2	II	First law of thermodynamics.	
3	III	Ideal gases and processes.	
4	IV	Second law of thermodynamics.	
5	V	Thermodynamic cycles.	

**9. SUGGESTED LEARNING RESOURCES****(A) List of Books:**

Sr. No.	Title of Books	Author	Publication
1.	Thermodynamics	R. Yadav	CPH
2.	Thermodynamics for Engineers	M.L. Mathur	Dhanpatrai & sons
3.	Heat Engines	C.S. Shah & N.C. Pandya	Charotar Publi. House
4.	Elements of Heat Engines Vol. I&II	R.C. Patel &	Acharya Book Depot
6.	Thermodynamics	SAAD	Prentice-Hall
7.	Engineering Thermodynamics- 2nd edition	P. K. Nag	McGraw Hill Education
8.	Applied Thermodynamics	R.C. Patel	Acharya Book Depot
9.	Thermodynamics	Gupta	Pearson

**(B) List of Software/Learning Websites:**

- a. <http://www.nptel.iitm.ac.in/video.php?subjectId=112105123>(IIT-B Video lectures)
- b. <http://www.thermofluids.net/>
- c. <http://www.learnerstv.com/Free-Engineering-Video-lectures-ltv301-Page1.htm>
- d. <http://www.grc.nasa.gov/WWW/k-12/airplane/thermo.html>
- e. <http://www.youtube.com/watch?v=Xb05CaG7TsQ>
- f. <http://www.youtube.com/watch?v=aAfBSJObd6Y>
- g. <http://www.youtube.com/watch?v=DHUwFuHuCdw>
- h. <http://www.youtube.com/watch?v=kJlmRT4E6R0>
- i. <http://www.youtube.com/watch?v=GKqG6n6nAmg>

**10. COURSE CURRICULUM DEVELOPMENT COMMITTEE****Faculty Members from Polytechnics**

- **Prof. S. R. Pareek**, Head of Department, Mechanical Engineering Department, Tolani F. G. Polytechnic, Adipur.
- **Prof. D. M. Trivedi**, Lecture in Mechanical Engineering, K.J. Polytechnic, Baruch.
- **Prof. Shah Atul S.**, Lecturer in Mechanical Engineering, Government Polytechnic, Waghai.
- **Prof. M. N. Patel**, Lecturer in Mechanical Engineering, Government Polytechnic, Chhota Udepur.

**Coordinator and Faculty Members from NITTTR Bhopal:**

- **Prof. Sharad Pradhan**, Associate Professor and Head Department of Mechanical Engineering,
- **Dr. Vandana Somkuwar** Associate Professor, Department of Mechanical Engineering

## GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

### Course Curriculum

#### FLUID MECHANICS AND HYDRAULIC MACHINES

(Code: 3331903)

Diploma Programmes in which this course is offered	Semester in which offered
Mechanical Engineering	3 <sup>rd</sup> Semester

### 1. RATIONALE

The main objective of this course is to understand the fundamentals of the fluid mechanics such as fluid and flow properties, fluid behaviour at rest and in motion and fundamental equations like mass, energy and momentum conservation of the fluid flow thereby developing an understanding of fluid dynamics in variety of fields. Applications of these basic equations have been highlighted for flow measurements. Hydraulic machinery plays an important role in the conversion of hydraulic energy to mechanical energy and vice-versa. Hydraulic turbines are used for meeting our day-to-day power demands. Also different types of pumps are essential equipment in all the industries. It is also tried to develop an understating of hydraulic & pneumatic devices generally used in industries through this course. Hydraulic systems have a wide range of applications in machine tools, material handling, marine, mining, metal processing, equipment and other fields. Similarly pneumatic control is extensively used as an effective method of automation technique.

### 2. COMPETENCY (Programme Outcome according to NBA Terminology)

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

- **Select, operate and maintain fluid machinery based on fluid laws and characteristics.**

### 3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
4	0	2	6	70	30	20	30	

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

#### 4. COURSE DETAILS

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
<b>Unit – I</b>  <b>Fluid and fluid properties</b>	1.a Explain the effect of fluid properties on a flow system.	1.1 Concept and classification of fluid. 1.2 Properties of fluid 1.3 Newton's law viscosity. 1.4 Simple numerical examples.
<b>Unit – II</b>  <b>Fluid statics</b>	2.a Select and use pressure measuring devices.	2.1 Laws of fluid statics. 2.2 Types, working and applications of pressure measuring devices (Manometers and mechanical gauges) with simple numerical examples. 2.3 Selection criteria for pressure measuring devices.
<b>Unit – III</b>  <b>Fluid kinematics</b>	3.a Identify type of fluid flow patterns. 3.b Describe and use Continuity equation to one dimensional fluid flow situations.	3.1 Concept of control volume. 3.2 Fluid flow <ul style="list-style-type: none"> <li>i. Continuity and energy equation.</li> <li>ii. Momentum equations (without derivation) and its application in impact of jet.(The detail applications should be dealt in Unit VII.)</li> <li>iii. Types of fluid flow.</li> <li>iv. Flow patterns for ideal, laminar, turbulent and compressible fluid flow of one dimension.</li> </ul> 3.3 Simple numerical problems on all of above.
<b>Unit – IV</b>  <b>Fluid dynamics and flow measurement</b>	4.a Explain and Apply Fluid equations (Energy, Momentum and Bernoulli's) in simple Industrial situations. 4.b Select and use flow measuring devices based on given situation.	4.1 Fluid energy-types and interrelations. 4.2 Euler's equation. <ul style="list-style-type: none"> <li>i. Concept and definition.</li> <li>ii. Understanding various terms in Euler's equation (No derivation).</li> </ul> 4.3 Bernoulli's equation. <ul style="list-style-type: none"> <li>i. Concept and definition.</li> <li>ii. Limitations and assumptions.</li> <li>iii. Derivation from Euler's</li> </ul>

		<p>equation.</p> <p>iv. Applications.</p> <p>4.4 Flow measurement.</p> <p>i. Parameters and units of measurements related to following devices.</p> <p>ii. Devices- classifications, principle, working, applications without derivation. (Pitot tube, Venturi meter, Flow nozzle, Rota meter, Orifice, Notch).</p> <p>4.5 Selection criteria for flow measuring device.</p> <p>4.6 Simple numerical examples on all of above.</p>
<p><b>Unit – V</b></p> <p><b>Flow through pipes</b></p>	<p>5.a Explain water hammer and surge tank</p> <p>5.b Select pipe of appropriate size based on given situation.</p>	<p>5.1 Introduction to pipe and pipe flow.</p> <p>5.2 Reynolds's experiment, friction factor, Darcy's equation, Moody's chart.</p> <p>5.3 Water hammer effect.</p> <p>5.4 Selection criteria for pipes and pipe sizes.</p> <p>5.5 Simple numerical examples.</p>
<p><b>Unit – VI</b></p> <p><b>Hydraulic pumps &amp; prime movers</b></p>	<p>6.a Select and use an appropriate pump with reference to given application.</p> <p>6.b Estimate performance parameters of a given Centrifugal and Reciprocating Pump.</p> <p>6.c Interpret characteristic curves of a given pump.</p> <p>6.d Select an appropriate turbine with reference to given situation.</p>	<p><b>Pumps:</b></p> <p>6.1 Concept and classification of pumps.</p> <p>6.2 Detailed study (construction, working and applications) of</p> <p>i. Centrifugal pump.</p> <p>ii. Reciprocating pump.</p> <p>iii. Submersible pump.</p> <p>iv. Rotary positive displacement type pumps like Gear pump and Van pump.</p> <p>v. Vacuum pump.</p> <p>6.3 Performance (efficiency, discharge, head, specific speed and power consumption) of centrifugal pump and reciprocating pump with simple numerical example.</p> <p>6.4 Characteristic curves of centrifugal pump and reciprocating pump.</p> <p>6.5 Need for priming of centrifugal pump.</p> <p>6.6 Selection of pumps.</p> <p><b>Hydraulic prime movers (Turbine).</b></p> <p>6.7 Classification, construction, working principle and applications</p>



		of: i. Pelton wheel. ii. Francis turbine. iii. Kaplan turbine. 6.8 Selection criteria of prime movers.
<b>Unit – VII</b> <b>Hydro pneumatic elements and devices</b>	7.a Select and use proper hydro-pneumatic devices/equipments.	7.1 Types, sketch, working, specifications, symbols and applications of hydraulic and pneumatic elements like: i. Cylinder. ii. Valve. iii. Manifolds, etc.  7.2 Hydraulic devices-  i. Hydraulic press. ii. Hydraulic accumulator. iii. Hydraulic lift iv. Hydraulic ram v. Hydraulic crane vi. Hydraulic coupling vii. Hydraulic intensifier. (Explain working of each with labelled schematic diagram, their specifications and Applications)

### 5. SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fluid and fluid properties	04	2	2	2	06
II	Fluid statics	07	2	3	4	9
III	Fluid kinematics	07	2	3	4	9
IV	Fluid dynamics and flow measurement	10	4	4	4	12
V	Flow through pipes	06	2	4	2	08
VI	Hydraulic pumps & prime movers	12	2	6	6	14
VII	Hydro pneumatics elements and devices	10	2	4	6	12
<b>Total</b>		<b>56</b>	<b>16</b>	<b>26</b>	<b>28</b>	<b>70</b>

#### Notes:

- a. 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.

- b. If midsem test is part of continuous evaluation, unit numbers I, II, IV (Up to 4.3 only), and V are to be considered. It is also compulsory for student to complete exercises.no.1 to 5 to eligible for midsem test.
- c. 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.

## 6. LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of practical skills (**Course 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 course outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of **Programme Outcomes/Course Outcomes in affective domain** as given in a common list at the beginning of curriculum document for this programme. Faculty should refer to that common list and should ensure that students also acquire those programme outcomes/course outcomes related to affective domain.

S. No.	Unit No.	Practical/Exercises (Course Outcomes in Psychomotor Domain according to NBA Terminology)	Approx. Hrs. Required
1	I	Demonstrate various fluid properties.	2
2	II	Demonstrate and Measure pressure using: i. Various manometers. ii. Various Pressure gauges.	4
3	IV	Verify Bernoulli's theorem.	2
4	IV	Measure fluid flow by Venturimeter and Nozzle.	4
5	IV	Measure fluid flow by Orifice meter and "V" notch.	4
6	III & V	Estimate Reynolds number using given test rig.	2
7	V	Determine major and minor head loss through pipes.	2
8	VI	Perform testing of centrifugal pump as per BIS.	2
9	VI	Perform testing of reciprocating pump as per BIS.	2
10	VII	Demonstrate use of different hydraulic and pneumatic devices.	2
11	ALL	A group of 5-6 students will take any one hydraulic/ pneumatic device for study/repair purpose. They will : a: Study the same and will prepare required sketches. b: Explain working. c: Identify faults if not working. d: Repair minor faults. (This exercise has to be identified and given to the students in the beginning of term.).	2
<b>Total</b>			<b>28</b>

**Notes:**

- a. It is compulsory to prepare log book of exercises. It is also required to get each exercise recorded in logbook, checked and duly dated signed by teacher.
- b. Student activities are compulsory and are also required to be performed and noted in logbook.
- c. Term work report must not include any photocopy/ies, printed manual/pages, lithos, etc. It must be hand written / hand drawn by student only.
- d. Term work report content of each Exercise should also include following.
  1. Exercise description / data and objectives.
  2. Drawing of Exercise / setup with labels/nomenclature to carry out the Exercise.
  3. The specifications of machines / equipments / devices / tools /instruments /items/elements which are / are used to carry out and to check Exercise.
  4. Process parameters / setup settings' values applied to carry out Exercise.
  5. Steps / Process description to execute Exercise.
  6. Information on recent machines / equipments / devices / tools /instruments /items available in market to carry out the Exercise.
  7. Special / Additional notes or remarks.
- e. For 20 marks ESE, students are to be assessed for competencies achieved. They should be given :
  - i. any one set of exercise/practical to be performed, and
  - ii. Competency based questions and answers.

**7. SUGGESTED LIST OF STUDENT ACTIVITIES**

1	Prepare a tabulated summary for types of fluid which is available around you. (Summary includes properties of fluid indicated in chapter-1)
2	List out any five pressure measuring devices available in market with its specifications and current market price.
3.	Prepare a tabulated summary for types of pipes available in market. (Summary includes type, specification, size range, material, rate and applications).
4	Identify any one hydraulic pump and one prime mover available in market in a group of five students with detail specifications and current price.
5	Visit a nearby related industry and prepare a summary of hydro-pneumatic devices used along with their specifications.

**8. SPECIAL INSTRUCTIONAL STRATEGIES (If any)**

Sr. No.	Unit	Strategies
1	I	Demonstration with fluids.
2	II	Video movies.
3	III	Video movies.
4	IV	Video movies.
5	V	Demonstration with pipes.
6	VI	Live models/actual equipments to be used.
7	VII	Live models/actual equipments to be used.

## 9. SUGGESTED LEARNING RESOURCES

### (A) List of Books:

S. No.	Title of Books	Author	Publication
1	Fluid mechanics& hydraulic Machines.	R.K.Bansal	Lakshmi publication
2	Fluid mechanics& hydraulic Machines. (in S.I. units)	R.S.Khurmi	S.chand & Co.Ltd
3	Hydraulic & Hydraulic machines	R.C. Patel & A.D. Pandya	Acharya Book Depot
4	Fluid mechanics& hydraulic	A.R. Basu	DHANPAT RAI&
5	Fundamental of fluid mechanics(in S.I. units)	Dr. D.S. Kumar	Ketson Pub. house
6	Fluid mechanics& hydraulic machines	S.C. Gupta	PERSON Education
7	Hydraulic Machines & Fluidics	Dr. Jagdishlal book co.	Metropolitan
8	Industrial Pneumatic control	Z.J. Lansky	Marcel Dekker, Inc

### (B) List of major equipment/materials:

- a. Different manometers.
- b. Pitot tube.
- c. Various mechanical pressure gauges.
- d. Hydraulic test rig-comprising facilities to verify Bernoulli's theorem , to measure fluid flow by Venturimeter ; nozzle; orifice meter , rota meter, "V" notch and major and minor head loss through pipes.
- e. Centrifugal pump test rig.
- f. Reciprocating pump test rig.
- g. Hydraulic prime movers (Pelton wheel) test rig.
- h. Working model of Francis turbine and Kaplan turbine.
- i. Working models and charts of hydraulic devices.
- j. Reynolds's experiment test rig.
- k. Vacuum pump.
- l. Gear pump.
- m. Submersible pump.
- n. Hydraulic and pneumatic elements like cylinders, valves, manifold, distributors, etc.(All major types).
- o. Hydraulic power pack.

**(C) List of Software/Learning Websites, concerned subject:**

- a. [www.youtube.com/watch?v=VyR8aeioQrU](http://www.youtube.com/watch?v=VyR8aeioQrU)
- b. [http://www.youtube.com/watch?v=R6\\_q5gxf4vs](http://www.youtube.com/watch?v=R6_q5gxf4vs)
- c. [howstuffworks.com](http://www.howstuffworks.com)
- d. <http://www.elearningsofttech.com/elearning-solutions-subjects-engineering-degree-diploma-courses/hydraulics-fluid-mechanics/>
- e. <http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-KANPUR/FLUID-MECHANICS/ui/TOC.htm>
- f. <http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-KANPUR/machine/ui/TOC.htm>
- g. [https://www.youtube.com/watch?v=F\\_7OhKUYV5c&list=PLE17B519F3ACF9376](https://www.youtube.com/watch?v=F_7OhKUYV5c&list=PLE17B519F3ACF9376)
- h. <https://www.youtube.com/watch?v=zOJ6gWDMTfE&list=PLC242EBB626D5FFB5>
- i. <http://www.youtube.com/watch?v=0p03UTgpnDU>
- j. <http://www.youtube.com/watch?v=A3ormYVZMXE>
- k. <http://www.youtube.com/watch?v=TjzKpke0nSU>
- l. <http://www.youtube.com/watch?v=v17GteLxgdQ>
- m. <http://www.youtube.com/watch?v=cIdMNOysMGI>

**10. COURSE CURRICULUM DEVELOPMENT COMMITTEE****Faculty Members from Polytechnics**

- **Prof. H.R. Saprmer**, Lecturer in Mechanical Engineering, Dr. J.N. Mehta Government Polytechnic, Amreli
- **Prof. M.P. Jakhaniya**, Lecturer in Mechanical Engineering, C.U. Shah Government Polytechnic, Surendranagar.
- **Prof. V.P. Patel**, Lecturer in Mechanical Engineering, N.M. Gopani Polytechnic, Ranpur
- **Prof. H.K. Patel**, Lecturer in Mechanical Engineering, Vallabh Budhi Polytechnic, Navsari.

**Coordinator and Faculty Members from NITTTR Bhopal**

- **Prof. Sharad Pradhan**, Associate Professor and Head Department of Mechanical Engineering
- **Dr. C.K. Chugh**, Professor, Department of Electronic Media

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD,  
GUJARAT**

**COURSE CURRICULUM**

**Course Title: Strength of Material  
(Code: 3331904)**

Diploma Programme in which this course is offered	Semester in which offered
Mechanical/ Mechatronics	THIRD

**1. RATIONALE**

We have already studied the external effects due to action of force system in Applied Mechanics in Second Semester. All Mechanical Engineering Components are subjected to different loadings and behave in a specific way. In this course, analysis of determinate structures / components under action of transverse loading, along with, analysis of members under direct and lateral along with shear loading & torsion is analysed. This course will lay sound foundation to analysis & design of Machine Components.

**2. COMPETENCY**

- Understand the behaviour and analyse Statically Determinate structure like beam, Column & Shaft under static loads & twisting moments
- Calculate the machine material properties & dimension of machine component due to direct & lateral loading and due to deflection.

**3. TEACHING AND EXAMINATION SCHEME**

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			C	ESE	PA	ESE	PA	
03	00	02	05	70	30	20	30	<b>150</b>

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

#### 4. COURSE DETAILS

Unit	Major Learning Outcomes	Topics and Sub-topics
<b>Unit – I</b>  <b>DIRECT STRESS &amp; STRAIN</b>	1a. Evaluate Material Properties Under Longitudinal , Lateral Loads & Thermal variation  1b. Analyse Composite & Compound Section for stress& strain.  1c. Compute Strain Energy under Different Types of Loading on elements.	1.1 Different types of Structures and Loads 1.2 Direct Stress , linear Strain , Hook's Law Calculate Numerical on Direct Stress & Linear Strain , Stress Strain curve of Mild Steel , Modulus of Elasticity ,Yield , Breaking & Ultimate Stress and factor of Safety 1.3 Lateral Strain and Poission's ratio 1.4 Temperature Stresses & Strain with & without yielding 1.5 Shear Stress , Shear Strain & Shear Modulus 1.6 Bulk Modulus & Volumetric Strain 1.7 Differentiate Sudden , Gradual & Impact Load Strain Energy & Proof Resilience for Sudden , Gradual & Impact Load with numerical problems
<b>Unit – II</b>  <b>MOMENT OF INERTIA</b>	2 Compute Moment of Inertia of Symmetric & asymmetric structural sections	2.1 Moment of Inertia & its Importance 2.2 Parallel & Perpendicular Axis Theorem 2.3 Formula of Moment of Inertia of solid & Hollow sections like Rectangle , Triangle , Circle 2.4 Moment of Inertia about C.G for I section , H section , Channel Section , Angle Section , T Section and Built up Section having flange plates to I & H Section and of Double Channels back to back & toe to toe
<b>Unit – III</b>  <b>S.F &amp; B.M IN BEAM</b>	3 D raw Shear Force & Bending Moment Diagram for Statically Determinate Beams	3.1 Statically Determinate Beams Like Cantilever , Simply Supported & Over Hang Beam 3.2 Relation between Shear Force and Bending Moment 3.3 Sagging & Hogging Bending Moment and its importance 3.4 Point of Contra flexure & its importance 3.5 S.F & B.M Diagram for Cantilever , Simply Supported & Over Hang Beam elements like shaft , axle , spindle subjected to Point Load and/ or U.D.L
<b>Unit – IV</b>  <b>BENDING STRESSES IN BEAM</b>	4 Use ' Theory of Bending' to compute stresses in Beams	4.1 Bending Theory Equation Bending stress , Sectional Modulus , Nutral Axis Application of Bending theory to Statically determinate beams elements like shaft , axle , spindle , pulley arm having

Unit	Major Learning Outcomes	Topics and Sub-topics
		rectangular or circular section to find out stresses
<b>Unit – V</b> <b>DEFLECTION OF BEAMS</b>	5 Determine deflection induced in Statically Determinate Beams	5.1 Slope & Deflection 5.2 Formulae for Cantilever Beam subjected to Point Load at free end and with full UDL 5.3 Formulae for S.S Beam subjected to Point Load at MID SPAN and with full UDL 5.4 Numerical problems on Slope and Deflection for 5.2 & 5.3
<b>Unit – VI</b> <b>COLUMNS &amp; STRUTS</b>	6 Calculate Load carrying capacity of Column & Strut	6.1 Column & Strut 6.2 Short & Long Column 6.3 End Condition of Column and effective Length of Column & Modes of Failure in column 6.4 Radius of Gyration , Slenderness Ratio 6.5 Euler's Crippling Load & its numerical 6.6 Rankin's load / Buckling Load of Column / screw of screw jack & its numerical
<b>Unit – VII</b> <b>COMBINED DIRECT &amp; BENDING STRESSES</b>	7 Analyse Structural components subjected to Axial Eccentric Loads	7.1 Eccentricity 7.2 Formula for combined Direct & Bending Stresses 7.3 Limit of Eccentricity 7.4 Core section for Rectangular & Circular ( Hollow & Solid ) 7.5 Numerical on Combined Stresses for Rectangle & Circular Section
<b>Unit – VIII</b> <b>PRINCIPAL PLANE &amp; PRINCIPAL STRESS</b>	8. Calculate Principal Stresses on a plane in a Strained structural Material	8.1 Formulae for Normal , Tangential & Resultant Stresses due to Direct Orthogonal Stresses & Shear Stress 8.2 Numericals on Principal Plane & Principal Stress 8.3 Formulae for Principal Stresses and for Location of Principal Planes 8.4 Numerical based on 8.3
<b>Unit – IX</b> <b>TORSION</b>	9a. Analyse Machine Components subjected to Torsion for torsional stress 9b. Calculate Power Transmitted by Shaft , spindle and axle subjected to Torsion	9.1 Torsion , Angle of Twist , Polar Moment of Inertia , Torsional Rigidity 9.2 Formula of Torsional Stress 9.3 Formula for Power Transmitted / Consumed for shaft , spindle and axle of solid and hollow sections subjected to Torsion 9.4 Numericals based on 9.2 & 9.3
<b>Unit – X</b> <b>MECHANICAL PROPERTIES OF MATERIALS</b>	10a. Identify various materials used in Mechanical Engineering 10b. Evaluate Mechanical Properties of Materials used	10.1 Various Mechanical Engineering Materials 10.2 Specifications of materials in accordance to BIS , ASME 10.3 Test Mechanical Properties like HARDNESS , IMPACT



Unit	Major Learning Outcomes	Topics and Sub-topics
		10.4 Compare materials with their utility point of view

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

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	<b>DIRECT STRESS &amp; STRAIN</b>	08	02	04	08	14
II	<b>MOMENT OF INERTIA</b>	04	01	00	04	05
III	<b>S.F &amp; B.M IN BEAM</b>	05	02	00	08	10
IV	<b>BENDING &amp; SHEAR STRESSES IN BEAM</b>	05	04	00	06	10
V	<b>DEFLECTION OF BEAM</b>	04	00	00	04	04
VI	<b>COLUMN &amp; STRUT</b>	03	00	00	04	04
VII	<b>COMBINED DIRECT &amp; BENDING STRESSES</b>	04	01	06	00	07
VIII	<b>PRINCIPAL PLANE &amp; PRINCIPAL STRESS</b>	04	02	05	00	07
IX	<b>TORSION</b>	03	01	00	04	05
X	<b>MECHANICAL PROPERTIES OF MATERIALS</b>	02	00	04	00	04
<b>Total</b>		<b>42</b>	<b>13</b>	<b>19</b>	<b>38</b>	<b>70</b>

## 7 SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills so that students are able to acquire the competency.

Following is the list of experiments for guidance.

S. No.	Unit No.	Practical/Exercise	Apprx. Hrs. Required
1	I	Draw Stress Strain Curve for Tension Test on Ductile Materials like Mild Steel , Aluminium	04
2	I	Determine Young's Modulus of wire of Given Material	02

S. No.	Unit No.	Practical/Exercise	Apprx. Hrs. Required
3	II	Calculate Moment of Inertia of Fly Wheel	02
4	VI	Demonstrate End Conditions of Column	02
5	X	Calculate Impact Value of Mild Steel using IZOD Impact Test Apparatus	02
6	X	Calculate Impact Value of Mild Steel using Charpy Impact Test	02
7	X	Calculate Brinell Hardness Number of given material	02
8	X	Calculate Hardness of given material using Rockwell Hardness machine	02
9	X	Find out Compressive Strength of C.I , M.S using Compression Testing Machine	02
10	I	Calculate at least Six Problems of Unit - I	02
11	III	Calculate at least Six Problems of Unit – III	02
12	VII	Calculate at least Six Problems of Unit VII	02
13	VIII	Calculate at least Six Problems of Unit VIII	02
		TOTAL	<b>28</b>

## 8 SUGGESTED LIST OF STUDENT ACTIVITIES

1. Market Survey specific to properties of Various type of Materials used in Mechanical Engineering
2. Student will prepare file based on practical

## 8. SUGGESTED LEARNING RESOURCES

### (A) List of Books:

S. No.	Title of Books	Author	Publication
1.	Strength of Material & Mechanics of Structures	Dr. B C Punamia	
2.	Strength of Material	S RAMAMURTHAN	
3.	Strength of Material	TimoShanku	
4.	Theory of Structures	R S KHURMI	

**B. List of Major Equipment/Materials**

1. Universal Testing Machine
2. SEARL'S Apparatus to find Young's Modulus
3. Working Model of End Conditions of Column
4. IZOD Impact Test Apparatus
5. CHARPY Test Apparatus
6. FLY WHEEL
7. Compression Testing Machine
8. Brinell Hardness Testing Machine
9. Rockwell Hardness Testing Machine

**C List of Software/Learning Websites**

1. [nptel.iitm.ac.in/courses/.../IIT.../lecture%2023%20and%2024.htm](http://nptel.iitm.ac.in/courses/.../IIT.../lecture%2023%20and%2024.htm)
2. [en.wikipedia.org/wiki/Shear\\_and\\_moment\\_diagram](http://en.wikipedia.org/wiki/Shear_and_moment_diagram)
3. [www.freestudy.co.uk/mech%20prin%20h2/stress.pdf](http://www.freestudy.co.uk/mech%20prin%20h2/stress.pdf)
4. [www.engineerstudent.co.uk/stress\\_and\\_strain.html](http://www.engineerstudent.co.uk/stress_and_strain.html)
5. [https://www.iit.edu/arc/workshops/pdfs/Moment\\_Inertia.pdf](https://www.iit.edu/arc/workshops/pdfs/Moment_Inertia.pdf)

**9. INSTRUCTIONAL STRATEGICS:**

Teachers can prepare or download ppt of different topic's Mechanical engineering application , can prepare alternative slides.

**10. COURSE CURRICULUM DEVELOPMENT COMMITTEE****Faculty Members from Polytechnics**

1. PROF. B G RAJGOR , H.O.D , APP. MECH. , BBIT , V V NAGAR
2. PROF. K VENKATESHWARLU , H.O.D , APP. MECH. , TFG POLYTECHNIC , ADIPUR
3. PROF. J H GABRA , I/C H.O.D , APP. MECH. , G.P , GODHARA
4. PROF D R KATARIYA , LME , G.P , BHUJ

**Coordinator and Faculty Members from NITTTR Bhopal**

1. Dr. A K JAIN , PROFESSOR , DEPARTMENT OF CIVIL & ENVIORNMENT ENGINEERING

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT****Course Curriculum****APPLIED ELECTRICAL AND ELECTRONICS.  
(Code: 3331905)**

<b>Diploma Programmes in which this course is offered</b>	<b>Semester in which offered</b>
Mechanical, Metallurgy, and Mining Engineering	3 <sup>rd</sup> Semester

**1. RATIONALE**

Electrical and electronics engineering equipment is widely used in mechanical/metallurgy/mining engineering applications and a diploma engineer from any of these disciplines have to identify the related equipment being used in the industry with respect to their working and major faults that could occur. Majority of mechanical/metallurgy/mining industries are of small and medium scale where electrical engineers are not recruited. For normal electrical and electronics tasks, shop floor mechanical /metallurgy/mining diploma engineer needs to attend the situation. If electrical personnel are to be called to electrical/electronic related issues, some basic reasons are primarily required to be known by them. Therefore, this course will help the student to acquire the requisite knowledge and skills.

**2. COMPETENCIES (Programme Outcomes as per NBA Terminology)**

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

- **Identify the major parts of electrical and electronic equipment being used in mechanical/metallurgy/mining engineering applications with respect to their working and major faults that could occur.**
- **Use electrical and electronic elements/systems to actuate simple mechanical mechanism.**
- **Attend normal electrical faults and use electrical tools and instruments for normal applications effectively.**

**3. TEACHING AND EXAMINATION SCHEME.**

<b>Teaching Scheme (In Hours)</b>			<b>Total Credits (L+T+P)</b>	<b>Examination Scheme</b>				
<b>L</b>	<b>T</b>	<b>P</b>		<b>Theory Marks</b>		<b>Practical Marks</b>		<b>Total Marks</b>
			<b>C</b>	<b>ESE</b>	<b>PA</b>	<b>ESE</b>	<b>PA</b>	
3	0	2	5	70	30	20	30	<b>150</b>

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

## 4. COURSE DETAILS.

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
<b>Unit – I Fundamentals of electrical engineering and magnetic circuit</b>	1a. Define the terms associated with magnetic circuits. 1b. Compare between right hand rule and cork screw rule.	1.1 Electricity generation-principle, working setup, elements and their functions. 1.2 Concept of AC (Alternating Current) and DC (Direct current). 1.3 Magnetic circuit: M.M.F, magnetic force, magnetic field strength, permeability, reluctance, magnetic flux, hysteresis loop. 1.4 Magnetic field of permanent magnet and current carrying conductor, Right hand rule and Cork Screw rule.
	1c. Define the terms: Electromotive force, current, voltage, resistance, and conductance. 1d. Define the parameters associated with AC supply.	1.5 Terminology associated with electrical circuit: Electromotive force, current, voltage, resistance, and conductance. 1.6 Ohm's law. 1.7 AC wave cycle, instantaneous value, amplitude, frequency, time period, R.M.S. value, mean value, phase, phase difference, power factor, electric field, work, power and energy.
	1e. Establish the relationship between line and phase quantities. 1f. Describe the concept of single phase and three phase supply with sketches.	1.8 Concept of line value and phase value, line voltage, line current, phase voltage and phase current. 1.9 Concept of single phase and three phase supply.
<b>Unit – II Electrical components, tools and instruments</b>	2a. State the specifications of electrical materials and select the components for simple applications.	2.1. Types, specifications, materials and applications of wires, cables and fuses. 2.2. Types, construction, symbols, materials and applications of switches/plugs/sockets.
	2b. Use electrical tools and instruments for simple applications. 2c. Describe with sketches the connection of the various types of meters and CRO to measure the various parameters.	2.3. Types, specifications, materials of construction and applications of various tools. 2.4. Meters: multimeter, clip-on, meter, tester, voltmeter, ammeter, energy meter, CRO- Types, specifications, materials of construction, connection method and applications.
<b>Unit – III Electrical Machines</b>	3a. Explain the working of single phase transformer with	3.1 Transformer Types: Core and shell type, auto transformers.

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
	schematic line diagrams. 3b. Describe the construction of core and shell type transformer with sketches. 3c. Explain the working of autotransformer with sketches. 3d. State the line and phase values for star and delta connections of transformers.	3.2 Construction and working of transformer, transformation ratio. 3.3 Comparison between conventional and auto transformer. 3.4 Three phase supply connections - Star and Delta connection-diagrams/circuit, applications.
	3e. Explain the working of a DC machine. 3f. Justify the need for starter in DC machines.	3.5 DC machines: construction, working and applications, necessity of starter. 3.6 DC and AC generators- construction, working and applications.
	3g. Explain the working of synchronous machines. 3h. Describe the working of a three phase induction motors. 3i. Describe the working of a single phase induction motors. 3j. List the common faults occurring in AC motors.	3.1 Synchronous machines: construction and working 3.2 Types of AC motors: Three phase and single phase- specification, construction, working, starting method, connection diagrams and applications. 3.3 Commonly occurring faults in single phase motor, three phase motor.
	3k. Describe the working of stepper motor with line diagrams 3l. Describe the working of servo motor with line diagram.	3.4 Fractional Horse power motors - construction, working, number of inputs, number of outputs and how to connect, common troubles and remedies: i. Stepper motor ii. Servo motors.
<b>Unit – IV Electrical Safety and Protection</b>	4a. Check the effectiveness of earth connections of any electrical installation. 4b. Check the insulation resistance of electrical installations.	4.1 Earthing. 4.2 Insulation.
	4c. List the different types of protective devices along with their symbols used in equipment and installations. 4d. Describe the working of optical fibres from opto-isolation point of view.	4.3 Safety and Protection- specification, working and applications of protective devices such as fuses, MCBs and ELCBs. 4.4 Concept of optical fibre communication. 4.5 Opto-isolation for circuit safety.
<b>Unit – V Electronic Components and Circuits</b>	5a. Specify values of different discrete electronic devices along with their symbols.	5.1 Discrete electronic components: Symbols, general construction and working: Resistor, Inductor, Capacitor, Diode, Transistor, photo diodes.

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
	5b. State the need for microcontrollers and PLCs used with various equipments.	5.2 Microcontrollers and PLCs (Programmable Logic Controller) - Concept, general constructional features, working and applications.
	5c. Interpret the circuit diagrams consisting of regulated power supply and different types of rectifiers	5.3 Regulated power supply, Rectifier (Half and Full wave), Uninterruptible power supply (UPS) -
	5d. Interpret the circuit diagrams consisting of different types of power electronic devices such as DIAC, TRIAC, SCR, IGBT, GTOs	5.4 Power electronic components: Symbols, general construction and working: DIAC, TRIAC, SCR, IGBT and GTO.
	5e. Use PCBs for simple applications.	5.5 PCB-concept and general applications. 5.6 PCBs for following applications: i. Movement of stepper motor according to input value of x, y and z coordinates. ii. Generate different time delay by 555 timers IC. iii. A circuit which latch the given input (Switch 1) and reset by another input (Switch 2). iv. Circuit to detect a given object. (Use photo diode and photo transistor).

## 5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fundamentals of electrical engineering and magnetic circuit.	08	06	06	02	14
II	Electrical components, tools and instruments	10	04	04	08	16
III	Electrical machines, drives and transformers	12	08	06	06	20
IV	Electrical safety and protection	04	00	02	04	06
V	Electronic components and circuits	08	06	04	04	14
		<b>42</b>	<b>24</b>	<b>24</b>	<b>22</b>	<b>70</b>

**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.
- If midsem test is part of continuous evaluation, unit numbers I, II (Up to 2.2), IV and V (only 5.1) are to be considered. It is also compulsory for student to complete experiment.no.1 to 5 to eligible for midsem test.
- 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.

## 6. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of practical skills (**Course 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 course outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of **Programme Outcomes/Course Outcomes in affective domain** as given in a common list at the beginning of curriculum document for this programme. Faculty should refer to that common list and should ensure that students also acquire those programme outcomes/course outcomes related to affective domain.



S. No.	UnitNo.	Practical/Exercise(Course Outcomes in Psychomotor Domain according to NBA terminology)	Apprx. Hrs. Required
1	I	a: Demonstrate generation of electricity and explain various terminologies associated with it. b: Demonstrate difference between AC and DC. c: Verify Ohm's law.	04
2	I	Perform any one from following. a: Obtain the required voltages across the branches in the given network. b: Obtain the required incoming current at different nodes of the given network.	02
3	II	Do electrical wiring for given case/parameters using electrical wires/cables, components and tools. Test the same and measure applicable parameters/variables like resistance, current, power, voltage, power factor, etc. Also do following. a: Identify the cables and fuses along with their specifications. b: Identify and state specifications of various meterstaken in use.	04
4	III	Perform following.(Any two, but preferably all). a: Connect the single phase electric motor to start them (using the circuit diagram). b: Connect the three phase electric motor to start them (using the circuit diagram).. c: Connect the DC motors to start them. (using the circuit diagram).	02
5	III	Perform any one from following.(Do both if possible). a: Connect the synchronous machine to run as a generator. (using the circuit diagram). b: Connect the synchronous machine to run as a motor.	02
6	III	Identify the faults in the given electric motor.	02
7	III	a: Operate the given stepper motors for the given speeds. (using the circuit diagram). b: Operate the given servo motors for the given speeds. (using the circuit diagram).	02
8	IV	a: Use the earth tester and megger for the given installation. b: Select the most appropriate protective device for the given application. c: Use fuse, MCBs and ELCBs for attending repair tasks.	04
9	V	Use PCB for simple applications.	04
10	V	Use PLC Or Microcontroller for specific applications.	02
<b>Total</b>			<b>28</b>

**NOTES:**

- It is compulsory to prepare log book of exercises. It is also required to get each exercise recorded in the logbook, checked and duly signed by teacher with date.
- Term work report must not include any photocopy/ies, printed manual/pages, litho,etc. It must be hand written / hand drawn by student only.
- For 20 marks ESE, students are to be assessed for practical skills achieved.

**7. SUGGESTED LIST OF STUDENT ACTIVITIES:**

- i. Write the specifications of lamp, CFL bulb, pump motor, fan and blender motor available at your room/house.
- ii. Identify few mechanical engineering situations which require automation.
- iii. Identify the type of electrical drives used in lathe, milling, grinding, shaper, power hack saw machines of your workshop. Also write their specifications.
- iv. Visit nearby workshop, industry, testing lab and prepare a list of machines, instruments which are controlled using PLC and microcontroller.

**8. SPECIAL INSTRUCTIONAL STRATEGIES (If Any).**

Sr. No.	Unit	Unit Title	Strategies
1	I	Fundamentals of electrical and magnetic circuits.	Demonstration. Movies.
2	II	Electrical components, tools and instruments	Demonstration.
3	III	Electrical machines, drives and transformers	Demonstration. Power point presentations, Movies.
4	IV	Electrical safety and protection	Real life situations, demonstrations, Movies.
5	V	Electronic components, tools and circuits	Real life situations, demonstrations, Movies.

**9. SUGGESTED LEARNING RESOURCES****A) List of Books:**

Sr.No.	Title of Books	Author	Publication
1.	Basic Electronics & Linear Circuits	Theraja, B.L.	McGraw Hill Education, New Delhi,
2.	A text book of Electrical Technology vol.2	Theraja, B.L.	S.Chand Publication, New Delhi 2011 or latest
3.	A Course In Electrical And Electronic Measurements And Instrumentation	Sawhney, A K	S.Chand Publication, New Delhi 2011 or latest
4.	Basic electronics	Mehta, V.K.	S.Chand Publication, New Delhi 2011 or latest

**B) List of Major Equipment/Materials with Broad Specifications**

- i. DC shunt, series and compound motor – 3 HP 230 V DC, 19 A, 1000 RPM
- ii. DC shunt motor-generator set – 3 HP, 230 V DC, 16 A, 1000 RPM,
- iii. Three Phase Induction motor-3 HP, 400 V, 50 Hz, 1500 RPM,
- iv. Three Phase Synchronous Machine-3 HP 400 V, 50 Hz, 1500 RPM,
- v. Single phase transformer – 230 V / 115 V, 1 kVA 1-phase transformer
- vi. Auto transformer : 0 – 230 V, 10 Amp
- vii. Welding transformer: 50 V, 50 /100 Amp

**C) List of Software/Learning Websites**

- i. [www.nptel.com/iitm/](http://www.nptel.com/iitm/)
- ii. [www.howstuffworks.com/](http://www.howstuffworks.com/)
- iii. [www.vlab.com](http://www.vlab.com)

**10. COURSE CURRICULUM DEVELOPMENT COMMITTEE.****- Faculty Members from Polytechnics**

- **Prof. Pratik Solanki**, Lecturer in Mechatronics, B.S.Patel Polytechnic, Kherva.

**Coordinator and Faculty Members from NITTTR Bhopal**

- **Dr. N P Patidar**, Associate Professor, Dept. of Electrical and Electronics Engineering
- **Dr. Joshua Earnest**, Professor, Dept. of Electrical and Electronics Engineering

# GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

## Course Curriculum

### COMPUTER AIDED MACHINE DRAWING (Code: 3331906)

Diploma Programme in which this course is offered	Semester in which offered
Mechanical Engineering	3 <sup>rd</sup> Semester

#### 1. RATIONALE

The students of mechanical engineering programme are mainly involved in drafting, manufacturing, inspection and planning activities (such as preparing process plans, preparing bill of materials, etc.) in industries. For all such activities, reference document is the drawing of component/assembly to be manufactured. In this context, it is of utmost importance to prepare, read and interpret these drawings correctly for production of components and assemblies accurately and precisely. The industrial practices of drafting are also important for the students to make them aware of drafting practices, symbols, codes, norms and standards generally used in industries.

Development of sketching ability also strengthens effective engineering communication & presentation. Now a days the market driven economy demands frequent changes in product design to suit the customer needs. With the introduction of computers the task of incorporating frequent changes as per requirement is becoming simpler. This course has been introduced at Diploma level in order to develop the skills in student so that they can generate various digital production drawings as required in industry using various CAD software.

#### 2. COMPETENCY (Programme Outcome according to NBA Terminology)

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

- **Prepare production drawings using computer and relevant software and following standards codes and norms.**

#### 3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	100
0	0	4	04	0	0	40	60	

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

#### 4. COURSE DETAILS

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
<b>Unit – I Introduction</b>	1.a Interpret drafting, tolerance and geometrical symbols in given production drawings. 1.b Appreciate AutoCAD (Mechanical) environment in context to production drawings.	1.1 Basic knowhow of computer hardware, software and peripherals. 1.2 Concept and need of machine drawings. 1.3 Drafting, tolerance and geometrical symbols used in machine drawing. 1.4 AutoCAD (Mechanical) screen, library, symbols, templates in context of machine drawing. 1.5 Drawing standards.(IS-696 /SP 46) (Drawing/printing/ storage)
<b>Unit – II 2D production drawings</b>	2.a Prepare and plot 2D production machine drawings using AutoCAD (Mechanical).	2.1 Simple 2D production drawings of 6-7 Mechanical components made up of minimum 5-6 manufacturing operations using Auto CAD (Mechanical).  2.2 2D assembly productions drawing of any one simple mechanical assembly having minimum 5-6 components each made up of 5-10 manufacturing operations using AutoCAD (Mechanical).  2.3 Take print outs of above drawings using Printer/plotter.
<b>Unit – III 2D parametric drawings</b>	4.a Prepare 2D parametric drawings of simple machine components using Pro/E or Solid Edge.	3.1 Concept and examples of parametric and non parametric models. 3.2 Concept, examples and applications of constraints and relations. 3.3 Simple 2D parametric drawings of 6-7 machine components made up of minimum 5-6 manufacturing operations each using sketcher mode.
<b>Unit – IV Project work</b>	4.b Prepare assembly drawing of mechanical components with codes, standards and symbols using AutoCAD (Mechanical)	4.1 Prepare one assembly drawing having 4-5 mechanical components, draw orthographic projections of each component with Institute template and take print out of it. (Group of 5-7 students).

**5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)**

Not Applicable

**6. SUGGESTED LIST OF PRACTICAL/EXERCISES**

The practical/exercises should be properly designed and implemented with an attempt to develop different types of practical skills (Course 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 course outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of programme outcomes/course outcomes in affective domain as given in a common list at the beginning of curriculum document for this programme. Faculty should refer to that common list and should ensure that students also acquire those programme outcomes/course outcomes related to affective domain.

<b>Ex. No.</b>	<b>Unit No.</b>	<b>Practical/Exercises (Course Outcomes in Psychomotor Domain according to NBA Terminology)</b>	<b>Approx. Hrs. Required</b>
1	I	a. Identify parts of computers. Recall basic knowledge to use computers. Use input devices. b. Prepare a report in tabular form on following. <ol style="list-style-type: none"> <li>i. All parts of computer, specifications and uses of each part (Namely keyboard, mouse, monitor, processor, RAM, SMPS, Motherboard, etc.)</li> </ol>	4
2	II	a. Prepare orthographic production drawings of 6-7 mechanical components (Minimum two should be based on real industrial components selected by student as student activity and approved by teacher) each made up of minimum 5-6 manufacturing operations using AutoCAD (Mechanical). Also take print outs of the same. b. Prepare report on following. <ol style="list-style-type: none"> <li>i. Select at least two physical mechanical components (approved by teacher). Sketch them with dimensions.</li> <li>ii. Write steps to prepare each drawing using AutoCAD (Mechanical). Steps must include followings.               <ol style="list-style-type: none"> <li>A. Sketch of components at each step with dimensions.</li> <li>B. Sequence of commands with name, options and values.</li> <li>C.</li> </ol> </li> </ol>	16
3	III	a. Prepare assembly drawing made up of 5-6 mechanical components using AutoCAD (Mechanical) and take print out of it. b. Prepare report on following:	14

Ex. No.	Unit No.	Practical/Exercises (Course Outcomes in Psychomotor Domain according to NBA Terminology)	Approx. Hrs. Required
		i. Select physical mechanical assembly in group of 5-6 students (approved by teacher). Measure and draw them with dimensions. ii. Write steps to prepare each drawing using AutoCAD (Mechanical). Steps must include followings. A. Sketch of each components and assembly for the same. B. Sequence of commands with name, options and values..	
4	IV	a. Prepare 2D parametric drawings of 6-7 mechanical components (Minimum two should be based on physical components selected by student and approved by teacher as student activity) each made up of minimum 5-6 manufacturing operations using Pro/E (Creo)/Solid Edge. Use constraints and relations also for preparing at least two drawings. Also take print outs of the same. b. Prepare report on following. i. Select at least two mechanical components. (Approved by teacher). Sketch them with dimensions. ii. Write steps to prepare each drawing. Steps must include followings. A. Sketch of components at each step with dimensions. B. Sequence of commands with name, options and values.	08
5	V	a. Prepare given project (as specified in Unit IV) in group of 7-8 students using AutoCAD (Mechanical). Prepare orthographic drawings. b. Identify various parts of given project. c. Prepare report on following: i. Measure dimensions of parts and draw their sketches. ii. Use drawing template and make orthographic assembly drawings.	14
Total Hours			56

**Notes:**

- Production drawing include surface roughness values, tolerances, limits, geometrical tolerances/ symbols, heat treatment/ surface treatment notes, etc.
- It is compulsory to perform students' activities given in table number 7.
- Submission includes objects, parts/assembly, print outs of drawings prepared, reports and student activities performed. (Term work must not include any photocopy/ies, printed manual/pages (except printouts of drawn

- parts/assemblies), litho, etc. It must be hand written/hand drawn (wherever required) by student only.
- d. The components and assembly for production drawing must be varied for each student/group (as applicable) in batch so that each student will have different problem.
  - e. Keep “Westernmann Table” (Revised to Indian Standards, New Age International Publishers) during practice periods.
  - f. For 40 marks under Practical Marks ESE, students are to be assessed for competencies achieved. Students are to be given data for practical ESE to:
    - i. Prepare production drawings using AutoCAD and Pro-E software.
    - ii. Interpret given production drawing/s.
    - iii. Refer and interpret data from data book/codes/standards/Westernmann Table.

## 7. SUGGESTED LIST OF STUDENT ACTIVITIES

SR.NO.	ACTIVITY.
1	Select at least four simple mechanical components each made up of minimum 5-6 manufacturing operations. Get them approved by teacher. Measure and sketch them in report pages with dimensions. (2 to be used for Ex.No.2 and 2 for Ex.No.4).
2	Select at least one simple mechanical assembly in group of 5-6 students, each made up of minimum 5-6 manufacturing operations. Get them approved by teacher. Measure and sketch them in report pages with dimensions. (For Ex.No.3).
3	Bring Actual assembly from workshop/industry, measure dimensions, sketch it and make 2D production drawing for the same.(For Ex.No.5).

## 8. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)

Sr. No.	Unit	Strategies	
1	I	Introduction	<ul style="list-style-type: none"> <li>• Show actual desktop and laptop computer system and detail out the functions of each component.</li> <li>• Demonstrate how to connect different parts of a desktop computer and finally its connection with printer.</li> <li>• Demonstrate the procedure of loading the AutoCAD software on a computer system</li> <li>• Give IS Codes of drawing for self study.</li> </ul>
2	II	2D Production Drawings	<ul style="list-style-type: none"> <li>• Bring actual industrial production drawings from nearby industry and distribute them among group of students for self study and interpretation.</li> <li>• Ask students to practice these drawings using AutoCAD software.</li> </ul>
3	III	2D Parametric Drawings	<ul style="list-style-type: none"> <li>• Bring small real components like Nut-Bolt, Washers, Cotter-knuckle Joints, Couplings, Pulleys in the class.</li> <li>• Ask students to use Vernier calliper to measure the dimensions and formulate relations between them.</li> </ul>



			<ul style="list-style-type: none"> <li>• Practice same relations with AutoCAD/Pro-E software to draw 2D/3D models of these component.</li> </ul>
4	IV	Project Work	<ul style="list-style-type: none"> <li>• Take the students for industrial visit.</li> <li>• Hands-on practice with drafting software to create a production drawing of an assembly.</li> </ul>

## 9. SUGGESTED LEARNING RESOURCES

### A. List of Books:

Sr. No.	Title of Books	Author	Publication
1	Machine Drawing including AutoCAD	Ajeet Singh	McGraw hill
2	Production Drawing	K L Narayan	New Age Publication
3	Fundamental of Geometric Tolerance and dimensioning	Alex Krulikowski	Cengage Learning
4	Engineering Graphics with AutoCAD	Sarkar .A.K	PHI india
5	Essentials of Engineering Drawing and Graphics using AutoCAD	Jeyapoovan	Vikas publication
6	Pro Engineer Wildfire 5.0 For Engineers And Designers	Sham Tickoo	Dream Tech press
7.	AutoCAD User Guide	Autodesk	Autodesk Press.

### B. List of Major Equipment/Materials:

- i. CAD Workstation.
- ii. 24" colour or mono plotter.
- iii. Laser Jet printer.

### C. List of Software:

- i. Autodesk AutoCAD Mechanical (Educational network licensed latest Version).
- ii. Pro/Engineer or Solid edge (Educational network licensed latest Version).

### D. Learning Websites.

- i. Autodesk Exchange/ AUGI.
- ii. PTC university tutorials.
- iii. Video tutorials from YouTube and other resources

## 10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### **Faculty Members from Polytechnics**

- **Prof. S.H. Sundarani**, Lecturer in Mechanical Engineering, Government Polytechnic, Ahmedabad.
- **Prof. J.B. Patel**, Lecturer in Mechanical Engineering, Sir Bhavsinhji Polytechnic Institute, Bhavnagar.
- **Prof. J.M. Patel**, Lecturer in Mechanical Engineering, B.S. Patel Polytechnic, Kherva.
- **Prof. D.B. Patel**, Lecturer in Mechanical Engineering, Government Polytechnic, Valsad.
- **Prof. T.B. Patel**, Lecturer in Mechanical Engineering, Government Polytechnic, Valsad.

### **Coordinator and Faculty Members from NITTTR Bhopal**

- **Prof. Sharad Pradhan**, Associate Professor & Head Department of Mechanical Engineering.
- **Dr. C.K. Chugh**, Professor, Department of Electronic Media.

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

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

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
<b>Mechanical Engineering, Mechatronics Engineering</b>	<b>4<sup>th</sup> Semester</b>

### 1. RATIONALE

Large number of industrial parts has to undergo various machining operations for conversion into finished products. Appropriate selection and usage of machine tool, work holding devices, cutting tools and process parameters plays very crucial role in obtaining good quality product at optimum cost. This course will make student familiar with fundamentals of cutting mechanics, kinematics, constructional features and selection criterion for various basic machine tools and automates with some basic exposure to conventional work holding devices and cutting tools and tool holders used on the same machines.

### 2. COMPETENCY

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

**Make a part/component as per given specification using appropriate machine tools, work holding devices, cutting tools & tool holders by employing optimum process parameters and safe working procedures.**

### 3. COURSE OUTCOMES

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

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

### 4. TEACHING AND EXAMINATION SCHEME

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

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

## 5. COURSE DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
<b>Unit – I</b>  <b>Introduction and mechanics of cutting</b>	1a. Explain mechanics of cutting.	1.1 Need, scope & importance of manufacturing processes in industries. 1.2 Need of attitude, knowledge & skill required for shop floor supervisor in machine tools based industries. 1.3 Differentiate between forming and generating processes. 1.4 Mechanics of cutting action, orthogonal and oblique cutting. (Without derivation).
	1b. Explain the effect of varying cutting parameters.	1.5 Chip formation, types of chips. 1.6 Forces acting on tool and chip, methods to compute cutting force using dynamometer. 1.7 Concept and definition of cutting speed, feed and depth of cut. 1.8 Cutting fluid- basic need, types, properties and its applications. 1.9 Influence of cutting variables on surface finish, tool life, economy, and mass production. 1.10 Safety precautions in machine tools.
<b>Unit – II</b>  <b>Basic machine tools-I</b>	2a. Explain classification, working principles, construction and operation of lathe and drilling machines.  2b. Describe mechanism & motion transmission in lathe and drilling machines.  2c. Explain work holding devices for lathe and drilling machines.	2.1 Define and classify basic machine tools. 2.2 Movements of tool, job, slides and work holding devices during cutting operation on various machine tools. 2.3 Lathe machine. <ol style="list-style-type: none"> <li>i. Types.</li> <li>ii. Working principle (using block diagram).</li> </ol> 2.4 All geared head stock centre lathe. <ol style="list-style-type: none"> <li>i. Constructional features.</li> <li>ii. Kinematics-(drive, head stock, feedbox, carriage, cross slide, top slide, swivel, apron, tailstock,) constructional sketch, working, and use.</li> <li>iii. Detailed specifications.</li> <li>iv. Operations performed.</li> <li>v. Work holding devices- constructional sketch, working and applications. (3 jaw chuck, 4 jaw chuck, face plate, centers).</li> </ol>

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		<ul style="list-style-type: none"> <li>vi. Lead screw and feed rod mechanisms.</li> <li>vii. Thread cutting setting-concept methods and simple numerical.</li> <li>viii. Accessories- types, constructional sketch, working and applications.</li> </ul> <p>2.5 Metal removal rate (MRR) – concept and method to calculate on lathe.</p> <p>2.6 Drilling machine.</p> <ul style="list-style-type: none"> <li>i. Types.</li> <li>ii. Working principle (using block diagram).</li> </ul> <p>2.7 Radial drilling machining.</p> <ul style="list-style-type: none"> <li>i. Constructional features.</li> <li>ii. Kinematics (drive, spindle speeds, feed mechanism, radial movement, etc.) constructional sketch, working, and use.</li> <li>iii. Detailed specifications.</li> <li>iv. Accessories- types, constructional sketch, working and applications.</li> <li>v. Tool holding and setting methods.</li> <li>vi. Operations performed.</li> <li>vii. Work holding devices- constructional sketch, working and applications.</li> </ul> <p>2.8 Metal removal rate (MRR) –method to calculate on drilling machine.</p>
<p><b>Unit – III</b></p> <p><b>Basic machine tools- II</b></p>	<p>3a. Explain classification, working principles, construction and operation of milling machine.</p> <p>3b Describe mechanism &amp; motion transmission in milling machine.</p>	<p>3.1 Milling machine.</p> <ul style="list-style-type: none"> <li>i. Types.</li> <li>ii. Working principle (using block diagram).</li> </ul> <p>3.2 Plain horizontal milling machining.</p> <ul style="list-style-type: none"> <li>i. Constructional features.</li> <li>ii. Kinematics (drive, spindle speeds, feed mechanism, table movement, etc.) constructional sketch, working, and use.</li> <li>iii. Detailed specifications.</li> <li>iv. Operations performed.</li> </ul>
	<p>3c. Select appropriate milling cutter for required milling</p>	<p>3.3 Milling cutters-types and applications.</p> <p>3.4 Up milling and down milling- concept, advantages, disadvantages and</p>

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

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
<b>Unit – V</b>  <b>Cutting tools and tool holders</b>	5a. Select cutting tool material for given work piece material and machining operation. 5b. Describe various effect of alloying elements on tool properties.	5.1 Various cutting tool materials, their compositions and properties. 5.2 Alloying elements in tool materials and their effects.
	5c. Interpret carbide insert and tool holder designation system. 5d. Suggest suitable carbide inserts and tool holder for specified operation.	5.3 Carbide inserts: <ol style="list-style-type: none"> <li>i. Designation method for turning, milling and drilling (As per ISO).</li> <li>ii. Need.</li> <li>iii. Benefits.</li> </ol> 5.4 Tool holders for carbide inserts: <ol style="list-style-type: none"> <li>i. Designation method for turning, milling and drilling (As per ISO).</li> <li>ii. Need.</li> <li>iii. Benefits.</li> <li>iv. Mounting and replacement methods of carbide insert.</li> </ol> 5.5 General cutting parameters for various cutting tool materials (HSS and Carbide) and work piece materials. (low carbon steel, high carbon steel, stainless steel, gunmetal, cast iron and aluminum).
	5e. Explain tool angles of cutting tools and their importance.	5.6 Cutting tool angles and their functions. 5.7 Various cutting tools (with tool geometry, nomenclature, tool materials, sketch/drawing of each, ISO/BIS standards) used for various operations on lathe, milling and drilling machines. <ol style="list-style-type: none"> <li>i. Single point cutting tool.</li> <li>ii. Plain milling cutter.</li> <li>iii. Side and face milling cutter.</li> <li>iv. Centre drill.</li> <li>v. Twist drill.</li> </ol> 5.8 Functions and types of chip breakers.
	5f. Explain factors affecting tool life.	5.9 Tool life, tool wear and machinability, factors affecting them. 5.10 Re-sharpening of cutting tools specified at 5.7 above.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
<b>Unit – VI</b> <b>Automates</b>	6a. Explain classification, working principles, construction and operation of capstan lathe, turret lathe and automats. 6b. Outline the tool layout for Capstan & Turret Lathe	6.1 Capstan and turret lathe: <ol style="list-style-type: none"> <li>Constructional features and working principle.</li> <li>Functions and applications.</li> <li>Difference between capstan and turret lathe.</li> <li>Preparation of tool layout.</li> <li>Merits and demerits.</li> <li>Turret lathe in comparison with basic centre lathe.</li> <li>Work holding devices.</li> </ol> 6.2 Single spindle Automats: <ol style="list-style-type: none"> <li>Need.</li> <li>Constructional features.</li> <li>Working principle and applications.</li> <li>Collets-constructional features and applications.</li> </ol> 6.3 Introduction to multi spindle automates and special purpose automates.

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

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction and mechanics of cutting	06	6	2	2	10
II	Basic machine tools-I	10	3	6	7	16
III	Basic machine tools-II	08	2	6	6	14
IV	Basic machine tools-III	06	2	6	2	10
V	Cutting tools and tool holders	08	2	4	8	14
VI	Automates	04	0	4	2	06
<b>Total</b>		<b>42</b>	<b>15</b>	<b>28</b>	<b>27</b>	<b>70</b>

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

**Note:** This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

### General Notes:

- If midsem test is part of continuous evaluation, unit numbers I, II (Up to 2.5 only) and III are to be considered.
- Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.



## 7. SUGGESTED LIST OF EXERCISES/PRACTICALS

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

*Note: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.*

*Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.*

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

5	III	<p><b>Milling Job:</b></p> <p>Prepare a job using milling operations including use of indexing head (Excluding gear tooth cutting). Student will also prepare report including:</p> <ol style="list-style-type: none"> <li>Drawing of the job.</li> <li>Operation sequences including details of cutting parameters used.</li> <li>Sketch of cutting tools used.</li> <li>Specification of machines used.</li> <li>Machine settings for indexing.</li> </ol>	10
6	IV	<p><b>Shaping and Drilling Job:</b></p> <p>Prepare a job having plain and inclined surfaces on shaping machine with minimum two holes as per given drawing. Student will also prepare report including:</p> <ol style="list-style-type: none"> <li>Drawing of the job.</li> <li>Operation sequences including details of cutting parameters used.</li> <li>Sketch of cutting tools used.</li> <li>Specification of machines used.</li> </ol>	10
7	V	<p><b>Single Point Cutting Tool:</b></p> <ol style="list-style-type: none"> <li>Sketch single point cutting tool(SPCT) with nomenclature.</li> <li>Grind SPCT as per given geometry.</li> <li>Sketch the set up to grind each angle of SPCT.</li> </ol>	04
8	VI	<p><b>Tool Layout:</b></p> <p>Prepare a tool lay-out of a given component for capstan and turret lathe.</p>	02
9	ALL	<p><b>Industrial Visit:</b></p> <p>Visit A Nearby Machine Shop And Prepare A Two Page Report Comprises Of List Of Machine Tools Including Automates, Its Technical Specification, Machining Parameters For Various Operations Being Performed, Cutting Tools And Work Holding Devices Used, Observation Of Skill And Safety Criteria.</p>	02
10	ALL	<p><b>Mini Project and Presentation:</b></p> <p>For a given product (different for each student) prepare complete report in suggested format including selection of raw material type &amp; section, sequence of various manufacturing operations, selection of machine, machining parameters, work holding device, tool holder, etc. For each machining operation. Each student will also present the outcome.</p>	06
<b>Total Hours</b>			56

**Notes:**

- It is compulsory to prepare log book of exercises. It is also required to get each exercise recorded in logbook, checked and duly dated signed by teacher.

- b. Term work report must not include any photocopy/ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only.
- c. Mini project and presentation topic/area has to be assigned to the student in the beginning of the term by batch teacher. This has to be assigned individually to each student.
- d. Student activities are compulsory and are also required to be performed and recorded in logbook.
- e. For 40 marks ESE, students are to be assessed for competencies achieved. They should be given following tasks (minimum two):
  - i. Sketch or explain tool geometry for a given cutting tool.
  - ii. Prepare a job on lathe machine. (At least two operations).
  - iii. Prepare a job on shaper and drilling machine. (At least two operations).
  - iv. Prepare a job on milling machine.
  - v. Prepare a tool lay out for a given component for capstan & turret lathe.

## 8. SUGGESTED LIST OF STUDENT ACTIVITIES

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

## 9. SPECIAL INSTRUCTIONAL STRATEGIES

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

			device catalogues
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## 10. SUGGESTED LEARNING RESOURCES

### (A). List of Books:

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

### (B) List of equipments:

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

**(C) List of Software/Learning Websites:**

- i. <http://nptel.iitm.ac.in/video.php?subjectId=112105126>
- ii. <http://nptel.iitm.ac.in/courses/Webcoursecontents/IIT%20Kharagpur/Manuf%20Proc%20II/pdf/LM-01.pdf>
- iii. <http://www.youtube.com/watch?v=H0AyVUfl8-k&list=PLEFE7D1579523C45D>
- iv. <http://www.youtube.com/watch?v=FFzRIop5bpg&list=PL843C2A830C65E2EE>
- v. <http://www.youtube.com/watch?v=81Fdif5e85c>
- vi. [http://www.youtube.com/watch?v=A0dTvf\\_Q8BA&list=PL2C105C94D2955C8B](http://www.youtube.com/watch?v=A0dTvf_Q8BA&list=PL2C105C94D2955C8B)
- vii. <http://www.youtube.com/watch?v=tDc0I9Gm8D4&list=PL3AFB507B668AF162>
- viii. <http://www.youtube.com/watch?v=THVgkBnjLq0>
- ix. <http://www.youtube.com/watch?v=6VpCBk7FahI>
- x. <http://www.youtube.com/watch?v=7wC1u4W0V1o>
- xi. <http://www.youtube.com/watch?v=VDIoUZuTunI>
- xii. <http://www.youtube.com/watch?v=fGqc9mZS0YI>
- xiii. <http://www.youtube.com/watch?v=Mn9jqI8rao>
- xiv. <http://www.youtube.com/watch?v=8SuoH5aL1SY>
- xv. [http://www.youtube.com/watch?v=xxNZSQML\\_ZA](http://www.youtube.com/watch?v=xxNZSQML_ZA)
- xvi. <http://www.youtube.com/watch?v=XXUHZxweBcw&list=PLD07DE61CB871A0CB>

**11. COURSE CURRICULUM DEVELOPMENT COMMITTEE****Faculty Members from Polytechnics.**

- **Prof. M. M. Jikar**, HOD, Mechanical Engineering, N. G. Patel Polytechnic, Bardoli.
- **Prof. J. P. Parmar**, Lecturer in Mechanical Engineering, C. U. Shah Polytechnic, Surendranagar.
- **Prof. R. M. Rajyaguru**, Lecturer in Mechanical Engineering, G. P. Rajkot.
- **Prof. M. K. Patel**, Lecturer in Mechanical Engineering, M. L. Institute of Diploma Studies, Bhandu.

**Coordinator and Faculty Members from NITTTR Bhopal.**

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

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

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

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
<b>Mechanical Engineering</b>	<b>4<sup>th</sup> Semester</b>

### 1. RATIONALE

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

### 2. COMPETENCY

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

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

### 3. COURSE OUTCOMES

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

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

### 4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
3	0	2	3	70	30	20	30	

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

## 5. COURSE DETAILS

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

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



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

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

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Two phase system	7	2	4	4	10
II	Boilers, mountings and accessories	10	7	4	4	15
III	Steam prime-movers	6	4	4	2	10
IV	Steam condenser & cooling towers	3	2	3	2	07
V	Air compressors	8	3	6	5	14
VI	Heat transfer	8	3	4	7	14
<b>Total</b>		<b>42</b>	<b>21</b>	<b>25</b>	<b>24</b>	<b>70</b>

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

**Note:** This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

### General Notes:

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

- b. Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.

## 7. SUGGESTED LIST OF EXERCISES/PRACTICALS

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

*Note: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.*

*Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.*

S. No.	Unit No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs. required
1	I	<b>Preparatory Activity:</b> a. List and define thermodynamic properties. b. Tabulate thermodynamic SI units and their conversions. c. Explain thermodynamic processes and their examples. d. Given the data, determine properties of steam using steam table and Mollier chart.	02
2	II	<b>Demonstration:</b> (Video/ Movie/Cut Sections /Models may be used in absence of Required Machine/ Equipment/ Device.): a. Steam boilers. b. Boiler mountings and accessories.	04
3	II	<b>Boiler Performance:</b> Boiler trial- determination of boiler efficiency, equivalent evaporation and Heat balance sheet. (Based on in-house performance or from the data collected during industrial visit.).	04
4	III	<b>Demonstration:</b> (Video/ Movie/Cut Sections /Models may be used in absence of Required Machine/ Equipment/ Device.): a. Steam prime movers-impulse and reaction turbines. b. Working of nozzles.	02
5	IV	<b>Demonstration:</b> (Video/ Movie/Cut Sections /Models may be used in absence of Required Machine/ Equipment/ Device.):	02

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

**Notes:**

- a. It is compulsory to prepare log book of exercises. It is also required to get each exercise recorded in logbook, checked and duly dated and signed by teacher.
- b. Term work report must not include any photocopy/ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only.
- c. Term work report content of each experience should also include following.
  - i. Experience set up sketch and specifications of boilers, mountings, accessories, condensers, cooling towers, air compressors, heat exchangers, etc (as applicable).
  - ii. Working for demonstration type experiences.
  - iii. Steps / process description to execute experience for performance type experience.
  - iv. Observation table, calculation and graphs if necessary.
- d. Mini project and presentation topic/area has to be assigned to the student in the beginning of the term by batch teacher. This may be assigned individually or in the group of maximum 3 to 5students.
- e. Student activities are compulsory and to be submitted along with term work.
- e. For ESE, students are to be assessed for competencies achieved through suggested list of activities/ practical. They should be given following tasks:
  - i. Identify the parts of equipment (Air compressor/ boiler/heat exchanger/ condenser).
  - ii. Identify location and function of boiler mountings/ accessories (any two).

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

## 8. SUGGESTED LIST OF STUDENT ACTIVITIES

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

## 9. INSTRUCTIONAL STRATEGIES

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

## 10. SUGGESTED LEARNING RESOURCES

### (A) List of Books:

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

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

**(B) List of major equipment/materials:**

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

**(C) List of Software/Learning Websites**

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

## 11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### Faculty Members from Polytechnics.

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

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

**Coordinator and Faculty Members from NITTTR Bhopal**

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

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

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

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
<b>Mechanical Engineering, Mechatronics Engineering</b>	<b>4<sup>th</sup> Semester</b>

**1. RATIONALE**

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

**2. COMPETENCY**

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

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

**3. COURSE OUTCOMES**

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

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

**4. TEACHING AND EXAMINATION SCHEME**

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
4	0	2	6	70	30	20	30	

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

## 5. COURSE DETAILS

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



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

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

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

**Note:** This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

### General Notes:

- If midsem test is part of continuous evaluation, unit numbers I, II, III and IV (Up to 4.2 only) are to be considered.
- Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.

## 7. SUGGESTED LIST OF EXERCISES/PRACTICALS

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

*Note: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.*

*Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.*

S. No.	Unit No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs. required
1	ALL	<b>Preparatory Activity:</b> a. Interpret and write various course related SI units and their conversions. b. Recall and write scalar and vector quantities.	02

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

	<p>part of syllabus) from mechanical laboratory/workshop/real life. Sketch the same. Take photograph of the same. Also record the movie of its working.</p> <p>c. Prepare subject related mechanism simple model. This has to be proposed by student/s and has to be approved by teacher.</p> <p>d. Present the experience with power point presentation and model prepared at c above. This has to include:</p> <ol style="list-style-type: none"> <li>i. Compiled information as per a above.</li> <li>ii. Explain the mechanism selected at b above. Use photographs and movie recorded.</li> <li>iii. Explain the working of model prepared at c above.</li> <li>iv. Photographs/movie of students working on project.</li> </ol> <p>e. Present student activities also.</p>	
	<b>Total Hours</b>	<b>28</b>

**Notes:**

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

**8. SUGGESTED LIST OF STUDENT ACTIVITIES**

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

**9. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)**

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

**10. SUGGESTED LEARNING RESOURCES****(A) List of Books:**

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

**(B) List of Software/Learning Websites:**

- i. <http://nptel.iitm.ac.in/video.php?subjectId=112104121>
- ii. <http://www.technologystudent.com/gears1/gears7.htm>
- iii. <http://kmoddl.library.cornell.edu/model.php?m=20>
- iv. <http://www3.ul.ie/~kirwanp/whatisacamandfollowersyste.htm>
- v. <http://nptel.iitm.ac.in/courses/Webcourse-contents/IIT-Delhi/Kinematics%20of%20Machine/index.htm>
- vi. [http://elearning.vtu.ac.in/12/enotes/Des\\_Mac-Ele2/Unit6-RK.pdf](http://elearning.vtu.ac.in/12/enotes/Des_Mac-Ele2/Unit6-RK.pdf)
- vii. [en.wikipedia.org/.../Canadian\\_Committee\\_for\\_the\\_Theory\\_of\\_Machines...](http://en.wikipedia.org/.../Canadian_Committee_for_the_Theory_of_Machines...)
- viii. [global.oup.com/.../theory-of-machines-and-mechanisms-978019537123...](http://global.oup.com/.../theory-of-machines-and-mechanisms-978019537123...)
- ix. [www.tequipment.com/Theory\\_of\\_Machines.aspx](http://www.tequipment.com/Theory_of_Machines.aspx)
- x. [www.researchgate.net/.../0094-114X\\_Mechanism\\_and\\_Machine\\_Theory](http://www.researchgate.net/.../0094-114X_Mechanism_and_Machine_Theory)
- xi. [www.journals.elsevier.com/mechanism-and-machine-theory/](http://www.journals.elsevier.com/mechanism-and-machine-theory/)
- xii. [journalseek.net/cgi-bin/journalseek/journalsearch.cgi?field=issn...](http://journalseek.net/cgi-bin/journalseek/journalsearch.cgi?field=issn...)
- xiii. [site.iugaza.edu.ps/wp-content/.../IUGAZA%20TOM2012\\_CH1-2.pdf](http://site.iugaza.edu.ps/wp-content/.../IUGAZA%20TOM2012_CH1-2.pdf)
- xiv. [www.iftomm.org/](http://www.iftomm.org/)
- xv. [www.wiziq.com/online-tests/44047-mechanical-theory-of-machine](http://www.wiziq.com/online-tests/44047-mechanical-theory-of-machine)
- xvi. [www.cs.ubc.ca/~murphyk/Teaching/CS340-Fall07/infoTheory.pdf](http://www.cs.ubc.ca/~murphyk/Teaching/CS340-Fall07/infoTheory.pdf)

**(C) List of equipments:**

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

**11. COURSE CURRICULUM DEVELOPMENT COMMITTEE****Faculty Members from Polytechnics:**

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

**Coordinator and Faculty Members from NITTTR Bhopal.**

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

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT****COURSE CURRICULUM  
COURSE TITLE: COMPUTER AIDED DESIGN  
(Code: 3341904)**

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
<b>Mechanical Engineering</b>	<b>4<sup>th</sup> Semester</b>

**1. RATIONALE**

The students of mechanical engineering programme are mainly involved in modelling, designing, manufacturing, inspection and planning activities (such as preparing design and production drawing, process plans, preparing bill of materials, etc.) in industries. For all such activities, reference document is the modelling and drawing of component/assembly to be manufactured. In this context, it is of utmost importance to prepare, read and interpret these drawings correctly for production of components and assemblies accurately and precisely. The industrial practices of modelling and designing are also important for the students to make them aware of modelling and designing practices, symbols, codes, norms and standards generally used in industries.

This course has been introduced at Diploma level in order to develop the skills in student so that they can generate various modelling and digital production drawings as required by industry using appropriate CAD software.

**2. COMPETENCY**

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

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

**3. COURSE OUTCOMES**

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

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



#### 4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
2	0	2	4	70	30	20*	30	

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

\* WITH EXTERNAL EXAMINER.

#### 5. COURSE DETAILS

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

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

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

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fundamentals of CAD	4	5	5	0	10
II	CAD Hardware	2	2	3	0	5
III	Geometric modeling	4	2	4	4	10
IV	3D Modeling using AutoCAD	8	4	6	10	20
V	3D parametric modelling	10	5	6	14	25
TOTAL		28	18	24	28	70

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

**Note:** This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

**General Notes:**

- a. If midsem test is part of continuous evaluation, unit numbers I, II, III and IV (Up to point number 4.2 only) are to be considered.
- b. Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.
- c. For theory paper, examiner has to give options of “Select and specify any one software from Creo, Unigraphics, CATIA, Solid Edge, Inventor etc” while asking the questions from Unit V.

**7. SUGGESTED LIST OF EXERCISES/PRACTICALS**

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

*Note: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.*

*Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.*

S. No.	Unit Number	Practical/Exercises (Outcomes' in Psychomotor Domain)	Hrs. required
1	ALL	<b>Preperatory Activity</b> Prepare a 2D drawing using AutoCAD and 2D parametric sketcher environment.	02
2	IV	<b>3DSolid Modeling-I</b> Prepare 3D solid models using AutoCAD (Three mechanical components).	04
3	IV	<b>3D Surface Model</b> Prepare simple surface model using AutoCAD (Two mechanical components).	02
4	V	<b>3D Solid Modeling-II:</b> Prepare 3D solid model using any one (from Creo, Unigraphics, CATIA, Solid Edge, Inventor etc) parametric software. (Three models that includes base features, Extrude/Protrude/Revolve).	05

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

**Notes:**

- a. It is compulsory to prepare log book of exercises. It is also required to get each exercise recorded in logbook, checked and duly dated signed by teacher.
- b. Term work report must not include any photocopy/ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only. Printouts of actually modelled parts/assemblies are to be permitted.
- c. Term work report content of each experience should include following.
  - i. Sketches of parts/assemblies.
  - ii. Steps followed with commands, its options with numeric values, position of UCS (in case of AutoCAD), planes selected, etc.
  - iii. Printouts of modelled parts/assemblies.
- d. Mini project and presentation topic/area has to be assigned to the student in the beginning of the term by batch teacher. This may be assigned individually or in the group of maximum 2 to 3 students.
- e. For 80 marks ESE, students are to be assessed for competencies achieved. They should be given following tasks:
  - i. Prepare solid models and assembly using AutoCAD and any one software (Creo, Unigraphics, CATIA, Solid Edge, Inventor etc).

**8. SUGGESTED LIST OF STUDENT ACTIVITIES**

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

**9. SPECIAL INSTRUCTIONAL STRATEGIES (If any)**

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

**10. SUGGESTED LEARNING RESOURCES****A. List of Books:**

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

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

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

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

**C. List of Software/Learning Websites:**

- i. <https://www.youtube.com/watch?v=WY0YuCkJWdw>
- ii. [https://www.youtube.com/watch?v=OIYrkF\\_FId8](https://www.youtube.com/watch?v=OIYrkF_FId8)
- iii. [https://www.youtube.com/watch?v=z0MW\\_usjaJo](https://www.youtube.com/watch?v=z0MW_usjaJo)
- iv. <https://www.youtube.com/watch?v=fx6kt9djIpc>
- v. <https://www.youtube.com/watch?v=8wdOIHxICxw>
- vi. <https://www.youtube.com/watch?v=srnm--IKtl4>
- vii. <https://www.youtube.com/watch?v=rtjDfZXscrI>

## 11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### Faculty Members from Polytechnics:

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

### Coordinator and Faculty Members from NITTTR Bhopal

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

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

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

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
<b>Mechanical Engineering, Mechatronics Engineering</b>	<b>4<sup>th</sup> Semester</b>

**1. RATIONALE**

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

**2. COMPETENCY**

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

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

**3. COURSE OUTCOMES (COs)**

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

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

**4. TEACHING AND EXAMINATION SCHEME:**

<b>Teaching Scheme (In Hours)</b>			<b>Total Credits (L+T+P)</b>	<b>Examination Scheme</b>				
<b>L</b>	<b>T</b>	<b>P</b>		<b>Theory Marks</b>		<b>Practical Marks</b>		<b>Total Marks</b>
<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>ESE</b>	<b>PA</b>	<b>ESE</b>	<b>PA</b>	
4	0	4	8	70	30	40	60	

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

## 5. COURSE DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
<b>Unit – I</b>  <b>Linear and angular measurement</b>	1a. Distinguish between accuracy, precision and error. 1b. Determine least count of given measuring instrument	1.1 Inspection, quality and quality control-definitions and differences. 1.2 Define accuracy, precision and error. 1.3 Principle of vernier scale and least count. 1.4 Surface plates-types, important features, standards/important sizes, applications and precautions in use.
	1c. Select suitable linear measurement instrument and measure the linear dimension of given component.	1.5 Types, constructional sketch, major parts and their functions, least count, measuring methods and measurement illustration (for e.g. 12.48mm) of: <ol style="list-style-type: none"> <li>i. Vernier caliper.</li> <li>ii. Micrometer.</li> <li>iii. Telescopic gauge.</li> <li>iv. Height gauge.</li> <li>v. Depth gauge.</li> </ol>
	1d. Describe the procedure for wring the slip gauge and set given dimension.	1.6 Slip gauge-types, applications, and wringing method.
	1e. Select suitable angular measurement instrument 1f. Describe the measurement procedure for the angular dimension of given component.	1.7 Sketch, major parts and their functions, least count, measuring methods and measurement illustration of: <ol style="list-style-type: none"> <li>i. Bevel Protector.</li> <li>ii. Sine bar.</li> <li>iii. Angle gauges.</li> <li>iv. Angle Dekkor.</li> <li>v. Spirit level.</li> <li>vi. Clinometers.</li> <li>vii. Auto collimator.</li> </ol> 1.8 Calibration – concept and need.
	<b>Unit – II</b>	2a. Explain working of dial indicators.



Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
<b>Measurement of geometrical tolerances</b>	2b. Select the measuring method and describe the measurement procedure for geometrical tolerance of given part/assembly.	2.2 Definition, symbol and measuring methods of: <ol style="list-style-type: none"> <li>i. Straightness.</li> <li>ii. Flatness.</li> <li>iii. Squareness.</li> <li>iv. Parallism.</li> <li>v. Perpendicularity.</li> <li>vi. Roundness.</li> <li>vii. Concentricity.</li> <li>viii. Cylindricity.</li> <li>ix. Run out and ovality.</li> </ol>
<b>Unit – III</b> <b>Measurement of surface roughness</b>	3a. Define various terminology used for surface roughness. 3b. Explain working of direct instrument methods.	3.1 Terminology used in connection with surface finish. 3.2 Comparison methods to inspect surface finish-concept and applications. 3.3 Direct instrument measurement methods-types and concepts. 3.4 Construction, working and applications of Talysurf surface roughness tester and Tomlinson tester.
	3c. Determine surface roughness of given data.	3.5 Centre line average and Root Mean Square systems of surface texture evaluation-terminology used, concept, equations and numerical examples. 3.6 Indication of various surface roughness characteristics with surface roughness symbols-interpretation.
<b>Unit – IV</b> <b>Gear and thread measurement</b>	4a. Define various terms used for gear nomenclature. 4b. Use gear tooth vernier to measure gear tooth thickness.	4.1 Types of gears. 4.2 Forms of gear teeth-types and concept. 4.3 Gear tooth Terminology. 4.4 Sketch, major parts and their functions, least count, measuring methods and measurement illustration of gear tooth vernier. 4.5 Derivation and numerical example to measure gear tooth thickness using: <ol style="list-style-type: none"> <li>i Gear tooth vernier.</li> <li>ii Constant chord method.</li> <li>iii Base tangent method.</li> </ol>
	4c. Explain working of profile projector.	4.6 Gear tooth profile measurement.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	4d. Define various terms used for thread nomenclature. 4e. Determine best wire size. 4f. Use two and three wire methods to determine effective diameter of thread. 4g. Describe method for measuring the pitch of given thread.	4.7 Threads-classification, elements, specifications and forms. 4.8 Measurement of major and minor diameters. 4.9 Three and two wire method of measuring effective diameter of external thread-concept, terminology used, best wire size, derivation of equation and numerical example. 4.10 Thread micrometer-sketch, method to use and determination of dimension. 4.11 Pitch measurement methods.
<b>Unit – V</b>  <b>Limit gauges, Transducers and sensors</b>	5a. Select and check the given dimension using limit gauge.	5.1 Limit gauges-classification, sketch and applications. 5.2 Comparators-concept, types and applications.
	5b. Define static characteristics of instruments.	5.3 Instrumentation-introduction, performance characteristics. 5.4 Static characteristics of instruments.
	5c. Explain various transducers and sensors.	5.5 Transducers-concept, classifications, physical quantities which can be measured, advantages and disadvantages. 5.6 Electrical transducers-types, working principles and applications. <ul style="list-style-type: none"> <li>i Linear Variable Differential Transformer (LVDT) type pressure gauge.</li> <li>ii Resistance type.</li> <li>iii Capacitance type.</li> <li>iv Inductance type (LVDT).</li> <li>v Piezo-electric.</li> </ul> 5.7 Sensors- classification and applications.
<b>Unit – VI</b>  <b>Non destructive testing</b>	6a. Explain various non destructive testing methods.	6.1 Non destructive testing (NDT) - concept, need and advantages. 6.2 NDT- important methods, working with sketch and applications.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
<b>Unit – VII</b>  <b>Temperature, pressure and flow measurement</b>	7a. Select and describe the method for using appropriate temperature measuring device to measure temperature of given hot body.	7.1 Introduction. 7.2 Classification, working principle, construction, working, advantages, limitations and applications of temperature measuring devices: <ol style="list-style-type: none"> <li>i. Mercury in glass thermometer.</li> <li>ii. Bimetallic thermometer.</li> <li>iii. Resistance thermometer.</li> <li>iv. Thermister.</li> <li>v. Thermocouple.</li> <li>vi. Radiation pyrometers.</li> <li>vii. Optical pyrometers.</li> </ol>
	7b. Select and describe the method for using appropriate pressure and flow measuring device to measure pressure/flow.	7.3 Pressure measurement scales. 7.4 Types and applications of manometers (only list and applications). 7.5 Working principle, construction, working, advantages, limitations and applications of pressure measuring devices: <ol style="list-style-type: none"> <li>i. Bellows type pressure gauge.</li> <li>ii. Diaphragm type pressure gauge.</li> <li>iii. Bourdon tube pressure gauge.</li> <li>iv. Dead weight piston gauge.</li> </ol> 7.6 Concept of transducer based pressure measuring devices- resistance type, capacitance type and inductance type. 7.7 Classification of flow measuring devices. 7.8 Working principle, construction, working, advantages, limitations and applications of volumetric flow measuring devices: <ol style="list-style-type: none"> <li>i. Bellows type.</li> <li>ii. Rotating impeller.</li> <li>iii. Rotating lobes.</li> <li>iv. Nutating Disc.</li> <li>v. Reciprocating piston.</li> <li>vi. Obstruction.</li> </ol> 7.9 Working principle, construction, working, advantages, limitations and applications of velocity measuring

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

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

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

**Legends:** R = Remembrance; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

**Note:** This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

### General Notes:

- If midsem test is part of continuous evaluation, unit numbers I (Up to 1.6 only), II, III and VII (Up to point number 7.6 only) are to be considered.
- Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.

## 7. SUGGESTED LIST OF EXERCISES/PRACTICALS.

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

*Note: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of*

certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs. required
1	I	<p><b>Preparatory Activity:</b></p> <ol style="list-style-type: none"> <li>S.I. basic, supplementary and derived units and their conversions. Convert given length, area and volume from one unit to another. (From mm to cm and m, from mm to inch, from m to yard and foot, from mm<sup>2</sup> to inch<sup>2</sup> and vice-versa, mm<sup>3</sup> to inch<sup>3</sup> and vice-versa ,etc.).</li> <li>Convert given degree to radian and vice-versa.</li> <li>Various drafting, surface finish and geometrical symbols.</li> <li>Define axis, axes, centre, angles, plane, solid angle.</li> </ol>	02
2	I	<p><b>Linear And Angular Measurement:</b></p> <p>Each student will select and bring at least such five mechanical components which will have use of instruments specified below. Same are to be approved by teacher. After approval, student will:</p> <ol style="list-style-type: none"> <li>Sketch each component.</li> <li>Sketch and label main parts of instruments to be used.</li> <li>Calculate least count of the instrument/s to be used.</li> <li>Measure and record applicable dimensions of each component using: <ol style="list-style-type: none"> <li>Vernier calliper.</li> <li>Inside micrometer.</li> <li>Outside micrometer.</li> <li>Telescopic gauge.</li> <li>Height gauge.</li> <li>Depth gauge.</li> <li>Bevel protector.</li> <li>Clinometers.</li> </ol> </li> </ol>	14
3	I	<p><b>Sine Bar:</b></p> <p>Measure angle between two planes with the help of sine bar and slip gauges.</p>	02
4	II	<p><b>Straightness:</b></p> <ol style="list-style-type: none"> <li>Sketch the part and setup, list the instruments used, list the steps followed and record the observations for checking straightness.</li> <li>Plot straightness observations on graph paper.</li> </ol>	02
5	II	<p><b>Flatness:</b></p> <p>Sketch the part and setup, list the instruments used, list the steps followed and record the observations for checking flatness.</p>	02

6	II	<p><b>Squareness, Perpendicularity And Parallity:</b>  Sketch the part and setup, list the instruments used, list the steps followed and record the observations for checking following.</p> <ol style="list-style-type: none"> <li>Squareness.</li> <li>Perpendicularity and Parallity.</li> </ol>	02
7	II	<p><b>Roundness, Cylindricity, Concentricity, Run Out And Ovality:</b></p> <ol style="list-style-type: none"> <li>Sketch the part and setup, list the instruments used, list the steps followed and record the observations for checking roundness, cylindricity, concentricity, run out and ovality.</li> <li>Prepare polar graph for roundness observations.</li> </ol>	02
8	III	<p><b>Surface Roughness:</b></p> <ol style="list-style-type: none"> <li>Tabulate machining processes, and roughness values (<math>R_a</math>, mm), roughness grade number and roughness symbol.</li> <li>Demonstrate various surfaces having different roughness values.</li> <li>For given component, sketch the component, judge the roughness of surfaces and show surface roughness symbols on applicable surfaces.</li> <li>Measure surface roughness value of given machined surface.</li> </ol>	04
9	IV	<p><b>Gear Measurement:</b></p> <ol style="list-style-type: none"> <li>Sketch gear tooth nomenclature.</li> <li>Sketch gear tooth vernier and label each part.</li> <li>Calculate chordal thickness and height of given gear.</li> <li>Determine tooth height.</li> <li>Measure and compare chordal thickness of given spurs gear using gear tooth vernier.</li> </ol>	02
10	IV	<p><b>Thread Measurement:</b>  For given external threaded part:</p> <ol style="list-style-type: none"> <li>Draw nomenclature for ISO screw threads (Internal and external both).</li> <li>Explain and derive best wire size.</li> <li>Sketch the part and show the dimensions to be measured.</li> <li>Sketch the set up and instruments used to measure/derive major diameter, minor diameter and effective diameter using two wire and three wire methods.</li> <li>Measure the pitch.</li> <li>Use threaded ring gauge.</li> <li>Record observations.</li> </ol>	04
11	V	<p><b>Limit Gauges:</b></p> <ol style="list-style-type: none"> <li>Demonstrate use of various limit gauges.</li> <li>Select appropriate limit gauge for given dimension/part and check the dimension with gauge.</li> <li>Record your observations.</li> </ol>	02
12	V	<p><b>Demonstration of Transducers and Sensors:</b></p> <ol style="list-style-type: none"> <li>Demonstrate electrical (LVDT type, resistance type, capacitance type, inductance type and piezo-electric.) transducers and various sensors.</li> <li>Sketch each demonstrated transducers and sensors and tabulate specifications, range, resolution and applications of each.</li> </ol>	04

13	VI	<b>Non Destructive Testing:</b> a. Demonstrate ultrasonic testing of NDT. b. Observe and interpret X ray test of any weld joint.	02
14	VII	<b>Temperature Measurement:</b> a. Sketch the set up and constructional sketch of thermocouple used to measure temperature. b. Measure the temperature of hot body/hot liquid with thermocouple. c. Record the observation.	02
15	VII	<b>Pressure Measurement:</b> a. Sketch the set up and constructional sketch of pressure gauge used to measure pressure. b. Measure the pressure with pressure gauge. c. Record the observation.	02
16	VII	<b>Flow Measurement:</b> a. Sketch the set up and venture meter used to measure flow. b. Measure the flow with venture meter. c. Record the observation.	02
17	ALL	<b>Mini Project and Presentation:</b> a. Select actual mechanical assembly from industry/real life/scrap shop/garage/etc. (made up of at least 4 to 5 mechanical components) and get it approved by teacher. b. Measure geometrical tolerances. Sketch setup drawing to measure geometrical tolerances. Measure geometrical tolerances and record the observations. c. Dismantle the assembly, sketch the parts and measure dimensions. Record your observations. d. Present the work including photographs and movies of actual project work.	06
<b>TOTAL</b>			<b>56</b>

**Notes:**

- a. It is compulsory to prepare log book of exercises. It is also required to get each exercise recorded in logbook, checked and duly dated signed by teacher.
- b. Term work report must not include any photocopy/ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only. Photographs/movies of group members actually working on mini project should be allowed.
- c. Term work report content of each experience should also include following.
  - i. Reports.
  - ii. Student activities.
- d. Mini project and presentation topic/area has to be assigned to the student in the beginning of the term by batch teacher. This may be assigned individually or in the group of maximum 2 to 3 students.
- e. For 40 marks ESE, students are to be assessed for competencies achieved. They should be given following tasks. ( i and any one from ii, iii and iv.)
  - i. Measure the linear/angular dimensions and geometrical tolerances of given part/assembly.
  - ii. Measure tooth thickness using gear tooth vernier.
  - iii. Measure effective diameter of given thread.
  - iv. Explain working of transducers and sensors.

## 8. SUGGESTED LIST OF STUDENT ACTIVITIES

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

## 9. SPECIAL INSTRUCTIONAL STRATEGIES

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

## 10. SUGGESTED LEARNING RESOURCES

### (A) List of Books:

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



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

**(B) List of equipments:**

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

**(C) List of softwares/ learning websites:**

- a. <http://en.wikipedia.org/wiki/Metrology> (metrology).
- b. <https://www.youtube.com/watch?v=4hlNi0jd0eQ> (vernier).
- c. <https://www.youtube.com/watch?v=FNdkYIVJ3Vc>(vernier).
- d. <https://www.youtube.com/watch?v=O8vMFFYNifo> (micrometer)
- e. <https://www.youtube.com/watch?v=h98HPVuWjLA> (depth micrometer)
- f. [https://www.youtube.com/watch?v=SmXfGan\\_NXQ](https://www.youtube.com/watch?v=SmXfGan_NXQ) (telescopic gauge)
- g. <http://www.authorstream.com/Presentation/007sandeepks-1858141-angular-measurment/> (angular measurement).
- h. <http://askguru.net/t-Angular-Measurement-ppt>
- i. <https://www.youtube.com/watch?v=aBzh6i5fQ70> (surface roughness)
- j. <https://www.youtube.com/watch?v=S7SXD6sKQ-I>(surface roughness)
- k. <https://www.youtube.com/watch?v=eVpoJzLJa0U>(surface roughness)
- l. <https://www.youtube.com/watch?v=3Od7vnoMwGg>(surface roughness)
- m. <https://www.youtube.com/watch?v=XnLiTPGE6pk> (three wire thread measurement)
- n. <https://www.youtube.com/watch?v=Gdvtw0pTAOs> (thread pitch).
- o. <https://www.youtube.com/watch?v=qMgXGedDffw> (dial indicator)
- p. <http://www.authorstream.com/Presentation/donzvasanth-1501139-unit-2-linear-angular-measurement/>
- q. [http://en.wikipedia.org/wiki/List\\_of\\_gear\\_nomenclature#Addendum](http://en.wikipedia.org/wiki/List_of_gear_nomenclature#Addendum) (gear nomenclature).
- r. <https://www.google.co.in/search?q=gear+tooth+vernier+caliper&tbm=isch&to=u&source=univ&sa=X&ei=MluEUsqS0SiKrQeywIFQ&ved=0CCgQsAQ&biw=1600&bih=804> (gear tooth vernier).
- s. <http://www.youtube.com/watch?v=lc4dsNvm2Ks> (principle of mech. meas).
- t. <http://www.youtube.com/watch?v=nv3GuJARjNU> (Transducers).
- u. <http://www.youtube.com/watch?v=iMIzApq1CQ0> (pressure measurement).
- v. <http://www.youtube.com/watch?v=JKuoQ5FV2c8> (temperature meas.).
- w. [http://www.youtube.com/watch?v=GNOI\\_7ftbQ0](http://www.youtube.com/watch?v=GNOI_7ftbQ0)(temperature meas.) .
- x. <http://www.youtube.com/watch?v=7xUdPVpafyI> (flow measurement).
- y. <http://www.ignou.ac.in/upload/Unit-4-62.pdf> (limit gauges).
- z. <http://www.scribd.com/doc/55242715/8/Types-of-limit-gauges>
- aa. [http://www.youtube.com/watch?v=v25PCV\\_IJCw](http://www.youtube.com/watch?v=v25PCV_IJCw) (sensors)
- bb. <http://www.youtube.com/watch?v=QItuf6lNvmI>(sensors)
- cc. <http://www.youtube.com/watch?v=pOvTyvBqzgM> (displacement sensors)
- dd. <http://www.youtube.com/watch?v=inLkCOWVgyM> (force sensors)
- ee. <http://www.youtube.com/watch?v=jxv0ITAr74A>(force sensors)
- ff. [http://www.youtube.com/watch?v=0MP\\_9n08urA](http://www.youtube.com/watch?v=0MP_9n08urA)(force sensors)
- gg. <http://www.youtube.com/watch?v=zAddvPHfKnw>(force sensors)
- hh. [http://www.youtube.com/watch?v=\\_fQSMVf3hdM](http://www.youtube.com/watch?v=_fQSMVf3hdM) (calibration).
- ii. [http://www.youtube.com/watch?v=HwSxBRaxn\\_4](http://www.youtube.com/watch?v=HwSxBRaxn_4)(calibration).
- jj. <http://www.youtube.com/watch?v=ZymDMUuVuyY> (geometrical Tol.)
- kk. <http://www.gobookee.org/measurement-of-geometric-tolerances-in-manufacturing/>
- ll. <http://www.me.metu.edu.tr/courses/me410/exp1/410exp1theory.pdf>
- mm. <http://www.youtube.com/watch?v=5eaSkU6Ecik> (flatness measurement)
- nn. <http://www.youtube.com/watch?v=1tBnpzyhVXU> (measuring straightness)

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

## 11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### Faculty Members from Polytechnics:

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

### Coordinator and Faculty Members from NITTTR Bhopal.

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

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

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

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
<b>Mechanical Engineering, Mechatronics Engineering</b>	<b>4<sup>th</sup> Semester</b>

### 1. RATIONALE

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

### 2. COMPETENCY

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

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

### 3. COURSE OUTCOMES

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

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

### 4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		C	ESE	PA	ESE	
3	0	2	5	70	30	20	30	<b>150</b>

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

## 5. COURSE DETAILS

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

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

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

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

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

**Note:** This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

### General Notes:

- If mid semester test is part of continuous evaluation, unit numbers I, II, III, and IV (Up to point number 4.6 only) are to be considered.
- Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.

## 7. SUGGESTED LIST OF EXERCISES/PRACTICALS.

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

**Note:** Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit Number	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs. required
1	I	<b>Preparatory Activity:</b> Study and demonstrate use of various types of tools. (Fix spanners, box spanners, ring spanners, allen keys, types of pliers, screw drivers, bearing puller, etc.).	02
2	II	<b>Measurement of Wear:</b> Measure wears of anyone of the following. a. Machine guide ways. b. Shaft –sleeve. c. Piston –cylinder. d. Bearing.	02
3	II	<b>Corrosion:</b> Each student will collect corroded component from field and identify the types of corrosion and possible causes. Student will also suggest prevention methods.	02
4	III	<b>Fault Tracing and Decision Tree:</b> Develop decision tree for location of fault for <b>any two</b> items from following- a. Internal combustion (IC) engine. b. Boiler. c. Pump. d. Machine tool. e. Air compressor. f. Electric motor.	04
5	IV	<b>Maintenance of Mechanical Based Equipment/Device/Machine.</b> Maintenance of <b>any two</b> from following. Batch may be divided in to two groups and each group may be given one case. a. Head stock. b. Tail stock. c. Feed box. d. Indexing head. g. Internal combustion (IC) engine. h. Pump. (Dismantle of given case, observe rules, follow sequence of dismantling operations, cleaning, inspection, measuring deviations , recovery methods, testing and assembling).	08



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

**Notes:**

- a. Term work report must not include any photocopies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only. However photographs/movies of actual performance by batch students and photographs of device/s undertaken for maintenance may be allowed by teacher.
- b. Term work report content of each experience should also include following.
  - i. The specifications of machines / equipments / devices / tools /instruments / items/ elements which is / are used to carry out and to check experience.
  - ii. Sequence of dismantling and assembling.
  - iii. Steps / process description to execute experience.
  - iv. Observations.
- c. Mini project and presentation topic/area has to be assigned to the student in the beginning of the term by batch teacher. This may be assigned individually or in the group of maximum 4 to 6 students.
- e. For 20 marks ESE, students are to be assessed for competencies achieved. They should be given following tasks:

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

## 8. SUGGESTED LIST OF STUDENT ACTIVITIES

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

## 9. SPECIAL INSTRUCTIONAL STRATEGIES (If any)

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

## 10. SUGGESTED LEARNING RESOURCES

### (A) List of Books:

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

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

**(B) List of Software/Learning Websites:**

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

**(C) List of equipments:**

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

**11. COURSE CURRICULUM DEVELOPMENT COMMITTEE****Faculty Members from Polytechnics:**

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

**Coordinator and Faculty Members from NITTTR Bhopal**

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

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

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

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
Mechanical Engineering	5 <sup>th</sup> 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				
L	T	P		Theory Marks		Practical Marks		Total Marks
2	0	2	4	ESE	PA	ESE	PA	
				70	30	20	30	

**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
<b>Unit – I</b> <b>Internal combustion engines.</b>	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.
<b>Unit- II</b>  <b>Alternate fuels.</b>	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.
<b>Unit- III</b>  <b>Refrigeration.</b>	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
<b>Unit-IV</b> <b>Air-Conditioning</b>	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
	<b>Total</b>	<b>28</b>	<b>26</b>	<b>22</b>	<b>22</b>	<b>70</b>

**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	<b>Preparatory Activity:</b> <ol style="list-style-type: none"> <li>a. Student will recall and write basic thermodynamic units.</li> <li>b. Teacher will demonstrate working of I.C. Engine.               <ol style="list-style-type: none"> <li>i) Demonstrate and explain working and function of I.C. Engine.</li> <li>ii) Demonstrate working of two stroke and four stroke engine.</li> </ol> </li> </ol>	02
2	I	<b>Demonstration of IC engine parts:</b> <ol style="list-style-type: none"> <li>a. Demonstrate and explain dismantling, assembling, working and inspection of fuel pump, fuel injector, carburetor and multipoint fuel injection system.</li> <li>b. Sketch and explain working of fuel pump, fuel injector, carburetor and multipoint fuel injection system.</li> <li>c. List dismantling and assembling methods/ steps in logical sequence.</li> <li>d. Record observations during inspection.</li> </ol>	04
3	I	<b>Valve timing diagram:</b> <ol style="list-style-type: none"> <li>a. Write specifications of IC engine undertaken for valve timing diagram.</li> </ol>	02

		<ul style="list-style-type: none"> <li>b. Perform and record angles and strokes.</li> <li>c. Prepare valve timing diagram.</li> <li>d. Interpret valve timing diagram.</li> </ul>	
4	I	<p><b>Perform test and prepare heat balance sheet of IC Engine. (Petrol and Diesel-both separately);</b></p> <ul style="list-style-type: none"> <li>a. Write specifications of IC engine undertaken for test.</li> <li>b. Demonstrate and perform test on IC engine.</li> <li>c. Observe and record test parameters.</li> <li>d. Derive required parameters- Indicated Power (IP), Break Power (BP), fuel consumption for varying load, efficiency, etc.</li> <li>e. Observe and record parameters required for heat balance sheet (For full load conditions).</li> <li>f. Prepare heat balance sheet.</li> <li>g. Interpret test results and heat balance sheet.</li> </ul>	04
5	III	<p><b>Refrigeration tubing operations:</b></p> <ul style="list-style-type: none"> <li>a. Demonstrate VCRS on any car/Bus from tubing point of view.</li> <li>b. Demonstrate various tubing tools and tubing operations.</li> <li>c. Perform various tubing operations.</li> <li>d. Sketch and explain VCRS demonstrated on any vehicle.</li> <li>e. Sketch and explain various tools used for refrigeration tubing.</li> <li>f. Describe tubing operations with neat sketches. Also state applications of each.</li> </ul>	02
6	III	<p><b>Leak detection, evacuation and refilling of the refrigerant:</b></p> <ul style="list-style-type: none"> <li>a. Demonstrate leak detection, evacuation and refilling of refrigerant.</li> <li>b. Demonstrate working of equipment / tools / instruments / devices used to demonstrate leak detection, evacuation and refilling of refrigerant.</li> <li>c. Explain various leak detection techniques.</li> <li>d. Sketch and explain working of equipment / tools / instruments / devices used to demonstrate leak detection, evacuation and refilling of refrigerant.</li> <li>e. List and explain the steps followed to perform leak detection, evacuation and refilling of refrigerant.</li> <li>f. Conclude your observations.</li> </ul>	04
7	III	<p><b>COP of VCRS:</b></p> <ul style="list-style-type: none"> <li>a. Sketch block diagram of VCRS.</li> <li>b. Write specifications of each component of VCRS taken for performance. (Of compressor, condenser, expansion device and evaporator).</li> <li>c. Perform, observe and record the parameters required to determine refrigeration effect (RE), work done (WD), mass flow rate and COP.</li> </ul>	02

		<p>d. Determination RE, WD, mass flow rate and COP.</p> <p>e. Plot the actual VCRS cycle on P-h chart and T-s diagram.</p> <p>f. Interpret the performance.</p>	
8	III	<p><b>Determination of properties of air:</b></p> <p>a. List and define various properties of air.</p> <p>b. List, sketch, demonstrate and explain working of various psychometric instruments.</p> <p>c. Perform, observe and record the properties.</p> <p>d. Calculate properties (Teacher will assign) of air from the readings taken.</p> <p>e. Given the data (Teacher will assign the data for four to five processes.), plot the processes on psychometric chart.</p>	02
9	III	<p><b>Determination of capacity of window / split air-conditioner.</b></p> <p>a. Sketch block diagram of setup.</p> <p>b. Perform, observe and record the parameters required to determine the capacity.</p> <p>c. Determine the capacity.</p> <p>d. Thumb rules to estimate the capacity.</p>	02
10	IV	<p><b>Industrial visit: (ANY TWO)</b></p> <p>a. Visit cold storage plant, ice plant and air-conditioning plant to observe VCRS, different kinds of ducting.</p> <p>b. Visit any Industry working on I C Engine manufacturing/ running or power plant working on I C Engine. ( D.G. Power Plant.)</p> <p>c. Visit any petrol/ diesel/ CNG/ LPG station and study different fuel filling systems along with different parameters affected.</p> <p>d. Student will visit and prepare industrial visit report.</p>	04
<b>Total Hours</b>			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.	A Text 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, with Multi-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 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](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)**

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
Mechanical Engineering	5 <sup>th</sup> 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				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
3	0	2	5	70	30	20	30	

**Legends:** L-Lecture; T – Tutorial/Teacher Guided 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
<b>Unit – I.</b> <b>Introduction.</b>	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.
<b>Unit– II</b> <b>Design of machine elements subjected to direct stresses.</b>	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: <ol style="list-style-type: none"> <li>Knuckle joint.</li> <li>Cotter joint.</li> <li>Riveted joints.</li> <li>Welded joint-fillet &amp; lap joint .</li> </ol>

	threaded fasteners.	v. Threaded fasteners & screw jack.
<b>Unit- III</b>  <b>Design of machine elements subjected to bending stresses.</b>	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.

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

**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
	<b>Total</b>	<b>42</b>	<b>14</b>	<b>23</b>	<b>33</b>	<b>70</b>

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

**Note:** This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

**General Notes:**

- If 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.
- 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	<p><b>Preparatory Activity :</b></p> <ol style="list-style-type: none"> <li>Interpret and write various course related SI units and their conversions.</li> <li>Write normal values of ultimate tensile strength, yield strength, density, modulus of elasticity and Poisson's ratio of commonly used materials.</li> <li>List normal values of factor of safety for different situations.</li> <li>Recall area, volume, section modulus, moment of inertia, radius of gyration, etc. for commonly used various section and shapes.</li> <li>Draw orthographic projections symbols.</li> <li>Draw symbols of threads, surface roughness, geometrical tolerances symbols, section lines, etc.</li> <li>Recall by sketching the general systems for limits, fits and tolerances.</li> </ol>	02
2	II,III, IV and V.	<p><b>Design of simple components:</b></p> <ol style="list-style-type: none"> <li>A C15 rod is subjected to tensile load of ....kN. Determine diameter of rod if factor of safety is.....</li> <li>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.</li> <li>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.</li> <li>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.</li> <li>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.</li> </ol> <p>(Note: Each student of the batch must have different values of data. Use design data book</p>	04

		wherever is necessary. Also assume suitable data if required. State the assumptions.)	
3	II,IV	<p><b>Design of assemblies:</b></p> <ol style="list-style-type: none"> <li>Take load =.....kN,</li> <li>Take material as.....</li> <li>Factor of safety =.....</li> <li>Design following showing other assumptions, steps and final dimensions. <ol style="list-style-type: none"> <li>Knuckle joint.</li> <li>Cotter joint.</li> <li>Screw jack.</li> <li>Flange coupling.</li> </ol> </li> </ol> <p>(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.)</p>	06
4	II,IV	<p><b>Sketches and drawings of design assemblies:</b></p> <ol style="list-style-type: none"> <li>Sketch production drawings of details (individual parts). Show dimensions calculated above at experience number 3. Use A4 size paper only.</li> <li>Prepare assembly drawings with dimensions and scale (if required). Use A4 size paper only.</li> <li>Show areas under various stresses induced using color codes.</li> </ol> <p>(Students are also expected to solve these as partial assignments at home.)</p>	02
5	II,IV	<p><b>Modeling:</b></p> <ol style="list-style-type: none"> <li>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).</li> <li>Take printout of the 3D models and orthographic views (with dimensions) of all parts and assemblies. Attach all prints with term work.</li> </ol>	06
6	III and VII	<p><b>Tutorials:</b></p> <ol style="list-style-type: none"> <li>Tutorial on bell crank lever design.(Teacher will assign the data- one problem).</li> <li>Tutorial on bearing. (Teacher will assign the data-one problems).</li> </ol> <p>(Students are also expected to solve these as partial assignments at home.)</p>	02
7	ALL	<p><b>Mini project:</b></p> <ol style="list-style-type: none"> <li>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,</li> </ol>	06

		<p>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.</p> <p>b. Batch students will design this assembly with dimensions. Show calculations and steps.</p> <p>c. Sketch production drawings (details and assembly) in A4 size drawing paper manually.</p> <p>d. Present this mini project with photos/movies of mini project execution and with work distribution executed. Use power point presentation.</p>	
<b>Total Hours</b>			<b>28</b>

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.

## 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.
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### 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](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](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](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](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](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](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](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](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](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](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)**

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
Mechanical Engineering/Mechatronics Engineering	5 <sup>th</sup> 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
<b>Unit – I.</b>  <b>Introduction to Manufacturing Engineering- III.</b>	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.

<b>Unit- II</b>  <b>Grinding and super finishing processes.</b>	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.
<b>Unit- III</b>  <b>Gear manufacturing and finishing processes.</b>	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.
<b>Unit-IV</b> <b>Thread production methods.</b>	4a. Explain thread production processes.	4.1 Thread nomenclature and important terminologies used in thread production. 4.2 Various threads production processes like turning, rolling, grinding, tapping, etc. their applications, advantages and limitations.
	4b. Describe constructional features and working of various thread production machines. 4c. Select appropriate thread production machine as per the given situation. 4d. Explain different steps for producing thread on thread production machine.	4.3 Constructional features including coolant and lubrication systems, motion and power transmission path, working and application of various threads production machines/ processes like lathe, rolling, grinding, tapping, etc. 4.4 Thread cutting parameters for commonly used materials and work-piece. 4.5 Tool mounting methods on thread production processes.
<b>Unit-V</b> <b>Broaching, jig boring and special purpose machine (SPM) tools.</b>	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.
<b>Unit-VI</b>  <b>Non-conventional and advance methods of machining.</b>	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	<b>23</b>	<b>30</b>	<b>17</b>	<b>70</b>

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

**Note:** This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

**General Notes:**

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

**7. SUGGESTED LIST OF EXERCISES/PRACTICALS.**

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

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



S. No.	Unit No.	Practical Exercises (outcomes in psycho-motor Domain)	Approx. Hours. required
1	I	<p><b>Preparatory activity (Includes Home Assignments):</b></p> <p>Demonstrate various cutting parameters, carbide inserts with ISO designation system and explain the steps to calculate cutting speeds. Student will prepare the report on following.</p> <ol style="list-style-type: none"> <li>Tabulate various cutting tools materials with main elements, properties and applications.</li> <li>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.</li> <li>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.</li> </ol>	02
2	All	<p><b>Mini Project:</b></p> <p>Manufacture the assembly which has been designed in the course Design of Machine Elements. Keep the same batch. Student will prepare the report on following.</p> <ol style="list-style-type: none"> <li>Prepare production drawings of the assembly and details.</li> <li>Manufacture the parts.</li> <li>Note down work holding devices, cutting tools and cutting parameters used for each part and each operations. Summarised this in tabular form.</li> <li>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.</li> </ol>	08
3	II, III,IV & V	<p><b>Kinematics and motion transmission systems:</b></p> <p>Demonstrate motion and power transmission path, transmission systems, work mounting systems, tool mounting systems and tool holders/holding systems of cylindrical/surface grinding, tool and cutter grinding, gear hobbing, gear milling, gear shaping, threading and broaching machines. Student will prepare the machine wise report on all machines included here.</p> <ol style="list-style-type: none"> <li>Sketch and label main elements of machine kinematics.</li> <li>Demonstrate and explain machining process with position/motion of work piece and tool. Video may</li> </ol>	08

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

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

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

**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](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](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	5 <sup>th</sup> 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.

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

### 4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
3	0	2	5	70	30	20	30	

**Legends:** L-Lecture; T – Tutorial/Teacher Guided 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
<b>Unit-1</b>  <b>Introduction to Industrial Engineering.</b>	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).
<b>Unit-2</b>  <b>Work Study.</b>	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

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

<p><b>Unit-4</b></p> <p><b>Statistical Quality Control (SQC).</b></p>	<p>4a. Explain various tools of SQC.</p> <p>4b. Compare variables and attributes</p> <p>4c. Calculate control limits, range / mean and prepare control charts.</p> <p>4d. Calculate number/percentage of items falling in and outside specifications limits from mean and standard deviation using normal distribution curve.</p> <p>4e. State and explain various methods of acceptance of incoming materials</p> <p>4f. Prepare and operate single and double sampling plans on the basis of given lot size, AQL and inspection level.</p> <p>4g. Describe process capability.</p> <p>4h. Explain consumers and producers risk.</p> <p>4i. State the importance of OC curve and interpret OC curves in a given situation.</p>	<p>4.1 Concept of variability.</p> <p>4.2 SQC tools and statistical fundamentals.</p> <p>4.3 Concept and differences between variables and attributes.</p> <p>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.</p> <p>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.</p> <p>4.6 Process capability – meaning, definition and method to calculate, numeric examples.</p> <p>4.7 Acceptance sampling:</p> <ul style="list-style-type: none"> <li>i. Quality control of incoming raw material and components.</li> <li>ii. Concepts of random sampling.</li> <li>iii. Sampling plans: definition, terminology, types (Single, double and multiple), implementing plans based on given input.</li> <li>iv. OC curve-concept, need, types and importance, interpretation of given OC curve.</li> </ul>
<p><b>Unit-5</b></p> <p><b>Plant layout and material handling equipments.</b></p>	<p>5a. Explain various types of plant layouts with their merits, demerits and their application.</p> <p>5b. Describe importance and applications of material handling equipment.</p> <p>5c. Select material handling equipments for given situation.</p>	<p>5.1 Plant layout: Definition and concept.</p> <p>5.2 Types of plant layout, their applications, advantages and limitations.</p> <p>5.3 Role of material handling systems in industries.</p> <p>5.4 Material handling equipment-Classification, types, specifications, applications and selection criteria.</p>
<p><b>Unit - 6</b></p> <p><b>Recent trends in industrial engineering.</b></p>	<p>6a. Explain ISO and its role in industries and business.</p> <p>6b. Explain TQC and TQM and its applications.</p> <p>6c. Explain six sigma and Kaizen with their</p>	<p>6.1 International Organization for standardization and its role, ISO standard series and quality managements system.</p> <p>6.2 Total Quality Control (TQC) and Total Quality Management (TQM)-philosophical concepts.</p>

	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.
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## 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:

- 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.
- 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	<b>Preparatory Activity:</b> <ol style="list-style-type: none"> <li>Prepare the table for values of surface finishes achieved in manufacturing processes.</li> <li>Give examples of enhancing productivity.</li> <li>Sketch drafting symbols.</li> <li>Given the readings, sketch how such can be shown using Vernier and micrometer.</li> </ol>	02
2.	ALL	<b>Mini Project and presentation:</b> <ol style="list-style-type: none"> <li>Sketch the parts taken in Design of Machine Elements (DME) under Mini project. The batch of DME is to be continued.</li> <li>Prepare process plans for each part.</li> <li>Prepare flow diagram for each part. Assume institute's workshop layout.</li> <li>Present the work including work distribution, photographs and movies of actual project work using power point presentation.</li> </ol>	04
3.	II	<b>Operation process chart (OPC):</b> Given real mechanical assembly having 6-8 components, prepare operation process chart. (This has to be assigned by teacher). <ol style="list-style-type: none"> <li>Sketch parts and assembly.</li> <li>Prepare OPC.</li> <li>Prepare process plans for all components. Use format given in Annexure-I.</li> </ol>	06
4.	II	<b>Flow diagram(FD):</b> Given real mechanical component having minimum 6-8 mechanical operations, prepare FD. (This has to be assigned by teacher). <ol style="list-style-type: none"> <li>Sketch component.</li> <li>Sketch institute workshop layout.</li> <li>Prepare FD.</li> </ol>	02
5.	II	<b>Man and machine chart:</b> Prepare man and machine chart for given situation. Teacher will assign the real situation. This include: <ol style="list-style-type: none"> <li>List objectives of preparing man and machine chart.</li> <li>Describe the situation assigned by the teacher.</li> <li>Prepare the man and machine chart.</li> <li>Interpret the chart and suggest if any further improvements can be made with respect to enhance productivity.</li> </ol>	02
6.	II	<b>Performance rating:</b> Calculate co-efficient of co-relation for time study person	02

		<p>using performance rating technique. Teacher will assign the situation. This include:</p> <ol style="list-style-type: none"> <li>Define performance rating.</li> <li>Describe the situation assigned by the teacher.</li> <li>List the steps followed to perform the exercise.</li> <li>Observe and record the observations.</li> <li>Plot, interpret and calculate the co-efficient of co-relation.</li> </ol>	
7.	II	<p><b>Time study:</b> 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:</p> <ol style="list-style-type: none"> <li>Sketch the part undertaken for time study.</li> <li>List elements to be considered.</li> <li>Observe and record elements time.</li> <li>List and justify allowances to be taken with values.</li> <li>Calculate standard time.</li> </ol>	02
8.	III	<p><b>Frequency distribution curve:</b></p> <ol style="list-style-type: none"> <li>Take live problem (may be measured variable dimension, result analysis, etc. (Teacher has to assign the live problem) and summarize the data.</li> <li>Perform and prepare frequency table.</li> <li>Determine central tendency, spread or dispersion and range, mode, median and mean standard deviation and variance.</li> <li>Prepare frequency bar, frequency polygon and frequency curve.</li> <li>Plot the areas under normal curve.</li> <li>Given the data (Teacher will assign the data), determine numbers/probabilities of acceptance/rejection using normal distribution table- 4 cases.</li> </ol>	02
9.	IV	<p><b>Control charts for variables:</b></p> <ol style="list-style-type: none"> <li>Define variable. Give five examples.</li> <li>For given live problem, determine subgroup size, measure the variable and record the observations.</li> <li>Perform necessary calculations and determine control limits.</li> <li>Plot <math>\bar{X} - R</math> chart and interpret the same.</li> </ol>	02
10.	IV	<p><b>Control charts for attributes:</b></p> <ol style="list-style-type: none"> <li>Define attribute. Give five examples.</li> <li>Explain binomial and Poisson distributions.</li> <li>For given live problems (different for different charts), determine parameters, record the observations of attribute.</li> <li>Perform necessary calculations and determine control limits.</li> <li>Plot p and c charts and interpret the same.</li> </ol>	02
11.	IV	<p><b>Acceptance sampling:</b></p> <ol style="list-style-type: none"> <li>Show double sampling plan using block diagram.</li> <li>Prepare/ operate double sampling plans on the basis of given lot size, AQL, inspection level and other input for a given problems.</li> </ol>	02

		c. Record the observations and conclude the outcome.	
12.	ALL	<b>Industrial Visit:</b> Visit at least two related industries. Prepare the report as guidelines provided in notes.	-
<b>Total Hours</b>			<b>28</b>

**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 Organisation, 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 $\pm$ 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](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](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:

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

**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	5 <sup>th</sup> 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.

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

**4. TEACHING AND EXAMINATION SCHEME**

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
2	0	2	4	70	30	20	30	

**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
<b>Unit – I</b> <b>Introduction.</b>	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.
<b>Unit – II</b> <b>Break even analysis.</b>	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.
<b>Unit –III</b> <b>Cost estimation of welding.</b>	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.
<b>Unit –IV</b> <b>Cost estimation of forging and casting.</b>	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.

<p><b>Unit –V</b></p> <p><b>Cost estimation of machined part.</b></p>	<p>5a. Estimate the machined part cost for lathe, drilling, milling and shaping operations.</p>	<p>5.1 The terminology associated with machine shop estimation.</p> <p>5.2 Procedure to estimate material cost.</p> <p>5.3 Procedure of estimating cost of machined part for following operations:</p> <ul style="list-style-type: none"> <li>i. Lathe operations (Facing, outside/inside turning, boring, drilling on lathe, grooving and out side threading).</li> <li>ii. Drilling operations (Drilling, reaming, tapping).</li> <li>iii. Shaping operations.</li> <li>iv. Milling operations (Face milling, side and face cutting, end milling, key way milling and gear forming).</li> <li>v. Cylindrical grinding operations (Plain cylindrical grinding).</li> </ul> <p>5.4 For given machined part, estimate material cost and machining cost.</p>
<p><b>Unit – VI</b></p> <p><b>Estimation of process cost.</b></p>	<p>6a. Identify the elements required to estimate the process cost.</p> <p>6b. Estimate the cost of processes required based on given set of input.</p>	<p>6.1 Understand importance of estimating various process costs.</p> <p>6.2 Procedure and steps to estimate cost for following processes:</p> <ul style="list-style-type: none"> <li>i. Producing power using diesel generating set (cost per hour and cost per unit).</li> <li>ii. Power produced at thermal power plants. (Cost per unit).</li> <li>iii. Pouch packaging. (Cost per pouch).</li> <li>iv. Heat exchanger, cooling or heating. (Cost per hour).</li> <li>v. Ice plant. (Cost per unit weight).</li> </ul> <p>6.3 Given the required set of input, estimate the cost of processes specified above.</p>
<p><b>Unit – VII</b></p> <p><b>Budgeting and contracting.</b></p>	<p>7a. Explain various budgetary and accounting terminologies.</p> <p>7b. Prepare simple budget.</p> <p>7c. Interpret given contract terms and conditions.</p> <p>7d. Select parameters, terms and conditions to be</p>	<p>7.1. Define budget and budgetary control.</p> <p>7.2. Purpose of budget.</p> <p>7.3. Various types of budgets.</p> <p>7.4. Benefits of budget.</p> <p>7.5. With given example, interpret industrial budget.</p> <p>7.6. Prepare simple budget given</p>

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

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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	<p><b>Preparatory activity:</b></p> <ol style="list-style-type: none"> <li>Write various equations to calculate area and volume of commonly used shapes.</li> <li>List densities of commonly used materials.</li> <li>Machining process parameters of various manufacturing processes (Covered in this course) for commonly used materials.</li> <li>Collect market rates for various consumables like diesel, welding rods, gas, cutting tools, electricity rates, etc. to be used in this course.</li> </ol>	02
2.	III, IV,V, VI	<p><b>Collection of parts:</b></p> <ol style="list-style-type: none"> <li>Collect the finished parts from industries/market/scrap merchants consisting:               <ol style="list-style-type: none"> <li>Welded parts (Minimum THREE).</li> <li>Casted parts (Minimum THREE).</li> <li>Forged parts (Minimum TWO).</li> <li>Parts having five to six machining operations like cutting, turning, threading, grinding, milling, shaping, drilling, etc.(Minimum FIVE).</li> </ol> </li> <li>Measure and prepare production drawings of all the parts using A4 size paper (Manually).</li> </ol> <p>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</p>	02



		the batch.	
3.	III	<b>Welding estimation:</b> <ol style="list-style-type: none"> <li>Determine raw material volume for all welded parts.</li> <li>Select welding rod to be used. Estimate quantity of welding rod required.</li> <li>Determine material and consumables costs.</li> <li>For each part, estimate welding cost. Show the assumptions and steps followed to estimate welding cost.</li> <li>Derive total cost of the part.</li> </ol>	02
4.	IV	<b>Casting estimation:</b> <ol style="list-style-type: none"> <li>Determine raw material volume for all casted parts (calculate input weight, cut weight, net weight, losses etc.).</li> <li>Prepare pattern drawings (production drawings with all dimensions, surface finishes, allowances, etc.) for all parts.</li> <li>Estimate pattern cost.</li> <li>Determine material and consumables costs.</li> <li>For each part, estimate casting cost. Show the assumptions and steps followed to estimate casting cost.</li> <li>Derive total cost of the part.</li> </ol>	04
5.	IV	<b>Forging estimation:</b> <ol style="list-style-type: none"> <li>Determine raw material volume for all forged parts.</li> <li>Prepare die drawings (production drawings with all dimensions, surface finishes, allowances, etc.) for all parts.</li> <li>Estimate dies cost.</li> <li>Determine material and consumables costs.</li> <li>For each part, estimate forging cost. Show the assumptions and steps followed to estimate forging cost.</li> <li>Derive total cost of parts.</li> </ol>	04
6.	V	<b>Machining estimation:</b> <ol style="list-style-type: none"> <li>Determine raw material volume for all machined parts.</li> <li>For each part, tabulate operation, cutting tool/s to be used and cutting parameters (speed, feed and depth of cut) to be used.</li> <li>Estimate raw material cost.</li> <li>For each part, estimate machining cost. Show the assumptions and steps followed to estimate machining cost.</li> <li>Derive total cost of parts.</li> </ol>	06
7.	VI	<b>Process estimation:</b> <ol style="list-style-type: none"> <li>Teacher will assign the input data. Estimate hourly rate of running diesel generating set. Show the assumptions and steps followed to estimate the rate.</li> <li>Teacher will assign the input data. Estimate hourly rate of running ice plant. Also estimate the rate to</li> </ol>	04

		<p>produce a Ton of ice with same data. Show the assumptions and steps followed to estimate the rate.</p> <p>c. Teacher will assign the input data. Estimate hourly rate of running heat exchanger. Show the assumptions and steps followed to estimate the rate.</p> <p>d. Teacher will assign the input data. Estimate unit rate of thermal power plant. Show the assumptions and steps followed to estimate the rate.</p>	
8.	ALL	<p><b>Mini Project and presentation:</b></p> <p>a. Sketch the parts taken in Design of Machine Elements (DME) under Mini project. The batch constituted in DME course is to be continued.</p> <p>b. Prepare process plans for each part.</p> <p>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).</p> <p>d. Estimate cost of parts and assembly. Show the assumptions and steps followed to estimate the costs.</p> <p>e. Present the work including work distribution, photographs and movies of actual project work using power point presentation.</p>	04
<b>Total Hours</b>			<b>28</b>

**Notes:**

- 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.
- Term work report must not include any photocopy/ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student himself.
- Mini project and presentation topic/area has to be assigned to the students in the beginning of the term by batch teacher.
- Student activities are compulsory and are part of term work.
- 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	5 <sup>th</sup> 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				Total Marks
				Theory Marks		Practical 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
<b>Unit – I</b>  <b>Introduction to self-employment and entrepreneurship development.</b>	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 <ol style="list-style-type: none"> <li>i. Concept and need in present Indian job market context.</li> <li>ii. Characteristics of self-employment areas for mechanical engineering field.</li> <li>iii. Broader ways to identify self-employment areas in mechanical engineering.</li> </ol> 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: <ol style="list-style-type: none"> <li>i. Concept and need.</li> <li>ii. Scope in local and global market.</li> <li>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.</li> </ol> 1.5 Concept and importance of productivity, quality, cost consciousness and customers' satisfaction. 1.6 Types of enterprise- <ol style="list-style-type: none"> <li>i. Sole partnership.</li> <li>ii. Partnership firm.</li> <li>iii. Joint stock company.</li> <li>iv. Co-operative society.</li> </ol>
<b>Unit II</b>  <b>Entrepreneurial support agencies.</b>	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: <ol style="list-style-type: none"> <li>i. Sources of information.</li> <li>ii. Financial assistance.</li> <li>iii. Technical assistance.</li> <li>iv. Training.</li> </ol> 2.4 Current state & national level promotional schemes for establishment of new

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
<p><b>Unit – III</b></p> <p><b>Project set up planning.</b></p>	<p>3a. Understand process of product selection and stages of product development.</p> <p>3b. Select appropriate process considering productivity.</p> <p>3c. Determination of capacity based on identified product &amp; process.</p> <p>3d. Select proper location and prepare suitable plant layout.</p>	<p>enterprise</p> <p>3.1 Product (Physical and service both-having mechanical features) selection:</p> <ul style="list-style-type: none"> <li>i. Concept and importance</li> <li>ii. Product selection</li> <li>iii. Effect of competitive or similar types of products on product selection</li> <li>iv. Product development stages.</li> </ul> <p>3.2 Process Selection:</p> <ul style="list-style-type: none"> <li>i. Concept and importance.</li> <li>ii. Factors affecting process selection.</li> <li>iii. Technology life cycle.</li> <li>iv. Productivity-concept &amp; importance.</li> <li>v. Flexibility.</li> </ul> <p>3.3 Process Conversion- Capacity Planning :</p> <ul style="list-style-type: none"> <li>i. Concept.</li> <li>ii. Importance.</li> <li>iii. Basic method to assess / estimate capacity.</li> </ul> <p>3.4 Selection of location and layouts:</p> <ul style="list-style-type: none"> <li>i. Concept.</li> <li>ii. Factors affecting selection of location.</li> <li>iii. Objectives and types of plant layout.</li> <li>iv. Factors affecting plant layout.</li> </ul>
<p><b>Unit – IV</b></p> <p><b>Project proposal planning.</b></p>	<p>4a. Describe the Management of the critical resources.</p> <p>4b. Define Marketing.</p> <p>4c. Explain need for enterprise, 4Ps channels (product, price, place and promotion).</p> <p>4d. Prepare preliminary and detailed project report.</p>	<p>4.1 7-M resources.</p> <p>4.2 Marketing- definition, need for enterprise, 4Ps channels (product, price, place and promotion).</p> <p>4.3 Market survey-concept, need and methods.</p> <p>4.4 Managing finance :</p> <ul style="list-style-type: none"> <li>i. Terminology used in financial management.</li> <li>ii. Concept of financial statement and types (balance sheet, profit &amp; loss statement and funds flow statement).</li> </ul> <p>4.5 Project report preparation for mechanical feature based product:</p> <ul style="list-style-type: none"> <li>i. Meaning of project planning and report.</li> <li>ii. Feasibility study.</li> <li>iii. Details required for preparing project plan.</li> <li>iv. Project cost estimation.</li> <li>v. Cost, Volume and Profit (CVP) analysis.</li> <li>vi. Preliminary project report (PPR) and detailed project report (DPR).</li> </ul>

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
<b>Unit – V</b> <b>Enterprise and risk management.</b>	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.
<b>Unit – VI</b> <b>Case studies.</b>	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
	<b>Total</b>	<b>42</b>	<b>23</b>	<b>20</b>	<b>27</b>	<b>70</b>

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

**Note:** This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

### General Notes:

- If mid semester test is part of continuous evaluation, unit numbers I, III (Up to 3.3 only) and IV are to be considered.
- 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	<b>Preparatory activity:</b> <ol style="list-style-type: none"> <li>List various types of industries.</li> <li>Narrate need of self employment.</li> <li>Anticipate importance of entrepreneurship development.</li> </ol>	2
2	I	<b>Creativeness and innovativeness:</b> <ol style="list-style-type: none"> <li>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.</li> <li>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.</li> <li>List at least ten mechanical engineering products which have passed through innovativeness.</li> </ol>	4
3	I	<b>Identification of self-employment areas:</b> <ol style="list-style-type: none"> <li>Teacher will assign this exercise in group of 5-6 students.</li> <li>List at least five mechanical feature based areas which have, in group's opinion, self-employment potential. Select any one promising area.</li> <li>Develop market survey format for the selected area.</li> <li>Perform market survey for self-employment</li> </ol>	4

		<p>opportunities.</p> <p>e. Describe the outcome. Also narrate the experience.</p> <p>f. It is compulsory to attach photographs of group conducting market survey.</p>	
4	II	<p><b>Visit report:</b></p> <p>a. Visit nearby :</p> <p>i. District Industries Centre (DIC).</p> <p>ii. Any one financial institution including bank.</p> <p>iii. Training institute / GITCO/EDI/ iNDEXTb/etc.</p> <p>b. Prepare the visit report which include followings:</p> <p>i. Brief history of organization.</p> <p>ii. Type and details of services /support/ assistance being given.</p> <p>iii. Any other information which are useful to be self-employer or entrepreneur.</p> <p>iv. Brochures/technical literature collected from agencies.</p>	4
5	III and IV	<p><b>Preparing project feasibility report of assigned product:</b></p> <p>a. Teacher will assign any one product (physical or service based having mechanical features) to the group of 5-6 students.</p> <p>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.</p>	8
6	VI	<p><b>Case analysis and presentations:</b></p> <p>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.</p>	6
<b>Total Hours</b>			<b>28</b>

**Notes:**

- 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.
- Term work report must not include any photocopy, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only.
- 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 : <a href="http://www.ediindia.org">http://www.ediindia.org</a>
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](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: PROJECT-I  
(COURSE CODE: 3351908)**

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
<b>Mechanical Engineering</b>	<b>5<sup>th</sup> Semester</b>

**1. RATIONALE.**

This course enables the students to exercise some of the knowledge and/or skills developed during the programme to new situation or problem for which there are number of engineering solutions. This course includes a planning of the project which is to be completed within the time allocated, the maintenance of a log book and the preparation of a report. The report contains the reasons for all decisions taken. This course also aims to develop the managerial skills such as leadership, coordination, team work, planning the resources, etc. Thus by studying this course, abilities like innovativeness, creativity, imitativeness, performance qualities, etc. are developed in students.

**2. COMPETENCY.**

- Apply innovative, creative and logical approach for problem identification.
- Plan resources optimally and economically.

**3. COURSE OUTCOMES.**

- i. Perform various tasks like market survey, industrial visits, creative and innovative techniques, etc to identify project.
- ii. Draw details and assembly production drawings.
- iii. Plan material and processes optimally and economically.
- iv. Develop sense of environmental responsibility.

**4. TEACHING AND EXAMINATION SCHEME.**

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	
0	1	3	4	0	0	40	60	100

**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
<b>Unit – I.</b>  <b>Introduction.</b>	1a. Appreciate objectives of learning this course.	1.1 Introduction. 1.2 Need, importance and objectives. 1.3 Examples of projects. 1.4 Expected benefits.
<b>Unit– II</b>  <b>Basic techniques and project problem identification.</b>	2a. Develop the positive attitude suitable for industrial environment. 2b. Apply basic techniques to identify and to define problems/projects. 2c. Identify the problem/project. 2d. Prepare details and assembly production drawings for manufacturing type projects. 2e. Define live problems at industry place. Also prepare necessary drawings for live problem solution at industry place. 2f. Develop generic and managerial skills. 2g. Plan time and material optimally and economically.	2.1 Attitude-Dos and Don'ts in context of industrial environment. 2.2 Need-the mother of invention. 2.3 Basic techniques. (It is expected that student also uses these basic techniques to develop their engineering and innovative thinking pattern, i.e. student uses these techniques as their thought drivers/techniques to identify/define problems/projects.) i. Productivity. ii. Quality. iii. Creativity and innovativeness. iv. Cost/waste reduction. v. Safety/security. vi. Pollution reduction/removal. vii. Humanity. viii. Cause and effect diagram (Fish bone diagram). ix. 5-S Strategies. x. 7-S Framework. xi. SWOT analysis. xii. Value Analysis. xiii. Market survey. xiv. Other/s included by concerned teacher.  2.4 Identification of problem/ project.(Each student will suggest one problems/ projects. Emphasis for project selection should be given to the area of elective group selected.).The project can be of: i. Manufacturing type at institute place. For critical processes/ operations, help of industries can be taken. ii. Live problem solution at industry place.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		iii. Combination of above two. The project should also be: <ol style="list-style-type: none"> <li>i. Preferably innovative in nature.</li> <li>ii. Feasible using the infrastructure of the institute.</li> <li>iii. To give practice for drawing/drafting using software.</li> <li>iv. Incorporating major manufacturing processes if possible.</li> <li>v. Non repetitive in nature.</li> <li>vi. To develop the generic as well as technology related skills.</li> <li>vii. Having measurable and analytical end results.</li> </ol> 2.5 Prepare details and assembly production drawings for manufacturing type projects. OR 2.5 Define live problems at industry place. Also prepare necessary drawings for live problem solution at industry place. 2.6 Prepare bill of material. 2.7 Cost estimation of parts and complete project.
<b>Unit– III</b> <b>Draft project report.</b>	3a. Prepare draft project report.	3.1 Prepare draft project report. 3.2 Present the draft project report.

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

Unit No.	Unit Title	Tutorial hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction.	2	NOT APPLICABLE			
II	Basic techniques and project problem identification.	6				
III	Draft project report.	6				
	Total	14				

**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.

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## 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)	Tutorial hours	Practice Hours
1	I	<b>Preparatory activities:</b> a. Objectives of learning this subject. b. List attitude dos and don'ts.	2	3
2	II	<b>Basic techniques.</b> a. Explain all basic techniques as per Unit II. b. Identify at least five needs which require product development/modification. Each student will identify separately. c. Given the live product/case (to be assigned by teacher), generate at least ten questions for each following basic techniques leading to identify project/problem: i. Productivity. ii. Quality. iii. Cost/waste reduction. iv. Value analysis. d. Carry out market survey for given product. (Teacher will assign the required data). e. Prepare cause and effect diagram (Fish bone diagram) for given data. (Teacher will assign the required data). f. Perform SWOT analysis for self. g. Briefly explain and present 5-S and 7-S frame work. h. Visit an industry and prepare the report on project which can be undertaken for manufacturing at institute place and/or live problems which can be solved at industry place. i. Carry out literature survey for basic	4	12



		techniques.		
3	III	<p>Identification of problem/project.  Student will practice and will identify at least one problem/ project and will prepare following.</p> <p>i. Details and assembly production drawings.(For manufacturing type project).</p> <p style="text-align: center;">OR</p> <p>i. Define live problems at industry place.  Also prepare necessary drawings for live problem solution at industry place.</p> <p>ii. Bill of material.</p> <p>iii. Cost estimation of parts and complete project.</p>	2	9
5	IV	<p><b>Draft project report:</b>  Prepare draft project report and include following.</p> <p>i. Activities performed at sr.no.2 from b to i. (Questions generated, market survey carried out, fishbone diagram, self SWOT analysis, tutorials, examples, 5-S and 7-S brief techniques, industrial visit outcome, literature survey).</p> <p>ii. Title of project.</p> <p>iii. Details and assembly production drawings prepared with use of software.(AutoCAD/ProE, CREO, etc.</p> <p style="text-align: center;">OR</p> <p>iii. Description of live problem to be solved at industry place.</p> <p>iv. Bill of material.</p> <p>v. Cost estimation of parts and complete project.</p>	6	18
Total Hours			14	42

**NOTE:**

- a. Prepare project report with MS Office with following guidelines.

PAGE	:	A4 (ON ONE SIDE)
MARGIN	:	TOP 15mm
	:	BOTTOM 15mm
	:	RIGHT 15mm
	:	LEFT 30mm
FONT	:	ARIAL
SIZE	:	TITLE :12 BOLD
	:	CONTENT :12
	:	SPACING :18 points.
HEADER	:	TITLE OF THE PROJECT, PAGE NUMBER ON TOP RIGHT.
FOOTER	:	ACADEMIC YEAR, SHORT NAME

OF THE INSTITUTE.

- 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. For practical ESE part, students are to be assessed for competencies achieved.

## 8. SUGGESTED LEARNING RESOURCES.

### A) References:

- a. Use of Library.
- b. Reference books.
- c. Hand books.
- d. Encyclopaedia.
- e. Magazines.
- f. Periodicals.
- g. Journals.
- h. Visits of industry, organizations related as per the requirement.
- i. Internet.

## 9. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### Faculty Members from Polytechnics

- K.H.Patel, Head of Mechanical Engineering Department, Dr. S.S.&S. Gandhi College of Engineering and Technology, Surat.
- 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

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT****COURSE CURRICULUM  
COURSE TITLE: COMPUTER AIDED MANUFACTURING (CAM)  
(COURSE CODE: 3361901)**

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
Mechanical Engineering	Sixth

**1. RATIONALE.**

The use of conventional machines is decreasing day by day. Evolution of information technology, variety of manufacturing concepts with zero lead time demand and quality consciousness has supported fast adaption of Computer Aided Manufacturing. CNC machines (computerized numerical control machines) are the main component in Computer Aided Manufacturing Systems. Efficient use of CNC machines requires excellent knowledge of programming and use of CNC tooling. In this course an attempt has been made to focus exclusively on constructional features of CNC machines, their programming and tooling, so that students may learn to use the CNC machines efficiently for manufacturing desired products. CAM is normally not only limited to machine tools but in real life its use has widened in almost all areas of manufacturing, processes and support activities.

**2. COMPETENCIES:**

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competencies.

- **Select required operating parameters, appropriate tools, tool holders, accessories and consumables for manufacturing a given job on CNC.**
- **Manufacture simple jobs using CNC part programming.**

**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. Identify different axes, machine zero, home position, controls and features of CNC machines.
- ii. Select, mount and set cutting tools and tool holders on CNC.
- iii. Prepare part programmes using ISO format for given simple components with and without use of MACRO, CANNED CYCLE and SUBROUTINE using ISO format.
- iv. Interface software application for auto part programming.

**4. TEACHING AND EXAMINATION SCHEME.**

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
2	0	2	4	70	30	20	30	

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
<b>Unit – I.</b> <b>Fundamentals of CAM.</b>	1a. Differentiate between NC, CNC and DNC. 1b. Identify parameters governing for selection of CNC machines.	1.1 CAM - concept and definition. 1.2 NC (Numerical Control), CNC (Computerized Numerical Control) and DNC (Direct Numerical Control) - concept, features and differences. 1.3 Advantages and limitations of CNC. 1.4 Selection criteria for CNC machines.
<b>Unit- II</b> <b>Constructional features of CNC machines.</b>	2a. Classify CNC machines. 2b. Identify role of main elements of CNC machines. 2c. Identify CNC axes. 2d. Preset tool on CNC machines. 2e. Use qualified tools and tool holders on CNC machines.	2.1 CNC machines: Types, classification, working and constructional features. 2.2 Spindle drives and axes drives on CNC machines. 2.3 Machine structure- Requirements and reasons. 2.4 Elements of CNC machines - Types, sketch, working and importance of: i. Slide ways. ii. Re-circulating ball screw. iii. Feedback devices (transducers, encoders). iv. Automatic tool changer (ATC). v. Automatic pallet changer (APC). 2.5 CNC axes and motion nomenclature. 2.6 CNC tooling : i. Tool presetting-concept and importance. ii. Qualified tools-definition need and advantages. iii. Tool holders- types and applications.

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
<b>Unit – III</b>  <b>CNC Turning &amp; Machining Centers.</b>	3a. List features of specified CNC turning and machining centre.  3b. Identify various work holding and tool holding devices.	3.1 CNC turning centres: <ol style="list-style-type: none"> <li>i. Types.</li> <li>ii. Features.</li> <li>iii. Axes nomenclature.</li> <li>iv. Specification.</li> <li>v. Work holding devices -types, working and applications.</li> <li>vi. Tool holding and changing devices - types, working and applications.</li> </ol> 3.2 CNC machining centres: <ol style="list-style-type: none"> <li>i. Types.</li> <li>ii. Features.</li> <li>iii. Axes nomenclature.</li> <li>iv. Specification.</li> <li>v. Work holding devices-types, working and applications.</li> <li>vi. Tool holding and changing device types, working and applications.</li> </ol>
<b>Unit – IV</b>  <b>CNC part programming.</b>	4a. Interpret ISO format of CNC part programming with used codes.  4b. Prepare part programme by using applicable codes like G& M etc.  4c. Apply advanced CNC part programming features like canned cycle, do loop, subroutine etc.,  4d. Describe procedure for Setting various compensations on CNC.  4e. Prepare part programme considering	4.1 Definition and importance of various positions like machine zero, home position, work piece zero and programme zero.  4.2 CNC part programming: programming format and structure of part programme.  4.3 ISO G and M codes for turning and milling-meaning and applications of important codes.  4.4 Simple part programming for turning using ISO format having straight turning, taper turning (linear interpolation) and convex/concave turning (circular interpolation).  4.5 Simple part programming for milling using ISO format.  4.6 Importance, types, applications and format for: <ol style="list-style-type: none"> <li>i. Canned cycles.</li> <li>ii. Macro.</li> <li>iii. Do loops.</li> <li>iv. Subroutine.</li> </ol> 4.7 CNC turning and milling part programming using canned cycles, Do loops and Subroutine.

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
	various compensations.	4.8 Need and importance of various compensations: i. Tool length compensation. ii. Pitch error compensation. iii. Tool radius compensation. iv. Tool offset. 4.9 Simple part programming using various compensations.
Unit – V <b>Recent trends in CAM.</b>	5a. Select suitable standard for CAD/CAM interfacing. 5b. List source of variability for adaptive control. 5c. Interpret different FMS layouts. 5d. Correlate areas of CIM. 5e. Identify types and elements of robots. 5f. Describe concept of Rapid prototyping.	5.1 Interfacing standards for CAD/CAM - Types and applications 5.2 Adaptive control- definition, meaning, block diagram, sources of variability and applications. 5.3 Flexible Manufacturing System (FMS) - concept, evaluation, main elements and their functions, layout and its importance, applications. 5.4 Computer Integrated Manufacturing (CIM) - Concept, definition, areas covered, benefits. 5.5 Robotics- definition, terminology, classification and types, elements and applications. 5.6 Rapid prototyping - Concept and application

#### 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	Fundamentals of Computer Aided Manufacturing	4	4	6	0	10
II	Constructional Features of CNC machines	5	6	4	4	14
III	CNC Turning & Machining Centers.	4	2	6	2	10
IV	CNC part programming.	10	4	6	14	24
V	Recent trends in CAM.	5	4	8	0	12
	<b>Total</b>	<b>28</b>	<b>20</b>	<b>30</b>	<b>20</b>	<b>70</b>

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

#### Notes:

- 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.

- b. If mid-sem test is part of continuous evaluation, unit numbers I, II and III are to be considered.
- c. 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	II	<p><b>Demonstrate constructional features of CNC:</b></p> <ol style="list-style-type: none"> <li>a. Demonstrate CNC machines and its operations.</li> <li>b. Identify major parts of CNC and draw sketch.</li> <li>c. Write specification of CNC taken for demonstration.</li> <li>d. Sketch important tool holders.</li> <li>e. Tabulate sensors / feedback devices with type, specification and purposes used on CNC taken for demonstration.</li> <li>f. Sketch display console. Also sketch symbols used on display console with meaning of each.</li> <li>g. State interfacing standards used.</li> </ol>	06
2	IV	<p><b>CNC turning part programming:</b></p> <p>Teacher will assign part drawings. Minimum five drawings having following details are to be assigned. This include parts-</p> <ol style="list-style-type: none"> <li>(i) Simple turning with steps, (ii) Turning with tapers, (iii) Turning with circular (concave / convex shape) interpolation, (iv) Turning using canned cycle - with threading or drilling or other and (v)Turning with use of subroutine or macro or do-loop.</li> </ol> <p>Students would:</p> <ol style="list-style-type: none"> <li>a. Sketch each part with dimensions.</li> <li>b. Prepare CNC part programme using G and M codes with ISO format.</li> </ol>	10

Sr. No.	Unit No.	Practical Exercises (outcomes in Psychomotor Domain)	Approx. Hours required
		c. Show various zeros and tool path on part sketch with color codes and dimensions. d. Simulate the prepared part programmes using available simulation softwares. e. Prepare the parts on CNC.	
3	IV	<b>CNC machining centre part programming:</b> Teacher will assign part drawings. Minimum three drawings having following details are to be assigned. This include parts- (i) Simple contour milling (ii) Contour milling with (convex / concave) circular interpolation and (iii) contour milling with drilling / tapping. Students would: a. Sketch each part with dimensions. b. Prepare CNC part programme using G and M codes with ISO format. c. Show various zeros and tool path on part sketch with color codes and dimensions. d. Simulate the prepared part programmes using available simulation softwares. e. Prepare the parts on CNC.	08
4	III	<b>Demonstration of CAD/CAM integration:</b> a. Demonstrate CAD / CAM integration. b. List interfacing standards.	02
5	ALL	<b>Industrial visit:</b> Visit nearby industry having CNC machines. List and state important features of them with detail specifications and name of manufacturers.	02
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 group of specified students in the beginning of the term by batch teacher, if applicable.
- d. For practical ESE part, students are to be assessed for competencies achieved.

**8. SUGGESTED LIST OF STUDENT ACTIVITIES.**

SR.NO.	ACTIVITY
i.	Visit nearby industry having CNC machines. List and state important features of them.
ii.	Prepare specifications of various types of CNC machines with images and names of manufacturers.



iii.	Download images and videos of CNC machines and its parts. Prepare one VCD/DVD in a batch and submit to batch teacher.
iv.	Download free simulation softwares available on website and practice for part programming.

### 9. SPECIAL INSTRUCTIONAL STRATEGIES (if any).

Sr. No.	Unit	Unit Name	Strategies
i.	I	Introduction.	Videos, Presentations, Demonstration.
ii.	II	Constructional Features of CNC machines	Videos, Presentations, Industrial Visits, Demonstration,
iii.	III	CNC Turning & Machining Centers..	Videos, Presentations, Industrial Visits, Demonstration,
iv.	IV	CNC part programming.	Simulation softwares, actual practice on CNC machines, Demonstration,
v.	V	Recent trends in CAM.	Videos, Presentations, Industrial Visits,

### 10. SUGGESTED LEARNING RESOURCES.

#### A. List of Books:

S. No.	Title of Book	Author	Publication
i.	CNC Machines.	Pabla B.S., Adithan M.	New Age International, New Delhi, 2014(reprint).
ii.	Computer Numerical Control-Turning and Machining centers.	Quesada Robert	Prentice Hall 2014.
iii.	CAD/CAM.	Sareen Kuldeep	S.Chand 2012.
iv.	Introduction to NC/CNC Machines.	Vishal S.	S.K.Kataria & Sons. 2012.
v.	Computer Aided Manufacturing.	Rao P N, Tiwari N K, Kundra T	Tata McGraw Hill 2014.
vi.	CAD/CAM: computer aided design and manufacturing.	Groover Mikell P, Zimmered W Emory	Prentice Hall 2011.

#### B) List of Major Equipment/ Instruments with Broad Specifications:

Sr. No.	Resource with brief specification.
i.	CNC Turning Centre (Tutor or Productive)- Minimum diameter 25 mm, Length 120 mm with ATC. (Approximate)

ii.	CNC Machining Centre (Tutor or Productive)- X axis travel - 225 mm, Y axis travel - 150 mm, Z axis travel - 115 mm, With ATC. (Approximate)
iii.	Simulation software likes: CNC Simulator Pro, Swansoft CNC, etc.
iv.	Latest version of CAD/CAM integration software like MASTER CAM, NX CAM. etc.

### C. List of Software/Learning Websites.

- i. <http://www.nptel.ac.in>
- ii. <http://www.youtube.com/watch?v=M3eX2PKM1RI>
- iii. [http://www.youtube.com/watch?v=EHQ4QIDqENI&list=PLBkqkLQO2nAt5MNLo eUhvKFS9M0p8y\\_1](http://www.youtube.com/watch?v=EHQ4QIDqENI&list=PLBkqkLQO2nAt5MNLo eUhvKFS9M0p8y_1)
- iv. <http://www.youtube.com/watch?v=hJFLcvtiNQI>
- v. <http://www.youtube.com/watch?v=BIM1AyxfYkw>.
- vi. <http://www.mtabindia.com>
- vii. <http://www.swansoftcncsimulator.com>

## 11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### Faculty Members from Polytechnics.

- **Prof K.P. Patel**, H.O.D, Mechanical Department, B.S.Patel Polytechnic, Kherva.
- **Prof J.B.Patel**, Sr. Lecturer, Mechanical Department, R.C.Technical Institute, Ahmedabad
- **Prof R.A.Prajapati**, Sr. Lecturer, Mechanical Department, R.C.Technical Institute, Ahmedabad

### Coordinator and Faculty Members from NITTTR Bhopal.

- **Dr. K.K. Jain**, Professor, Department of Mechanical Engineering, NITTTR, Bhopal
- **Dr. A.K. Sarathe**, Associate Professor; Department of Mechanical Engineering.

### SUGGESTED QUESTION PAPER FORMAT

(This is for reference only and is in suggestive form. Paper setter may opt for other marks distribution pattern maintaining distribution of marks as per specification table)

Q.NO.	SUB Q.NO.	QUESTION	MARKS DISTRIBUTION			UNIT
			R	U	A	
1		Answer ANY seven from following.				14
	i.		2			I
	ii.		2			I
	iii.		2			I
	iv.		2			II
	v.		2			III
	vi.		2			IV
	vii.		2			IV
	viii.		2			IV
	ix.		2			V
	x.		2			V
2	a.			6		I
		OR				
	a.			6		I
	b.			4		II
		OR				
	b.			4		II
	c.				4	II
		OR				
	c.				4	II
3	a.		6			II
		OR				
	a.		6			II
	b.			4		V
		OR				
	b.			4		V
	c.			4		V
		OR				
	c.			4		V
4	a.	Given the simple part drawing of milling contour with circular interpolation, prepare the CNC part programme using G and M codes with ISO format.			7	IV
		OR				
	a.	Given the simple part drawing of milling contour with circular interpolation, prepare the CNC part programme using G and M codes with ISO format.			7	IV
	b.			4		IV

	c.			3		IV
5	a.	Given the simple part drawing, prepare the CNC turning part programme using G and M codes with ISO format. Include circular interpolation.			7	IV
	b.			4		III
	c.			3		III

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

**COURSE CURRICULUM  
COURSE TITLE: TOOL ENGINEERING  
(COURSE CODE: 3361902)**

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
Mechanical Engineering	Sixth

**1. RATIONALE.**

Tools are as basic component for any machining process. The quality and efficiency of any machining operation basically depends upon quality of tools which in turn depends upon the proper shape, size and material of the tools. Productivity and quality of machining operations may further be enhanced by proper and quick mounting of tools and jobs on machines. Jigs and fixture plays an import roll in this process. Therefore this course attempts to develop abilities in students to select a tool of proper size and shape for required machining operation. The design of cutting tools, jigs and fixtures are also dealt with in this course. This course is therefore a core course for mechanical engineers.

**2. COMPETENCY.**

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competencies.

- **Develop the ability to select and/or design cutting tools, tool holders, dies, jigs and fixture for given simple component.**

**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. Re-sharpen given cutting tool.
- ii. Select proper tool for given manufacturing operation
- iii. Interpret designation system of cutting tool and tool holder.
- iv. Select locating and clamping devices for given component.
- v. Select and design jig and fixture for given simple component.
- vi. Classify and explain various press tools and press tools operations.
- vii. Select a die for a given simple component.

**4. TEACHING AND EXAMINATION SCHEME.**

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
3	0	2	5	70	30	20	30	

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

## 5. COURSE CONTENT DETAILS.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
<b>Unit – I.</b>  <b>Introduction.</b>	1a. Explain role of tool engineering in industries. 1b. Establish importance of process planning in tool engineering. 1c. Identify and select elements of universal acts in manufacturing operations.	1.1 Concept, meaning and definitions of tool, tool design and tool engineering. 1.2 Tools-types, classification, features & applications. 1.3 Tool engineering-functions and importance to enhance productivity and quality. 1.4 Importance of process planning in tool engineering. 1.5 Economy-concept, meaning, importance and principles in tool engineering. 1.6 Universal acts & their elements of a manufacturing operation with suitable simple example.
<b>Unit – II</b>  <b>Cutting tools and tool holders.</b>	2a. List cutting tool materials. 2b. Interpret ISO-designation for carbide inserts. 2c. Describe process for re-sharpening commonly used cutting tools. 2d. Interpret ISO-designation for tool holders for carbide inserts. 2e. Mount tool holders on conventional milling and drilling machines.	2.1 Cutting tool materials-types, composition, properties and applications. 2.2 Carbide inserts-types, ISO-designation and applications. 2.3 Re-sharpening methods of following cutting tools: i. Drill. ii. Side and face milling cutter. iii. End mill. iv. Centre drill, type A and B. v. Gear hob. 2.4 Tool holders for turning and milling carbide inserts-types, ISO-designation and applications. 2.5 Tool holding and tool mounting systems for conventional milling and drilling machine tools.
<b>Unit – III</b>  <b>Locating and clamping devices.</b>	3a. Explain location and 3-2-1 principle of location. 3b. Establish importance of degree of freedom in location. 3c. Select and use appropriate	3.1 Concept, meaning and definitions of location and clamping. 3.2 Use of locating and clamping principles in day-to-day supervision on shop floor. 3.3 Degree of freedom-concept and importance. 3.4 3-2-1 principle of location. 3.5 Locators: i. Types- ii. Sketches with nomenclature. iii. Working. iv. Applications.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	locator for given work piece. 3d. Select and use appropriate clamping device for given work-piece situation.	3.6 Fool proofing and ejecting. 3.7 Clamping devices: i. Types. ii. Sketches with nomenclature. iii. Working. iv. Applications.
<b>Unit – IV</b> <b>Jigs and fixtures.</b>	4a. Differentiate between jigs and fixtures. 4b. Select and design appropriate jig or fixture for given simple work-piece.	4.1 Concept, meaning, differences and benefits of jigs and fixtures. 4.2 Types, sketches with nomenclature, working and applications of jigs. 4.3 Types, sketches with nomenclature, working and applications of fixtures. 4.4 Steps to design jigs and fixture. 4.5 For given simple component: i. Select type (Jig or fixture). ii. Develop locating method. iii. Develop clamping method. iv. Design jig and fixture (as applicable). v. Prepare details and assembly sketches.
<b>Unit – V</b> <b>Press tools.</b>	5a. Select suitable press tool operation for given simple press tool component. 5b. Operate simple press tool. 5c. Calculate press tonnage and center of pressure for given press tool component. 5d. Determine dimensions of punch and die for given press tool component. 5e. Determine shear angle. 5f. Prepare scrap strip layout for given press tool component.	5.1 Press working processes-types, sketches and applications. 5.2 Press tools: types, working, components and their functions. 5.3 Concept, meaning, definitions and calculations of press tonnage and shut height of press tool. 5.4 Shear action in die cutting operation. 5.5 Centre of pressure: Concept, meaning, definition, methods of finding and importance. 5.6 Die clearance: Concept, meaning, definition, reasons, effects and methods of application. 5.7 Cutting force: Methods to calculate and methods of reducing. 5.8 Shear angle- concept, need and method to give shear angle on punch and die. 5.9 Scrap strip layout: - Concept, importance, method to prepare, and determining percentage stock utilization. 5.10 Types, working, and applications of stock stop, pilots, strippers and knockouts. 5.11 Cutting dies-types and applications.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	5g. Design progressive cutting die for given simple press tool component.	5.12 Design of progressive cutting die: <ol style="list-style-type: none"> <li>Sketch the component.</li> <li>Prepare scrap strip layout.</li> <li>Calculate tonnage.</li> <li>Determine centre of pressure.</li> <li>Determine dimensions of punches, die block and die shoe.</li> <li>Prepare sketch of stripper plate.</li> <li>General assembly sketch of punches arrangement, die block, die shoe and stripper plate.</li> </ol>
<b>Unit – VI</b> <b>Dies and moulds.</b>	6a. Calculate bend radii, bend allowance and spring back for given simple part. 6b. Describe working of various dies. 6c. Select type of die/mould for given part.	6.1 Bending: <ol style="list-style-type: none"> <li>Types.</li> <li>Parts and functions of bending die.</li> <li>Definition, calculations and factors affecting bend radii, bend allowance and spring back.</li> <li>Method to compute bending pressure.</li> <li>Types, sketch, working and applications of bending dies.</li> </ol> 6.2 Drawing dies-types and method to determine blank size for drawing operation. 6.3 Types, sketch, working and applications of drawing dies (embossing, curling, bulging, coining, swaging and hole flanging). 6.4 Forging dies- terminology, types, sketch, working and applications. 6.5 Sketch, working and applications of following dies/mould: <ol style="list-style-type: none"> <li>Extrusion.</li> <li>Plastic injection.</li> <li>Blow moulding.</li> </ol>

#### 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	2	4	0	6
II	Cutting tools and tool holders.	7	4	4	4	12
III	Locating and clamping devices.	7	4	4	4	12
IV	Jigs and fixtures.	10	4	5	7	16
V	Press tools.	10	4	2	8	14



Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
VI	Dies and moulds.	5	4	6	0	10
	<b>Total</b>	<b>42</b>	<b>22</b>	<b>25</b>	<b>23</b>	<b>70</b>

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

**Notes:**

- 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.*
- If mid-sem test is part of continuous evaluation, unit numbers I, II, III and V (Up to 5.5 only) are to be considered.
- 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	I	<b>Preparatory activity:</b> <ol style="list-style-type: none"> <li>Tabulate most commonly used limits, fits and tolerance values.</li> <li>Tabulate BIS designation and applications of most commonly used tool materials.</li> <li>Tabulate machining processes and surface finish achieved.</li> <li>Demonstrate models of / actual jigs, fixtures and progressive cutting dies.</li> </ol>	04
2	II	<b>Cutting tools re-sharpening.</b> <ol style="list-style-type: none"> <li>Draw the cutting tool with nomenclature taken for re-sharpening.</li> <li>Re-sharpen any one cutting tool from following. <ol style="list-style-type: none"> <li>Drill.</li> <li>Side and face milling cutter.</li> </ol> </li> </ol>	04

		iii. Centre drill, type A. c. Freehand sketch set ups for grinding each angle.	
3	III, IV	<b>Design of fixture:</b> Faculty will demonstrate working of any one fixture. Faculty will assign one simple component for designing of fixture. Develop the design and: a. Sketch the component. b. Prepare production drawings of all parts of fixture (Details). c. Draw assembly.	06
4	III, IV	<b>Design of jig:</b> Faculty will demonstrate working of any one jig. Faculty will assign one simple component for designing of jig. Develop the design and: a. Sketch the component. b. Prepare production drawings of all parts of jig (Details). c. Draw assembly.	06
5	V	<b>Design of progressive die:</b> Faculty will demonstrate working of various press tools operations. Faculty will assign one simple component for designing of progressive cutting die. Develop the design and: a. Draw the component. b. Draw scrap strip layout. c. Calculate tonnage and centre of pressure. d. Work out dimensions of punches and die. e. Production drawings of die block, die shoe and stripper plate. f. Draw assembly which include punches, die, die shoe and stripper plate only.	08
<b>Total Hours</b>			<b>28</b>

**Notes:**

- a. Use only sketch-book to carry practice work as term work.
- b. Production drawings include-drawings with dimensions-scale, surface finish symbols, limits/fits, tolerances, surface treatment/s, heat treatment/s and other notes/details required to manufacture the part.
- c. Assembly drawing include minimum two views (one preferably sectional view if required) and parts list.
- d. In examination, students are required to sketch freehand only.(For all questions).
- e. 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.
- f. Term work report must not include any photocopy/ies, printed manual/pages, litho, etc. It must be hand written / hand drawn by student only.
- g. For practical ESE part, students are to be assessed for competencies achieved. They should be given experience/part of experience to perform as under.
  - i. Design jig or fixture or progressive die for given simple part.

**8. SUGGESTED LIST OF STUDENT ACTIVITIES.**

SR.NO.	ACTIVITY
1	Download the catalogues for cutting tools, jigs and fixtures and prepare report on their features and specifications.
2	Visit nearby manufacturing unit and prepare the list with specifications of cutting tools, hand tools, press tools, measuring tools and consumables being used there.

**9. SPECIAL INSTRUCTIONAL STRATEGIES (if any).**

Sr. No.	Unit	Unit Name	Strategies
1	I	Introduction.	Movie, Industrial visit.
2	II	Cutting tools and tool holders.	Demonstration of physical cutting tools and tool holders.
3	III	Locating and clamping devices.	Demonstration of physical locating and clamping devices in operation, video movies,
4	IV	Jigs and fixtures.	Demonstration with operations, video movies, Industrial visits.
5	V	Press tools.	Demonstration with operations, video movies, Industrial visits.
6	VI	Dies and mould.	Video movies, Industrial visits.

**10. SUGGESTED LEARNING RESOURCES.****A. List of Books:**

S. No.	Title of Book	Author	Publication
1.	Fundamentals of tool design	ASTME	PHI.
2.	Tool design.	Donaldson & Lecain.	TME
3.	Tool engineering	Doyal.	
4.	Principles of tool & jig design	M. H. A. Kempster.	
5.	Jigs and fixture	P. H. Joshi	TMGH
6.	Design Of Jigs Fixtures And Press Tools	C. Elanchezhian, T. Sunder Selwyn, B. Vijaya Ramnath	Eswar Press,2007, 2 <sup>nd</sup> Edition
7.	Cutting tools standards.	-	BIS
8.	Production technology	-	HMT
9.	PSG Design data book	PSG, Coimbatore	PSG, Coimbatore

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

Sr. No.	Resource with brief specification.
1	Tool and cutter grinding machine.
2	Cutting tools, mainly set consisting assorted sizes of drill bits, set consisting assorted

	sizes of end mills, set consisting assorted sizes of side and face milling cutters, set consisting assorted sizes of centre drills-Type A and B, assorted carbide inserts,
3	Tool holders for carbide inserts, drill spindles/quills, milling machine quills,
4	Most commonly used set of locators and clamping devices, jigs and fixtures.
5	Models of jigs and fixtures.
6	Press-2.5 to 5 Tonnes,(Hydraulic or electrical operated), set of assorted sizes punches and dies,

### C. List of Software/Learning Websites.

- i. <http://www.psgdesigndata.org>
- ii. <http://www.carrlane.com>
- iii. <http://www.nptel.ac.in>

## 11. COURSE CURRICULUM DEVELOPMENT COMMITTEE.

### Faculty Members from Polytechnics.

- **Prof. A.M. Talsaniya**, Lecturer in Mechanical Engineering, Sir BPI, Bhavnagar.
- **Prof. K.H. Patel**, Head of Mech. Engg. Dept., Dr. S.& S.S. Ghandhy College of Engg. & Tech., Surat
- **Prof. M.M. Jikar**, Head of Mech. Engg. Dept., N.G.PATEL POLYTECHNIC, Isroli, Bardoli.

### Coordinator and Faculty Members from NITTTR Bhopal.

- **Dr. K.K. Jain**, Professor, Department of Mechanical Engineering,
- **Dr. A.K. Sarathe**, Associate Professor; Department of Mechanical Engineering.

### SUGGESTED QUESTION PAPER FORMAT

(This is for reference only and is in suggestive form. Paper setter may opt for other marks distribution pattern maintaining distribution of marks as per specification table)

Q.NO.	SUB Q.NO.	QUESTION	MARKS DISTRIBUTION			UNIT
			R	U	A	
1		Answer ANY seven from following.				14
	i.		2			I
	ii.		2			I
	iii.			2		II
	iv.			2		II
	v.		2			III
	vi.		2			IV
	vii.		2			IV
	viii.		2			III
	ix.		2			V
	x.		2			V
2	a.			4		I
		OR				
	a.			4		I
	b.		4			II
		OR				
	b.		4			II
	c.		4			III
		OR				
	c.		4			III
	d.			2		V
		OR				
	d.			2		V
3	a.				4	II
		OR				
	a.				4	II
	b.		4			VI
		OR				
	b.		4			VI
	c.			6		VI
		OR				
	c.			6		VI
4	a.	Given simple component drawing, show the design of jig by freehand sketches of assembly with minimum two views. (Preferably one sectional view).			8	IV
		OR				
	a.	Given simple component drawing, show the design of fixture by freehand sketches of assembly. Also freehand sketch for locators.			8	IV
	b.			4		IV
	c.			2		II
5	a.	Given simple component for designing progressive cutting die, sketch scrap strip layout, calculate tonnage, calculate centre of pressure and determine dimensions of punch and die considering clearance.			8	V
	b.				2	III
	c.			4		III

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

**COURSE CURRICULUM  
COURSE TITLE: INDUSTRIAL MANAGEMENT  
(COURSE CODE: 3361903)**

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
Mechanical Engineering	Sixth

**1. RATIONALE.**

Technicians of mechanical engineering disciplines are expected to work during most of their career at middle level. They are also expected to deal with workforce and management problems. In the present era of competition, optimum utilization of the resources with achieving higher productivity is essential for any industry to survive. Quality and cost controls are also other important factors which contribute to the day to day supervision issues. This course aims to deal effectively with such issues along with familiarization of acts and laws applied to industries.

**2. COMPETENCY.**

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competencies.

- **Recognize organization structure, human resource issues in industries and major provisions of factory acts.**
- **Plan, use, monitor and control resources optimally and economically.**

**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. Interpret given organization structure, culture, climate and major provisions of factory acts and laws.
- ii. Explain material requirement planning and store keeping procedure.
- iii. Plot and analyze inventory control models and techniques.
- iv. Prepare and analyze CPM and PERT for given activities.
- v. List and explain PPC functions.

**4. TEACHING AND EXAMINATION SCHEME.**

<b>Teaching Scheme (In Hours)</b>				<b>Total Credits (L+T+P)</b>	<b>Examination Scheme</b>			
					<b>Theory Marks</b>		<b>Practical Marks</b>	
<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>ESE</b>	<b>PA</b>	<b>ESE</b>	<b>PA</b>	<b>100</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>70</b>	<b>30</b>	<b>0</b>	<b>0</b>	

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

## 5. COURSE CONTENT DETAILS.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
<p><b>Unit – I.</b></p> <p><b>Introduction.</b></p>	<p>1a. Describe the types of organization structure.</p> <p>1b. Identify factors affecting moral.</p> <p>1c. Explain important provisions of factory act and labour laws.</p>	<p>1.1 System- concept, definition, types, parameters, variables and behavior.</p> <p>1.2 Management – definition and functions.</p> <p>1.3 Organization structure:</p> <ul style="list-style-type: none"> <li>i. Definition.</li> <li>ii. Goals.</li> <li>iii. Factors considered in formulating structure.</li> <li>iv. Types.</li> <li>v. Advantages and disadvantages.</li> <li>vi. Applications.</li> </ul> <p>1.4 Concept, meaning and importance of division of labor, scalar &amp; functional processes, span of control, delegation of authority, centralization and decentralization in industrial management.</p> <p>1.5 Organizational culture and climate – meaning, differences and factors affecting them.</p> <p>1.6 Moral-factors affecting moral.</p> <p>1.7 Relationship between moral and productivity.</p> <p>1.8 Job satisfaction- factors influencing job satisfaction.</p> <p>1.9 Important provisions of factory act and labor laws.</p>
<p><b>Unit – II</b></p> <p><b>Critical Path Method (CPM) and Programme Evaluation Review Technique (PERT).</b></p>	<p>2a. Draw CPM and PERT diagrams based on given conditions and data.</p> <p>2b. Determine critical path on CPM and PERT.</p> <p>2c. Calculate floats on CPM and PERT.</p>	<p>2.1 CPM &amp; PERT-meaning, features, difference, applications.</p> <p>2.2 Understand different terms used in network diagram.</p> <p>2.3 Draw network diagram for a real life project containing 10-15 activities, computation of LPO and EPO.(Take minimum three examples).</p> <p>2.4 Determination of critical path on network.</p> <p>2.5 Floats, its types and determination of floats.</p> <p>2.6 Crashing of network, updating and its applications.</p>

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
<b>Unit – III Materials Management.</b>	3a. Apply the procedure for purchase. 3b. Practice the store keeping procedures. 3c. Interpret given inventory model. 3d. Derive Economic Order Quantity for given data. 3e. Identify applications of Material Requirement Planning (MRP).	3.1 Material management-definition, functions, importance, relationship with other departments. 3.2 Purchase - objectives, purchasing systems, purchase procedure, terms and forms used in purchase department. 3.3 Storekeeping- functions, classification of stores as centralized and decentralized with their advantages, disadvantages and application in actual practice. 3.4 Functions of store, types of records maintained by store, various types and applications of storage equipment, need and general methods for codification of stores. 3.5 Inventory control: i. Definition. ii. Objectives. iii. Derivation for expression for Economic Order Quantity (EOQ) and numeric examples. iv. ABC analysis and other modern methods of analysis. v. Various types of inventory models such as Wilson's inventory model, replenishment model and two bin model. (Only sketch and understanding, no derivation.). 3.6 Material Requirement Planning (MRP)-concept, applications and brief details about software packages available in market.
<b>Unit – IV Production planning and Control (PPC).</b>	4a. Schedule the operations based on available data using PPC techniques. 4b. Schedule using critical ratio scheduling technique 4c. Identify the factors and resources	4.1 Types and examples of production. 4.2 PPC : i. Need and importance. ii. Functions. iii. Forms used and their importance. iv. General approach for each type of production. 4.3 Scheduling- meaning and need for productivity and utilisation. 4.4 Gantt chart- Format and method to prepare. 4.5 Critical ratio scheduling-method and numeric examples.



Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	affecting the bottlenecking. 4d. Schedule using Gantt chart with the help of Annexure-I for given data.	4.6 Scheduling using Gantt Chart (for at least 5-7 components having 5-6 machining operations, with processes, setting and operation time for each component and process, resources available, quantity and other necessary data), At least two examples. 4.7 Bottlenecking- meaning, effect and ways to reduce.
<b>Unit – V</b> <b>Value Analysis (VA) and Cost Control.</b>	5a. Apply value analysis and cost control techniques for given case.	5.1 VA-definition, terms used, process and importance. 5.2 VA flow diagram. 5.3 DARSIRI method of VA. 5.4 Case study of VA-at least two. 5.5 Waste-types, sources and ways to reduce them. 5.6 Cost control-methods and important guide lines.
<b>Unit – VI</b> <b>Recent Trends in IM.</b>	6a. Describe recent practices being adopted in industrial management.	6.1 ERP (Enterprise resource planning) - concept, features and applications. 6.2 Important features of MS Project. 6.3 Logistics- concept, need and benefits. 6.4 Just in Time (JIT)-concept and benefits. 6.5 Supply chain management-concept and benefits.

#### 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	6	4	0	10
II	Critical Path Method (CPM) and Programme Evaluation Review Technique (PERT).	10	4	6	7	17
III	Materials Management.	8	6	4	4	14
IV	Production Planning and Control (PPC).	10	6	4	7	17
V	Value Analysis (VA) and Cost Control.	4	4	2	0	6
VI	Recent Trends in IM.	4	6	0	0	6
	Total	42	32	20	18	70

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

**Notes:**

- 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.
- If mid-sem test is part of continuous evaluation, unit numbers I, II (Up to 2.4 only) and IV (Up to 4.7 only) are to be considered.
- 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 PRACTICAL/EXERCISE**

.....**Not Required**.....

**8. SUGGESTED LIST OF STUDENT ACTIVITIES.**

Sr. No.	Activity
i.	Given the data, prepare the network diagram and determine critical path, EPO, LPO and floats.
ii.	Given the data, prepare the scheduling using Gantt chart.
iii.	Perform value analysis for given case.

**9. SPECIAL INSTRUCTIONAL STRATEGIES (if any).**

Sr. No.	Unit	Unit Name	Strategies
i.	I	Introduction.	Video movies.
ii.	II	Critical path method (CPM) and pre evaluation review technique (PERT).	Video movies, solving tutorials, real life industries situation, industrial visits.
iii.	III	Materials management.	Video movies, real life industries situation, industrial visits.
iv.	IV	Production planning and control (PPC).	Video movies, solving tutorials, real life industries situation, industrial visits.
v	V	Value analysis (VA) and cost control.	Analyzing real cases, video movies.
vi	VI	Recent trends in IM.	Industrial visits, movies.

**10. SUGGESTED LEARNING RESOURCES.****A. List of Books:**

S. No.	Title of Book	Author	Publication
i.	CPM & PERT principles and Applications.	L.S.Srinath.	
ii.	Modern Production Management.	Buffa.	
iii.	Materials Management.	N. Nair.	
iv.	Industrial Engineering & Management.	O. P. Khanna.	
v.	Value Analysis.	Mikes.	

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

Sr. No.	Resource with brief specification.
1	Necessary freeware-other softwares.

**C. List of Software/Learning Websites.**

- i. [www.youtube.com/watch?v=SF53ZZsP4ik](http://www.youtube.com/watch?v=SF53ZZsP4ik)
- ii. [www.youtube.com/watch?v=iPZlQ3Zx5zc](http://www.youtube.com/watch?v=iPZlQ3Zx5zc)
- iii. [web.stanford.edu/class/cee320/CEE320B/CPM.pdf](http://web.stanford.edu/class/cee320/CEE320B/CPM.pdf)
- iv. [www.criticaltools.com/pertchartexpertsoftware.htm](http://www.criticaltools.com/pertchartexpertsoftware.htm)
- v. [en.wikipedia.org/wiki/Program\\_evaluation\\_and\\_review\\_technique](http://en.wikipedia.org/wiki/Program_evaluation_and_review_technique)
- vi. [www.netmba.com/operations/project/pert/](http://www.netmba.com/operations/project/pert/)

**11. COURSE CURRICULUM DEVELOPMENT COMMITTEE****Faculty Members from Polytechnics.**

- **Prof. A. M. Talsaniya**, Lecturer in Mechanical Engineering, Sir BPI, Bhavnagar.

**Coordinator and Faculty Members from NITTTR Bhopal.**

- **Dr. Vandna Somkuwar**, Associate Professor, Department of Mechanical Engineering,
- **Dr. A.K. Sarathe**, Associate Professor; Department of Mechanical Engineering.

## ANNEXURE – I

## A. GIVE DETAILS OF EACH PART IN FOLLOWING FORMAT.

PART NUMBER				PART NAME	
MATERIAL				BATCH QUANTITY	
OP.NO.	PROCESS	SETTING TIME / BATCH (MIN).	OP. TIME / PIECE (MIN).	MACHINE	

## B. RESOURCE DETAILS:

NAME OF MACHINE	NUMBER OF MACHINES	MACHINE AVAILABLE FOR NUMBER OF HOURS / DAY (TOTAL FOR ALL SHIFTS).	NUMBER OF WORKING DAYS / MONTH.	TOTAL HOURS AVAILABLE PER MONTH

### SUGGESTED QUESTION PAPER FORMAT

(This is for reference only and is in suggestive form. Paper setter may opt for other marks distribution pattern maintaining distribution of marks as per specification table)

Q.NO.	SUB Q.NO.	QUESTION	MARKS DISTRIBUTION			UNIT
			R	U	A	
1		Answer ANY seven from following.				14
	i.		2			I
	ii.		2			I
	iii.		2			II
	iv.		2			II
	v.		2			III
	vi.		2			III
	vii.		2			IV
	viii.		2			IV
	ix.			2		V
	x.		2			VI
2	a.		4			I
		OR				
	a.		4			I
	b.			4		I
		OR				
	b.			4		I
	c.			3		II
		OR				
	c.			3		II
	d.			3		II
		OR				
	d.			3		II
3	a.		4			III
		OR				
	a.		4			III
	b.				4	III
		OR				
	b.				4	III
	c.		3			IV
		OR				
	c.		3			IV
	d.		3			VI
		OR				
	d.		3			VI
4	a.	Given the data, prepare network diagram and determine critical path. Number of events should not be more than 7.			7	II
		OR				
	a.	Given the data, prepare network diagram. Calculate EPO and LPO at each node. Number of events should not be more than 7.			7	II
	b.			4		III
	c.			3		IV
5	a.	Given the data, prepare the scheduling using Gantt chart. Number of the components should not be more than 4.			7	IV
	b.		4			V
	c.		3			VI



**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

**COURSE CURRICULUM  
COURSE TITLE: POWER PLANT ENGINEERING  
(COURSE Code: 3361906 )**

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
Mechanical Engineering	Sixth

**1. RATIONALE.**

Availability of power is the one key area where most of the Indian industry is facing problems. In India, even today, short fall of power generation is about 30 percent. Fuel supply and distribution is also an area where country is still developing smooth lines of supply. Since power and energy is required by every sector of economy, the growth in this sector is must if Indian economy grows in any sector. Many of the job opportunity in private as well as public sector are therefore waiting for students in this field. Hence, this course attempts to provide them basic knowledge of the technologies available at plant level and would also acquaint them with the latest technological advances taking place in this sector.

**2. COMPETENCY.**

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competency.

- **Apply knowledge of mechanical engineering related to power generation systems, their control and economics in different type of power plants for their operation and maintenance.**

**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.

- Identify elements and their functions of steam, hydro, diesel, nuclear, wind and solar power plants.
- Operate equipments of different power plants.
- Analyze economics of power plants and list factors affecting the power plants
- Determine performance of power plants based on load variations.

**4. TEACHING AND EXAMINATION SCHEME.**

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
03	00	02	05	70	30	20	30	

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

## 5. COURSE CONTENT DETAILS.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
<b>Unit – I.</b> <b>Introduction to Power plants.</b>	1a. Describe energy conversion in power plants. 1b. List features of National Grid. 1c. Identify elements and their functions of hydro, diesel and nuclear power plants.	1.1. Energy needs of India. 1.2. Introduction to power plants & their importance, power plants concepts, types and energy conversion in each type. 1.3. National Grids. 1.4. Hydro power plant: General arrangement & its operation, classification, advantages and disadvantages, technical data of hydro power plants in Gujarat. 1.5. Diesel power plant: General arrangement & its operation, classification, advantages and disadvantages, technical data of diesel engine power plants in Gujarat. 1.6. Nuclear power plant: general arrangement & its operation, classification, basic nuclear physics fundamentals, criteria for selection of installation of nuclear power plant, advantages and disadvantages, technical data of nuclear power plants in Gujarat, safe disposal of nuclear waste.
<b>Unit – II</b> <b>Steam power Plants.</b>	2a. Plot different heat cycles on P-V and T - s diagram. 2b. Calculate different parameters for heat cycles.	<b>A. Heat Cycles</b> 2.1 Working of Rankine cycle, reheat cycle, reheat regenerative cycle, reheat regenerative cycles and plot them on P-v and T-s diagram. 2.2 Simple numerical based on above.
	2c. Sketch working of different high pressure boilers. 2d. Identify various elements of FBC boiler and describe their functions.	<b>B. High Pressure Boilers.</b> 2.3 Working sketch and working of high pressure boilers: Lamont boiler, Benson boiler, Loeffler boiler, Velox boiler, Schmidt Hartman boiler, Ramsin boiler 2.4 Stirling boiler (three steam drum, two mud drum boiler)-sketch and working. 2.5 Fluidized bed combustion boilers(FBC): principle, need, types, different arrangement, control system and advantages over other boiler systems. 2.6 Need of water treatment plant for boilers.
	2e. Sketch layout of modern thermal power plant. 2f. Identify parts and state functions of steam	<b>C. Important Auxiliaries of Steam Power Plants.</b> 2.7 Schematic diagram of modern thermal power plant. 2.8 Super heaters and air pre heaters.



Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	m traps, heaters and fuel handling system. 2g. Explain concept of ESP.	2.9 Fuel handling systems-methods of coal handling like pulverized fuel system, etc. 2.10 Concept of Electro-Static Precipitators (ESP).
	2h. Describe various control systems of power plant. 2i. Explain working of various temperature and feed water control systems. 2j. Explain importance and need of record keeping	<b>D. Steam Power Plant Controls</b>  2.11 Effect of load variation in steam power plant. 2.12 Area and centralized control system of power plants. 2.13 Basic elements and requirements of good control system of power plant. 2.14 Instrumentations used in modern power plants. 2.15 Concept of Steam temperature control and feed water control systems. 2.16 Need of record keeping.
<b>Unit – III</b>  <b>Gas Turbine Power Plant.</b>	3a. Sketch and label arrangements of gas turbine power plant. 3b. Compare different methods to improve efficiency in gas turbine power plant. 3c. Calculate thermal efficiency of gas turbine power plant.	3.1 Introduction to gas turbine power plant. 3.2 Concept of Brayton cycle. 3.3 Arrangement of open and close cycle with constant pressure gas turbine power plant. 3.4 Components of gas turbine power plant. 3.5 Essential auxiliaries of gas turbine power plant. 3.6 Methods to improve the thermal efficiency of a simple open cycle constant pressure gas turbine power plant (No derivation). 3.7 Simple numerical based on above. 3.8 Advantages of gas turbine power plant over others.
<b>Unit – IV</b>  <b>Solar and Wind Power Plants.</b>	4a Explain wind and solar power plant 4b Observe conversion system for solar power plant. 4c Project potential of wind and solar power in India	4.1 Wind power plant: introduction, advantages and disadvantages. 4.2 Introduction to solar power plant. 4.3 Solar cell and solar panel. 4.4 Conversion systems for solar energy: i. Low temperature system with flat plate collector. ii. Medium temperature system with concentrator collector. iii. Tower concept for power generation. iv. Satellite solar power. v. Zero energy house concept. 4.5 Potential of solar and wind energy in India.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – V <b>Economic Analysis of Power Plants.</b>	5a Calculate performance of power plants based on load variations.	5.1 Cost of electrical energy. 5.2 Selection of type of generation. 5.3 Performance and load deviation of power plants. 5.4 Simple numerical based on above.

## 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 Power Plants.	08	8	4	0	12
II	Steam Power Plant.	20	12	12	6	30
III	Gas Turbine Power Plant.	05	2	4	6	12
IV	Solar and Wind Power Plants.	04	4	4	0	08
V	Economic Analysis of Power Plants	05	0	2	6	08
		<b>42</b>	<b>26</b>	<b>26</b>	<b>18</b>	<b>70</b>

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

### Notes:

- 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.
- If mid-sem test is part of continuous evaluation, unit numbers I , II (Up to 2.6 only) and III are to be considered.
- Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.
- In examination, example of same chapter is to be asked in place of example.

## 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 to IV	<b>Preparatory activity:</b> <ol style="list-style-type: none"> <li>Prepare list of various major power plants installed in Gujarat along with their total capacity.</li> <li>Visit websites of NTPC, BHEL etc and find out the technical information about their machineries or Plants.</li> </ol>	02
2	II	<b>Study of high pressure boilers (any three):</b> Students would: <ol style="list-style-type: none"> <li>Demonstrate working of boilers and different components on them. (Actual or Video).</li> <li>Draw schematic diagram with labels for each.</li> <li>Write specification of each boiler.</li> <li>List functions and explain working of different components of each boiler.</li> </ol>	02
3	I to IV	<b>Presentation ( In a group of 4 - 6 students):</b> Faculty will assign any one topic from following. <ol style="list-style-type: none"> <li>Steam based power plant.</li> <li>Gas turbine power plant.</li> <li>Solar power plant.</li> <li>Wind power plant.</li> <li>Nuclear power plant.</li> </ol> Students would: <ol style="list-style-type: none"> <li>Download technical specifications/ catalogues, videos or any other suitable presentations on given topic.</li> <li>Tabulate comparison of different power plants of same category, based on their different technical aspects.</li> <li>Prepare the presentation and present the same during the laboratory hours in front of your classmates.</li> </ol>	06
4.	I to IV	<b>Model preparation and exhibition (In a group of 08 - 12 students):</b> Faculty will assign any one topic from following. <ol style="list-style-type: none"> <li>Steam based power plant along with auxiliaries.</li> <li>Gas turbine power plant.</li> <li>Solar power plant.</li> <li>Wind power plant.</li> <li>Nuclear power plant.</li> <li>Any other relevant assigned by batch teacher.</li> </ol> Students would prepare a model on the topic assigned by batch teacher using preferably waste material. <ol style="list-style-type: none"> <li>Prepare work distribution matrix.</li> <li>Prepare the schematic diagram.</li> <li>Prepare model diagram with dimensions.</li> <li>List steps to be followed to prepare the model.</li> </ol>	12

		<p>e. Prepare the model and list the difficulties and remedial measures undertaken.</p> <p>f. Prepare charts/ PPTs/ videos or other supporting materials for open air seminar presentation if required.</p> <p>g. Arrange exhibition of the model prepared in the department. Above developed model should be demonstrated in the institute with open air seminar and present the same amongst the students and faculty. Students should explain their findings and learning to other students. Record the movie of exhibition.</p>	
5.	I to V	<p><b>Industrial visit:</b> Faculty would Arrange industrial visit on any one of following (Compulsory):</p> <ol style="list-style-type: none"> <li>i. Thermal power plant.</li> <li>ii. Gas turbine power plant.</li> <li>iii. Nuclear power plant.</li> <li>iv. Wind turbine power plant.</li> </ol> <p>Student would prepare report on visit. Report should include specification of plant, circuit diagram, working principle of major components, etc.</p>	06
<b>Total Hours</b>			<b>28</b>

**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/ model preparation and presentation topic/area has to be assigned to the group of specified students in the beginning of the term by batch teacher, if applicable.
- d. Each student will make his/her folder having the name as <batch number-enrollment number> and will save his/her downloaded content, presentation and all soft content of experiment number 4 (Model preparation). A DVD is to be made which will contain folders of all students. Same DVD is to be submitted to batch teacher.
- e. For practical ESE part, students are to be assessed for competencies achieved.

**8. SUGGESTED LIST OF STUDENT ACTIVITIES.**

SR.NO.	ACTIVITY
1	Prepare charts of different high pressure boilers, gas turbine cycles, steam turbine power plant, wind turbine power plant, solar power plant, etc. on half imperial drawing sheet. Attach the same with term work.
2	Visit websites of reputed power companies such as NTPC, NHPC, NPCIL, BHEL, GEDA, SUZLON, GE, SIEMENS, ENERCON etc.
3	Download videos for working of different power plants.
4.	Prepare chart on any one component of any power plant on half imperial drawing sheet. Attach the same with term work.
5.	Visit diesel power plant available in your institute/ nearer to your institute and understand different elements, working, circuits, and specifications.

**9. SPECIAL INSTRUCTIONAL STRATEGIES (if any).**

Sr. No.	Unit	Unit Name	Strategies
1	II	Introduction to power plants.	Videos, industrial visits.
2	II	Steam power plant.	Videos, industrial visits, models, actual demonstration of parts / working models.
3	III	Gas turbine power plant.	Videos, industrial visits, models, actual demonstration of parts / working models.
4	IV	Solar and wind power plants.	Videos, industrial visits, models, actual demonstration of parts / working models.
5	V	Economic analysis of power plants.	Examples, tutorials, industrial visits, case examples.

**10. SUGGESTED LEARNING RESOURCES.****A. List of Books:**

S. No.	Title of Book	Author	Publication
1.	Power Plant Engineering.	Dr. P C Sharma	S. K. Kataria
2.	Power Plant Engineering.	Domkundwar	
3.	Power Plant Engineering.	P K Nag	Tata Mc Graw Hill
4.	Power Plant Engineering.	Black & Veatch	Springer, 1996
5.	Power Plant Engineering.	C. Elanchezian, L. Saravanakumar, B. Vijaya Ramnath	I.K. International Publishing House
6.	Power Station Engineering and Economy.	Bernhardt G A Sarotzki, William A Vopat	Tata Mc Graw Hill
7.	A Text Book of Power Plant Engineering.	R K Rajput	Laxmi Publications,
8.	Power Plant Control and Instrumentation.	David Lindsley	The Institute Of Electrical Engineers
9.	Nuclear Power Plant Engineering.	James H. Rust	Haralson Publishing Company
10.	Steam power plant engineering.	Louis Allen Harding	J. Wiley & Sons, inc

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

Sr.No.	Resource with brief specification.
1	Demonstration models of steam power plant and its auxiliaries, Gas turbine power plant and its auxiliaries, wind turbine power plant and its auxiliaries, nuclear power plant and its auxiliaries, solar power plant and its auxiliaries, etc.

**C. List of Software/Learning Websites.**

- i. <http://nptel.ac.in/courses/112105051/>
- ii. [https://www.youtube.com/watch?v=Ota2\\_LUuar0](https://www.youtube.com/watch?v=Ota2_LUuar0)
- iii. [https://www.youtube.com/watch?v=Ota2\\_LUuar0](https://www.youtube.com/watch?v=Ota2_LUuar0)
- iv. <https://www.youtube.com/watch?v=3dJAtHaSQ98>
- v. <https://www.youtube.com/watch?v=xokHLFE96h8>
- vi. <http://www.tatapower.com/businesses/renewable-energy.aspx>
- vii. <http://www.cleanlineenergy.com/technology/wind-and-solar>
- viii. <https://www.youtube.com/watch?v=kbuLfXgw4Gs>
- ix. <https://www.youtube.com/watch?v=r9q80sSHxKM>
- x. [https://www.youtube.com/watch?v=GZKKWz\\_tX1c](https://www.youtube.com/watch?v=GZKKWz_tX1c)
- xi. download other power plant related videos from youtube.com for study purpose.

**11. COURSE CURRICULUM DEVELOPMENT COMMITTEE****Faculty Members from Polytechnics.**

- **Prof. S. R. Pareek**, Head of Department, Mechanical Engineering, Tolani F.G. Polytechnic, Adipur.
- **Prof. M. N. Patel**, LME, Government Polytechnic, Chhota Udepur.
- **Dr. Shah Atul S.**, LME, Dr. S & SS Ghandhy Collage of Engineering and Technology, Surat.
- **Prof. Haresh G Ranipa**, LME, Shri N M Gopani Polytechnic, Ranpur.
- **Prof. Patadiya Viren N.**, LME, N.M. Gopani Polytechnic, Ranpur.
- **Prof. (Smt.) Krutika V Prajapati**, LME, Parul Institute of Engineering and Technology, Vadodara.
- **Prof. Patel Rameshbhai Babubhai**, LME, R.C.T.I., Ahmedabad.
- **Prof. Ajbani Vimlesh Chandrakant**, LME, Government Polytechnic, Ahmedabad.

**Coordinator and Faculty Members from NITTTR Bhopal.**

- **Dr. A.K. Sarathe**, Associate Professor; Department of Mechanical Engineering.
- **Dr. K.K. Jain**, Professor, Department of Mechanical Engineering,

Q.NO.	SUB Q.NO.	QUESTION	MARKS DISTRIBUTION			UNIT
			R	U	A	
1		Answer ANY seven from following.				14
	i.		2			I
	ii.		2			I
	iii.		2			II
	iv.		2			II
	v.		2			II
	vi.		2			II
	vii.		2			III
	viii.		2			IV
	ix.		2			IV
	x.		2			V
2	a.		3			IV
		OR				
	a.		3			IV
	b.			3		IV or V
		OR				
	b.			3		IV or V
	c.		4			II
		OR				
	c.		4			II
	d.			4		II
		OR				
	d.			4		II
3	a.				3	II
		OR				
	a.				3	II
	b.				3	II
		OR				
	b.				3	II
	c.			4		II
		OR				
	c.			4		II
	d.			4		III
		OR				
	d.			4		III
4	a.				3	III
	a.				3	III
	b.			4		I
		OR				
	b.			4		I
	c.				7	V
5	a.		4			I
	b.			4		II
	c.				3	III
	d.			3		IV

**SUGGESTED QUESTION PAPER FORMAT**

(This is for reference only and is in suggestive form. Paper setter may opt for other marks)

distribution pattern maintaining distribution of marks as per specification table)



**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

**COURSE CURRICULUM  
COURSE TITLE: THERMAL SYSTEMS AND ENERGY EFFICIENCY  
(COURSE CODE: 3361907)**

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
Mechanical Engineering	Sixth

### 1. RATIONALE.

Thermal systems are most important part of industrial sector. In the absence of proper operation & maintenance of thermal systems it becomes difficult to manage economic use of energy and its conservation with the least damage to the environment. This course provides the underpinning knowledge and skills related to principles, types & working of these systems like boilers, heat exchangers, furnaces, HVAC etc. which are normally high energy consumption devices. Study of this course would help students to choose proper design and specifications of these high energy consuming devices so that energy is saved in resulting low cost of production as well as less damage to environment. This course is therefore a key course for thermal engineers.

### 2. COMPETENCY.

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- **Apply concepts, laws and principles of thermal systems to operate and maintain them for efficient use of energy and its conservation as per industrial norms & regulations.**

### 3. COURSE OUTCOMES (COs).

The theory should be taught and practicals 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.

- Select available energy sources in a given situation.
- Determine boiler performance based on energy efficiency parameters.
- Analyze performance of furnace for a particular application.
- Determine the performance of heat exchanger in a given situation.
- Calculate load of HVAC systems.

### 4. TEACHING AND EXAMINATION SCHEME.

Teaching Scheme (In Hours)				Total Credits (L+T+P)	Examination Scheme			
					Theory Marks		Practical Marks	
L	T	P	C	ESE	PA	ESE	PA	150
03	00	02	05	70	30	20	30	

**Legends:** L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P -Practical; C – Credit, ESE -End Semester Examination (3 hours duration) ; PA - Progressive Assessment.

**5. COURSE CONTENT DETAILS.**

<b>Unit</b>	<b>Major Learning Outcomes</b> (in cognitive domain)	<b>Topics and Sub-topics</b>
<b>Unit – I.</b> <b>Introduction to Energy Sources and Thermal Systems.</b>	1a. Compare various energy sources & forms. 1b. Differentiate various renewable and non-renewable energy sources. 1c. Explain Energy conservation and related act. 1d. Describe basic concepts of various thermal systems.	1.1 Energy sources: <ol style="list-style-type: none"> <li>i. Primary and secondary.</li> <li>ii. Commercial energy and non-commercial.</li> <li>iii. Various forms of energy, i.e. potential energy (chemical, nuclear or stored mechanical, gravitational energy), kinetic energy (radiant, thermal, motion, sound, electrical energy) and high grade energy and low grade energy.</li> <li>iv. Renewable and nonrenewable.</li> </ol> 1.2 Energy conservation and its importance. 1.3 Overview of Energy Conservation Act 2001. 1.4 Introduction to various thermal systems like furnace, steam generation and distribution system, heat exchanger, HVAC(Heating, Ventilating and Air Conditioning) and refrigeration system, cogeneration system (concept, need and principle based on steam and gas turbine cogeneration system), air compressor.
<b>Unit – II</b> <b>Boilers.</b>	2a. Determine performance of boilers by direct and indirect method. 2b. Analyze effect of energy efficiency parameters on performance of boiler. 2c. Describe energy saving measures in steam distribution system.	2.1 Performance evaluation of typical boiler system (Attached data sheet is allowed in exams): <ol style="list-style-type: none"> <li>i. Indirect method.</li> <li>ii. Direct method.</li> </ol> 2.2 Energy efficiency measures in boiler system. 2.3 Steam distribution system and concept of steam pipe sizing. 2.4 Steam traps-operation and maintenance of: <ol style="list-style-type: none"> <li>i. Float and thermostatic.</li> <li>ii. Thermodynamic.</li> <li>iii. Inverted bucket.</li> <li>iv. Thermostatic with thermal element (Bellow or bi-metallic strip).</li> </ol> 2.5 Energy saving in steam distribution systems.
<b>Unit – III</b> <b>Furnaces.</b>	3a. Describe concept and types of furnaces. 3b. Determine the performance of heat treatment furnaces.	3.1 Concept of furnace. 3.2 Classification and working of furnaces: <ol style="list-style-type: none"> <li>i. Forging furnace.</li> <li>ii. Rerolling mill furnace (batch type, continuous pusher type, continuous steel reheating furnace,(pusher type, walking hearth type, rotary hearth</li> </ol>

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	3c. Derive energy efficiency parameters.	type, continuous recirculating bogie type etc.). 3.3 Heat transfer in furnaces. 3.4 Performance evaluation of typical heat treatment furnace system (Attached data sheets are allowed in exams). i. Indirect method. ii. Direct Method. 3.5 Energy efficiency measures in furnace systems.
<b>Unit – IV</b> <b>Heat Exchangers and Air Compressor.</b>	4a. Differentiate heat exchangers. 4b. Determine performance of Heat exchangers based on given method. 4c. Describe energy saving measures in air compressor.	4.1 Heat exchangers: types and classification. 4.2 Performance evaluation of heat exchangers based on LMTD and NTU methods (Attached data sheets are allowed in exams). 4.3 Air compressor: Free air delivery (Attached data sheets are allowed in exams), energy saving measures.
<b>Unit – V</b> <b>HVAC systems.</b>	5a. Use concept of HVAC and refrigeration system. 5b. Calculate load of HVAC system based on given data	5.1 Concept of HVAC and refrigeration system. 5.2 Selection criteria for suitable refrigeration system. 5.3 Load calculation for refrigeration/ air conditioning system, such as: room, restaurant, cold storage, theatre, conference hall, sweet shop, etc. (Attached data sheets are allowed in exams). 5.4 Energy efficiency measures in refrigeration/ air conditioning systems.

## 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 Energy Sources and Thermal Systems.	06	02	04	02	08
II	Boilers.	08	02	03	09	14
III	Furnaces.	08	02	04	12	18
IV	Heat Exchangers and Air Compressors.	10	02	03	09	14
V	HVAC systems.	10	02	04	10	16
	Total	42	10	18	42	70

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

**Notes:**

- a. 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.
- b. Duration of End Semester Examination (Theory) is 3 hours.**
- c. If mid-sem test is part of continuous evaluation, unit numbers I, II and IV are to be considered.
- d. 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.
- e. Use of enclosed data sheets are to be allowed to student during examination (They should be provided by the examining agency).
- f. In examination, example of same chapter is to be asked in place of example.

**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 to V	Preparatory activity: a. Visit laboratory/ workshop and identify various thermal systems such as heat exchangers, boilers, furnaces, air compressors, etc. Write down technical specifications of the same along with manufactures. b. Compare price of various fuels. c. Plot sankey diagram for given data. d. Interpret terms and equations of data sheets provided with the curriculum.	04
2	II	<b>Case study (based on real life example):</b> a. Calculate losses in the boiler using given data by direct and indirect method. b. Prepare sankey diagram. c. Prepare heat balance sheet. d. List various instrumentation required to measure the required data.	04
3	III	<b>Case study (based on real life example):</b>	04

		<ul style="list-style-type: none"> <li>a. Calculate losses in the furnace using given data by direct and indirect method.</li> <li>b. Prepare sankey diagram.</li> <li>c. Prepare heat balance sheet.</li> <li>d. List various instrumentation required to measure the required data.</li> </ul>	
4	IV	<p><b>Case study (based on real life example):</b></p> <ul style="list-style-type: none"> <li>a. Calculate efficiency and over all heat transfer co efficient of heat exchanger based on given data. Use LMTD or NTU methods.</li> <li>b. List various instrumentation required to measure the required data.</li> </ul> <p style="text-align: center;"><b>OR</b></p> <ul style="list-style-type: none"> <li>a. Write technical specifications of any heat exchanger available in vicinity.</li> <li>b. Determine its performance based on the technical data available. Tabulate the observation.</li> <li>c. List the parameters which lead to energy losses in heat exchangers. Also show the effect of such parameters.</li> <li>d. Recommend your suggestions for energy saving in heat exchangers.</li> </ul>	04
5	V	<p><b>Case study (based on real life example):</b></p> <ul style="list-style-type: none"> <li>a. Calculate air conditioning load of given room/ conference hall. Use standard data sheets. (Volume not more than 80-100 m<sup>3</sup>.)</li> <li>b. List various instrumentation required to measure the required data.</li> </ul>	06
6	V	<p><b>Case study (based on real life example):</b></p> <ul style="list-style-type: none"> <li>a. Calculate refrigeration/ air conditioning load of given theater/ restaurant/cold storage. Use standard data sheets. (Volume &gt;200 m<sup>3</sup>.)</li> <li>b. List various instrumentation required to measure the required data.</li> </ul>	06
<b>Total Hours</b>			<b>28</b>

**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. 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.**

SR.NO.	ACTIVITY
1	List thermal systems employed in your house, shops, malls in nearby area. Identify the parameters which lead to energy losses. List energy saving measures.
2	Visit any industry and find the major areas boilers/ furnaces/ air compressor system/ heat exchangers etc. from point of energy conservation.

3	Present seminar on energy conversion act 2001 and latest amendments.
4	Visit any small shop where refrigeration repairing or maintenance work is done. List the equipments used in the refrigeration maintenance with its technical data. Prepare a layout of shop. List different work carried out for maintenance in refrigeration/ air conditioning. Prepare a report along with photographs of the equipments.

### 9. SPECIAL INSTRUCTIONAL STRATEGIES (if any).

Sr. No.	Unit	Unit Name	Strategies
1	I	Introduction to energy sources and thermal systems.	Demonstration of systems, movies, industrial visits, on-hand practice on available systems.
2	II	Boilers.	Standard data of boiler room and other auxiliaries from real life example, Industrial visits, movies.
3	III	Furnaces.	Standard data of furnace room and other auxiliaries from real life example, Industrial visits, movies.
4	IV	Heat exchangers and air compressors.	Standard data of any heat exchanger from thermal plant and air compressor room as well as air compressor system, Industrial visits, and movies.
	V	HVAC systems.	Standard data of load calculation to compare with the calculated load calculations, industrial visits, demonstration of plants having HVAC systems.

### 10. SUGGESTED LEARNING RESOURCES.

#### A. List of Books:

S. No.	Title of Book	Author	Publication
1.	Materials science	R.S.Khurmi, R.S.Sedha	S.Chand
2.	Material science	O. P. Khanna	
3.	Guide book for NCE for EM & EA (Vol I to IV)	--	Bureau of Energy Efficiency
4.	Energy Conservation Guide book	Steven R. Patrick, Dale R. Patrick, Stephen W. Fardo	
5.	Energy Management Handbook	Wayne C. Turner	
6.	The Efficient Use of Energy	The Rt Hon Tony Benn, MP	BSI, 2 Park street, London

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

Sr.No.	Resource with brief specification.
1	Experimental setup for Heat exchanger (Plate Heat Type heat exchanger is preferable) Facilities preferable are: In/ out flow quantity of both fluids, In/ Out temperature of both fluids, In/ out pressure drop of both fluids, specific heat of both fluids, number of passes available etc. This parameters are required to measure performance of heat exchanger.

2	Experimental setup for air compressor, boiler already prescribed in thermal engineering-I.
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### C. List of Software/Learning Websites.

- i. [http://nptel.ac.in/courses/112101005/downloads/Module\\_4\\_Lecture\\_7\\_final.pdf](http://nptel.ac.in/courses/112101005/downloads/Module_4_Lecture_7_final.pdf)
- ii. <http://btech.mit.asia/downloads/svlomte/HT2011.pdf>
- iii. [http://powermin.nic.in/acts\\_notification/pdf/ecact2001.pdf](http://powermin.nic.in/acts_notification/pdf/ecact2001.pdf)
- iv. [www.energymanagertraining.com](http://www.energymanagertraining.com) (register for free guide book downloads)
- v. <http://www.ureda.uk.gov.in/upload/downloads/Download-7.pdf>
- vi. <http://www.fao.org/docrep/t0269e/t0269e05.htm>
- vii. <http://energy.gov/eere/government-energy-management>
- viii. [http://www.sarienergy.org/PageFiles/What\\_We\\_Do/activities/SAWIE/wiser/cap\\_dev\\_program\\_for\\_afghan\\_women\\_march\\_22-30\\_2010/PRESENTATIONS/24032010/ENGLISH/Energy\\_Conservation\\_Act\\_2001\\_NT\\_Nair.pdf](http://www.sarienergy.org/PageFiles/What_We_Do/activities/SAWIE/wiser/cap_dev_program_for_afghan_women_march_22-30_2010/PRESENTATIONS/24032010/ENGLISH/Energy_Conservation_Act_2001_NT_Nair.pdf)

## 11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### Faculty Members from Polytechnics.

- **Prof. S. R. Pareek**, Head of Department, Mechanical Engineering, Tolani F. G. Polytechnic, Adipur.
- **Prof. M. N. Patel**, LME, Government Polytechnic, ChhotaUdepur.
- **Dr. Shah Atul S.**, LME, Dr. S & SS Ghandhy Collage of Engineering and Technology, Surat.
- **Prof. Hareesh G. Ranipa**, LME, Shri N M Gopani Polytechnic, Ranpur.
- **Prof. Patadiya Viren N.**, LME, N.M.Gopani Polytechnic, Ranpur.
- **Prof. (Smt.) Krutika V. Prajapati**, LME, Parul Institute of Engineering and Technology, Vadodara.
- **Prof. Patel Rameshbhai Babubhai**, LME, R.C.T.I., Ahmedabad.
- **Prof. Ajbani Vimlesh Chandrakant**, LME, Government Polytechnic, Ahmedabad.

### Coordinator and Faculty Members from NITTTR Bhopal.

- **Dr. A.K. Sarathe**, Associate Professor; Department of Mechanical Engineering.
- **Dr. K.K. Jain**, Professor, Department of Mechanical Engineering.

**DATA SHEETS (Allowed in Final Examinations) :****1. BOILERS:**Direct method:

$$\text{Boiler Efficiency}(\eta) = (\text{Heat output} / \text{Heat input}) \times 100$$

$$\text{Boiler Efficiency}(\eta) = \frac{M \times (h_g - h_f)}{mf \times \text{GCV}} \times 100$$

where, M	=	Quantity of steam generated per hour in kg/ hr
mf	=	Quantity of fuel used per hour in kg/ hr
GCV	=	Gross calorific value of fuel (kCal/ kg of fuel)
$h_g$	=	Enthalpy of saturated steam in kCal/ kg of steam
$h_f$	=	Enthalpy of feed water in kCal/ kg of water
Temperatures are in degree centigrade and pressure in kg/ cm <sup>2</sup>		

Indirect Method:

Conversion of proximate analysis into ultimate analysis,

$$\begin{aligned} \%C &= 0.97C + 0.7(VM + 0.1A) - M(0.6 - 0.01M) \\ \%H &= 0.036C + 0.086(VM - 0.1A) - 0.0035M^2(1 - 0.02M) \\ \%N_2 &= 2.10 - 0.020VM \end{aligned}$$

Where, %C	=	% of fixed carbon
A	=	% of ash
VM	=	% of volatile matter
M	=	% of moisture in general notations.

Theoretical air required for combustion:

$$\begin{aligned} \text{Theoretical air required for combustion} &= [11.6C + \{34.8(H_2 - \frac{O_2}{8})\} + 4.35S] / 100 \text{ kg / kg of fuel} \\ \% \text{ Excess air supplied (EA)} &= \frac{O_2 \%}{21 - O_2 \%} \times 100 = \frac{7900[(CO_2\%)_t - (CO_2\%)_a]}{(CO_2\%)_a [100 - (CO_2\%)_t]} \rightarrow \text{From flue gas analysis} \\ (CO_2\%)_t &= \text{Theoretical } CO_2 \\ (CO_2\%)_a &= \text{Actual } CO_2 \% \text{ measured in flue gas} = \frac{\text{Moles of C}}{\text{Moles of } N_2 + \text{Moles of C}} \\ \text{Moles of } N_2 &= \frac{\text{Wt of } N_2 \text{ in theoretical air}}{\text{Mol. wt of } N_2} + \frac{\text{Wt of } N_2 \text{ in fuel}}{\text{Mol. wt of } N_2} \\ \text{Moles of C} &= \frac{\text{Wt of C in fuel}}{\text{Molecular Wt of C}} \\ \text{Actual mass of air supplied / kg of fuel (AAS)} &= [1 + \frac{EA}{100}] \times \text{theoretical air} \end{aligned}$$



$$\text{Total mass of dry flue gas} = \left(C \times \frac{44}{12}\right) + \left(\text{AAS} \times \frac{77}{100}\right) + \left[(\text{AAS} - \text{Theoretical Air}) \times \frac{23}{100}\right] + \left(S \times \frac{64}{32}\right) + N_2$$

$$\% \text{ Loss due to dry flue gas} = L_1 = \frac{m_d \times C_p \times (T_f - T_a)}{\text{GCV of fuel}} \times 100 = \text{Total AAS} + 1$$

Where,  $m_d$  = Mass of dry flue gas in kg/ kg of fuel  
 = Combustion product from fuel:  $\text{CO}_2 + \text{SO}_2 + \text{N}_2$  in fuel +  $\text{N}_2$  in actual mass of air supplied +  $\text{O}_2$  in flue gas ( $\text{H}_2\text{O}$ /water vapour in the flue gas should not be considered)  
 $C_p$  = Specific heat of flue gas in kCal/ kg degree C  
 $T_f$  = Flue gas temperature in degree C  
 $T_a$  = Ambient temperature in degree C

$$\% \text{ Heat loss due to evaporation of water formed due to } H_2 \text{ in fuel} = L_2 = \frac{9H_2[584 + C_p(T_f - T_a)]}{\text{GCV of fuel}} \times 100$$

$$\% \text{ Heat loss due to moisture present in fuel} = L_3 = \frac{M[584 + C_p(T_f - T_a)]}{\text{GCV of fuel}} \times 100$$

$$\% \text{ Heat loss due to moisture present in air} = L_4 = \frac{\text{AAS} \times \text{Humidity factor} \times C_p(T_f - T_a) \times 100}{\text{GCV of fuel}}$$

where (for  $L_3$  to  $L_4$ ),  
 $H_2$  = kg of hydrogen present in fuel on 1 kg basis  
 $C_p$  = Specific heat of superheated steam in kCal/ kg degree C  
 $T_f$  = Flue gas temperature in C  
 $T_a$  = Ambient temperature in C  
 584 = Latent heat corresponding to partial pressure of water vapour  
 $M$  = kg moisture in fuel on 1 kg basis  
 AAS = Actual mass of air supplied per kg of fuel  
 Humidity factor = kg of water/ kg of dry air

DBT (Degree C)	WBT degree C	Relative Humidity	Kg water per kg of dry air(Humidity Factor)
20	20	100	0.016
20	14	50	0.008
30	22	50	0.014
40	30	50	0.024

$$\text{Heat loss due to incomplete combustion} = L_5 = \frac{\% \text{CO} \times C}{\% \text{CO} + \% \text{CO}_2} \times \frac{5744}{\text{GCV of fuel}} \times 100$$

Where,  
 $L_5$  = %Heat loss due to partial conversion of C to CO  
 $\text{CO}$  = Volume of CO in flue gas leaving economiser %  
 $\text{CO}_2$  = Actual volume of  $\text{CO}_2$  in flue gas %  
 $C$  = Carbon content kg/ kg of fuel

**OR**

When CO is obtained in ppm during the flue gas analysis

$\text{CO formation}(M_{\text{co}})$  =  $\text{CO}(\text{in ppm}) * M_f * 28 * 10^{-6}$   
 $M_f$  = Fuel consumption in kg/ he  
 $L_5$  =  $M_{\text{co}} * 5744$

$$\% \text{ Heat loss due to radiation \& convection} = L_6 = 0.548 \left[ \left( \frac{T_s}{55.55} \right)^4 - \left( \frac{T_a}{55.55} \right)^4 \right] + [1.957 \times (T_s - T_a)^{1.25} \times \sqrt{\left[ \frac{(196.85V_m + 68.9)}{68.9} \right]}]$$

Where,  $L_6$  = Radiation loss in  $W/m^2$   
 $V_m$  = Wind velocity in m/s  
 $T_s$  = Surface temperature (K)  
 $T_a$  = Ambient temperature (K)

$$\% \text{ Heat loss due to unburnt in flyash} = L_7 = \frac{\text{Total ash collected per kg of fuel burnt} \times \text{GCV of flyash} \times 100}{\text{GCV of fuel}}$$

$$\% \text{ Heat loss due to unburnt in bottom ash} = L_8 = \frac{\text{Total ash collected per kg of fuel burnt} \times \text{GCV of bottom ash} \times 100}{\text{GCV of fuel}}$$

$$\text{Boiler Efficiency in } \% \eta = 100 - (\text{Addition of } \%L_1 \text{ to } \%L_8)$$

## 2. Furnace:

**Specific energy consumption** = Quantity of fuel or energy consumed/ quantity of material processed.

Direct Method:

$$\text{Thermal efficiency of furnace} = \frac{\text{Heat in stock (material) in kCal}}{\text{Heat in fuel in kCal}} \times 100$$

$$\text{Heat imparted to stock } Q = mC_p(t_2 - t_1)$$

Where,  $Q$  = Quantity of heat in kCal  
 $m$  = Mass of material in kg  
 $C_p$  = Mean Specific Heat in kCal/ kg degree C  
 $t_2$  = Final temperature desired in degree C  
 $t_1$  = Initial temperature of the charge before it enters the furnace in degree C

Indirect Method:

Calculation of air quantity and specific fuel consumption:

$$\text{Theoretical air required for combustion} = [11.6C + \{34.8(H_2 - \frac{O_2}{8})\} + 4.35S] / 100 \text{ kg / kg of fuel}$$

$$\text{Excess air supplied (EA)} = \frac{O_2\%}{21 - O_2\%} \times 100$$

$$\text{Actual mass of air supplied / kg of fuel (AAS)} = [1 + \frac{EA}{100}] \times \text{theoretical air}$$

$$\begin{aligned} \text{Total mass of dry flue gas} &= \text{Mass of C} + \text{Mass of } N_2 \text{ in fuel} + \text{Mass of } SO_2 + \\ &\quad \text{Mass of } N_2 \text{ in Combustion air supplied} + \text{Mass of } O_2 \text{ in flue gas} \\ \text{or} \\ &= \left(C \times \frac{44}{12}\right) + \left(AAS \times \frac{77}{100}\right) + \left[(AAS - \text{Theoretical Air}) \times \frac{23}{100}\right] + \left(S \times \frac{64}{32}\right) + N_2 \end{aligned}$$

Above values can be taken from proximate or ultimate analysis of fuel.

Specific fuel consumption(F) = Amount of fuel consumed in kg per hour/ amount of billet in tonne per hour

Heat input calculation for furnace heat balance sheet (one tonne basis):

Heat Input = Combustion heat of fuel  $Q_1$  + Sensible heat of fuel  $Q_2$   
 = (fuel consumption per tonne of billet \* GCV) + (fuel consumption per tonne of billet \*  $C_p$  of fuel \* Temperature difference of flue gas to atmosphere)  
 =  $Q_1 + Q_2$  in kCal per tonne of billet.

Heat out to furnace calculation for heat balance sheet (on one tonne basis):

$$\text{Heat carried away by 1 tonne of billet} = Q_3 = 1000 \text{ kg / tonne} \times C_p(T_o - T_i)$$

Where,  $T_o$  = Temperature of billet at outlet of furnace in degree C  
 $T_i$  = Temperature of atmosphere at outlet  
 $C_p$  = Specific heat of billets in lCal/ kg/degree C

Sensible heat loss in flue gases:

$$\text{Heat loss in flue gas} = Q_4 = \text{Sensible heat loss} = m \times C_{p_{fg}} \times (T_1 - T_a)$$

Where,  $m$  = Amount of fuel consumed per tonne of billet in kg/ tonne of billet.  
 $C_{pg}$  = Specific heat of flue gas ~ 0.24 kCal/ kg/degree C  
 $T_1$  = Temperature of flue gas in degree C  
 $T_a$  = Temperature of atmosphere at base in degree C  
 Assumption: 1 kg of oil require 14 kg of air to burn fully.

$$\text{Heat loss due to formation of water formed due in fuel} = Q_5 = \frac{F \times (M + 9H_2)[584 + C_{p_{sup,heat wat}}(T_1 - T_a)]}{GCV \text{ of fuel}} \times 100$$

Where,  $C_{p_{super heated water}}$  = Specific heat of superheated water vapour in kCal/ kg/degree C

$$\text{Heat loss due to moisture in combustion air} = Q_6 = F \times AAS \times \text{Humidity of air} \times C_{p_{sup,heat wat}}(T_1 - T_a)$$

$$\text{Heat loss due to partial combustion of } CO = Q_7 = \frac{F \times \%CO \times C}{\%CO + \%CO_2} \times 5654$$

Amount of heat loss from furnace body and other sections  $Q_7$

= heat loss from furnace body ceiling q1 + heat loss from furnace side wall q2+ bottom q3 + heat loss from flue gas duct between furnace exit and air pre heater q4

$$q1 = (h \times \Delta T^{1.25} \times A_i) + (4.88 \times \varepsilon \times [(\frac{T_w}{100})^4 - (\frac{T_a}{100})^4] \times A_i)$$

Where, h = Natural convective heat transfer rate for ceiling in kCal/ m<sup>2</sup> h degree C  
 Tw = External temperature of ceiling in degree C  
 Ta = Room temperature in degree C  
 Δt = Tw- Ta  
 Ai = Ceiling surface area in m<sup>2</sup>  
 ε = emissivity of furnace body surface

$$q2 = (h \times \Delta T^{1.25} \times A_i) + (4.88 \times \varepsilon \times [(\frac{T_w}{100})^4 - (\frac{T_a}{100})^4] \times A_i)$$

Where, h = Natural convective heat transfer rate for side wall in kCal/ m<sup>2</sup> h degree C  
 Tw = External temperature of side wall in degree C  
 Ta = Room temperature in degree C  
 Δt = Tw- Ta  
 Ai = side wall surface area in m<sup>2</sup>  
 ε = emissivity of furnace body surface

q3 = Bottom: But as bottom surface area is not exposed to the atmosphere, here it is ignored.

$$q4 = (h \times \frac{\Delta T^{1.25}}{D^{1.25}} \times A_i) + (4.88 \times \varepsilon \times [(\frac{T_w}{100})^4 - (\frac{T_a}{100})^4] \times A_i)$$

Where, h = Natural convective heat transfer rate for duct in kCal/ m<sup>2</sup> h degree C  
 Tw = External temperature of flue gas duct in degree C  
 Ta = Room temperature in degree C  
 Δt = Tw- Ta  
 Ai = external flue gas duct in m<sup>2</sup>  
 ε = emissivity of furnace body surface  
 D = Outside diameter of flue gas duct

Q<sub>8</sub> = q1+ q2+ q3+ q4 kCal per hour/ Amount of billet (t/ hr)

$$\text{Radiation heat loss through furnace opening} = Q_9 = hr \times A \times \phi \times 4.88 [(\frac{T_f}{100})^4 - (\frac{T_o}{100})^4] / t$$

Where, hr = Open time during the period of heat balancing  
 Tf = Furnace temperature in degree C  
 To = base temperature in degree C  
 A = Area of opening in m<sup>2</sup>  
 φ = Co efficient based on the profile of the furnace opening  
 = Dia. of shortest side/ wall thickness  
 t = Amount of billet in ton/ hour

Q10 = Other types of unaccounted heat losses like heat carried away by the cooling water in flue damper and furnace excess door, Radiation from furnace bottom, Heat accumulated by refractory, Instrumental error or any other errors etc.

Q<sub>heat balance</sub>: (Q<sub>1</sub>+Q<sub>2</sub>) = (Q<sub>3</sub>+Q<sub>4</sub>+Q<sub>5</sub>+Q<sub>6</sub>+Q<sub>7</sub>+Q<sub>8</sub>+Q<sub>9</sub>+Q<sub>10</sub>)

### 3. HEAT EXCHANGER.

Over all heat transfer co efficient:

$$Q = UA \times LMTD$$

Where,  $Q$  = Heat transfer in kCal/ hr  
 $U$  = Overall heat transfer co efficient in kCal/ hr/ m<sup>2</sup>/ degree C  
 $A$  = Heat transfer area in m<sup>2</sup>  
 $LMTD$  = Logarithmic Mean Temperature difference in degree C

$$\varepsilon = \text{Heat exchanger effectiveness} = \frac{\text{Actual heat transfer rate in kCal / hr}}{\text{Max. possible heat transfer rate in kCal / hr}} = \frac{Q}{Q_{\max}} = \frac{Q}{C_{\min} \times \Delta T_{\max}}$$

Where,  $C_{\min}$  = Lower of two fluid heat capacities in kCal/ hr degree C  
 $\Delta T_{\max}$  = Max. temp. difference from terminal stream temperature. in degree C

$$\text{Heat duty of hot fluid} = Q_h = W \times C_{ph} \times (T_{hi} - T_{ho})$$

$$\text{Heat duty of cold fluid} = Q_c = w \times C_{pc} \times (T_{co} - T_{ci})$$

Where,  $C_{ph}$  &  $C_{pc}$  = Specific heat of hot and cold fluid respectively in kCal/ kg Degree K  
 $T_{hi/ho}$  &  $T_{co/ci}$  = Temperature at inlet (i) and outlet (o) of hot and cold fluids respectively in degree C  
 $W, w$  = Hot and cold fluid flow respectively.

$$\text{Heat duty of heat exchanger } Q = \text{Sensible heat } q_s + \text{Latent heat } q_l$$

$$q_s = W \times C_{ph} \times (T_{hi} - T_{ho}) / 3600 = w \times C_{pc} \times (T_{co} - T_{ci}) / 3600 \dots \text{in kW}$$

$$q_l = W \times \lambda_h / 3600 = w \times \lambda_c / 3600 \dots \text{in kW}$$

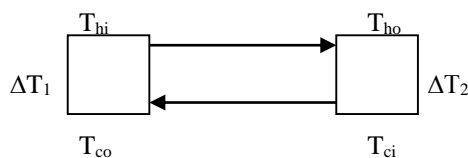
Where,  $\lambda_h$  &  $\lambda_c$  = Latent heat of condensation for hot fluid and latent heat of vaporization for cold fluid in kJ/ kg

$$\text{Hot fluid pressure drop} = \Delta P_h = P_i - P_o$$

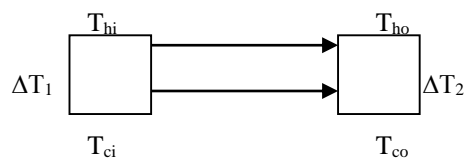
$$\text{Hot fluid temperature range} = \Delta T_h = T_{hi} - T_{ho}$$

$$\text{Cold fluid pressure drop} = \Delta P_c = P_i - P_o$$

$$\text{Cold fluid temperature range} = \Delta T_c = T_{co} - T_{ci}$$



Counter flow heat exchanger



Parallel flow heat exchanger

$$LMTD \text{ for counter flow} = \frac{(T_{hi} - T_{co}) - (T_{ho} - T_{ci})}{\ln[(T_{hi} - T_{co}) - (T_{ho} - T_{ci})]}$$

$$LMTD \text{ for parallel flow} = \frac{(T_{hi} - T_{ci}) - (T_{ho} - T_{co})}{\ln[(T_{hi} - T_{ci}) - (T_{ho} - T_{co})]}$$

**LMTD correction factor F:** (where two dimensionless numbers R and S are to be used as below)

$$R = \frac{T_a - T_b}{t_b - t_a} \quad P = \frac{t_b - t_a}{T_a - t_a}$$

Where,  $T_a$  &  $T_b$  = Inlet and outlet temperature of shell side fluid  
 $t_a$  &  $t_b$  = Inlet and outlet temperature of tube side fluid

For  $R \neq 1$ , compute as following:

$$\alpha = \left[ \frac{1 - RP}{1 - P} \right]^{\frac{1}{N}} \quad \& \quad S = \frac{\alpha - 1}{\alpha - R} \quad \& \quad F = \frac{\sqrt{R^2 - 1} \ln \left( \frac{1 - S}{1 - RS} \right)}{(R - 1) \ln \left[ \frac{2 - S(R + 1 - \sqrt{R^2 + 1})}{2 - S(R + 1 + \sqrt{R^2 + 1})} \right]}$$

For  $R = 1$ , compute as following:

$$S = \frac{P}{N - (N - 1)P} \quad \& \quad F = \frac{S\sqrt{2}}{(1 - S) \ln \left[ \frac{2 - S(2 - \sqrt{2})}{2 - S(2 + \sqrt{2})} \right]}$$

Where,  $N$  = No of shell side passes  
 $S$  &  $\alpha$  = Parameters used to calculate LMTD correction factors

Corrected LMTD	=	$F \cdot \text{LMTD}$
Overall heat transfer co efficient U	=	$Q / (A \cdot \text{Corrected LMTD})$

#### 4. REFRIGERATION AND AIR CONDITIONING LOAD CALCULATIONS: (Use standard Refrigeration Tables for values of different factors)

a. **External roof and walls (sensible):**

$$Q = UA[(TETD_p \times F_C) + (TETD_A \times F_R)]$$

Where,  $U$  = Overall heat transfer co efficient for roof walls in  $W/m^2$  degree K  
 $A$  = Area of wall in  $m^2$   
 $TETD$  = Total Equivalent Temperature Difference,  
 Time Integrated peak and average respectively  
 $F$  = Convective and radiative factor respectively for walls

b. **Glass Conduction (sensible):**

$$Q = UA\Delta T$$

Where,  $U$  = Overall heat transfer co efficient for glass in  $W/m^2$  degree K  
 $A$  = Area of glass in  $m^2$   
 $\Delta T$  = Outside and inside temperature difference in degree C.

**Glass Solar load (sensible):**

$$Q = A[SC\{(F_C \times SHGF_p) + (F_R \times SHGF_A)\}]$$

Where, A = Glass Area m<sup>2</sup>  
 SHGF = Solar heat gain factor for peak and average  
 SC = Shading co efficient  
 F = Convective and radiative factor respectively for glass

**c. Ceiling/ Roof/ Floor/ Partition sensible (not exposed):**

$$Q = UA\Delta T$$

Where, U = Overall heat transfer co efficient for Ceiling/ Roof/ Floor/ Partition in W/m<sup>2</sup> degree K  
 A = Area of Ceiling/ Roof/ Floor/ Partition in m<sup>2</sup>  
 ΔT = Outside and inside temperature difference in degree C.

**d. People Or Occupants (sensible and latent):**

$$Q_s = \text{No of occupants in space} \times \text{Sensible heat gain factor per occupant}$$

$$Q_s = \text{No of occupants in space} \times \text{Latent heat gain factor per occupant}$$

**e. Lights (sensible):**

$$Q = \text{Input} \times \text{Allowance} \times \text{Use}$$

Where, Input = Input rating from electrical plants or lighting fixture data  
 Allowance = Usage of tube lights ~1.2  
 Use = Actual wattage in use/ installed wattage and to be decided based on application.

**f. Motors and other load (sensible):**

$$Q = \text{Power of motor} \times \text{Load factor} \times \text{Use factor}$$

Where, Power of motor = Name plate details of motor  
 Load factor = Depends on relative placement of motor and load  
 Use factor = Generally taken as 1 if not specified.

**g. Appliances (sensible):**

$$Q_s = \text{No appliances in space} \times \text{Sensible heat factor}$$

$$Q_s = \text{No of appliances in space} \times \text{Latent heat factor}$$

**h. Ventilation and Infiltration (sensible):**

$$Q_s = 20.43 \times Q_m (t_o - t_i) W$$

$$Q_L = 49.1 \times Q_m (W_o - W_i) W$$

Where, Qm = Outside air in m<sup>3</sup>/ min infiltration or ventilation which ever is more.  
 t = Outside and inside temperature difference respctively in degree K.  
 W = Humidity ratio difference of outside and inside in gms/ kg

**i. Ventilation and Infiltration (latent):**

$$\text{Infiltration for room} = HLWG / 60$$

$$\text{Door inf iltration} = \text{door opening} \times \text{Factor} / 60$$

Where, H	=	Room height in m.
W	=	Room width in m
L	=	Room Length in m
G	=	Factor for infiltration

## 5. AIR COMPRESSOR AND FREE AIR DELIVERY:

**Load unload test of compressor for compressed air system leakage:**

$$\% \text{ Leakage} = \frac{\text{Time for load in min utes}}{\text{Time for load} + \text{Time for unload in min utes}} \times 100$$

$$\text{System leakage quantity} = \frac{\text{Time for load in min utes}}{\text{Time for load} + \text{Time for unload in min utes}} \times \text{Comp. capacity in m}^3 / \text{min}$$

**Free air delivery by nozzle method:**

$$Q_{\text{free}} = c \times \pi \times \frac{d^2}{4} \times \frac{T_a}{P_a} \left[ \frac{2(P_{bn} - P_n)(P_{bn} - R)}{T_{bn}} \right]^{1/2}$$

Where, $Q_{\text{free}}$	=	Free air delivery in m <sup>3</sup> / sec
c	=	Flow constant to be specified
d	=	diameter of nozzle in m
$T_a$	=	Absolute inlet temperature in degree K
$P_a$	=	Absolute inlet pressure in kg/ cm <sup>2</sup>
$P_{bn}$	=	Absolute pressure before nozzle in kg/ cm <sup>2</sup>
$P_{bn}-P_n$	=	Difference of pressure across nozzle in kg/ cm <sup>2</sup>
R	=	Gas constant for air and is taken as 287.10 J/ kg K
$T_{bn}$	=	Absolute temperature before nozzle in degree K

Isothermal efficiency = Isothermal Power/ Actual measured input power

Isothermal Power =  $PV \log_e r / 36.7$

Where, P	=	Absolute inlet pressure in kg/ cm <sup>2</sup>
V	=	Free air delivery in m <sup>3</sup> / hr
r	=	pressure ratio $P_d/P$
$P_d$	=	Delivery Pressure m <sup>3</sup> / hr

Volumetric Efficiency =  $[\text{Free air delivery (in m}^3/\text{min)} / \text{Compressor displacement (in m}^3/\text{hr)}] \times 100$   
 =  $[\text{Free air delivery (in m}^3/\text{min)} / (0.785 \times D^2 \times L \times N \times X \times n)]$

Where, D	=	Cylinder bore in m
V	=	Free air delivery in m <sup>3</sup> / hr
L	=	Stroke length in m
N	=	RPM of compressor or speed in RPM
x	=	Single or double acting compressor cylinder
n	=	Nos. of cylinder in compressor

Specific power consumption at rated discharge pressure = Power consumption in kW/ Free air delivered m<sup>3</sup>/ hr



## SUGGESTED QUESTION PAPER FORMAT

(This is for reference only and is in suggestive form. Paper setter may opt for other marks distribution pattern maintaining distribution of marks as per specification table)

Q.NO.	SUB Q.NO.	QUESTION	MARKS DISTRIBUTION			UNIT
			R	U	A	
1		Answer ANY seven from following.				14
	i.		2			I
	ii.		2			II
	iii.		2			III
	iv.		2			IV
	v.		2			V
	vi.		2			I
	vii.		2			II or III
	viii.		2			IV
	ix.			2		IV
	x.				2	I
2	a.			3		II
		OR				
	a.			3		II
	b.			3		II
		OR				
	b.			3		II
	c.				4	III
		OR				
	c.				4	III
	d.			4		V
		OR				
	d.			4		V
3	a.			3		II
		OR				
	a.			3		II
	b.			3		IV
		OR				
	b.			3		IV
	c.				4	II
		OR				
	c.				4	II
	d.				4	III
		OR				
	d.				4	III
4	a.				3	IV
		OR				
	a.				3	IV
	b.			4		III
		OR				
	b.			4		III
	c.				7	V
5	a.			4		I
	b.				4	III
	c.				3	V
	d.				3	IV

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

**COURSE CURRICULUM  
COURSE TITLE: PROJECT - II  
(COURSE CODE: 3361910)**

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
Mechanical Engineering	SIXTH

**1. RATIONALE.**

This course enables the students to exercise some of the knowledge and/or skills developed during the programme to new situation or problem for which there are number of engineering solutions. This course include planning of the tasks which are to be completed within the time allocated, and in turn, helps to develop ability to plan, , use, monitor and control resources optimally and economically. By studying this course abilities like creativity, imitativeness and performance qualities are also developed in students. Leadership development and supervision skills are also integrated objectives of learning this course.

**2. COMPETENCY.**

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

- **Plan, use, monitor and control resources optimally and economically.**
- **Identify the problem and apply innovative, creative and logical approach for problem solving.**

**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. Plan and identify materials, processes and other resources optimally.
- ii. Develop innovative and creative ideas.
- iii. Develop leadership, interpersonal skill and team work.
- iv. Develop sense of environmental responsibility.
- v. Purchase raw material/standard parts.
- vi. Interpret the drawings, manufacture, assemble, inspect & if necessary modify the parts/unit/assembly of the project work.
- vii. Familiar with fast changes in technology.

**4. TEACHING AND EXAMINATION SCHEME.**

<b>Teaching Scheme (In Hours)</b>			<b>Total Credits (L+T+P)</b>	<b>Examination Scheme</b>				
				<b>Theory Marks</b>		<b>Practical Marks</b>		<b>Total Marks</b>
<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>ESE</b>	<b>PA</b>	<b>ESE</b>	<b>PA</b>	
<b>0</b>	<b>0</b>	<b>6</b>	<b>6</b>	<b>0</b>	<b>0</b>	<b>60</b>	<b>90</b>	

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

**5. 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.	Practical Exercises (outcomes in Psychomotor Domain)	Approx Hours. required
1	<p><b>Preparatory Activity:</b></p> <ol style="list-style-type: none"> <li>a. Keep project report of V semester course Project-I- 3351908.</li> <li>b. Appreciate the importance of course outcomes.</li> <li>c. Recall and strengthen know-how for engineering drawing fundamentals which includes:               <ol style="list-style-type: none"> <li>i. Most commonly used limits and fits with values.</li> <li>ii. Various machining processes and surface roughness symbols.</li> </ol> </li> <li>d. Evaluate all the projects (Of Project –I- 3351908) drawings and select feasible project for execution in batch. (Total projects will be equal to number of students in a batch. Evaluate and select in such a way that selected project will be executed in groups. That is, there may be 3-5 projects, remaining will be dropped, and for selected project, there will be distribution of the students in group.) Attach selected project drawings.</li> <li>e. Recheck and correct (Minor corrections) if necessary, project production drawings of selected projects (The project drawings of the student prepared in course Project –I- 3351908).</li> </ol>	08
2	<p><b>Work allocation matrix:</b> Prepare work allocation matrix along with provision of follow-up remarks and notes. (Suggested format of work allocation matrix with provision of follow-up is attached herewith in Annexure -I).</p>	04
3	<p><b>Project execution:</b> Execute project preparation activities as per work allocation matrix. (Option of flexi time based work can also be practiced. For this option, it may not be necessary to exactly follow the time table slots. This can be on continuous base also.)</p>	64
4	<p><b>Documentation and presentation:</b> Documentation of final project report which includes following in sequence.</p>	08

	<ul style="list-style-type: none"> <li>a. Title page-(Suggested as per Annexure-II.)</li> <li>b. Certificate –As per Annexure-III.</li> <li>c. Index.</li> <li>d. Preface/Acknowledgement.</li> <li>e. Course outcomes.</li> <li>f. Project title.</li> <li>g. Assembly and detail production drawings.</li> <li>h. List of activities (suggested as per Annexure – IV) and work allocation matrix.</li> <li>i. Plant layout with dimensions.</li> <li>j. List and specifications of machineries, equipments and tools.</li> <li>k. Bill of material with make or buy decision.</li> <li>l. Specifications of bought out parts.</li> <li>m. Process sheets-As per format given in course Industrial engineering.</li> <li>n. Flow process charts.</li> <li>o. Specification and consumption of consumables.</li> <li>p. Details of inspection / testing carried out.</li> <li>q. Details of rework / rectifications carried out.</li> <li>r. Cost estimation.</li> <li>s. Monitoring and control report/sheet.</li> <li>t. Notes on troubleshooting.</li> <li>u. Notes on individual achievement of skills / experience /problems / solutions.</li> <li>v. References.</li> <li>w. Day to day logbook as per Annexure-V.</li> <li>x. Presentation including moments at work-video/photographs in action.</li> </ul>	
	<b>TOTAL</b>	<b>84</b>

**Notes:**

- a. Prepare project report with MS Office with following guidelines.

PAGE:	A4 (ON ONE SIDE).
MARGINN:	TOP :15mm. BOTTOM :15mm. RIGHT :15mm. LEFT :30mm.
FONT:	ARIAL.
SIZE:	12-BOLD, CONTENT12, SPACING 18 POINTS,
HEADER:	TITLE OF THE PROJECT, PAGE NUMBER ON TOP RIGHT.
FOOTER:	ACADEMIC YEAR, SHORT NAME OF THE INSTITUTE.

- b. Term work (hard copy) should also include experience logbook duly certified by workshop instructors (as applicable), Industry/Market/Field personnel (as applicable) and subject teachers.

- c. Term work has to be defended (along with term work of V semester and VI semester) by practical / oral examination to be conducted by external and internal examiners. Power point presentation is also to be included.

## 6. SUGGESTED LIST OF STUDENT ACTIVITIES.

SR.NO.	ACTIVITY
1	Suggest further improvement / research which can be carried out.

## 7. SUGGESTED LEARNING RESOURCES.

### A. List of Books:

- i. Use of Library.
- ii. Reference books.
- iii. Hand books.
- iv. Encyclopedia.
- v. Magazines.
- vi. Periodicals.
- vii. Journals.
- viii. Visits of industry, organizations related as per the requirement.
- ix. Internet.

## 8. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### Faculty Members from Polytechnics.

- K.H.Patel, Head of mechanical engineering department, Dr. S.S.and S. Gandhi College of engineering and technology, Surat.
- A.M.Talsaniya, Lecturer in Mechanical engineering, Sir BPI, Bhavnagar.

### Coordinator and Faculty Members from NITTTR Bhopal.

- **Dr. K.K. Jain**, Professor, Department of Mechanical Engineering, NITTTR, Bhopal
- **Dr. A.K. Sarathe**, Associate Professor; Department of Mechanical Engineering.

**ANNEXURE-I****WORK ALLOCATION MATRIX (SUGGESTED)****ENROLLMENT NO. OF STUDENT:****NAME OF STUDENT:****BATCH:**

ACTIVITY NO.	SHORT DESCRIPTION OF ACTIVITY	WHO WILL PERFORM?	PLANNED DATES		ACTUAL DATES		WHO HAS / HAVE PERFORMED?	REASON/S FOR ANY DELAY / DEVIATION FROM PLANNING	INITIAL OF TEACHER
			STARTING	ENDING	STARTING	ENDING			
1	Preparing and maintaining logbook as per Annexure-V.								
2	Finalization of assembly and detail drawings (This must be production drawings with suitable scale along with dimensions, tolerances, surface roughness symbols, heat treatment / other treatments required, material , quantity per assembly for components drawings ,etc.								
3	Preparing master schedule and work allocation matrix in group.								
4	Preparation of bill of material.								
5	Collecting data and specifications of available resources-mainly material and machineries / equipment/facilities and tools.								
6	Make or Buy decision.								
7	Preparing specifications of bought-out parts.								

8	Preparation of process planning (sheets) for all components in standard format.								
9	List, quantities and specifications of consumables.								
10	Preparation of list of required tools-cutting tools, jigs, fixtures, measuring instruments and other tools along with necessary specifications and sketches if required.								
11	Identifying and locating required resources like material, machineries/equipments / facilities and tools.								
12	Preparing plant layout.								
13	Manufacturing of components.								
	a) <name of component 1>								
	b) <name of component 2>								
	c) <name of component 3>								
	d) <name of component 4>								
	n) <name of component n>								
14	Details of inspection carried out.								
15	Assembly.								
16	Details of testing carried out.								
17	Rework / rectification activities if required.								
18	1) Project monitoring and control, record keeping.								
19	Costing.								

20	Preparation of notes on troubleshooting.								
21	Preparation of notes individually on : a. Extent to which he/she has achieved learning outcomes. b. Own experience in executing project. c. He/ She has faced technical problems during execution of project and solutions found.								
22	Preparation of list of references.								
23	Preparation of project report.								
24	Presentation.								



ANNEXURE-II  
TITLE PAGEINSTITUTE  
LOGO

&lt; NAME AND ADDRESS OF INSTITUTE &gt;

**TERM WORK REPORT**

SUBJECT : PROJECT – II

SUBJECT CODE :

DISCIPLINE : MECHANICAL ENGINEERING

ENROLMENT NUMBER :

NAME OF STUDENT :

DIVISION / BATCH :

**SUBMISSION**

SUBMITTED - V SEM. : &lt;DATE&gt;

SUBMITTED-VI SEM. : &lt;DATE&gt;

**ANNEXURE-III****CERTIFICATE**

*THIS IS TO CERTIFY THAT  
SHRI / KUM.....  
HAS SATISFACTORILY COMPLETED HIS / HER  
TERMWORK IN THE SUBJECT  
PROJECT – II ( <SUBJECT CODE > )  
WITHIN THE PRESCRIBED TIME LIMIT AND PRESCRIBED BOUNDARY.*

DATE :

STUDENT

DATE :

INSTITUTE GUIDE

DATE:

HEAD OF DEPTT.

DATE:

PRINCIPAL

**ANNEXURE-IV****SUGGESTED LIST OF ACTIVITIES.**

- 1) Preparing and maintaining logbook as per Annexure-V.
- 2) Finalization of assembly and detail drawings (This must be production drawings with suitable scale along with dimensions, tolerances, surface roughness symbols, heat treatment / other treatments required, material , quantity per assembly for components drawings ,etc.
- 3) Preparing master schedule and work allocation matrix in group.
- 4) Preparation of bill of material.
- 5) Collecting data and specifications of available resources-mainly material and machineries / equipment/facilities and tools.
- 6) Make or Buy decision.
- 7) Preparing specifications of bought-out parts.
- 8) Preparation of process planning (sheets) for all components in standard format.
- 9) List, quantities and specifications of consumables.
- 10) Preparation of list of required tools-cutting tools, jigs, fixtures, measuring instruments and other tools along with necessary specifications and sketches if required.
- 11) Identifying and locating required resources like material, machineries/equipments / facilities and tools.
- 12) Preparing plant layout.
- 13) Manufacturing of components.
  - a. <name of component 1>
  - b. <name of component 2>
  - d. <name of component 3>
  - e. ..
  - n. <name of component n>
- 14) Details of inspection carried out.
- 15) Assembly.
- 16) Details of testing carried out.
- 17) Rework / rectification activities if required.
- 18) Project monitoring and control, record keeping.
- 19) Costing.
- 20) Preparation of notes on troubleshooting.
- 21) Preparation of notes individually on :
  - a. Extent to which he/she has achieved learning outcomes.
  - b. Own experience in executing project.
  - c. He/ She has faced technical problems during execution of project and solutions found.
- 22) Preparation of list of references.
- 23) Preparation of project report.
- 24) Presentation.

**ANNEXURE-V**

## FORMAT FOR DAY TO DAY LOG BOOK

ENROLLMENT NUMBER OF THE STUDENT :			
NAME OF THE STUDENT :			
DATE:	HOURS	DETAILS OF WORK CARRIED OUT.	SIGNATURE OF TEACHER / GUIDE / INSTRUCTOR.

DATE:	HOURS	DETAILS OF WORK CARRIED OUT.	SIGNATURE OF TEACHER / GUIDE / INSTRUCTOR.

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

**COURSE CURRICULUM**

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

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
Mechanical Engineering	5 <sup>th</sup> 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				Total Marks
				Theory Marks		Practical 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
<b>Unit – I. Introduction.</b>	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.
<b>Unit – II Marketing.</b>	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.
<b>Unit – III</b>  <b>Supervision with cost &amp; quality control</b>	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.
<b>Unit – IV</b>  <b>Data base management system.</b>	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).
<b>Unit – V</b> <b>Information systems.</b>	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
<b>I</b>	Introduction.	6	4	6	0	10
<b>II</b>	Marketing.	8	6	4	4	14
<b>III</b>	Supervision with cost & quality control.	10	7	4	5	16
<b>IV</b>	Data base management systems.	10	7	4	5	16
<b>V</b>	Information systems.	8	0	4	10	14
	<b>Total</b>	<b>42</b>	<b>24</b>	<b>22</b>	<b>24</b>	<b>70</b>

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

*Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.*

### General Notes:

- If midsem test is part of continuous evaluation, unit numbers I, II and III (Up to 3.7 only) are to be considered.
- Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.

## 7. SUGGESTED LIST OF EXERCISES/PRACTICALS.

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills (**outcomes in 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	<b>Preparatory activities:</b> Student will practice and prepare the report on following. <ol style="list-style-type: none"> <li>Importance of attitude and information systems in day to day operations of shop floor/plant.</li> <li>Objectives of learning this subject.</li> <li>Definitions and illustrations of system, data and information.</li> <li>Attitude dos and don'ts as supervisor on shop floor/plant.</li> </ol>	2
2	II	<b>Forecasting:</b> 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	<b>Market survey, sales and service:</b> Student will practice and will prepare report on following. <ol style="list-style-type: none"> <li>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.</li> <li>Teacher will assign any one mechanical engineering</li> </ol>	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	<p><b>Quality circle:</b> 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.</p> <ol style="list-style-type: none"> <li>Reproduce the case.</li> <li>List the objectives to be solved.</li> <li>Viewpoints of each member.</li> <li>Group discussion on view points of each member listing the merits and demerits of each.</li> <li>Suggestive outcome/s of the quality circle group.</li> <li>Benefits sought if suggestive outcome/s of group is /are implemented.</li> </ol>	2
5	V	<p><b>Management information system:</b> Student will practice and will prepare report on following.</p> <ol style="list-style-type: none"> <li>Select and name data base management system software.</li> <li>List and explain features of selected data base management software.</li> <li>Explain how data entry, editing, sorting and retrieval are performed in selected data base management system software.</li> <li>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.</li> </ol>	8
6	ALL	<p><b>Mini project and presentation:</b></p> <ol style="list-style-type: none"> <li>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. <ol style="list-style-type: none"> <li>How output planning is done?</li> <li>How materials purchase quantities are decided?</li> <li>What is the system of inventory control?</li> <li>Whether computers are used in any way or not. If used, for what purpose, these are used.</li> <li>How they are optimizing utilization of resources?</li> <li>How is the quality control system?</li> <li>How rework and rejection records are kept?</li> <li>What they do to reduce rejection and rework?</li> <li>Do they keep record keeping systems for utilization of resources?(Human-man power, machines, equipment, devices, plants, etc.). If yes, how they</li> </ol> </li> </ol>	8

		<p>are maintaining? If no, suggest any computer based system with details.</p> <p>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.</p> <p>xi. Any other point/s suggested by teacher.</p> <p>b. Prepare power point presentation and present the work including photographs and movies of actual project work.</p> <p>(This may be flexi –time based work. It may not be necessary to exactly follow the time table slots.)</p>	
<b>Total Hours</b>			<b>28</b>

**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](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](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

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

**COURSE CURRICULUM  
COURSE TITLE: MANUFACTURING SYSTEMS  
(COURSE CODE: 3361904)**

Diploma Programme in which this course is offered	Semester in which offered
Mechanical Engineering	Sixth

**1. RATIONALE.**

Manufacturing processes converts raw material to finished product for customer usage. Customer is the key player in market and needs and desires of customer has increased the varieties and features in products. This has increased the complexities at almost all the stages of manufacturing. Performance of a product depends on its quality in terms of accuracy of size, shape and constraints/relation between its features. Conversion cost and time can be optimized by judicious usage of energy, motions, resources, time etc without affecting the quality desired by the customer.

Manual operations have limitations in terms of power, precision and repetitions. Recent techniques / electronics devices provide precision machine control compare to conventional machines. Objective of leaning this subject is to make aware the students about the advance manufacturing practices/methods being implemented at leading industries across the globe, which ultimately leads to more customer satisfaction in terms of low cast and high quality.

**2. COMPETENCY.**

The course content should be taught and implemented with the aim to develop required skills so that students are able to acquire following competency:

- **Identify and use the proper manufacturing systems to manufacture products at internationally competitive price with innovation and better quality.**

**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. Explain role of computers and information technology in manufacturing systems.
- ii. Develop an FMS (Flexible Manufacturing System) layout for given simple part family, using group technology concepts to and make proper grouping as per their attributes.
- iii. Recognize use of robotics, programmable logic controllers, microcontrollers and recent advances in the field of manufacturing.

**4. TEACHING AND EXAMINATION SCHEME.**

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
3	0	2	5	70	30	20	30	

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

### 5. COURSE CONTENT DETAILS.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
<b>Unit – I</b> <b>Introduction.</b>	1a. Develop familiarity with transformation and manufacturing systems. 1b. Describe role of computers in manufacturing industries. 1c. Identify the stage of given product on product life cycle. 1d. Identify the stage of specified technology on technology life cycle. 1e. Explain the need to manufacture products at international competitive price with better quality & innovation.	1.1 Evolution of transformation & manufacturing systems. 1.2 Need of attitude, knowledge & skill required for application of manufacturing systems. 1.3 Need for system approach. 1.4 Role of computers and information technology in manufacturing and manufacturing systems. 1.5 Product life cycle & its importance. 1.6 Technology life cycle. 1.7 Scope, importance and challenges in Indian context to manufacture products at international competitive price with better quality & innovation.
<b>Unit – II</b> <b>Group Technology (GT) &amp; Cellular Layout.</b>	2a. Select type of production layouts for given parts. 2b. Select and develop GT codes for given parts. 2c. Identify features and develop part families of the given parts. 2d. Prepare cell layout of given part family.	2.1 GT - concept, definition, need, scope, & benefits. 2.2 Production layout-types, features and applications. 2.3 GT Layout -concept, need, benefits, comparison with conventional layout with examples. 2.4 GT- codification systems- types, method of coding and examples. 2.5 Part features- concept, types and examples. 2.6 Part family- concept, method to form and approach to form cell using part families. 2.7 Types and comparison of cell: manual and automatic cell, assembly cell. 2.8 Steps of cell design and cell layout.
<b>Unit – III</b>	3a. Identify role of major elements of FMS. 3b. Develop simple FMS layout for given data	3.1 Flexible Manufacturing System (FMS) –concept, definition and comparison with other manufacturing systems.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
<b>Flexible Manufacturing System (FMS).</b>	and family of components.	3.2 Major elements of FMS and their functioning: <ol style="list-style-type: none"> <li>i. Tool handling system.</li> <li>ii. Material handling system.</li> <li>iii. Automated guided vehicles (AGV).</li> <li>iv. Automated storage and retrieval system (AS/RS).</li> <li>v. Main frame computer.</li> </ol> 3.3 FMS layout - concept, types and applications. 3.4 Data required developing an FMS layout. 3.5 Signal flow diagram and line balancing in FMS. 3.6 FMS layout illustrations (Minimum two).
<b>Unit – IV Robotics.</b>	4a. Describe the importance of robotics in industry. 4b. Select appropriate sensor for given application.	4.1 Robots-concept, definition, benefits and various areas of application in manufacturing systems. 4.2 Terminology used in robotics. 4.3 Robots-types, physical configuration, classification and selection criterion. 4.4 Axes nomenclature. 4.5 Types and uses of Manipulators & Grippers. 4.6 Sensors- types, classifications, working principle and applications of position, force & torque, proximity, vision, velocity & acceleration sensors. 4.7 Overview of robot programming methods & languages.
<b>Unit – V Programmable Logic Controller (PLC) &amp; Micro-Controllers (MC).</b>	5a. Explain the need and importance of PLC and microcontrollers used in various equipments. 5b. Select appropriate control system for given situation. 5c. Prepare the circuit diagram for given condition using logic gates.	5.1 Role of control system in instrumentation 5.2 Open and close loop control system, types and block diagram. 5.3 Servomechanism and regulators with suitable examples. 5.4 Basic control actions - on-off, proportional, derivative, integral control, proportional derivative (PD), proportional integral (PI), p proportional integral and derivative (PID) control. 5.5 Basic digital logic gates: symbol, operation, truth-table and examples of



Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		<p>AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR gates.</p> <p>5.6 PLC: Concept, general constructional features, types of diagrams, working and major applications in manufacturing systems.</p> <p>5.7 Use of SCADA (Supervisory Control And Data Acquisition) in PLC design.</p> <p>5.8 Microcontrollers: introduction, hardware components, i/o pins, ports; selection of micro controllers &amp; embedded controllers, applications.</p>
<p><b>Unit – VI</b></p> <p><b>Recent Trends</b></p>	<p>6a. Identify the applications of various advance techniques used in manufacturing</p>	<p>6.1 Computer Aided Process Planning (CAPP) - concept, types, features, methods and importance.</p> <p>6.2 Computer Integrated Manufacturing (CIM): need, block diagram, functional areas covered and their importance.</p> <p>6.3 Protocols in CIM- their features, functions and applications.</p> <p>6.4 Computer Aided Inspection (CAI) - concept, benefit, types, working and examples. Coordinate Measuring Machine (CMM) - its working and applications.</p> <p>6.5 Rapid Prototyping (RP): working principles, methods, applications and limitations, rapid tooling, techniques for rapid prototyping.</p> <p>6.6 Artificial intelligence- concept, definition and application areas, neural network: working principles, applications and limitations.</p> <p>6.7 Lean manufacturing - concept, sources of waste, benefits and applications.</p> <p>6.8 Factory of future (FOF).</p>

#### 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.	04	02	04	00	06

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
II	Group Technology (GT) & Cellular Layout.	06	04	04	04	12
III	Flexible Manufacturing System (FMS).	06	04	04	04	12
IV	Robotics.	10	07	04	04	15
V	Programmable Logic Controller (PLC) & Microcontrollers.	10	07	04	04	15
VI	Recent Trends.	06	06	04	00	10
	Total	42	30	24	16	70

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

#### Notes:

- 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.
- If mid-sem test is part of continuous evaluation, unit numbers I, II, IV and VI are to be considered.
- Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.

#### 7. SUGGESTED LIST OF EXERCISES/PRACTICALS.

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills (**outcomes in 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	--	<p><b>Presentation on "How it's made":</b> Faculty will assign any one part from Annexure-I. (Each student will have different part in a batch). Student will download movies/content and will present with the concept "How it's made". Note: Each student will make his/her folder having the name as &lt;batch number_Enrollment number&gt; and will save his/her</p>	04

		downloaded content. A DVD is to be made which will contain folders of all students. Same DVD is to be submitted.	
2	II	<p><b>GT codes:</b> Faculty will ask each student to bring at least one component having mechanical features and having more than 5-6 machining operations. Each student will also prepare the drawing and process plan (As per attached Annexure-II). Then the data will be interchanged by batch students. Collection of parts and making drawing and process plans will be as home assignment. Faculty will assign this task in very first period of practice. Students would:</p> <ol style="list-style-type: none"> <li>Prepare drawing of part brought by the student.</li> <li>Prepare process plan as per Annexure-II for the part brought by student.</li> <li>Interchange part drawings and process plans. (No photo copies are allowed. Each student in a batch will have total drawings and process plans equal to number of students in a batch who have brought parts. This may be also given as home assignment).</li> <li>Prepare feature matrix.</li> <li>Select GT coding system and assign GT code to each part.</li> </ol>	04
3	III	<p><b>FMS layout:</b> Students would:</p> <ol style="list-style-type: none"> <li>Develop part family (May be 3-6 parts) from all parts. (Taken in Ex. No. 2 above.) This is to be carried out logically from feature matrix.</li> <li>Assume quantities of each part of part family developed in a. above.</li> <li>Assume additional data for following: <ol style="list-style-type: none"> <li>Number of shifts and working hours in each shift.</li> <li>Average number of working days in a month.</li> <li>Utilisation factor of FMS unit.</li> </ol> </li> <li>Prepare process time matrix. (Suggested format is attached as per Annexure-III).</li> <li>Determine type and number of work stations.</li> <li>Perform necessary calculations and prepare conceptual FMS layout.</li> </ol>	06
4	IV	<p><b>Demonstration:</b> Students would:</p> <ol style="list-style-type: none"> <li>Demonstrate working of following: <ol style="list-style-type: none"> <li>Robot-anyone.</li> <li>Sensors-each one from force &amp; torque type, velocity and acceleration type, proximity type, position type and vision type.</li> <li>PLC-anyone.</li> <li>MC-anyone.</li> <li>Control system-anyone.</li> </ol> </li> <li>Sketch following. <ol style="list-style-type: none"> <li>Configuration sketch of robot demonstrated.</li> <li>Working sketch of sensors demonstrated.</li> <li>Block diagrams of PLC and MC demonstrated.</li> <li>Circuit diagram of control system demonstrated.</li> </ol> </li> </ol>	06

5	All	<p><b>Mini project (In the group of 4-6 students):</b> Students would:</p> <ol style="list-style-type: none"> <li>a. Prepare at least one from the following (as approved by the faculty):             <ol style="list-style-type: none"> <li>i. Prepare simple circuit using application of sensor.</li> <li>ii. Prepare simple robot using available kit.</li> <li>iii. Prepare ladder diagram for any one real life PLC application.</li> <li>iv. Build and operate the functionality of basic or advance logic gates.</li> </ol> </li> <li>b. Prepare report which includes sketches, specifications, observation tables, parameters, truth tables, applications, etc. (as applicable).</li> <li>c. Present the project.</li> </ol>	04
6	All	<p><b>Industrial visit and report :</b> Students would:</p> <p>Visit any one advanced manufacturing system /CAD-CAM based industry/centre of excellence/exhibition and prepare brief report on it.</p>	04
<b>Total Hours</b>			<b>28</b>

**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 group of specified 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 to:
  - i. Code the given part using GT coding system.
  - ii. Identify the features of given part.
  - iii. Prepare simple FMS layout based on given inputs.
  - iv. Prepare simple circuit diagram for given conditions using logic gates.
  - v. Prepare simple ladder diagram for given conditions for PLC.
  - vi. Select the suitable sensor for given conditions.
  - vii. Identify robotic elements. Select suitable gripper for given part. Sketch geometrical configuration of given type of robot. Identify various terminologies with robot model/sketch.

**8. SUGGESTED LIST OF STUDENT ACTIVITIES.**

Sr. No.	Activity
i.	Prepare a list of mechanical features based product/products in the market that faces challenges related to quality or cost; but has a market potential.
ii.	Visit nearby industry and present a case study covering the scope of this subject.
iii.	Visit or participate in the technical events, exhibition, conference, seminar (with presentation).
iv.	Collect / download videos / presentations / case study on advances in manufacturing systems.

**9. SPECIAL INSTRUCTIONAL STRATEGIES (if any).**

Sr. No.	Unit	Unit Name	Strategies
i.	I	Introduction.	Presentation, Video.
ii.	II	Group Technology (GT) & cellular layout.	Presentation, Video, Assignment, Industrial Visit, demonstration of real parts with features identification.
iii.	III	Flexible Manufacturing system (FMS).	Presentation, Video, Simulated models.
iv.	IV	Robotics.	Demonstration, Video, Presentation, Industrial Visit, Mini Project.
v.	V	Programmable Logic Controller (PLC) & Microcontrollers.	Demonstration, Video, Presentation, Industrial Visit, Mini Project.
vi.	VI	Recent trends.	Video, Case study, Industrial Visit, Seminars.

**10. SUGGESTED LEARNING RESOURCES.****A. List of Books:**

S. No.	Title of Book	Author	Publication
i.	CAD/CAM/CIM.	P. Radhakrishnan & S. Subranarayan.	New Age Intentional
ii.	Computer Integrated Design & Manufacturing.	Bedworth, Wolfe and Anderson	McGraw Hill International Publication.
iii.	Mechatronics.	-	HMT
iv.	Introduction to Robotics.	Arthur J. Critchlow	McMillan publication
v.	Robotics for engineers.	Yorom Koran	McGraw Hill Publication
vi.	Computer aided manufacturing.	Rao, Tiwari & Kundra.	Tata McGraw Hill Publication
vii.	Computer Aided Design & Manufacturing.	Dr Sadhu Singh.	KP
viii.	Computer Integrated Manufacturing.	S.K.Vajpayee.	PHI
ix.	Automation, Production and Computer integrated Manufacturing.	Mikell P. Groover.	PHI
x.	Mechatronics.	Bradleg and Offers.	Chapman and Hall
xi.	Practical Robotics.	William C. Burns Jr. & Janet Evans Worthington	PHI
xii.	Basic electronics.	Mehta ,V.K.	S.Chand Publication, New Delhi.

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

Sr.No.	Resource with brief specification.
i.	Kits on robotics.
ii.	Set of sensor / transducer demonstration and operation trainer kit. (This should include sensors/transducers as per syllabus.)
iii.	Analog to digital and digital to analog trainer modules.
iv.	Digital logic trainer board.
v.	PLC trainer.
vi.	Microcontroller trainer.

**C. List of Software/Learning Websites.**

- i. <http://www.vlab.com>
- ii. <http://www.mtabindia.com>
- iii. <http://www.nptel.ac.in>

**11. COURSE CURRICULUM DEVELOPMENT COMMITTEE****Faculty Members from Polytechnics.**

- **Prof. J. P. Parmar**, Lecturer in Mechanical Engineering, C. U. Shah Polytechnic, Surendranagar.
- **Ms A. Y. Pathak**, Lecturer in Mechanical Engineering, Sir Bhavsinhji Polytechnic Institute, Bhavnagar.
- **Prof. M. M. Jikar** HOD, Mechanical Engineering Department, N. G. Patel Polytechnic, Bardoli.
- **Prof. A. M. Talsaniya**, Lecturer in Mechanical Engineering, Sir Bhavsinhji Polytechnic Institute, Bhavnagar.

**Coordinator and Faculty Members from NITTTR Bhopal.**

- **Dr. K.K. Jain**, Professor, Department of Mechanical Engineering
- **Dr. A.K. Sarathe**, Associate Professor; Department of Mechanical Engineering.

**ANNEXURE – I****LIST OF PARTS FOR “HOW IT’S MADE”**

<b>SR. NO.</b>	<b>TOPIC</b>	<b>SR. NO.</b>	<b>TOPIC</b>
1	Glass.	31	Plastic bags.
2	Capsules (medicine).	32	PVC room/mobile house.
3	Tablets (medicine).	33	Pipes-ERW, seam less, PVC/steel, small to very large size.
4	Safety pin.	34	Oil paint.
5	Plastic chair.	35	Refilling of gas cylinders.
6	Springs.	36	Televisions / computer monitors.
7	Chain (cycle).	37	Drug (liquid) manufacturing.
8	Bearings.	38	Diamond polishing.
9	Plastic bottle.	39	Lamps- conventional (resistance).
10	Milk/oil pouch packaging.	40	CFL lamps.
11	PCBs.	41	LED lamps.
12	Nut/bolts.	42	Car assembly.
13	Crank shaft.	43	Truck assembly.
14	Piston/cylinder.	44	Aero plane assembly.
15	Vitrified tiles.	45	Any other as specified by teacher.
16	Electrical wires / cables.		
17	Steel wire ropes.		
18	Electrical switches.		
19	Pouch printing.		
20	Cloth manufacturing. (Textile).		
21	Cloth printing (Textile).		
22	Embroidery machine working.		
23	Bottling. (Of soda, beverages, etc.)		
24	Lathe bed.		
25	Bikes engine.		
26	Computer's hard disc.		
27	Circlips.		
28	Oil seals.		
29	Semiconductors.		
30	Product made from Micro machining .		

**ANNEXURE –II**

**PROCESS SHEET/DETAILS- TO BE MADE FOR EACH PART SEPARATELY.**

Part No/Id:		Raw material:	
Name of the Part:		Raw weight:	
Drawing No:		Finished wt:	

Op. No	Name of Operation	Size, tolerance, surface finish, etc. required	Machine details	Machining Parameters			Tools, Jig, Fixture, coolant, etc. required	Measuring instruments required	Locating surface  (Give surface numbers in sketch)	Clamping surface  (Give surface numbers in sketch)	Time		Remarks
				speed	feed	Depth of cut					Set up (Min.)	Machining (Min.)	



**ANNEXURE – III  
PROCESS TIME MATRIX**

PART NUMBE R	QUANTIT Y PER UNIT TIME ( MAY BE PER WEEK OR MONTH OR YEAR)	TIME PER PIECE (IN MINUTES) AND TOTAL TIME FOR GIVEN QUANTITY FOR MAJOR PROCESSES FROM WORK CENTRE POINT OF VIEW.													
		TURNING													
		TIME / PIECE	TOTAL TIME	TIME / PIECE	TOTAL TIME	TIME / PIECE	TOTAL TIME	TIME / PIECE	TOTAL TIME	TIME / PIECE	TOTAL TIME	TIME / PIECE	TOTAL TIME	TIME / PIECE	TOTAL TIME
<b>TOTAL</b>															

### SUGGESTED QUESTION PAPER FORMAT

(This is for reference only and is in suggestive form. Paper setter may opt for other marks distribution pattern maintaining distribution of marks as per specification table)

Q.NO	SUB Q.NO	QUESTION	MARKS DISTRIBUTION			UNIT
			R	U	A	
1		Answer ANY seven from following.				14
	i.		2			I
	ii.		2			I
	iii.		2			II
	iv.		2			II
	v.			2		III
	vi.			2		III
	vii.				2	IV
	viii.				2	IV
	ix.		2			VI
	x.		2			VI
2	a.		7			IV
		OR				
	a.		7			IV
	b.			4		V
		OR				
	b.			4		V
	c.		3			V
		OR				
	c.		3			V
3	a.				4	II
		OR				
	a.				4	II
	b.				4	III
		OR				
	b.				4	III
	c.		3			V
		OR				
	c.		3			V
	d.		3			VI
		OR				
	d.		3			VI
4	a.				4	V
	a.				4	V
	b.		3			VI
		OR				
	b.		3			VI
	c.			4		IV
	d.			3		VI
5	a.			4		I
	b.			4		II
	c.		6			III

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

**COURSE CURRICULUM  
COURSE TITLE: FABRICATION TECHNOLOGY  
(COURSE CODE 3361905)**

Diploma Programme in which this course is offered	Semester in which offered
Mechanical Engineering	Sixth

**1. RATIONALE.**

This course focuses on fabrication of different machine parts and process equipment used in various engineering application. This course would help students to learn application of different tools, equipment & machineries used in fabrication of process equipment and various fabrication works in deferent engineering application. This course also tries to develop safety consciousness in students for fabrication work. Students also become conversant with related manufacturing codes & standards of process equipment e.g. ASME, TEMA, BIS - 2825, BS - 5500. This also provides opportunity for hands on practice for student to develop skills and to understand basic technical requirement for process equipment fabrication. This course thus provides necessary knowledge and skills required in fabrication industry, and hence it is a key course for mechanical engineers.

**2. COMPETENCY.**

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competency.

- **Plan and supervise fabrication of different process equipment using appropriate methods, various fabrication standards, codes and safety norms.**

**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. Interpret the fabrication drawings and plan the fabrication processes requirements and calculate the materials requirements.
- ii. Develop welding documents like WPS, WPQ, SWP and WTP.
- iii. Suggest steps for erection, installation and commissioning of fabricated equipment.
- iv. Follow safety norms during fabrication process.

**4. TEACHING AND EXAMINATION SCHEME.**

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
3	0	2	5	70	30	20	30	

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

## 5. COURSE CONTENT DETAILS

<b>Unit</b>	<b>Major Learning Outcomes</b> (in cognitive domain)	<b>Topics and Sub-topics</b>
<b>Unit – I</b> <b>Introduction</b>	1a. List the factors affecting weldability. 1b. Explain importance of weldability. 1c. Compare different power sources. 1d. List national and international level third party agencies.	1.1 Need and scope of fabrication technology in industries. 1.2 Weldability-concept, meaning, definition and factors affecting it and its importance. 1.3 Power source-classification, advantages, limitations, features, applications and selection criteria. 1.4 List of national and international fabrication industries and third party inspection agencies.
<b>Unit – II</b> <b>Drawing Interpretation.</b>	2a. Interpret manufacturing/ welding drawings. 2b. Prepare bill of materials, parts list and quantity. 2c. Explain procedure for weld edge preparation. 2d. Develop WPS, WPQ, WTP and SWP documents. 2e. Interpret different terms of code.	2.1 Welding location of elements, welding general nomenclature, welding symbols as per IS: 696-1972, welding supplementary symbols, abbreviations used for welding processes and welding position. 2.2 Interpretation and method to work out bill of material for following types of drawings: <ol style="list-style-type: none"> <li>i. Welding / fabrication.</li> <li>ii. Process and instrumentation.</li> <li>iii. Piping isometric.</li> </ol> 2.3 Types, sketch, edge preparation and applications of weld - square butt, groove, fillet, plug, Types of joint butt, lap, corner, tee and edge, Types of weld edge preparation 2.4 Welding documents - Weld Test Plan (WTP) and Shop Weld Plan (SWP). 2.5 Introduction to ASME section IX Welding Procedure Specification (WPS) and Welder Performance Qualification (WPQ). 2.6 Need and application areas of different codes used in fabrication industries remaining ASME sections, ASTM, AWS, IS, BIS, JIS, EN, DIN, TEMA, EJMA.
<b>Unit – III</b>	3a. Use equipment/ machineries for edge preparation.	3.1 Equipment/machines used for edge preparation, their working & features. 3.2 Preheating and inter-pass: need, method and applications.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
<b>Fabrication Processes and Safety.</b>	3b. Select preheating, post heating and PWHT method. 3c. Explain different methods of relieving thermal stresses. 3d. Set different arc welding parameters. 3e. Explain advance welding methods and welding automation. 3f. Explain various fabrication procedures. 3g. Calculate Ovality, shell plate orientation and arc length. 3h. Identify fabrication stages for equipment to be fabricated. 3i. Describe safety norms to be followed during fabrication activities.	3.3 Post heating-need, method and applications. 3.4 Post Weld Heat Treatment (PWHT)- need, methods, applications and selection criteria. 3.5 Methods of relieving thermal stresses. 3.6 Arc welding parameters-setting criteria: <ol style="list-style-type: none"> <li>i. Voltage.</li> <li>ii. Current.</li> <li>iii. Welding speed.</li> <li>iv. Welding feed.</li> <li>v. Arc length.</li> </ol> 3.7 Advance welding methods and their applications. <ol style="list-style-type: none"> <li>i. Ultrasonic welding.</li> <li>ii. Laser beam welding.</li> <li>iii. Electron beam welding.</li> <li>iv. Friction stir welding.</li> </ol> 3.8 Welding automation. 3.9 Process equipment fabrication procedures: <ol style="list-style-type: none"> <li>i. Plate edge bending and rolling.</li> <li>ii. Weld edge preparation.</li> <li>iii. Marking procedures of shell and dish end.</li> <li>iv. Plate cutting by gas and plasma arc with automation.</li> <li>v. Shell alignment by string and laser beams.</li> <li>vi. Orientation marking on shell for nozzles.</li> <li>vii. Reference line marking by dumpy level.</li> <li>viii. Ovality measurement of shell and it's rectification by spiders.</li> <li>ix. Profile checking by template.</li> <li>x. Circularity measurement by swing arm method.</li> <li>xi. Offset rectification by wedge.</li> <li>xii. Strip cladding and overlay</li> </ol> 3.10 Fabrication steps/stages of: <ol style="list-style-type: none"> <li>i. Electrical power/communication transmission tower.</li> <li>ii. Pressure vessel.</li> <li>iii. Heat exchanger.</li> </ol> 3.11 Need, precautions and safety norms during welding and fabrication process.

<b>Unit</b>	<b>Major Learning Outcomes</b> (in cognitive domain)	<b>Topics and Sub-topics</b>
<b>Unit – IV</b> <b>Inspection and Testing.</b>	4a. Distinguish weld defects and thermal distortion. 4b. Identify factors affecting weld quality. 4c. Explain testing and inspection procedures.	4.1 Common weld defects, their causes and remedies; 4.2 Thermal distortion-concept, meaning, definition, causes, effect and types. 4.3 Methods and equipments used to control thermal distortion. 4.4 Weld quality-concept, meaning, definition, importance and affecting factors 4.5 Introduction to inspection and testing. 4.6 Stages of inspection. 4.7 Types, methods of testing and importance of destructive testing (DT).(tensile test, compressive test, impact test, bend test, hardness test.) 4.8 Types, methods of testing and importance of Non Destructive Testing (NDT). ( Liquid penetrate testing, Magnetic Particle Testing, Ultrasonic Testing, Radiography Testing, Eddy Current Testing) 4.9 Special types of test like Hydro test, Pneumatic test, and Leak test by soap water and helium gas.
<b>Unit – V</b> <b>Surface preparation, Finishing and Coating Methods.</b>	5a. Explain surface preparation, finishing and coating method.	5.1 Surface preparation methods, sand blasting and ball blasting. 5.2 Surface finishing methods, brushing and grinding. 5.3 Surface colour coating by brush, roller and spray applications.
<b>Unit – VI</b> <b>Installation, Erection and Commissioning.</b>	6c. Describe steps for erection, installation and commissioning of various fabricated equipment. 6c. Suggest steps for erection, installation and commissioning for given equipment.	6.1 Erection steps for common fabrication structure. 6.2 Erection steps for equipment to be fabricated. 6.3 Erection steps for piping. 6.4 Installation and commissioning procedures for plant machineries and fabricated equipment.

## 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.	4	6	0	0	6
II	Drawing Interpretation	14	9	5	6	20
III	Fabrication Processes and Safety.	8	5	5	4	14
IV	Inspection and Testing.	8	7	3	4	14
V	Surface Preparation, Finishing and Coating Methods	4	0	8	0	8
VI	Installation, Erection and Commissioning.	4	0	3	5	8
	<b>Total</b>	<b>42</b>	<b>27</b>	<b>24</b>	<b>19</b>	<b>70</b>

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

### Notes:

- 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.
- If mid-sem test is part of continuous evaluation, unit numbers I,II (Up to 2.3 only),III and V are to be considered.
- Ask the questions from each topic as per marks weightage. Numerical questions are to be asked only if it is specified. Optional questions must be asked from the same topic.

## 7. SUGGESTED LIST OF EXERCISES/PRACTICALS.

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills (**outcomes in 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	II	<b>Interpretation of fabrication drawing:</b>	04

		<p>Teacher will issue one fabrication drawing and one piping drawing for interpretation.</p> <ol style="list-style-type: none"> <li>a. For fabrication / welding drawing: Students would: <ol style="list-style-type: none"> <li>i. Name the item which has been drawn and given for interpretation.</li> <li>ii. Prepare bill of materials. (Parts name, part material, raw material size and quantity).</li> <li>iii. Tabulate welding / fabrication symbols used with interpretation of each.</li> <li>iv. Calculate shell plate size, dish end plate and pipe and flange sizes for nozzle (as applicable).</li> <li>v. Orientation marking of nozzle on shell and dish end, if applicable.</li> </ol> </li> <li>b. For piping isometrics drawings : Students would calculate <ol style="list-style-type: none"> <li>i. Start-end point co-ordinates.</li> <li>ii. Pipe length and size required for loop.</li> <li>iii. Total no. of joints required for loop.</li> <li>iv. Total no. of supports required for loop.</li> <li>v. Total no. of elbows, T joints, reducers for loop etc.</li> <li>vi. Erection in inch-meter.</li> <li>vii. Weld joints in inch-dia.</li> </ol> </li> </ol>	
2	III	<p><b>Prepare WPS and WPQ:</b> Prepare one WPS (Welding Procedure Specification) and one WPQ (Welder Performance Qualification) based on given variables and data.</p>	2 Hrs
3	I to V	<p><b>Complex job as mini project work:</b> Fabricate one complex job by using welding processes in group of 4 to 6 students, from the following suggested areas.</p> <ol style="list-style-type: none"> <li>i. Model fabrication of industrial shade.</li> <li>ii. Model fabrication transmission tower.</li> <li>iii. Heat exchanger.</li> <li>iv. Condenser, radiator.</li> <li>v. Bridge structure.</li> <li>vi. Model of ship.</li> <li>vii. Domestic applications (car shades, grills, gate, sign boards, etc.).</li> <li>viii. Frames/truss.</li> <li>ix. Food processing vessels.</li> <li>x. Piping for transferring oil, gas, water, etc.</li> <li>xi. EOT crane structure.</li> <li>xii. Other equivalent structure assigned by teacher.</li> </ol> <p>This includes followings:</p>	18 Hrs



		<ul style="list-style-type: none"> <li>a. Sketches.</li> <li>b. Bill of material.</li> <li>c. Steps to fabricate.</li> <li>d. Method employed for weld edge preparation.</li> <li>e. Selection of welding process and process parameters.</li> <li>f. List of consumables used with specifications and quantity.</li> <li>g. Pre and/or post weld heat treatment processes used.</li> <li>h. WPS and WPQ.</li> <li>i. Presentation including photographs/video of actual work being carried out.</li> </ul> <p>(Option of flexi time based work can also be practiced. For this option, it may not be necessary to exactly follow the time table slots. This can be on continuous base also).</p>	
4	V	<p><b>Prepare SWP and WTP:</b> Prepare one Shop Weld Plan (SWP) and one Weld Test Plan (WTP) for typical pressure vessel job.</p> <ul style="list-style-type: none"> <li>a. Sketch the job.</li> <li>b. List the steps followed to prepare plans.</li> <li>c. Prepare plans.</li> </ul>	2 Hrs
5	VI	<p><b>Liquid penetrate testing:</b></p> <ul style="list-style-type: none"> <li>a. Demonstrate liquid penetrate testing of weldment.</li> <li>b. Write specification of test liquid.</li> <li>c. List steps followed.</li> <li>d. Sketch the path tested.</li> <li>e. Write conclusion with interpretation.</li> <li>f. Attach photograph.</li> </ul>	2 Hrs
<b>Total Hours</b>			<b>28 Hrs</b>

**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 group of specified students in the beginning of the term by batch teacher, if applicable.
- 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:**

SR.NO.	ACTIVITY
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i.	Visit fabrication industry and prepare report on equipment/machineries specification, problem faced in operating equipment/machineries and safety precautions.
ii.	Submit assignment given by subject teacher.

### 9. SPECIAL INSTRUCTIONAL STRATEGIES (if any).

Sr.No.	Unit	Unit Name	Strategies
i.	I	Introduction to Fabrication Technology.	Lecture on fabrication technology and it's uses.
ii.	II	Drawing interpretation.	Use drawings from various fabrication industries related to equipment fabrication, structural fabrication, piping isometrics etc. and explain to students, movies, industrial visits.
iii.	III	Fabrication processes and safety.	Use video/animations available on internet related to various fabrication processes, industrial visits, demonstration.
iv.	IV	Inspection and testing.	Use various inspection and testing related presentations from various websites, movies, actual demonstration, and industrial visits.
v.	V	Surface preparation, finishing and coating methods.	Use charts and posters to show the surface preparation, finishing and coating activity, movies, industrial visits, demonstration.
vi.	VI	Installation, erection and commissioning.	Show operational manuals for installation, erecting and commissioning procedures for equipments and visit industry site where actual installation, erection and commissioning activities ongoing.

### 10. SUGGESTED LEARNING RESOURCES.

#### A) List of Books:

S. No.	Title of Book	Author	Publication
i.	Welding technology.	Khanna,O.P	Dhanpat Rai Publications, New Delhi - 22 <sup>nd</sup> Edition
ii.	Welding engineering and technology.	Parmar, R.S.	Khanna Publishers, New Delhi - 1 <sup>st</sup> edition
iii.	Modern arc welding Technology.	Nadkarni, S.V.	Advani oerlikon, Mumbai – 6 <sup>th</sup> edition
iv.	Structural steel fabrication and erection	Saxena, S.K.; Asthana, R.B.	Somaiya Publishers, New Delhi – 3 <sup>rd</sup> edition

v.	Metal cutting science and production technology	Jain, K.C.; Agrawal L.N.	Khanna Publishers, New Delhi - 4 <sup>th</sup> edition
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### B) List of Major Equipment/ Instrument with Broad Specifications:

SR.NO.	Resource with brief specification.	
i.	Welding power source rectifier.	<ol style="list-style-type: none"> <li>1. AC input 440 volts, 3 ph, 50 Hz.</li> <li>2. DC output 115 volts- 230 volts.</li> <li>3. Output wattage (1 to 5 kW).</li> </ol>
ii.	Portable Plate rolling machine.	<ol style="list-style-type: none"> <li>1. Three high rolling machine with 0.5 meter length with max. plate thickness capacity up to 10mm.</li> <li>2. 3-phase induction motor with 5kW capacity.</li> <li>3. Suitable reduction gear box.</li> </ol>
iii.	Gas cutting set.	<ol style="list-style-type: none"> <li>1. Acetylene and oxygen gas cylinder.</li> <li>2. Pressure regulator and gas flow measuring device.</li> <li>3. Cutting torch with back fire arrester.</li> <li>4. Various nozzle tip set (2 to 6 mm).</li> </ol>

### C) List of Software/Learning Websites.

- i. <https://www.engineering.osu.edu>
- ii. [www.aws.org](http://www.aws.org)
- iii. [www.careersinwelding.com](http://www.careersinwelding.com)
- iv. [www.weldingalloys.com](http://www.weldingalloys.com)
- v. [www.adorweldingacademy.com](http://www.adorweldingacademy.com)
- vi. [www.themanufacturinginstitute.org](http://www.themanufacturinginstitute.org)
- vii. [www.asme.org](http://www.asme.org)
- viii. [www.weldingdesign.com](http://www.weldingdesign.com)
- ix. [www.engineeringtoolbox.com](http://www.engineeringtoolbox.com)
- x. [www.asnt.org](http://www.asnt.org)
- xi. [www.twi-global.com](http://www.twi-global.com)
- xii. <http://www.vlab.com>

## 11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

### Faculty Members from Polytechnics.

- **Prof. D. R. Katariya**, Lecturer in Mechanical Engineering, G.P.Bhuj.

- **Prof. P. L. Bhogayata**, Lecturer in Mechanical Engineering, Sir B.P.Institute, Bhavnagar.
- **Prof. D. M.Patel**,Principal, Shree V & K Patel Institute of Engineering, Kadi, Dist.: Mehsana.

**Coordinator and Faculty Members from NITTTR Bhopal.**

- **Dr. Vandana Somkuwar**, Associate Professor, Department of Mechanical Engineering,
- **Dr. K.K. Jain**, Professor, Department of Mechanical Engineering,

**SUGGESTED QUESTION PAPER FORMAT**

(This is for reference only and is in suggestive form. Paper setter may opt for other marks distribution pattern maintaining distribution of marks as per specification table)

Q.NO.	SUB Q.NO.	QUESTION	MARKS DISTRIBUTION			UNIT
			R	U	A	
1		Answer ANY seven from following.				14
	i.		2			I
	ii.		2			II
	iii.		2			II
	iv.				2	II
	v.				2	IV
	vi.				2	IV
	vii.			2		V
	viii.			2		V
	ix.			2		VI
	x.			2		VI
2	a.		5			II
		OR				
	a.		5			II
	b.			5		II
		OR				
	b.			5		II
	c.				4	II
		OR				
	c.				4	II
3	a.		5			III
		OR				
	a.		5			III
	b.			5		III
		OR				
	b.			5		III
	c.				4	III
		OR				
	c.				4	III
4	a.		7			IV
		OR				
	a.		7			IV
	b.			3		IV
	c.		4			II

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5	a.		5			V
	b.		5			VI
	c.		4			I

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

**COURSE CURRICULUM  
COURSE TITLE: HYDRAULIC SYSTEMS  
(COURSE CODE: 3361908)**

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
Mechanical Engineering	Sixth

**1. RATIONALE.**

The laws, principles and concepts of hydraulics play very important role in the innovation, development and improvement of engineering processes and devices. Different types of hydraulic elements like pumps, valves and actuators are essential elements in all the manufacturing industries. This course is designed to develop understanding of hydraulic systems which are widely used for operation and controls in machine tools, material handling, automobile, marine, mining, metal processing, equipment and other fields. This course also enables the diploma students to operate and troubleshoot different types of hydraulic systems in industries.

**2. COMPETENCY.**

The course content should be taught and implemented with the aim to develop required skills in students so that they are able to acquire following competency:

- **Use and maintain hydraulic machineries based on fluid laws and characteristics.**

**3. COURSE OUTCOMES.**

The theory should be taught and practicals 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:

- Select hydraulic fluid based on given conditions.
- Select, operate and maintain various hydraulic elements such as pumps and actuators.
- Operate and maintain various hydraulic control valves and accessories.
- Design hydraulic circuits by selecting suitable components for a given application.
- Operate and maintain various hydraulic devices such as hydraulic brake, power steering, jack etc.
- Install, maintain, and troubleshoot various hydraulic systems.

**4. TEACHING AND EXAMINATION SCHEME.**

<b>Teaching Scheme (In Hours)</b>			<b>Total Credits (L+T+P)</b>	<b>Examination Scheme</b>				<b>Total Marks</b>
				<b>Theory Marks</b>		<b>Practical Marks</b>		
<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>ESE</b>	<b>PA</b>	<b>ESE</b>	<b>PA</b>	<b>150</b>
<b>3</b>	<b>0</b>	<b>2</b>	<b>5</b>	<b>70</b>	<b>30</b>	<b>20</b>	<b>30</b>	

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

## 5. COURSE CONTENT DETAILS.

Unit	Major Learning Outcomes (in Cognitive Domain)	Topics and Sub-topics
<b>Unit – I</b>  <b>Fundamentals of Hydraulics.</b>	1a. Compare fluid power transmission with electrical and mechanical transmission. 1b. Describe various laws governing fluid flow. 1c. Select appropriate hydraulic fluid for given application.	1.1 Power transmission modes and comparison. 1.2 Fluid power – history, concept and definition. 1.3 Application of hydraulic and pneumatic in fluid power. 1.4 Hydrostatic and hydrodynamic-concept and definitions. 1.5 Definition and interrelationships of various terms (properties) used in hydraulics. 1.6 Laws governing fluid flow: i. Pascal’s law. ii. Continuity equation. iii. Bernoulli’s theorem. 1.7 Flow through pipes-types, pressure drop in pipes. 1.8 Hydraulic fluid - types, ISO/BIS standards and designations, properties and their advantages and limitations. 1.9 Hydraulic systems –applications, advantages and limitations.
<b>Unit– II</b>  <b>Hydraulic Elements-I.</b>	2a. Select appropriate hydraulic pipe for given application. 2b. Describe pumping theory. 2c. Select and maintain appropriate pump for given application. 2d. Select and maintain appropriate hydraulic elements (actuators, motors and cylinders). 2e. Apply linear motion methods for cylinders in machineries.	2.1 Basic hydraulic system. 2.2 Hydraulic pipes – Types, standards, designation and specifications, pressure ratings, applications, selection criteria. 2.3 Pumping theory & classification. 2.4 General assembly sketch, main parts, working principle, working, applications and comparison of following pumps: i. External, Internal gear pumps & Ge-rotor.(Generator rotor). ii. Lobe. iii. Screw. iv. Vane. v. Piston. 2.5 Selection criteria of pumps. 2.6 Hydraulic Actuators - classification, construction, working and applications. 2.7 Cylinder cushions and mountings.

Unit	Major Learning Outcomes (in Cognitive Domain)	Topics and Sub-topics
		2.8 Various methods of applying linear motion (horizontal, vertical, inclined, first class lever, second class lever, third class lever, bent lever, toggle lever mechanism).
<b>Unit- III</b>  <b>Hydraulic Elements-II.</b>	3a. Use various hydraulic control valves. 3b. Differentiate between proportional and servo valve. 3c. Select and use various hydraulic accessories with its location on hydraulic system.	3.1 Classification of Hydraulic control valves. 3.2 Types, construction, working and applications of: <ol style="list-style-type: none"> <li>i. Pressure control valves.</li> <li>ii. Directional control valves.</li> <li>iii. Flow control valves.</li> <li>iv. Proportional control valve (Proportional pressure relief valve, Proportional pressure reducing valve, Proportional direction valve).</li> <li>v. Servo control valves. (Mechanical hydraulic servo valve, Electro hydraulic servo valve, Single stage, two stage Flapper type, Jet pipe type).</li> </ol> 3.3 Comparison of proportional and servo control valves. 3.4 Selection of control valves. 3.5 Hydraulic Accessories: types, construction, working and applications of: <ol style="list-style-type: none"> <li>i. Strainers and filters.</li> <li>ii. Seals (static and dynamic).</li> <li>iii. Hydraulic reservoirs.</li> <li>iv. Hydraulic accumulators.</li> <li>v. Manifold.</li> <li>vi. Heat exchangers.</li> <li>vii. Oil level and pressure indicator.</li> </ol>
<b>Unit-IV</b>  <b>Hydraulic Circuit Design.</b>	4a. Describe ISO symbols and guiding rules for designing hydraulic system. 4b. Design hydraulic circuit based on given system requirements.	4.1 ISO symbols used in hydraulic circuits. 4.2 Circuit diagram, components, working and application of following hydraulic circuits: <ol style="list-style-type: none"> <li>i. Control of single acting cylinder.</li> <li>ii. Control of double acting cylinder.</li> <li>iii. Pump unloading circuit.</li> </ol>



<b>Unit</b>	<b>Major Learning Outcomes (in Cognitive Domain)</b>	<b>Topics and Sub-topics</b>
		iv. Intensifier Circuit. v. Regenerative Circuit. vi. Synchronizing circuits. vii. Automatic Cylinder Reciprocation circuit. viii. Sequencing circuits. ix. Meter-in and Meter-out circuit. x. Two hand safety control. xi. Emergency cut-off control. 4.3 Hydraulic system design i. Method and steps of designing a hydraulic circuit from working conditions.
<b>Unit-V Hydraulic Devices.</b>	5a. Identify different parts in a given hydraulic device. 5b. Describe function and working of various parts in hydraulic devices.	5.1 Hydraulic Devices – Concept and applications. 5.2 Construction, working principle, major elements, performance variables and applications of following devices: i. Automotive hydraulic brake. ii. Industrial Fork lift. iii. Hydraulic jack. iv. Hydraulic press. v. Automotive power steering. vi. Hydraulic lift.
<b>Unit-VI Installation, Maintenance and Trouble-Shooting.</b>	6a. Describe steps for installation of various hydraulic components. 6b. Identify the various faults in the system and the remedial actions for them.	6.1 Installation of hydraulic system. 6.2 Causes and remedies for troubles arising in hydraulic elements. 6.3 Maintenance of hydraulic systems. i. Maintenance schedule. 6.4 Troubleshooting of hydraulic system.

**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	Fundamentals of Hydraulics.	4	4	2	2	8
II	Hydraulic Elements-I.	8	4	4	4	12
III	Hydraulic Elements-II.	8	4	4	4	12
IV	Hydraulic Circuit Design.	12	4	8	6	18
V	Hydraulic Devices.	6	2	4	6	12
VI	Installation, Maintenance and Troubleshooting.	4	2	2	4	8
	<b>Total</b>	<b>42</b>	<b>20</b>	<b>24</b>	<b>26</b>	<b>70</b>

**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.
- If mid-sem test is part of continuous evaluation, unit numbers I, II and III are to be considered.
- 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 tutorial/practical/exercises should be properly designed and implemented with an attempt to develop different types of cognitive and practical skills (**Outcomes in cognitive, psychomotor and affective domain**) so that students are able to acquire the competencies. 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	<b>Preparatory activity:</b> a. Tabulate properties of fluid, units and importance in fluid systems. b. Tabulate different hydraulic oil available in	02

Sr. No.	Unit No.	Practical Exercises (outcomes in Psychomotor Domain)	Approx Hours. required
		market, ISO / BIS designation, important properties and applications.	
2	II,III	<b>Demonstration of various hydraulic elements:</b> <ol style="list-style-type: none"> <li>Demonstrate various hydraulic elements covered in theory classes..</li> <li>Tabulate all hydraulic elements with name, symbol, sketch, specifications and applications.</li> <li>Design the hydraulic system circuit based on given input and parameters and using simulation software.</li> </ol>	06
3	IV	<b>Performance:</b> <ol style="list-style-type: none"> <li>Design, assemble and operate hydraulic system, based on given simple system requirements (Design mainly include selection and arrangement of elements). <ol style="list-style-type: none"> <li>Control of single acting cylinder</li> <li>Control of double acting cylinder</li> <li>Meter-in and meter-out circuits</li> <li>Regenerative Circuit</li> <li>Synchronizing circuits</li> <li>Automatic Cylinder Reciprocation circuit</li> <li>Sequencing circuits (manual &amp; automatic)</li> <li>Circuit using accumulator.</li> </ol> </li> <li>Sketch the system diagram with symbols.</li> <li>Prepare the list of items and also list the steps of assembly.</li> <li>Observe and record the parameters. Change any one parameter and observe the effect on other parameters.</li> </ol>	16
4		<b>Seminar presentation:</b> <ol style="list-style-type: none"> <li>Prepare and present seminar topic individually. (Seminar topic has to be given by teacher).</li> <li>Download visual aids, videos, contents and other related instructional material for the given case / situation. (Case/situation has to be given by teacher) Present and discuss the same in your class.</li> </ol>	4
<b>Total Hours</b>			<b>28</b>

**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. Each student will make his/her folder having the name as <batch number Enrollment number> and will save his/her presentation and downloaded content. A DVD is to be made which will contain folders of all students. Same DVD is to be submitted.
- d. Seminar presentation topic/area has to be assigned to the group of specified students in the beginning of the term by batch teacher.
- e. For practical ESE part, students are to be assessed for competencies achieved. They should be given to perform any one pneumatic system from experiment number 3.

## 8. SUGGESTED LIST OF STUDENT ACTIVITIES.

Following is the list of proposed student activities such as:

- i. Prepare journals based on practical performed in laboratory.
- ii. Assignments on theories taught in classroom.
- iii. Prepare/Download a dynamic animation to illustrate the following:
  - Working principle of hydraulic pumps.
  - Working principle of hydraulic valves and actuators.
  - Working of different types of hydraulic devices (applications).
- iv. Download the catalogue of Hydraulic devices.
- v. Arrange visit to nearby Hydraulic equipment based industries.

## 9. SPECIAL INSTRUCTIONAL STRATEGIES (if any).

Sr.No.	Unit	Unit Name	Strategies
1	I	Fundamentals of hydraulics.	Demonstration of hydraulic devices, showing applications, videos.
2	II	Hydraulic elements-I.	Demonstration of elements working, dismantling of elements, presentations, actual uses, movies.
3	III	Hydraulic elements-II.	Demonstration of elements working, dismantling of elements, presentations, actual uses, movies.
4	IV	Hydraulic Circuit Design.	Demonstration of actual circuits, videos on steps to prepare circuit, on-hand practice, movies.
5	V	Hydraulic Devices.	Demonstration of hydraulic devices, showing applications, videos.
6	VI	Installation, Maintenance and Troubleshooting.	Demonstration of hydraulic devices in dismantled condition, exercise on identifying elements and faults, on-hand practice to maintain/repair simple devices, showing applications and videos.

**10. SUGGESTED LEARNING RESOURCES****A) List of Books**

<b>Sr. No.</b>	<b>Title of Book</b>	<b>Author</b>	<b>Publication</b>
i.	Oil Hydraulic Systems	Majumdar, S.R.	Tata Mcgraw-Hill Publication, 3/e, 2013
ii.	Hydraulic and Pneumatic Controls	Srinivasan, R.	Vijay Nicole Imprints Private Limited, 2/e, 2008
iii.	Fluid Power Generation, Transmission and Control	Jagadeesha, T.	Universities Press (India) Private Limited, 1/e, 2014
iv.	Hydraulic And Pneumatics A Technician's & Engineer's Guide	Parr, Andrew	Jaico Publishing House, 2/e, 2013
v.	Hydraulic And Pneumatics Controls Understanding Made Easy	Shanmuga Sundaram, K.	S. Chand Company Ltd., 1/e, 2006
vi.	Industrial Fluid Power Vol. I, II, & III	Hedges, Charles S.	Womack Educational Publications, 3/e, 2009

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

<b>Sr. No.</b>	<b>Resource with brief specification.</b>
i.	<b>Electro-hydraulic Trainer kit (with/without proportional valves)</b> Components required: Pump, Reservoir, pressure relief valve, check valves, Directional control valves (manual and electrically operated), Flow control valves (fixed and variable), pressure reducing valve, Cylinders, Motor, Accumulator, hosepipes, accessories and setup for electro-hydraulic circuits.
ii.	Working model of pumps, valves and actuators.
iii.	Cut section of various pumps, valves and actuators

**C) List of Software/Learning Websites**

- i. [www.boschrexroth.co.in](http://www.boschrexroth.co.in)
- ii. <http://www.automationstudio.com/>
- iii. <http://www.howstuffworks.com/search.php?terms=hydraulics>
- iv. <http://hyperphysics.phy-astr.gsu.edu/hbase/fluid.html#flucon>
- v. <http://www.youtube.com/watch?v=FVR7AC8ExIM>
- vi. <http://www.youtube.com/watch?v=iOXRoYHdCV0>
- vii. <http://www.youtube.com/watch?v=qDinpuq4T0U>
- viii. <http://www.youtube.com/watch?v=xxoAm3X4iw0>

- ix. <http://www.youtube.com/watch?v=JsFcfudj3rE>
- x. <http://www.youtube.com/watch?v=CoprDVMvKso>
- xi. <http://www.youtube.com/watch?v=YxxSmz86zDg>
- xii. <http://www.brighthubengineering.com/fluid-mechanics-hydraulics/>
- xiii. <http://www.hypneu.com/index.html>
- xiv. <http://www.nfpa.com/default.aspx>
- xv. [www.festo.com](http://www.festo.com)
- xvi. [www.nptel.iitm.ac.in](http://www.nptel.iitm.ac.in)
- xvii. Automation Studio 5.0 or higher version
- xviii. Festo Fluidsim,
- xix. Hypneu, AUTOMSIM, LVSIM®HYD, LogicLab, etc.

## 11. COURSE CURRICULUM DEVELOPMENT COMMITTEE.

### Faculty Members from Polytechnics.

- **Prof. P. S. Patel**, Lecturer in Mechatronics Engineering, B. S. Patel Polytechnic, Ganpat vidhyanagar, Kherva.
- **Prof. M. A. Patel**, Lecturer in Mechatronics Engineering, B. S. Patel Polytechnic, Ganpat vidhyanagar, Kherva.
- **Prof. H. M. Shah**, Lecturer in Mechanical Engineering, B. S. Patel Polytechnic, Ganpat vidhyanagar, Kherva.
- **Prof. H. R. Saprumer**, Lecturer in Mechanical Engineering, Sir Bhavsinhji Polytechnic Institute, Bhavnagar.

### Coordinator and Faculty Members from NITTTR, Bhopal.

- **Dr. K. K. Jain**, Professor, Department. of Mechanical Engineering,
- **Dr. C. K. Chugh**, Professor, Department of Mechanical Engineering,

### SUGGESTED QUESTION PAPER FORMAT

(This is for reference only and is in suggestive form. Paper setter may opt for other marks distribution pattern maintaining distribution of marks as per specification table)

Q.NO.	SUB Q.NO.	QUESTION	MARKS DISTRIBUTION			UNIT
			R	U	A	
1		Answer ANY seven from following.				14
	i.		2			I
	ii.		2			I
	iii.		2			II
	iv.		2			II
	v.		2			III
	vi.		2			III
	vii.		2			IV
	viii.		2			IV
	ix.			2		I
	x.		2			V
2	a.				3	I
		OR				
	a.				3	I
	b.			3		II
		OR				
	b.			3		II
	c.			4		III
		OR				
	c.			4		III
	d.				4	IV
		OR				
	d.				4	IV
3	a.				3	VI
		OR				
	a.				3	VI
	b.				3	III
		OR				
	b.				3	III
	c.	MINOR CIRCUIT		4		IV
		OR				
	c.	MINOR CIRCUIT		4		IV
	d.			4		V
		OR				
	d.			4		V
4	a.			3		VI
	a.			3		VI
	b.				4	II
		OR				
	b.				4	II
	c.	MAJOR CIRCUIT		7		IV

5	a.				4	V
	b.	SYMBOLS	4			IV
	c.			3		III
	d.				3	V



**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT**

**COURSE CURRICULUM  
COURSE TITLE: PNEUMATIC SYSTEMS  
(COURSE CODE: 3361909)**

<b>Diploma Programme in which this course is offered</b>	<b>Semester in which offered</b>
Mechanical Engineering	Sixth

**1. RATIONALE.**

Different types of pneumatic elements like compressors, valves and actuators are essential in all the manufacturing industries. This course is designed to develop understanding of such pneumatic systems which are widely used in machine tools, material handling, construction, mining, elevators, material processing equipment and other fields. This course also enables the diploma students to operate and troubleshoot different types of pneumatic systems in industries.

**2. COMPETENCY.**

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- **Operate and maintain pneumatic machineries based on fluid laws and characteristics.**

**3. COURSE OUTCOMES (COs):**

The theory should be taught and practicals 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.

- Select pneumatic power system based on given conditions.
- Select, operate and maintain various pneumatic elements such as compressors, valves, actuators and accessories.
- Design pneumatic circuits by selecting suitable components for a given application.
- Use and maintain various pneumatic devices and systems.
- Install, maintain, and troubleshoot various pneumatic systems.
- Develop hydro pneumatics circuit diagram for given application.

**4 TEACHING AND EXAMINATION SCHEME**

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	150
3	0	2	5	70	30	20	30	

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

## 5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (In cognitive domain)	Topics and Sub-topics
<b>Unit – I</b>  <b>Fundamentals of Pneumatics.</b>	1a. Compare pneumatic with pneumatics. 1b. Select appropriate pneumatic fluid for given application. 1c. Describe different laws governing the compressible fluids (gases).	1.1 Definition and history of Pneumatics. 1.2 Pneumatic systems: <ol style="list-style-type: none"> <li>i. Basic components.</li> <li>ii. Comparison to pneumatic systems.</li> <li>iii. Advantages and limitations.</li> <li>iv. Applications of pneumatics.</li> </ol> 1.3 Compressible fluids - types, properties of air, applicable gas laws (Boyle's, Charles', Gay-Lussac' laws).
<b>Unit– II</b>  <b>Pneumatic Elements.</b>	2a. Select appropriate air compressor, receiver for given application. 2b. Use and maintain of FRL unit in pneumatics. 2c. Describe piping layout. 2d. Select and maintain appropriate pneumatic elements (actuators, motors and cylinders). 2e. Select and maintain appropriate pneumatic control valves. 2f. Use logic valves in pneumatic circuit.	2.1 Basic pneumatic system. 2.2 Types, construction, working, specifications and selection criteria of following air preparation and conditioning elements: <ol style="list-style-type: none"> <li>i. Air compressors</li> <li>ii. Air receivers</li> <li>iii. Air dryers</li> <li>iv. Air filters, regulators and lubricators (FRL unit).</li> </ol> 2.3 Pneumatic pipes- materials, BIS, ASME and DIN designations, standards, properties and selection criteria. 2.4 Piping layout-important considerations, precautions and route optimization. 2.5 Pneumatic cylinders- types, construction, working, materials, specifications, mounting & cushioning. 2.6 Pneumatic motors- types, construction, working, specifications and applications. 2.7 Types, constructions, designations, working, applications and selection criteria of following: <ol style="list-style-type: none"> <li>i. Directional control valves.</li> <li>ii. Flow control valves.</li> <li>iii. Pressure control valves.</li> <li>iv. Special valves- quick exhaust valve and time delay valve.</li> <li>v. Logic valves- shuttle valve and twin pressure valve.</li> </ol> 2.8 Other fittings.

Unit	Major Learning Outcomes (In cognitive domain)	Topics and Sub-topics
<b>Unit- III</b>  <b>Pneumatic Circuit Design.</b>	3a. Describe ISO symbols and guiding rules for designing pneumatic system. 3b. Describe various components of pneumatic circuit based on given system requirements. 3c. Design pneumatic logic circuit based on given system requirements.	3.1 ISO symbols used in pneumatic circuits. 3.1 Circuit diagram, components, working and application of following pneumatic circuits: <ol style="list-style-type: none"> <li>i. Control of single acting cylinder.</li> <li>ii. Control of double acting cylinder.</li> <li>iii. Speed control circuit.</li> <li>iv. Automatic cylinder reciprocation circuit.</li> <li>v. Quick exhaust circuit.</li> <li>vi. Two step feed control circuit</li> <li>vii. Time delay circuit.</li> <li>viii. Two hand safety control circuit.</li> </ol> 3.2 Pneumatic logic circuit design: <ol style="list-style-type: none"> <li>i. Classic method, cascade method, step counter method, karnaugh-veitch maps and combinational circuit design.</li> </ol> 3.3 Components of electrical controls- switches, relays, solenoids, timers. 3.4 Electro-pneumatic circuits: <ol style="list-style-type: none"> <li>i. Reciprocation of cylinder using pressure switches.</li> <li>ii. Control of a cylinder using a single limit switch.</li> <li>iii. Automatic dual cylinder sequencing circuits.</li> </ol>
<b>Unit-IV</b>  <b>Pneumatic Devices.</b>	4a. Identify different parts in a given pneumatic device. 4b. Describe function and working of various parts in pneumatic devices.	4.1 Pneumatic devices – concept and need. 4.2 Construction, working principle, major elements, performance variables and applications of following devices: <ol style="list-style-type: none"> <li>i. Automotive pneumatic brake.</li> <li>ii. Automotive air suspension.</li> <li>iii. Pneumatic drill.</li> <li>iv. Pneumatic gun (tools).</li> </ol>
<b>Unit-V</b>  <b>Installation, Maintenance and Trouble- Shooting.</b>	5a. Describe steps for installation of various pneumatic components. 5b. Identify the various faults in the system and the remedial actions for them.	5.1 Installation of pneumatic system. 5.2 Causes and remedies for troubles arising in pneumatic elements. 5.3 Maintenance of pneumatic systems: <ol style="list-style-type: none"> <li>i. Maintenance schedule.</li> </ol> 5.4 Troubleshooting of pneumatic system.

Unit	Major Learning Outcomes (In cognitive domain)	Topics and Sub-topics
<b>Unit-VI</b> <b>Hydro-Pneumatics.</b>	6a. Explain working of hydro-pneumatic elements. 6b. Compare hydro-pneumatic with pneumatic and pneumatic systems.	6.1 Hydro-pneumatics – concept, advantages and disadvantages. 6.2 Types, construction, working, circuit diagram and application of following hydro-pneumatic elements: i. Air oil reservoir. ii. Pneumatic series check unit. iii. Pneumatic parallel check unit. iv. Hydro pneumatic cylinder. v. Air oil intensifier. 6.3 Comparison between hydro-pneumatic, pneumatic and pneumatic systems.

## 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	Fundamentals of Pneumatics.	4	4	2	2	8
II	Pneumatic Elements.	14	4	8	8	20
III	Pneumatic Circuit Design.	12	4	8	6	18
IV	Pneumatic Devices.	4	2	4	2	8
V	Installation, Maintenance and Troubleshooting.	4	2	4	2	8
VI	Hydro-Pneumatics.	4	2	2	4	8
	<b>Total</b>	<b>42</b>	<b>18</b>	<b>28</b>	<b>24</b>	<b>70</b>

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

### Notes:

- 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.
- If mid-sem test is part of continuous evaluation, unit numbers I, II and VI are to be considered.
- 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 tutorial/practical/exercises should be properly designed and implemented with an attempt to develop different types of cognitive and practical skills (**Outcomes in cognitive, psychomotor and affective domain**) so that students are able to acquire the competencies.

*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)	Hours required
1	I	<b>Preparatory activity:</b> Students would: a. Tabulate physical properties of compressible fluid, units and importance in fluid systems.	02
2	II	<b>Demonstration of various pneumatic elements:</b> Students would: a. Demonstrate various pneumatic elements covered in theory classes. b. Tabulate all pneumatic elements with name, symbol, sketch, specifications and applications. c. Based on given input and parameters, design the pneumatic system circuit using simulation software. Take printout also.	06
3	III,IV	<b>Performance:</b> Students would: a. Design, assemble and operate pneumatic system, based on given simple system requirements (Design mainly include selection and arrangement of elements). Perform at least 7 practical on kit. i. Control of single acting cylinder ii. Control of double acting cylinder iii. Meter-in and meter-out circuits iv. Automatic cylinder reciprocation circuit v. Quick exhaust circuit vi. Two step feed control circuit vii. Time delay circuit viii. Reciprocation of cylinder using pressure switches / limit switches ix. Synchronizing circuits x. Sequencing circuits (manual & automatic) b. Sketch the system diagram with symbols. c. Prepare the list of items and also list the steps of assembly. d. Observe and record the parameters. Change any one parameter and observe the effect on other parameters.	16
4		<b>Seminar presentation:</b> Students would: a. Prepare and present seminar topic individually. (Seminar topic has to be given by teacher). b. Download visual aids, videos, contents and other related instructional material for the given case / situation. (Case/situation has to be given by teacher) Present and discuss the same in your class.	4
<b>Total Hours</b>			<b>28</b>

**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. Each student will make his/her folder having the name as <batch number\_ Enrollment number> and will save his/her presentation and downloaded content. A DVD is to be made which will contain folders of all students. Same DVD is to be submitted.
- d. Mini project and presentation topic/area has to be assigned to the group of specified students in the beginning of the term by batch teacher.
- e. For practical ESE part, students are to be assessed for competencies achieved. They should be given to perform any one pneumatic system from experiment number 3.

**8. SUGGESTED LIST OF STUDENT ACTIVITIES**

Following is the list of proposed student activities such as:

- i. Prepare/Download animation to illustrate working principle of Air compressors, valves, actuators and devices.
- ii. Make comparative table for pneumatic and pneumatic systems.
- iii. Download the catalogue of pneumatic devices.
- iv. Arrange visit to nearby pneumatic equipment based industries.
- v. Show video/animation films explaining the function of pneumatic compressors, valves, FRL unit, actuators and their accessories.

**9. SPECIAL INSTRUCTIONAL STRATEGIES (if any).**

Sr.No.	Unit	Unit Name	Strategies
1	I	Fundamentals of pneumatics.	Demonstration of pneumatic devices, showing applications, videos.
2	II	Pneumatic elements.	Demonstration of elements working, dismantling of elements, presentations, actual uses, movies.
3	III	Pneumatic circuit design.	Demonstration of actual circuits, videos on steps to prepare circuit, on-hand practice, movies.
4	IV	Pneumatic devices.	Demonstration of pneumatic devices, showing applications, videos.
5	V	Installation, maintenance and troubleshooting.	Demonstration of pneumatic devices in dismantled condition, exercise on identifying elements and faults, on-hand practice to maintain/repair simple devices, showing applications and videos.
6	VI	Hydro-pneumatics.	Demonstration, industrial visits, movies.

## 10. SUGGESTED LEARNING RESOURCES.

### A) List of Books.

Sr. No.	Title of Book	Author	Publication
1.	Pneumatic Systems	Majumdar, S.R.	Tata Mcgraw-Hill Publication, 3/e, 2013
2.	Pneumatic And Pneumatic Controls	Srinivasan, R.	Vijay Nicole Imprints Private Limited, 2/e, 2008
3.	Pneumatics Concepts, Design And Applications	Jagadeesha, T.	Universities Press (India) Private Limited, 1/e, 2014
4.	Pneumatic And Pneumatics A Technician's & Engineer's Guide	Parr, Andrew	Jaico Publishing House, 2/e, 2013
5.	Pneumatic And Pneumatics Controls Understanding Made Easy	Shanmuga Sundaram, K.	S.Chand Company Ltd., 1/e, 2006
6.	Industrial Fluid Power Vol. I, II, & III	Hedges, Charles S.	Womack Educational Publications, 3/e, 2009

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

Sr. No.	Resource with brief specification.
1	<b>Electro-pneumatic Trainer kit</b> <u>Components required:</u> Air compressor, Pressure relief valve, check valves, Directional control valves (manual, pilot operated and electrically operated), Flow control valves (fixed and variable), pressure reducing valve, Cylinders, Motor, Accumulator, tubes, quick exhaust valve, time delay valve, limit switches, pressure switches, proximity sensors, setup for electro-pneumatic circuits.
2	Working model of compressors, valves and actuators.
3	Cut section of various compressors, valves and actuators

### C) List of Software/Learning Websites.

- i. [www.festo.com](http://www.festo.com)
- ii. [www.boschrexroth.co.in](http://www.boschrexroth.co.in)
- iii. [www.nptel.iitm.ac.in](http://www.nptel.iitm.ac.in)
- iv. <http://www.howstuffworks.com/search.php?terms=pneumatics>
- v. <http://www.youtube.com/watch?v=MbKrIieogNc>
- vi. <http://www.youtube.com/watch?v=7JuNbHb5NrQ>
- vii. <http://www.youtube.com/watch?v=NakOoD-G0IY>
- viii. <http://www.youtube.com/watch?v=bG2mCiQgbwE>
- ix. <http://www.youtube.com/watch?v=cB3OCPqmUDQ>
- x. <http://www.youtube.com/watch?v=5q7YasmwXCs>
- xi. [http://www.youtube.com/watch?v=a5Ebx\\_\\_l5-g](http://www.youtube.com/watch?v=a5Ebx__l5-g)
- xii. <http://www.nfpa.com/default.aspx>

- xiii. <http://www.automationstudio.com/>
- xiv. <http://www.hypneu.com/index.html>
- xv. Automation Studio 5.0 or higher version
- xvi. Festo Fluidsim,
- xvii. Hypneu, AUTOSIM, LVSIM@PNEU, LogicLab, etc.

## **11. COURSE CURRICULUM DEVELOPMENT COMMITTEE.**

### **Faculty Members from Polytechnics.**

- **Prof. P. S. Patel**, Lecturer, Department of Mechatronics Engineering, B. S. Patel Polytechnic, Kherva.
- **Prof. M. A. Patel**, Lecturer, Department of Mechatronics Engineering, B. S. Patel Polytechnic, Kherva.
- **Prof. H. M. Shah**, Lecturer, Department of Mechanical Engineering, B. S. Patel Polytechnic, Kherva.
- **Prof. H. R. Saprmer**, Lecturer, Department of Mechanical Engineering, Sir Bhavsinhji Polytechnic Institute, Bhavnagar.

### **Coordinator and Faculty Members from NITTTR, Bhopal.**

- **Dr. K. K. Jain**, Professor, Department of Mechanical Engineering,
- **Dr. C. K. Chugh**, Professor, Department of Mechanical Engineering,



### SUGGESTED QUESTION PAPER FORMAT

(This is for reference only and is in suggestive form. Paper setter may opt for other marks distribution pattern maintaining distribution of marks as per specification table)

Q.NO.	SUB Q.NO.	QUESTION	MARKS DISTRIBUTION			UNIT
			R	U	A	
1		Answer ANY seven from following.				14
	i.		2			I
	ii.		2			I
	iii.		2			II
	iv.		2			II
	v.		2			II
	vi.				2	III
	vii.		2			IV
	viii.			2		I
	ix.		2			VI
	x.		2			V
2	a.				3	I
		OR				
	a.				3	I
	b.				3	II
		OR				
	b.				3	II
	c.			4		II
		OR				
	c.			4		II
	d.				4	III
		OR				
	d.				4	III
3	a.				3	IV
		OR				
	a.				3	IV
	b.			3		V
		OR				
	b.			3		V
	c.	MINOR CIRCUIT		4		III
		OR				
	c.	MINOR CIRCUIT		4		III
	d.				4	VI
		OR				
	d.				4	VI
4	a.				3	V
		OR				
	a.				3	V
	b.			4		II
		OR				
	b.			4		II
	c.	MAJOR CIRCUIT		7		III
5	a.			4		IV
	b.				4	II
	c.	SYMBOLS	3			III
	d.			3		VI