



**SOLAPUR UNIVERSITY, SOLAPUR**  
**FACULTY OF ENGINEERING & TECHNOLOGY**  
**Mechanical Engineering**

**Structure of T.E. (Mechanical Engineering) w.e.f. from 2014-15**

**Semester-I**

Sr.No.	Subject	Teaching / Week					Examination Scheme				
		L	T	P	Dr	Total	TP	TW	OE	POE	Total
1	Theory of Machine –II	3		2		5	100	25	25		150
2	Heat and Mass Transfer	3		2		5	100	25		25	150
3	Metallurgy	3		2		5	100	25	25		150
4	Machine Design – I	3		2		5	100	25			125
5	Professional Elective - I	3		2		5	100	25			125
6	Advanced Computer Programming-I	1		2		3		25			25
7	Workshop Practice – IV			2		2		25			25
8	Self Learning (HSS)						50				50
<b>Total</b>		<b>16</b>		<b>14</b>		<b>30</b>	<b>550</b>	<b>175</b>	<b>50</b>	<b>25</b>	<b>800</b>

<b>Professional Elective I</b>	Machine Tool Design	Fluid Machinery and Fluid Power	Material Handling Systems
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**Semester-II**

Sr.No.	Subject	Teaching / Week					Examination Scheme				
		L	T	P	Dr	Total	TP	TW	OE	POE	Total
1	Metrology and Mechanical Measurements	3		2		5	100	25			125
2	Internal Combustion Engine	3		2		5	100	25			125
3	CAD/CAM	3		2		5	100	25			125
4	Machine Design – II	3		2		5	100*	25	25		150
5	Professional Elective –II	3		2		5	100	25			125
6	Advanced Computing Techniques-II	1		2		3		25			25
7	Workshop Practice- V			2		2		25		#50	75
8	Self Learning (Technical)							50			50
<b>Total</b>		<b>16</b>		<b>14</b>		<b>30</b>	<b>500</b>	<b>225</b>	<b>25</b>	<b>50</b>	<b>800</b>

'#' indicates practical examination only

'\*' indicates Open Book theory Examination

<b>Professional Elective II</b>	1) Experimental Stress Analysis	2) Power Plant and Energy Engineering	3) Tool Engineering	4) Mechanical Vibration
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**Note –**

- The Practical batch shall be of 15 students. After formation of batches, if the number of students remaining is more than 7 a new batch shall be formed.
- Syllabus of Self learning (H.S.S.) is common for all Under Graduate Programs under Faculty of Engineering and Technology.
- Practical / Tutorial load indicates the load per batch.
- TW: Term work assessment shall be a continuous process based on the performance of student in assignment, class test, quizzes, homework, interaction during theory and laboratory session, hand written lab book/ hand written journal, sheet drawing, subject seminar presentation etc. as applicable.
- Industrial Training (B.E. Part 1) of minimum 30 days in one/two slot shall be completed in any vacation after SE Part-II but before BE Part-I & the report shall be submitted in BE Part-I.
- Electives -: To offer a particular subject as an Elective, minimum 15 students shall opt for the same. Appropriate Electives Subjects may be added when required.
- For the subject Advanced Computing Techniques-I and Advanced Computing Techniques-II any one subject given with syllabus is to be selected by the student.

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**T.E. (Mech.) Part-I**  
**1.0 Theory of Machines-II**

**Teaching Scheme :**  
**Lectures : 3 Hrs. /Week**  
**Practical : 2 Hrs./Alternate Week**

**Exam Scheme :**  
**Theory Paper : 100 Marks**  
**Term Work : 25 Marks**  
**Oral : 25 Marks**

**Course Objectives :-**

- 1) To Study design of gears, gear trains and their applications
- 2) To Learn concept & design of flywheel & applications of gyroscope
- 3) To Introduce the concepts of balancing & vibration

**Course Outcomes :-**

- 1) To select gear as per requirement & will be able to understand proper application of gear train
- 2) To understand flywheel details & compare with governor, also will clear concepts of gyroscope
- 3) To do balancing & vibration calculations

**Section – I**

**1. Toothed Gearing :**

**(06)**

Geometry of motion, Gear geometry, Types of gear profile- involute & cycloidal, Theory of Spur, Helical & Spiral gears, Interference in involute tooth gears and methods for its prevention, Contact ratio, Path of contact, Efficiency and center distance of spiral gears.

**2. Gear Trains :**

**(05)**

Types of Gear trains- Simple, Compound, Epicyclic, Reverted gear train, Tabular method for finding the speeds of elements in simple and compound epicyclic gear train, Differential gear box. Equivalent mass and Moment of Inertia applied to gear trains.

**3. Turning Moment diagram and Flywheel:**

**(04)**

Function of flywheel and study of turning moment diagrams. Coefficient of fluctuation of speed energy. Determination of size of the flywheel for various application.

**4. Gyroscope :**

**(04)**

Gyroscopic couple, Spinning and Precessional motion, Gyroscopic couple and its effect on i) Aero plane ii) Ship iii) Four-Wheeler iv) Two –Wheeler

**Section – II**

**5. Balancing :**

**(07)**

Static and Dynamic balancing of rotary and reciprocating masses. Primary and Secondary forces and couples. Direct and Reverse cranks. Balancing of Single cylinder, Multi cylinder-In-line and V-Engines. Study of various balancing machines.

**6. Vibrations :**

**(03)**



Basic concepts and definitions, vibration measuring parameters- Displacement, Velocity and acceleration, Free and forced vibrations. Types of damping , Equivalent Springs.

**7. Single degree of freedom systems : (05)**

Free vibrations with and without damping (Rectilinear, Torsional & Transverse), degree of damping. Logarithmic decrement, equivalent viscous damping, Coulomb damping.

**8. Forced Vibrations : (03)**

Forced vibrations with viscous damping, magnification factor, frequency response curves, vibration isolation and transmissibility. Whirling of Shafts and Critical speeds (No numerical treatment)

**9. Torsional Vibrations : (03)**

Introduction to natural frequency of torsional vibrations, single rotor, two rotor and three rotor system, torsionally equivalent shafts.

**Note:** For topic 1 to 7 both Numerical & Theoretical treatment & Topic 8 only theoretical.

**Term Work**

1. Experiment to generate involute gear tooth profile.
2. Two Problems on each type of Epicyclic gear train using tabular method.
3. Experiment on Gyroscope.
4. Balancing of rotary masses (Static and Dynamic).
5. Determination of MI by Bi-filar suspension, Trifilar suspension or compound pendulum.
6. Experiment on free longitudinal vibration of Helical Spring.
7. Experiment on forced vibration characteristics ( Undamped & damped )
8. **Experiment on Free Torsional Vibration of Two Rotor System**  
( First four experiments are compulsory & Any three from 5 to 8 )

**Text Books :**

1. Theory of Machines by Khurmi Gupta
2. Theory of Machines by Rattan S.S.
3. Theory of Machines by Thomas Bevan.
4. Mechanical Vibrations by Grover

**Reference Books :**

1. Theory of Machines & Mechanisms by Shigley
2. Mechanism and Machine Theory by Rao, Dukkupati.
3. Theory of Machines by Dr. V.P.Singh
4. Theory of Machines by Ballaney
5. The complete Automotive Technology by William Crouse Angline
6. Mechanical Vibrations by Dr. V.P.Singh
7. Theory Machines and Mechanisms by Sayyad F.B. and Singhal



**# Exam paper pattern :**

- a. Objectives - 20 marks - 20 questions of 1 marks
- b. Sec I should be of 4 questions. Out of which any 3 should be solved.  
3 questions of 13 marks & one question of 14 mark.
- c. Each question should have sub-question with 6+7 or 8+5 or 10+3 pattern  
No question should be of 13 marks alone ( Except balancing problem of sheet, if required )
- d. same should be followed for sec II

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## T.E. (Mech.) Part-I

### 2.0 HEAT AND MASS TRANSFER

#### Teaching Scheme :

Lectures : 3 Hrs. /Week

Practical : 2 Hrs./Week

#### Exam Scheme :

Theory Paper : 100 Marks

Pract. & Oral Exam.: 25 Marks

Term Work : 25 Marks

#### Course Objectives:

1. To teach students the basic principles of conduction, radiation, and convection heat transfer.
2. To extend the basic principle of conservation of energy to systems which involve conduction, radiation, and heat transfer.
3. To train students to identify, formulate and solve engineering problems involving heat transfer.
4. To train students to identify, formulate and solve engineering problems involving forced convection heat transfer, natural convection heat transfer, and heat exchangers.

#### Course Outcomes

1. Students will demonstrate an understanding of the basic concepts of conduction, radiation, and convection heat transfer
2. Students will demonstrate an understanding of the concept of conservation of energy and its application to problems involving conduction, radiation, and/or convection heat transfer. This principle will be used to formulate appropriate mathematical models and associated thermal boundary conditions.
3. Students will demonstrate the ability to formulate practical conduction heat transfer problems by transforming the physical system into a mathematical model, selecting an appropriate solution technique and evaluating the significance of results.
4. Students will demonstrate the ability to formulate practical forced and natural convection heat transfer problems by transforming the physical system into a mathematical model, selecting an appropriate solution technique and evaluating the significance of results. Students will also demonstrate an ability to analyze the performance.



### **1. Steady State Heat Conduction (08)**

Modes of heat transfer. Basic laws of heat transfer, Introduction to modes of heat transfer, Thermal conductivity and its variation with temperature for various Engg. Materials (Description only). Derivation of Generalized Heat Conduction equation in Cartesian co-ordinate, its reduction to Fourier, Laplace and Poisson's equations. Generalized Heat conduction equation in cylindrical and spherical coordinates (no derivation) and its reduction to one dimension (1D), Heat conduction through plane wall, cylinder, sphere; composites, critical radius of insulation for cylinder and sphere. One dimensional steady state heat conduction with uniform heat generation for wall & cylinder). Systems with negligible internal resistance, Biot and Fourier number and their significance, Lumped Heat capacity Analysis.

### **2. Extended Surfaces (03)**

Types and applications of fins, Heat transfer through rectangular and circular fins. Fin effectiveness and efficiency.

### **3. Convection (09)**

Concept of Hydrodynamic and thermal boundary layer, local and average convective coefficient for laminar and turbulent for flat plate and pipe. Dimensional analysis, Physical significance of dimensionless numbers, Reynolds analogy for laminar flow, Numerical correlations to solve various problems. Dimensional analysis, Physical significance of dimensionless numbers, Numerical correlations to solve natural convection problems, Combined free and forced convection problems.

### **4. Boiling and condensation (02)**

Pool boiling curves, Forced boiling, Techniques for enhancement of boiling, Nusselt's theory of condensation, Filmwise and dropwise condensation. (Only Descriptive)

### **5. Radiation (08)**

Nature of thermal radiation, definitions of absorptivity, reflectivity, transmissivity, monochromatic emissive power. Total emissive power and emissivity, Concept of black body & gray body, Kirchoff's law, Wein's law and Planck's law. Deduction of Stefan Boltzman equation. Lambert cosine rule, Intensity of radiation. Energy exchange by radiation between two black surfaces with non-absorbing medium in between and in absence of reradiating surfaces.



Geometric shape factor. Energy exchange by radiation between two gray surfaces without absorbing medium and absence of reradiation and Radiosity. Radiation network method, network or two surfaces which see each other and nothing else.

## **6. Heat Exchangers (06)**

Classification & Types of Heat exchangers, Fouling factor, Overall heat transfer coefficient, Analysis by LMTD and NTU method for parallel and counter flow, Design consideration for Heat exchangers. Heat pipe.

## **7. Mass Transfer (02)**

Introduction, Modes of mass transfer, Analogy between heat and mass transfer, Mass diffusion (Mass basis, Mole basis), Fick's law of diffusion, Significance of various dimensions numbers.

## **8. Finite Difference applications in heat conduction and convection (02)**

Introduction to finite difference, Finite difference methods for solving conduction and convection problems. One dimensional steady state heat conduction-boundary conditions, Finite difference applications in convective heat transfer (Introduction only).

### **LIST OF EXPERIMENTS**

Experiment must be set simultaneously and the no. of students in each group working on a setup shall not exceed 04 students.

Any 08 Experiments based on following list plus two computer application assignments.

1. Determination of thermal conductivity of insulating powder.
2. Determination of thermal conductivity of Composite wall or lagged pipe.
3. Determination of thermal conductivity of Metals at different temperatures
4. Determination of Heat Transfer Coefficient for natural convection.
5. Determination of Heat Transfer Coefficient for forced convection.
6. Determination of Emissivity.
7. Determination of Stefan Boltzmann Constant.
8. Boiling Heat Transfer.
9. Condensation Heat Transfer.
10. Trial on Heat Exchangers.
11. Heat Pipe Demonstration/Trial.
12. Determination of diffusivity of volatile liquid..





NOTE- The parameters such as Temperature, flow rate, pressure shall be acquired by Data acquisition system or data logger to ensure precise steady state condition while performing above experiments.

**Instructions for Practical Exam :**

1. Four to Five experiments shall be selected for Practical Examination.
2. The Number of Students for each practical set up would not be more than 04 Students.
3. Oral will be based on the Practical performed in the examination and the experiments included in the Journal.

**Text Books :**

1. A Text Book on Heat Transfer by Dr. S. P. Sukhatme, Orient Longman Publi. Hyderabad
2. Heat Transfer by P.K. Nag, Tata McGraw hill Publishing Company Ltd., New Delhi.
3. Heat and Mass Transfer by R.K. Rajput, S. Chand & Company Ltd., New Delhi. 110055
4. Engineering Heat and Mass Transfer, Mahesh M. Rathore, University Science Press, New Delhi-110002

**Reference Books :**

1. Heat Transfer by J.P. Holman , McGraw Hill Book Company, New York.
2. Fundamentals of Heat and Mass Transfer by R.C. Sachdev, Willey Eastern Ltd.,
3. Heat Transfer – A Practical approach by – Yunus -A – Cengel( Tata McGraw Hill)
4. Heat Transfer by Chapman A.J. McGraw Hill Book Company, New York.
5. Heat and Mass Transfer, S.C. Arrora and S. Dokoundwar, DhanpatRai and Sons, Delhi.
6. Fundamentals of Heat and Mass Transfer by C.P. Kothandaraman
7. Heat and Mass Transfer by Dr. D. S. Kumar S.K. Kataria& Sons, Delhi.
8. Fundamentals of Heat & Mass Transfer (Fifth Edi.), Frank P. Incropera, David P. Dewitt, Wisley India.
9. Heat & Mass Transfer, G. Kamraj, P.Raveendran SciTech Publi.
10. Heat Transfer V C RAO University press
11. Heat Transfer Dr. S. N. SaphaliTechmachpublication Pune



## T.E. (Mech.) Part-I

### 3.0 METALLURGY

**Teaching Scheme :**  
**Lectures : 3 / week**  
**Practicals : 2 hrs./ week/ batch**

**Examination Scheme :**  
**Theory : 3 hrs. 100marks**  
**Term work -25**  
**Oral -25**

#### Course Objectives

To make the students proficient in :

1. Structures, composition, properties, applications of materials and their selection for design purpose.
2. Testing of materials and its significance.
3. Heat treatment processes for different engineering materials.
4. Powder metallurgy process and nano materials and its applications.

#### Course Outcomes

Students will be able to :

1. Demonstrate relevance of principles of physical Metallurgy and its significance.
2. Apply their knowledge regarding selection of materials for engineering applications.
3. Demonstrate the significance of heat treatment processes and their applications in the field of Automotive and Machine tool industries.
4. Get acquainted with advance materials and their applications.

#### SECTION - I

- |    |  |     |
|----|--|-----|
| 1. | a) Classification of metallic materials.   | (1) |
|    | b) Concept of alloying, classification of cooling curves, equilibrium diagram.       |     |
|    | Introduction to solid solution, types (in brief)                                     | (3) |
| 2. | Study of Ferrous materials & alloys.   |     |
|    | a) Iron-Iron carbide equilibrium diagram   | (3) |
|    | b) Plain carbon steels, composition, applications & properties                       | (1) |
|    | c) Effect of alloying elements on steels   | (1) |
|    | d) Study of some important alloy steels. (Application)                               | (3) |
|    | i) Nickel-chromium steel      ii) Hadfield manganese steel                           |     |
|    | iii) Hadfield silicon steel      iv) Free cutting steel      v) HSLA steel           |     |
|    | vi) High speed steel      vii) HCHC steel      viii) Maraging steel                  |     |
|    | ix) Water, oil, air hardening steel      x) Hot & cold working tool steel, die steel |     |
|    | xi) Stainless steel      xii) Dual phase steel      xiii) Invar Spring Steel         |     |



- e) Cast irons: composition, properties applications & comparisons of various types of cast irons. i.e. white iron, gray iron, SG iron, malleable iron, alloy cast irons, patented CI like mehanite. (2)
3. Study of nonferrous metals & alloys (w. r. t. Composition, Properties, Applications, Standards and Specification).
- a) Copper alloys, brasses, bronzes. (2)
- b) Aluminium alloys: wrought & cast aluminium alloys. (1)
- c) Study of solder materials, babbits, Fusible alloys like woods metals, Newtons metal. (1)
- d) Introduction to Nano materials. (1)
- e) Introduction to Composites and Dispersion strengthened materials. (1)

### SECTION -II

4. Heat treatment of steel (3)
- a) Heat treatment, definition, concept, objectives Introduction to isothermal transformation & TTT diagram for eutectoid Steel. Transformation on continuous cooling, critical cooling rate
- b) Annealing & normalizing- purposes, types, application, comparison (2)
- c) Hardening & tempering:- concept, process, applications property changes, quenching media, methods of hardening- austempering, martempering, hardening with self tempering, concept of harden ability in brief, objectives & types of tempering, Sub zero treatment. (3)
- d) Surface hardening treatment, carburising, nitriding, cyaniding, & Carbonitriding. Processes, purposes, applications and comparison (3)
- Induction & flame hardening, processes, applications, comparison
5. Powder metallurgy
- a) Significance, methods of powder manufacture, mixing / blending, compaction methods, sintering processes & its significance, advantages & limitations (4)
- b) Typical powder metallurgy applications and their flow chart: - Self lubricated bearings, cemented carbide cutting tools, friction materials, etc
6. a) Destructive testing methods, test procedure in brief, significance of (3)
- i) Hardness testing ii) Tensile testing iii) Impact testing iv) Creep v) Fatigue testing
- b) Study of non destructive methods such as i) dye penetrant test ii) magnetic particle test iii) ultrasonic test iv) radiography v) Eddy current test Significance & comparison of these tests. (2)



### Term work

1	Study of Metallurgical Microscope	1 turn
2	Specimen preparation and Mounting process	2 turns
3	Macro examination and Spark test (Optional)	1 turn
4	Study of microstructures of Steels	1 turn
5	Study of grain size measurement (Optional)	1 turn
6	Study of microstructures of Cast irons	1 turn
7	Study of microstructures of Non ferrous alloys	1 turn
8	Study and demonstration of Heat treatment processes	3 turns
9	Study of Microstructures of Annealed, Normalized, Hardened, Hardened & Tempered samples	1 turn
10	Study of microstructures of Surface hardened samples	1 turn
11	Study and demonstration of Tensile, Impact, and Hardness tests, Creep test.	2 turns
12	Study and demonstration of any of the NDT processes (Optional)	1 turn

**Note: Journal based on above**

### Recommended Books:

#### Text Books

1. Material Science and Metallurgy – Dr. Kodgire (Everest , Pune).
2. Engineering Metallurgy I & II – A. S. Gholap & M. S. Kulkarni
3. Introduction to Engg. Materials – B. K. Agarwal (TMH).

#### Reference Books

1. Heat treatment principles and technique - Rajan Sharma & Sharma
2. Introduction to Physical metallurgy – Avner, TMH.
3. Engineering Metallurgy Vol. I & II – R. A. Higgins (ELBS).
4. Engineering Metallurgy – E. C. Rollason (ELBS)
5. Engineering Metallurgy - Lakthin (MIR Publishers).

**\*Paper setting shall be based on syllabus and term work.**



## T.E. (Mech.) Part-I

### 4.0 Machine Design-I

#### Teaching Scheme :

Lectures: 3 Hrs. / Week

Practical: 2 Hrs. / Week

#### Examination Scheme

Theory Paper: 100 Marks.

Term Work: 25 Marks.

#### Course Objectives

1. To learn the fundamentals of machine design.
2. To design basic machine elements such as knuckle joint, lever, spring under static loading.
3. To learn the environmental, manufacturing considerations in design.
4. To enable students to design machine elements for fluctuating load, design of shaft, keys, coupling and design of joints.

#### Course Outcomes

1. To apply basic design procedure to various machine elements.
2. To consider environmental, manufacturing constraints in design of machine elements.
3. To design machine elements for fluctuating load, design of shaft, keys, coupling and design of joints.

### SECTION-I

#### 1. Fundamentals of machine design. (05)

Concept of Machine design, Types of loads, Factor of safety- its selection and significance, Theories of elastic failure and their applications, General design procedure, Review and selection of various engineering materials properties and I.S. coding of various materials, Factors governing selection of Engineering materials.

#### 2. Design of simple machine parts (05)

Cotter joint, knuckle joint, turn buckle, levers.

#### 3. Design against fluctuating loads. (05)

Stress concentration causes and remedies, fatigue failure, endurance limit, notch sensitivity, Goodman and Soderberg diagram, modified Goodman diagram, design under combined stress, design for finite and infinite life under reversed stresses.

#### 4. Selection of Belt (05)

Selection of flat and V belt from standard manufacturers' catalogue/Design data book.



## SECTION-II

### 5. Design Considerations for: (05)

Design for manufacture, Design for casting, Design for forging, machining, assembly, design with non-metals, Design for environment

### 6. Design of shafts, keys and couplings. (05)

ASME code, types of shafts – solid, hollow, line, transmission and splined shafts. Types of couplings- Muff, rigid flange and flexible bush pin type coupling. Design of keys.

### 7. Design of springs. (05)

Types of springs and their applications, stresses induced in helical spring, design of helical (compression and tension) springs subjected to static loading, series and parallel springs. Introduction to leaf springs.

### 8. Design of Joints. (05)

Types: Welded joints, bolted joints, riveted joints, design for transverse and eccentric loading.

### Term work

Part A: Assignment based on the following.

- Selection of materials for various engineering applications showing their IS codes, composition and properties
- Problems on design of helical Springs subjected to static load.
- Problems on bolted and welded joints.

Part B : Design and drawing of the following.

- Knuckle joint or turn buckle.
- Rigid or flexible flange coupling.

### Text books:

- Design of Machine Elements by V.B.Bhandari.
- Machine Design by Robert L. Norton.
- PSG Design data Book.

### Reference Books

- Design of Machine Element by J.F. Shigley, McGraw Hill Publi.
- Design of Machine Element by M.F.Spotts, Pearson Education Publication
- Design of Machine Elements by P. Kannaiah, Scitech Publication.



**T.E. (Mech.) Part-I**  
**Professional Elective-I**  
**5.1 MACHINE TOOL DESIGN**

**Teaching Scheme :**

**Lectures : 3 / week**

**Practicals : 2 hrs./ week/ batch**

**Examination Scheme :**

**Theory : 3 hrs. 100marks**

**Term work -25**

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**Course Objectives**

1. To study machine tools types and general principle of design, and recent trends.
2. To make student familiar with machine tool drives its classification, working and design.
3. To learn design of machine tool structure, guide ways, slideways and column.
4. To analyse the dynamics of machine tool and control system in machine tool.

**Course Outcomes**

1. To demonstrate principle of machine tool design.
2. To design machine tool structure, guide ways, slideways and column.
3. To select machine tool drives, design calculations for spindle, bearing.
4. To do dynamic analysis of machine tools and control systems.

**SECTION-I**

**1: General Principles of Machine Tool Design (05)**

Classification of machine tools, General requirements of machine tool design, Engineering design process applied to machine tools, Layout of machine tools, working and auxiliary motions in machine tools.

**2: Design of Machine Tool Drives (05)**

Types of Speed and feed regulation, Classification of speed and feed boxes, Design of feed box, Speed box, Development of gearing diagram.

**3: Design of Machine Tool Structures (05)**

Functional requirements of machine tool structures, Design criteria & procedure for machine tool structures, Materials for machine tool structures, Design of beds, columns and housings and other parts of machine tools, Method to improve the stiffness and rigidity of structure, Overall compliance of machine tool.

**4: Design of Guideways (05)**

Functions and types of Guideways, Design of slideways, Design criteria and calculations for slideways, Guideways operating under liquid friction conditions, Design of Aerostatic slideways, Design of Antifriction slideways.



## SECTION -II

### 5: Design of Spindles and Spindle Supports

(05)

Functions of spindle unit and requirements, Materials, Machine tool compliance & machining accuracy, Design calculations of spindles, Bearings for spindles.

### 6: Dynamics of Machine Tools

(05)

Forced vibrations of machine tools, Dynamic characteristics of elements and systems, Stability analysis.

### 7: Control Systems in Machine Tools

(05)

Functions, requirements and classification, Control systems for speeds and feeds, various motions etc. Manual & automatic control systems. Ergonomic aspects of design for machine tool control elements such as levers, handwheels, buttons etc.

### 8: Trends and developments in machine tool design.

(05)

[Note: Numerical Treatment for units 2, 3, 4, 5 and 6 only]

## TERM WORK

### 1 Any one problem on

(a) Design of a spur/helical gear box for machine tool - Report containing all calculations, Sketches for design of a typical gear box.

(b) Two sheet of A2 size containing drawing of details and assembly for a typical gear box as per (i)

### 2 Any two assignments on the following

(a) Selection of belts for a machine tool.

(b) Hydraulic system in a machine tool.

(c) Design of guideways based on wear resistance and stiffness.

(d) Designing machine tool for leanness.

\*Standard Design data books for all above experiments should be used.

### Text Books :

1 Machine tool design and numerical control by N.K.Mehta, Tata Mc- Graw Hill Publication

2 Design of Machine Tools by S.K.Basu, Oxford and IBH publishing, New Delhi

3 Principals of machine Tools by Sen. and Bhattacharya, New age central book agency

### Reference Books:

1 Mechanical Vibration by G. K. Grover, Published by Nemchand & Brothers, Roorkee

2 Mechanical Vibration by Dr. V. P. Singh, Published by S. Chand & Sons New Delhi.

3 Principals of machine Tools by Koenigs-Berger

4 Machine Design by T H Wentzell Cengage Learning

5 ANIL GUPTA and T K KUNDRA “A review of designing machine tool for leanness” sadhana - vol. 37, part 2, April 2012, pp.241-259. Publication. Indian academy of sciences. Available at [www.ias.ac.in/sadhana/Pdf2012Apr/241.pdf](http://www.ias.ac.in/sadhana/Pdf2012Apr/241.pdf)

6 Handbook of production technology by CMIT Bangluru.





**T.E. –Mechanical - Part-I**  
**Professional Elective -I**  
**5.2 FLUID MACHINERY & FLUID POWER**

**Teaching Scheme**  
**Lectures : 3 Hrs/Week**  
**Practicals : 2 Hrs/Week**

**Examination Scheme**  
**Theory : 100 Marks**  
**Term Work: 25 Marks**

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**Course objectives:**

- 1.To study different types of water turbines, Gas turbines and Pumps, in all details..
- 2.To construct velocity triangles for turbines and pumps.
- 3.To learn the fundamentals and applications of fluid power technology, besides construction & working of different components.
- 4.To design various types of hydraulic & pneumatic circuits & their applications.

**Course outcomes:**

At the end of this course, the student will be able to

- 1.Classify turbines and pumps. Select/design water turbines, gas turbines & centrifugal pumps to meet the specific requirements.
- 2.Draw velocity triangles for turbines and pumps.
- 3.Analyse different components of hydraulic and pneumatic systems.
- 4.Prepare different hydraulic & pneumatic circuits needed for different applications.

**SECTION -I**

**1.Impulse Water Turbines :**

**(05)**

Euler's equation for rotodynamic machines, Classification of water turbines, Pelton wheel, Work done and efficiencies of Pelton wheel, Working proportions of Pelton wheel, Design of pelton Turbine runner, Governing of Pelton turbine, Performance characteristics of Pelton turbine .(Numerical Treatment)

**2.Reaction Water Turbine:**

**(05)**



Construction and Working of Francis, Kaplan turbine. Work done and efficiencies of Francis & Kaplan turbine, Working Proportions of Francis & Kaplan turbine, Specific speed of turbine (Pelton, Francis & Kaplan turbine), Model testing, unit quantities, Prediction of performance at other operating conditions, Draft tube (Theoretical treatment only), Types and function, Governing of reaction turbines, Performance characteristics of Francis & Kaplan turbine. (Numerical Treatment).

**3. Centrifugal Pumps: (05)**

Working principle, construction, types, various Heads, multistage pumps, Velocity triangles, Minimum starting speed, Cavitation, Maximum Suction Height & Net Positive Suction Head, Methods of priming, Calculations of efficiencies, Discharge, blade angles, Heads, Power required, impeller dimensions, specific speed of pumps, Performance characteristics of pumps. (Numerical Treatment)

**4. Gas Turbines: (05)**

General aspects, Classification of gas turbines, merits of gas turbines, constant pressure combustion gas turbines-open cycle gas turbine, methods for improvement of thermal efficiency of open cycle gas turbine plant-intercooling, reheating, regeneration, effect of operating variables on thermal efficiency, closed cycle gas turbine, uses of gas turbine, gas turbine fuels. (Numerical Treatment on basic Joule Cycle)

**SECTION – II**

**1. Introduction to Fluid Power and Hydraulic System elements : (05)**

Types, advantages, applications of fluid power, Pumps- Types, working, Characteristics, Applications. Seals & Packing- Types, materials, Applications. Hydraulic Actuators- Linear & Rotary, Types, Working, Cushioning effects, Calculation of force & velocity of piston. System components: Accumulators, Intensifiers, their types, working, applications. Symbols used in hydraulic and pneumatic circuits.

**6. Pneumatic System Elements : (05)**

Piping, materials and pressure ratings, piping layout, air compressors, types, working, selection criteria, FRL unit, construction and working, pneumatic cylinders and air motors, construction and working, types.

**7. Hydraulic and Pneumatic Control Elements : (05)**

Hydraulic - Pressure control valves- Direct acting type, pilot operated, sequence, counter balancing, unloading, pressure reducing, Construction & Working. Direction control valves- Types, construction & working, Spool actuation methods, spool centre positions, Flow control valves- Compensated & Non-



Compensated, Construction & Working. Pneumatic -Direction control valves, Flow control valves and pressure control valves–types and working.

**8. Hydraulic and Pneumatic Circuits & their applications : (05)**

Speed control circuits, Regenerative, Sequencing, Counter balancing, Synchronizing, Traverse & Feed circuit, Hydraulic and pneumatic clamping & braking systems, Pneumatic power tools, time delay circuits

**Term-Work**

**Compulsory:**

1. A drawing sheet on standard symbols of hydraulic & pneumatic components.

**List of Experiments**

**A) Fluid Machinery-**

**Minimum 3 experiments from the following**

2. Trial on a Pelton wheel.
3. Trial on a Francis/ Kaplan turbine.
4. Trial on a centrifugal pump.
5. Trial on gear pump

**B) Fluid Power**

**Minimum 3 assignments from the following**

6. Study of Pressure Control Valves & circuits using pressure control valves
7. Study of flow control valves & circuits using flow control valves
8. Study of direction control valves & check valves circuits.
9. Study of hydraulic power unit & accessories.
10. Demonstration of Minimum of Three hydraulic circuits such as :Basic hydraulic, Regenerative, Speed control(Meter in, meter out & bleed off), Sequencing, Synchronization, traverse & feed, circuit for riveting machine, automatic reciprocating, fail safe circuit, counter balance circuit, actuator locking, circuit for hydraulic press, unloading circuit, motor braking circuit.
11. Demonstration on Pneumatic Trainer of Minimum of Three Pneumatic circuits (based on syllabus of UNIT 10 above).

**C) Industrial visit to one of the following.**

- Hydro-electric power station
- Pumping station
- Service station of Earth Moving equipment's.

Note: Students should write visit report based on the observations made during the visit.



### **Text Books**

1. “A text book of Fluid Mechanics & Hydraulic Machines”, Dr.R.K. Bansal, Laxmi Publications Ltd.
2. Thermal Engineering R.K. Rajput
3. “Oil Hydraulics- Principle & Maintenance”, Majumadar, Tata McGraw Hill
4. “Pneumatics- Principle & Maintenance”, Majumadar, Tata McGraw Hill

### **Reference Books**

1. Theory of Hydraulic Machinery”, V.P. Vasandani, Khanna Publishers, Delhi.
2. “Hydraulic Machines”, Dr. J. Lal, Metropolitan Book Co. Pvt. Ltd., Delhi.
3. Vickers Manual on Industrial Hydraulics
4. Festo’s Manual on Pneumatic Principle, applications
5. “ABC’s of Hydraulic Circuits”, H L Stewart, (Taraporwala Press)
6. “ABC’s of Pneumatic Circuits”, H L Stewart, (Taraporwala Press)
7. Hydraulics and Pneumatics’ H.L.Stewart –, Industrial Press



**T.E. –Mechanical - Part-I**  
**Professional Elective -I**  
**5.3 MATERIAL HANDLING SYSTEMS**

**Teaching Scheme :**

**Lectures :** 3 Hrs / weeks

**Practical:** 2 Hours / week

**Examination Scheme:**

**Theory Exam.:** 100 Marks

**Term work :** 25 Marks

**Oral Exam.:** 25 Marks

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**Course Objectives:**

1. To study material handling equipments
2. To design material handling System like storing, hoisting, and conveying equipments.
3. To enhance knowledge in CIMS in material handling systems.
4. To make aware of safety regulations in material handling.

**Course Outcomes**

At the end of this course, the students will be able to :

1. To design and process material handling System like storing, hoisting, and conveying equipments.
2. Implement CIMS in material handling systems.
3. Implement safety regulations in material handling.

**SECTION – I**

**1. Introduction –**

**(04)**

Principles of material handling, Objective & benefits of better material handling, material handling and plant layout, concepts of unit load, containerization and palletisation.

**2. Material handling Equipments and Systems for Various Materials -**

**(12)**

- a) Storing equipments like pallets, bins, racks, decking, order picking, positioning equipments.
- b) Hoisting equipments like jacks, pulleys, hand trolleys, hoists, power hoist, various types of cranes & elevators.
- c) Conveying equipments like belt, chain, roller, wheel, trolley, tray conveyors, gravity & vibratory type conveyors, screw conveyors.
- d) Mobile equipments like hand trucks, fork lift trucks, powered industrial trucks and tractors, powered stackers, reach trucks, order pickers.



### 3. Material Handling in CIMS –

(04)

Need, Comparison with conventional systems, Equipment like industrial robots and automatically guided vehicles etc.

## SECTION –II

### 4. Material Flow –

(04)

Operation sequence, material flow pattern, stages of material flow at receiving, in process and at shipping, flow planning criteria & design of flow pattern.

### 5. Selection of Material Handling Equipment –

(12)

Factors affecting selection of material handling equipment, Material handling equation, Choices of Material Handling Equipment, General Procedure for Selection, Basic Analytical techniques, Selection of suitable types of material handling systems, Functions and Parameters, affecting service, packing and storage material, Selection of Material Handling Equipment in Green Sand Moulding Foundry, Sugar Manufacturing Industry.

### 6. Safety & Training

(04)

Need, Environmental and human factors in material handling, Safety Regulations

#### Term Work:

- |   |                                    |
|---|------------------------------------|
| 1. Plant layout consideration                   | 2. Material flow analysis          |
| 3. Storing equipment                            | 4. Hoisting equipment              |
| 5. Conveyor equipment                           | 6. Mobile equipment                |
| 7. Selection of M.H. equipment & safety aspects | 8. Industrial visits & its report. |

#### Books Recommended

##### Text books

1. Material Handling - Immer J. R. (McGraw Hill)
2. Material Handling System Design - James Apple ((John Wiley)
3. Material Handling Principles & Practice - Theodore H. Allegre Sr. (CBS Publishers & Distributors)

##### Reference books

1. Plant Layout & Material Handling - James Apple (John Wiley)
2. Material Handling- John R. Immer- McGraw Hill Co. Ltd., New York
3. Work Study - O. P. Khanna (Dhanpatrai & Sons)
4. Work Study – I. L. O.



**T.E. –Mechanical - Part-I**  
**6.0 Advanced Computer Programming – I**  
**(JAVA Programming)**

**Teaching Scheme**

**Theory: 1 hour a week**

**Practical: 2 hours a week**

**Examination Scheme**

**University Exam: Nil**

**Term Work : 25 Marks**

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**Course Objectives:**

1. To learn the basic syntax and semantics of JAVA
2. To make students familiar with the general programming concepts of JAVA such as variables branching, loops and functions.
3. To make the students learn and program JAVA scripts.
4. Learn to make JAVA applets develop GUI based applications in JAVA.

**Course Outcomes:**

A student who has successfully completed this course must be able to accomplish the following tasks;

1. Install JAVA IDE & develop simple applications using JAVA.
2. Read from and write to text and excel files and debug errors.
3. Write JAVA applet for windows based applications such as Word & Excel and JAVA scripts for CAD software such as CATIA & AutoCAD.
4. Develop a small JRE based application or Applet for a mechanical engineering subject.

**1.Overview of Java:**

**(01)**

Java history, Java features, Java vs. C and C++, Installing Java, Exploring the IDE, Simple Java program, JVM, command line arguments.

**2.General Programming:**

**(03)**

Constants, Variable, data types, operators and expressions, branching, looping, calling object methods, creating a function. Program plan, assigning static properties & dynamic properties, adding runtimes, testing and deploying the program.

**3.OOP:**

**(03)**

Define class, methods declaration, creating objects, constructors, methods overloading, static members, nesting of methods, overriding methods, final variables and methods, interfaces, packages.

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- 4.Interface and packages:** (01)  
Using packages and interfaces, I/O classes creating files, reading/writing characters.
- 5.Arrays, Strings and Vectors:** (01)  
1D and 2D arrays, strings, vectors
- 6.Debugging:** (01)  
Types of Errors exceptions, exception handling, using catch statements, using finally statement.
- 7.Applets:** (02)  
Applets, Applets vs. Applications, writing the applet code, creating executable applets, designing web page, running applets.
- 8.Graphics:** Graphics class, draw lines and rectangles, drawing circles and arcs, drawing polygons, drawing graphs and bar charts. (02)

**Termwork:**

*The termwork is based on the following list of Computing Assignments.*

- 1) Assignment on Fundamentals of Java programming.
- 2) Programming exercises on Variables and parameters.
- 3) Programming exercises on branching and looping
- 4) Programming exercises on Console I/O.
- 5) Assignment on object objects, classes and methods.
- 6) Programming exercises on Arrays, strings and vectors.
- 7) Programs on packages and interfaces.
- 8) Programs on Exception handling.
- 9) Assignment on Java Applet.
- 10) Assignment on graphics.

**Text Books:**

1. *Programming with JAVA: A Primer (4<sup>th</sup> Edition)* - E. Balaguruswamy TMH
2. *JAVA: The Complete Reference(5<sup>th</sup> Edition)* - Herbert Scheldt (TMH)
3. *Essential JAVA for Scientists and Engineers* - Malan and Hahn (BH)

**Reference Books:**

1. *Object Oriented Programming through JAVA* - P. Radhakrishna (University Press)
2. *Java Programming for Beginners* -Motwani (Shroff Publication)
3. *Let us JAVA* -Yeshwant Kanetkar (BPB)
4. *JAVA in Easy Steps* -Mike McGrath (TMH)





**T.E. –Mechanical - Part-I**  
**6.0 Advanced Computer Programming – I**  
**(Visual Basic Programming)**

**Teaching Scheme**

**Theory:** 1 hour a week

**Practical :** 2 hours a week

**Examination Scheme**

**University Exam:** Nil

**Term Work :** 25 Marks

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**Course Objectives:**

1. To learn the basic syntax and semantics of Visual Basic
2. To make students familiar with the general programming concepts of Visual Basic such as variables branching, loops and functions.
3. To make the students learn and use VBA scripts.
4. To develop GUI based applications in Visual Basic.

**Course Outcomes:**

A student who has successfully completed this course must be able to accomplish the following tasks;

1. Install Visual Basic IDE & develop simple applications using Visual Basic.
2. Write VB macros for windows based applications such as Word and Excel & a VBA scripts for CAD software such as CATIA & AutoCAD etc.
3. Read from and write to text and excel files and debug errors.
4. Develop and manage simple databases.

**1.Overview of VB:**

**(01)**

The .Net framework, the .Net languages, Installing VB, Exploring the IDE, Starting a new VB projects, adding visual control and codes, saving projects, form properties, editing form properties, coding property values, dialog box, using buttons and controls.

**2.General Programming:**

**(02)**

Variable and parameters, scope of variables, branching, looping, calling object methods, creating a function. Program plan, assigning static properties & dynamic properties, adding runtimes, testing and deploying the program.

**3.OOP:**

**(02)**

Objects and Classes, Arrays of Objects, Inheritance

**4.Debugging:**

**(01)**

Error detection, compile errors, debugging, detecting runtime errors, fixing runtime errors.

**5.Using Multimedia:**

**(02)**



Color, font, image, open, save dialogs, creating an application menu, adding and controlling forms, playing multimedia.

### **6.Scripting:**

**(02)**

VBA macros create word and excel macros, advanced macros, VB script, writing script for internet explorer, scripting activeX objects, dynamic scripts.

### **7.String Processing:**

**(02)**

Reading text files, Streaming lines of text, reading spreadsheets, reading XML files, creating XML dataset, RSS feed, XML attributes.

### **8.Database Programming:**

**(02)**

Database in excel, designing a database, creating a database, defining tables, table relationships, creating a dataset, data controls, build SQL queries.

### **Termwork:**

**The term work is based on the following list of Computing Assignments.**

Assignment on VB controls and events.

- 1) Programming exercises on Variables and parameters.
- 2) Programming exercises on branching and looping
- 3) Assignment on object methods and function procedures.
- 4) Programming exercises on Arrays.
- 5) Assignment on multimedia.
- 6) Programming exercises on VBA macros and scripting.
- 7) Programming exercises on string processing
- 8) Assignment on database.
- 9) Assignment on object oriented programming.

### **Text Books:**

1. Introduction to Programming using Visual Basic  
-David Schneider (Pearson Education System)
2. Microsoft Visual Basic 2010 Step by Step  
-Michael Halvorson (Microsoft Press)
3. Visual Basic 6: The Complete Reference  
-Noel Jerke (MGH)

### **Reference Books:**

1. Visual Basic -Mike McGrath (TMH)
2. Visual Basic 2010 in Simple Steps -Kogent Learning Solutions ( Dreamtech Press)

### **T.E. –Mechanical - Part-I**

### **7.0 Workshop Practice – IV (T.E. Part - I)**

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**Teaching Scheme**  
**Practical: 2hrs/week**

**Examination Scheme**  
**Term- Work – 25 Marks**

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**Course Objective:**

- i) To make the students aware with various skills involved in manufacturing & Assembly.
- ii) To develop skills to operate different machine tools.
- iii) To make the students aware of limits, fits & tolerance while manufacturing assembly.
- iv) To make students aware of operation sequence, speed feed selection for different materials & operations

**Course Outcomes:**

- i) To create confidence amongst the students in Production / manufacturing activities.
- ii) Students should get experience about manual skills required to perform machining operations.
- iii) To create confidence in students while designing limits, fits & tolerances during manufacturing.
- iv) To create awareness in students regarding time management, work study, method study & tool engineering

1. A composite job consisting of three components machined from  $\Phi 32$  mm MS bar.

(Excluding commercial components) requiring minimum five operations listed below:

1. Turning
2. Drilling
3. Boring
4. Hand tapping
5. Milling
6. Internal & External V-threading
7. Grinding

2. The components of the composite job shall carry at least two specified close tolerance operations. In addition to the above, following operations are to be demonstrated during the term. (These are not to be included in the job operations for term work & exams.)



1. Shaping
  2. Slotting
  3. Grinding
  4. Form Turning
  5. Knurling
  6. Grooving
4. Journal should contain detailed process sheet of above job.
  5. Assessment of Workshop Practice-IV-Term work shall be done for 50 % Work or one major Component & Workshop Practice-V-Term work shall be done for remaining work at the end of T.E. (Mech.) Part II.
  6. Practical examination of 6 Hrs. duration having component of 2 to 3 parts.

**Note:** Material specification for practical work & examination is raw material  $\Phi 32\text{mm MS bar}$ .

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**Books:**

1. Workshop Technology (Volume II) by Raghuvanshi.
2. Workshop Technology (Volume II) by HajraChowdhary.
3. Workshop Technology (Volume II) by W.A.J.Chapman.

**Reference Books:**

1. Production Technology by P.C.Sharma.
2. Production Technology – HMT Handbook.
3. Production Technology (Volume II) by Gupte-Patel.
4. HGerling, All About Machine Tools, New Age International, 1995.



**T.E. –Mechanical - Part-I  
8.0 Self Learning (HSS)**

**Examination Scheme  
Theory Paper : 50 Marks**

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**Note: Syllabus is common for all branches of Engineering Faculty.**

**MyUniversityBuzz**

**T.E.(Mech.)Part-II  
Metrology & Mechanical Measurements**



**Teaching Scheme :**  
**Lectures-3hours per week**

**Practical- 2 hours per week**

**Examination Scheme :**  
**TheoryPaper:100 Marks**

**Term Work: 25 Marks**

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**Course Objectives:**

1. To study the principles of measurement of various mechanical properties such as geometrical, dimensional, pressure, temperature etc.
2. To learn the use of various measuring instruments with different setups for accurate measurements.
3. To get acquainted with various standards of measurements & the calibration process of Instruments.

**Course Outcomes :**

1. Students will understand the design & construction of measuring instruments.
2. Students will setup the Instruments & accessories for measurement of properties by avoiding errors.
3. Students will calibrate the simple instruments using more accurate standards.
4. Students will use the instruments for various industrial applications such as quality control, process control etc.

## **Section- I**

### **1. Introduction : Standards of Measurement & Principles of measurement:**

**(05)**

Need & Concept of measurement, Precision and accuracy. Classification of standards, International standards of length, Line, End & Wave length standards, Slip gauges: Slip-gauge set (M-45,M-87) specification, Selection of slip Gauges including numerical problems. Measuring principles of vernier caliper & micrometer

### **2. Systems of Limits, Fits & Tolerances and Limit Gauging:**

**(05)**

Terminology, Types of tolerances, Accumulation of tolerances, Types of fits, Hole & shaft base systems of limits, fits and tolerances, Use of tolerance charts, Numerical problems based on fundamental deviations & fundamental tolerance grades. Taylor's Principal of gauge design, types of gauges, Design of limit gauges, Disposition of gauge tolerances & wear allowances, numerical problem on gauge design.

### **3. Comparators & angular measurements:**

**(05)**

Introduction to comparators, Characteristics, Classification of comparators, mechanical comparators-Johnson Mikrokator, Sigma Comparators dial indicators, Optical Comparators –Principles ,Pneumatic Comparators, Angular Measurements - Bevel Protractor, Spirit level, Clinometers, Principle & use of Sine Bars, Sine Centre, Use of angle gauges (Numerical on Building of angles) Autocollimator.

### **4. Screw-Threads & Gear Metrology & Recent trends in measurement:**

**(05)**

Basic elements of screw-thread measurement, Methods of measurement of effective diameter, floating carriage micrometer. Basic elements of spur-gear measurement, Methods of measurement of gear tooth thickness. Introduction to modern measurement techniques- Co-ordinate Measuring Machine, Profile projector, Introduction to laser

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## Measurement, Metrology & Automatic inspection system.

### Section- II

#### 5. Introduction to Mechanical Measurement: (05)

Need of Mechanical Measurement, Instruments, Measurement methods, Generalized measurement system & its functional elements, Instrument characteristics-Static & Dynamic characteristics, Calibration, Classification of transducers.

#### 6. Measurement of temperature, Pressure & Vacuum: (05)

Importance of temperature measurement, Thermometer, Thermocouple-Principle, Types, Calibration, RTD, Thermistor. Importance of pressure & Vacuum measurement, Range of high pressure & vacuum Bourdon tubes, Dead weight pressure-gauge tester, Diaphragm gauge, LVDT, Piezo-electrical pressure gauge, Low vacuum gauges-McLeod gauge, Pirani gauge.

#### 7. Measurement of angular speed & flow: (05)

Importance of angular speed measurement, Mechanical tachometers, Electrical tachometers- Drag cup, Inductive, Photoelectric pickup, Stroboscope. Importance of Flow measurement, Turbine meter, Rotameter, Gas flow meter, Hot wire anemometer.

#### 8. Measurement of Force, Torque & Strain: (05)

Force measurement- Balance, Proving Ring, Hydraulic, Pneumatic Load Cell, Torque measurement- Hydraulic, Eddy Current. Classification of strain gauges, Principle of electrical strain gauge, Gauge factor (Analytical treatment), Wheatstone's network using strain gauges. Simple Numerical problems.

(5)

### TERM-WORK

#### **A) Metrology Laboratory :**

Any five of the following experiments (Experiment No. 1 is compulsory).

1. Uses of various measuring instruments .Vernier instruments, Micrometer instruments, Dial instruments and Auxiliary instruments for carrying out measurements.
2. Calibration of Vernier caliper / Micrometer using slip gauges.
3. Use of at least one type of each class of comparator such as mechanical, optical, pneumatic, etc.
4. Measurement of angle using Bevel protractor and sine bar / sine centre. Use of Clinometer and Angle gauges.
5. Measurement of Gear tooth thickness using gear tooth vernier caliper/ plate type micrometer
6. Measurement of diameters of screw threads.
7. Use of advanced measuring equipment such as Co-ordinate Measuring Machine / Metro scope/ Profile projector.



## **B) Mechanical Measurements Laboratory**

Any five out of the following experiments:

1. Temperature Measurement using thermo couples, RTD, Thermistor.
  2. Testing of mechanical pressure gauge using Dead Weight pressure tester.
  3. Vacuum measurement using U tube manometer & Mechanical Vacuum Gauge.
  4. Angular speed measurement using mechanical tachometer ,stroboscope, photo electric pick up, inductive pick-up.
  5. Flow measurement using Rotameter.
  6. Measurement of bending strain or load using strain gauges.
  7. Use of proving ring,load cells.
  8. Measurement of torque.
- \* Industrial Visit (Recommended for modern measuring instruments/ Calibration Lab)

### **Text Books:**

1. Engineering Metrology: I.C. Gupta
2. Mechanical Measurement & Control: Dr.D.S. Kumar
3. A Text Book Metrology : M. Mahajan

### **Reference Books :**

1. Practical Engineering Metrology: Sharp KWB, Pitman, London.
2. Engineering Metrology: R.K.Jain, Khanna Publishers.
3. Mechanical Measurement: Sohni & Dr. Radhakrikshan.
4. Mechanical Measurement: Beckwith, Buck, Roy

***(NOTE: SEPARATE ANSWER BOOKS FOR SECTION -I & SECTION-II)***





**T.E. (Mechanical) Part – II**  
**2.0 Internal Combustion Engine**

**Teaching Scheme**  
**Lecturers: 3 Hrs/ Week**  
**Practical: 2 Hrs/ Week**

**Examination Scheme**  
**Theory: 100 Marks**  
**Term work: 25 Marks**

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**Course Objective:**

1. Learn to classify different types of internal combustion engines and their applications.
2. To make students familiar with the design and operating characteristics of internal combustion engines.
3. To study the thermodynamics, combustion, heat transfer, friction and other factors affecting engine power, efficiency and emissions.
4. To introduce students to future internal combustion engine technology and market trends.

**Course Outcomes :**

1. To recognize and understand the reasons for differences in the construction of different types of internal combustion engines.
2. To understand the reasons for differences among operating characteristics of different engine types and designs
3. To elect the appropriate engine for a given application.
4. To conduct performance tests on engines and Compare experimental results with theoretical predictions.
5. To compare experimental results with theoretical predictions and make proper justifications for

**Section I**

**1. Introduction to I.C. Engines & Engine Cycles:**

**(06)**

Introduction, Basic engine components and nomenclature, Classification of I. C. Engines. Engine cycles, Deviation of actual cycles from air standard cycles, Valve timing diagram for high & low speed engine, Port timing diagram. Engine selection.

*(Theoretical treatment only)*

**2. Fuel systems for S.I. Engines:**

**(05)**

Engine fuel requirements, Elementary and complete carburetor (Float, Idling and Acceleration system, Choke, Compensating system, economizer), Derivation for calculation of A/F ratio (exact and approximate method), Design of carburetor - Calculation of main dimensions of air and fuel supply, Effect of altitude on Air fuel ratio. Electronic Petrol injection system (MPFI)

*(Numerical on calculations of main dimension of carburetor)*

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### 3. Fuel Systems for C.I. Engines:

(05)

Requirements of injection system, Fuel metering, pressurizing and injecting system, Types of injection system- Individual pump, Common rail and Distributor systems, Unit injector, Types of fuel nozzles- single hole, multi hole, pintle, and pintaux, Formation of Spray, Atomization and penetration. Governing of C.I. engines. Electronic control for diesel engine management,  
(Numerical on calculations of main dimension of fuel injection system).

### 4. Engine systems.

(04)

- Ignition system: (Magneto, CDI, Electronic)
- Lubrication system (types of lubrication systems and lubricants)
- Engine starting system. (Starter motor, Bendix drive,)
- Engine cooling system ( Cooling system types, coolants)
- Intake and exhaust systems (Intake manifold, intake runners, exhaust manifold, muffler)  
(Theoretical treatment only)

## Section II

### 5. Combustion in Engines:

(06)

**Combustion In SI Engine:** Stages of combustion, Ignition lag, Flame propagation, Factors affecting flame speed, Abnormal combustion, Influence of engine design and operating variables on detonation, Requirements of combustion chambers of S. I. Engines. (Theoretical treatment only)

**Combustion in C.I. Engines:** Stages of combustion, Delay period, Factors affecting delay period, Abnormal combustion - Diesel knock, Influence of engine design and operating variables on diesel knock, Comparison of abnormal combustion in S I and C I engines,. Requirements of combustion chambers for C. I. engines. (Theoretical treatment only)

### 6. Engines testing and performance enhancement:

(06)

**Engines testing:-** Performance parameters, Performance curves, Measurement of performance parameters like torque, power, Volumetric Efficiency, Mechanical Efficiency, BSFC, Brake and Indicated Thermal efficiencies. Heat Balance Sheet. (Numerical on engine performance)

**Performance enhancement:** Introduction to method of improving engine performance.

**Supercharging:-** Purpose of supercharging, Thermodynamic cycle of supercharged engine, Types of superchargers, Turbo charging, Advantages and disadvantages, Limitations of supercharging for S.I. and C.I. Engines. (Theoretical treatment only)

### 7. Fuels

(04)

SI Engine fuel: Fuel rating, Octane number, Fuel additives, HUCR



CI Engine fuel: Cetane number, Additives

Alternative fuels: Alternative fuel for S. I. Engines & C. I. engines, Blending, Use of CNG, Bio-gas, Non-edible oils, Ethanol, Methanol, Hydrogen, Electronic engine management system for variable valve timing, fuel supply and pollution control. Introduction to hybrid vehicles. (*Theoretical treatment only*)

### **8.Engine Emission and Engine electronics:**

**(04)**

S.I. engine emission (HC, CO, NO<sub>x</sub>) Control methods- Evaporative (ELCD), Thermal, Catalytic converters, C.I. Engines Emission (CO, NO<sub>x</sub>, Smog, Particulate), Control methods- Chemical, EGR, Standard pollution Norms – Bharat-I,II,III. Introduction to carbon credit. Engine electronics. (*Theoretical treatment only*)

### **Term Work**

Minimum **four** experiments from Study Group and Test Group Each.

#### **Study Group:**

- 1 Constructional details of I.C. engines
- 2 Study of Engine systems: Air, exhaust, Cooling, Lubrication
- 3 Study of ignition systems, Starting systems.
- 4 Dismantling and assembly of Carburetor or injection system.
- 5 Dismantling and assembly of engine
- 6 Study of fuel injection system of diesel engine
- 7 Assignment on latest trends in IC Engine.

#### **Text Group:**

1. Test on four stroke Diesel Engine.
- 2 Test on four stroke Petrol Engine.
- 3 Morse Test.
- 4 Test on computer controlled I.C. Engine
- 5 Measurement of exhaust emissions of SI / CI engines.
- 6 Test on variable compression ratio engine, to predict the effect of variable compression ratio on I.C.Engine performance.
- 7 Visit to an engine manufacturing company / repairing unit

#### **Text book**

- 1 Internal Combustion Engines Mathur and Sharma Dhanpat Rai
- 2 Engineering Fundamentals of the Internal Combustion Engine Willard Pulkrabek, Prentice Hall
- 3 Internal Combustion Engines Rajput, Dhanpat Rai Publications
- 4 Internal Combustion Engines – Ganesan, Tata McGraw Hill



## Reference Books

Sr. No	Title	Author / Authors	Publisher
1	Internal Combustion Engines Fundamentals	John Heywood	McGraw Hill
2	Internal Combustion Engines Emission and Control	Eran Sher	SAE
3	Engine Emissions	Purandir	Narosa
4	Alternative Fuels	S.S Thipse	Jaico
5	Internal Combustion Engines Fundamentals	Maleev	McGraw Hill
6	Internal Combustion Engines Vol. 1 and Vol. 2	C.F Taylor	MIT Press
7	Internal Combustion Engines	Obert	McGraw Hill
8	Internal Combustion Engines: Applied Thermo sciences	Fergusson & Kirkpatrick	Wiley
9	SAE Handbook	SAE	SAE
10	Performance Testing of Internal Combustion Engines	SAE	SAE



**T.E. (Mech) Part –II**

**3.0 Computer Aided Design & Computer Aided Manufacturing  
(CAD/CAM)**

**Teaching Scheme:**  
**Lectures: 3Hrs/Week**  
**Practical: 2Hrs/Week**

**Examination Scheme**  
**Paper: 100 Marks**  
**Term Work: 25 Marks**

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**Course objectives:**

1. To create an awareness regarding Geometric Modeling activities in Industries.
2. To create an awareness regarding CAM activities in Manufacturing Industries.
3. To develop part programming capabilities for CNC machines.
4. To empower students to learn advanced tools in Automation.

**Course Outcomes:**

1. To handle CAD related problems from industries.
2. To handle CAM related problems of manufacturing industries.
3. To learn CAD/CAM softwares to be updated with time.
4. To design NC Part Programs to suit Industrial requirements.

**Section-I**

**1. Introduction to CAD / CAM: (04)**

Product Design Concept, Product Cycle and CAD / CAM, Advantages of CAD / CAM, Hardware for standalone CAD system, Graphics Workstation, Types of Input Devices, CPU and Output Devices, Softwares for CAD / CAM, Functions of a Graphics Software, Selection of CAD / CAM Software

**2. Computer Graphics: (05)**

Geometric Transformations, Homogeneous Coordinates, Windowing and Viewing Transformations, Coordinate Transformations, Standardization in Graphics Software, CAD / CAM Data Exchange.

**3. Geometric Modeling: (05)**

Introduction, Types of Geometric Modeling, Parametric representation of basic entities like line and circle, Introduction to basic curves - Hermite, Bezier, B-Spline, NURBS, concept of CSG and Boolean operations, Feature based modeling.

**4. Automation: (06)**

Concept & Definition of Automation, Types, Advantages and Limitations of Automation, Group Technology, part family, Classification and Codification System, Merits and Demerits of Group Technology, Concept of a Machine Cell, CAPP, Retrieval and Generative type of CAPP, Computer Integrated Manufacturing (CIM) concept and elements, MRP, concept of ERP, concept of Rapid Prototyping.



### **5. Fundamentals of NC system:**

**(06)**

Evolution of NC and Retrofitting, Elements of NC Manufacturing System, concept of work zero and machine zero, Types of NC systems, Structure, Drives and other devices, Steps in NC Manufacturing, Advantages and Disadvantages of NC Technology, Flexible Manufacturing System (FMS), Elements of FMS, Applications of FMS, Merits and Demerits in FMS.

### **6. CNC- DNC Technology:**

**(03)**

Classification of CNC machine tools, CNC controllers, Features and Advantages of CNC, Adaptive Control, Advantages of Adaptive Control, Direct Numerical Control (DNC), Types of DNC, Advantages and Disadvantages of DNC.

### **7. Tooling for CNC Machines:**

**(03)**

Tool holders, Adapters, Tool magazines, Automatic tool changers, Pallets, Tool setting, Modular tooling.

### **8. Manual Part Programming:**

**(08)**

Principles of an NC Program, Word Address Format (WAF), Machining Formulas, Tool Length and Cutter Diameter Compensation, Canned Cycles for Lathe, Milling and Drilling, Subprogram or Subroutines, DO Loop, Macros, Diameter versus Radius Programming, CAD / CAM Systems for Part Programming.

### **List of Experiments**

1. One assignment on CAD/CAM fundamentals/basics.
2. Assignment on Modeling & Drafting of any two mechanical components.
3. Assignment on Modeling of simple Assembly of around 3-5 machine components.
4. Assignment based on group technology and /or Computer Aided Process Planning (preferably based on small part family).
5. Part programming of one job using CAM software or Programming and manufacturing of one job on CNC lathe or CNC Milling machine.
6. Assignment based on Industrial visit and its report based on CNC/FMS/Automation.

### **Text books:**

1. Introduction to CAD/CAM, Rao P.N., -Tata McGraw Hill Publishing Co.
2. Automation, Production Systems and Computer Integrated Manufacturing, Grover M.P.- Prentice Hall of India
3. Numerical Control -Computer Aided Manufacturing, Kundra, Rao, Tiwari- Tata McGraw Hill Pub.Co.
4. CAD/CAM/CAE, Chougule N.K.- SCITECH Publications (I) Pvt. Ltd.
5. CAD/CAM/CIM, P. Radhakrishanan.

### **Reference Books:**

1. Theory and Practice , Ibrahim Zeid – CAD/CAM - Tata McGraw Hill Publishing Co.
2. CAD/CAM - Mastering , Ibrahim Zeid --Tata McGraw Hill Publishing Co.
3. Computer Integrated Design and Manufacturing , D.D. Bedworth, M.R Henderson & P.M. Wolfe- -Tata McGraw Hill Pub. Co.
4. CAD/CAM Theory and Concepts, Kuldeep Sareen, C.Grewal, -S.Chand & Co.Ltd.
5. Computer Graphics by Hearn and Baker.



## T.E. (Mech) Part –II

### 4.0 Machine Design-II

**Teaching Scheme :**  
**Lectures: 3 Hrs. / Week**  
**Practical: 2 Hrs. / Week**

**Examination Scheme**  
**Theory Paper: 100 Marks.**  
**Term Work: 25 Marks.**  
**Oral :25 Marks**

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#### Course Objectives :

1. To design transmission system elements such as gears, bearings.
2. To design pressure vessels using various IS codes.
3. To learn the procedure of optimum design for simple machine elements such as shaft.

#### Course Outcomes:

At the end of this course, the student will be

1. To design various transmission system elements.
2. To apply various IS codes for design of Pressure vessels.
3. To provide optimum design of simple machine elements such as shaft.

#### SECTION-II

- 1.Spur Gear:** (06)  
Design considerations of gears, gear materials, types of gear tooth failures, hunting tooth, gear tooth loads, minimum number of teeth, face width, Lewis equation, Spott's equation, Buckingham's Equation, gear design for maximum power transmission.
- 2. Helical Gears:** (04)  
Virtual number of teeth, force analysis, beam and wear strength, effective load on gear tooth, introduction to herring bone gears.
- 3.Pressure vessel:** (07)  
**a.** Types of pressure vessels- horizontal and vertical, thick and thin cylinders, failure criteria of vessels – Lamé's equation, Clavarino's equation, Birnie's equation, Autofrettage and compound cylinders, Types of supports.  
**b.** Introduction to design of pressure vessels as per codes,, classification of pressure vessels as per IS:2825,1969, shell and end closures. Effect of opening and nozzle in shell and covers.
- 4. Optimum Design :** (03)  
Introduction to optimum design for mechanical elements, adequate and optimum design, Johnson's method of optimum design- simple problems on shafts subjected to torsional and bending moments.

#### SECTION-II

- 5.Bevel Gear:** (05)  
Terminology and geometrical relation. Guidelines for selection of dimensions and minimum number of teeth force analysis, mounting of bevel gears, beam strength and wear strength, dynamic tooth load.



## **6. Worm Gear:**

**(05)**

Terminology and geometrical relations, materials, types of failures, standard dimensions and recommendations of worm gearing, force analysis of worm drive, friction in worm gear, efficiency and design criteria of worm drive as per IS7443-1974, load rating of worm drive, strength and wear rating of worm gear, thermal considerations in worm drive.

## **7. Rolling Contact Bearing:**

**(05)**

Types, static and dynamic load capacities, Stribeck's equation. equivalent bearing load, load-life relationship, bearing life, load factor, selection of bearing from manufactures catalogue. Ball and Roller bearing, Design for variable load and speed, Bearings with probability of survival other than 90 %. Lubrication and mountings, dismounting and preloading of bearings.

## **8. Sliding contact bearing:**

**(05)**

Bearing material and their properties, bearing types and their construction details.

Hydro-dynamic lubrication : Reynolds's equation for one dimensional flow, Performance analysis of Hydrodynamic bearing by Raimondi and Boyd method.

Introduction to hydro static bearings.

### **Term Work**

#### **a) Design and drawing of (any one) using design data book**

- 1) Gear box
- 2) Pressure vessel

#### **b) Assignments on**

1. Spur/Helical gears
2. Bevel/worm gears
3. Bearing/Pressure vessels
4. Introduction to tribology

#### **Text book:**

- 1) Design of Machine Elements by V.B.Bhandari.
- 2) Machine Design by Robert L. Norton.
- 3) PSG Design data Book.

#### **Reference Books:**

- 1) Design of Machine Elements by J.E. Shigely
- 2) Engg. Design Material and processing approach by George Dieter.
- 3) Design of Pressure Vessel by Harvey.
- 4) Machine Design by Hall, Holowenko, Schaum's outline series.
- 5) Introduction to Tribology by Mujumdar.
- 6) Machine Tool Design by N.K.Mehta.
- 7) Tribology by R.B.Patil





**T.E. (Mech) Part –II**  
**Professional Elective – II**

**5.1 EXPERIMENTAL STRESS ANALYSIS**

**Teaching Scheme :**  
**Lectures: 3 Hrs. / Week**  
**Practical: 2 Hrs. / Week**

**Examination Scheme**  
**Theory Paper: 100 Marks.**  
**Term Work: 25 Marks.**  
**Oral :25 Marks**

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**Course Objectives :**

4. To make students familiar with various stress analysis methods such as photo elasticity, strain gauges, moiré fringes, brittle coating methods.
5. To design strain gauge systems for measurement of force, torque.
6. To enable use of rosette system for stress analysis.

**Course Outcomes:**

1. To apply various stress analysis methods such as photo elasticity, strain gauges, moiré fringes, brittle coating methods in typical stress analysis problems.
2. To implement strain gauge systems for measurement of force, torque.
3. To implement rosette system for stress analysis.

**Section I**

**1.a) Principles of Experimental approach:**

**(05)**

Introduction to ESA, Advantages of ESA techniques, Necessity of various ESA methods, methodology of problem solving by ESA

**b) Theory of Photo Elasticity:**

- i) Introduction : Optics related to photo elasticity- Ordinary light, Monochromatic light, polarized light, natural and artificial birefringence.
- ii) Stress optic law in two dimensions at normal incidence, material fringe value in terms of stress function.

**2.Polariscope :**

**(05)**

Plane polariscope, Circular polariscope, Different arrangements.

(a) Effect of stressed model in plane polariscope – Isoclinics, Isochromatics

(b) Effect of stressed model in circular polariscope – Isochromatics

(c) Use of white light and determination of orders of isochromatic fringes seen in the circular polariscope.

(d) Fractional fringe measurement :

(e) Tardy's Method(with derivation) (ii) Babinet Soleil Method.

**3. Photoelastic Materials:**

**(05)**

(a) Criterion for selection of model materials.

(b) Properties of commonly employed photoelastic materials

(c) Casting technique and machining of model.

(d) Conclusions pertaining to material selection

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- (e) Calibration methods -circular disc, tensile specimen, beam model,  
Significance of material fringe value.

**4. Analysis Techniques:**

(05)

- a) Determination of direction of Principal stresses at given point
- b) Determination of exact fringe order  $N$  and the principal stress difference  $(\sigma_1 - \sigma_2)$  at the given point.
- c) Separation methods
  - Method based on Hooke's Law
  - Electrical analogy method
  - Oblique incidence method
  - Shear difference method
- d) Scaling model results to prototype

**Section II**

**5. Elementary Treatment on the following:**

(05)

- (a) Brittle coating method - merits, demerits and applications
- (b) Moiré fringe method - merits, demerits and applications
- (c) Birefringent coating-principle and working of reflection polariscope

**6. Strain Measurement Methods : Electrical Resistance Strain Gauge:**

(05)

Introduction, types, construction and material, Gauge factor, cross or transverse sensitivity, correction for transverse strain effect, semi-conductor strain gauge.

7.

(05)

- a) Selection And Mountings Of Strain Gauges:  
Grid, backing, adhesive, mounting methods, checking gauge installation, Moisture proofing.  
Strain Gauge Circuitry:

- b) Measurement of force or load, Measurement of torque., Strain measurement of rotating shaft, Measurement of pressure or vacuum.

**8. Computation of Stresses:**

(05)

- (a) Introduction – Analysis of strain gauge data by analytical and graphical methods.
- (b) Analysis when principal stress directions are known.
- (c) Analysis when principal stress directions are unknown. i) Delta rosette
  - ii) Tee-rosette
  - iii) Four element rectangular rosette
  - iv) Rectangular rosette – Two and three element.



## Term Work

Minimum four experiments from Sr. No 1-5 and minimum four experiments from Sr. No.6-10 to be performed

- 1 Sheet casting and preparation of photo elastic model
- 2 Assignment on Calibration of photo elastic model material.
- 3 Assignment on isoclinic, iso-chromatics and tardy method.
- 4 Assignment on Separation of stresses using oblique incidence method.
- 5 Study of moiré fringe technique and brittle coating method.
- 6 Bonding of Strain Gauge and checking its installation
- 7 Comparison of two arm and four arm sensitive bridges.
- 8 Measurement of force using load cell.
- 9 Measurement of torque using strain gauge circuitry.
- 10 Measurement of bidirectional stress using strain gauge/load cell.

## Text Books :

- 1 Experimental stress analysis – Dally and Riley.-McGraw Hill
- 2 Experimental stress analysis – Dr. Sadhu Singh., Khanna Publications.
- 3 Experimental stress analysis – L.S.Srinath., Tata McGraw Hill
- 4 Experimental stress analysis – Dove and Adams
- 5 The strain gauge primer – Perry Listner.
- 6 Moiré fringes – Theocoris. Pergamon press limited.
- 7 Experimental stress analysis – Doyle



**T.E. (Mech) Part –II**  
**Professional Elective – II**

**5.2 POWER PLANT AND ENERGY ENGINEERING**

**Teaching Scheme :**

Lectures : 3 Lectures / weeks

Practical : 2 Hours / week

**Examination Scheme:**

Theory Exam.: 100 Marks

Term work : 25 Marks

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**Course Objective:**

1. To study of Power Station performance evaluation & economic analysis.
2. To Study of various non-conventional energy sources & principles of energy Conservation & audit.

**Course Outcomes:**

Students after learning this subject can able to,

1. get basic knowledge for effective use of available energy sources by suitable planning of power generation in thermal, hydro, gas & atomic power plant.
2. create awareness and knowledge for economical cost analysis of electrical energy.

**Section – I**

**1. Introduction of Energy Sources :**

**(04)**

Forms & characteristics of renewable energy sources, Organization of Power Sector in India, Impact of energy sources (coal, oil, natural gas, solar, wind, biomass, hydro, geothermal, tidal, wave, ocean thermal and nuclear) on environment, Role of private sector in energy management.

**2. Loads on Power Plant :**

**(05)**

Introduction, Different load curves and load factors, Effect of variable load on power plant, design & operation, comparison of the various power plants. (Numerical treatment)

**3. Peak Load & Base Load Power Plants :**

**(05)**

Introduction & classification, Requirement of peak load plant, Types, Pumped storage plants, Compressed air storage plants, Load sharing between base load & peak load power stations. (Numerical treatment)

**4. Economic Analysis of Power Plants :**

**(06)**

Introduction, Cost of electric energy, Fixed and operating cost, Methods of determining depreciation, Selection of site for Power station(thermal, hydro, nuclear), Selection of generation equipment, Tariff methods. (Numerical treatment)

**Section – II**

**5. Solar Energy :**

**(05)**

a) Solar radiation outside the earth's atmosphere & at the earth's surface, Solar radiation measurement – Pyranometer & Pyrheliometer, solar radiation geometry. LAT & SCT, Solar concentrators-Method and classification, Types of concentrators.

b) Liquid flat plate collector – General, Performance analysis, Effects of various parameters.  
(Numerical treatment)

**6. Wind Energy :**

**(06)**

Introduction, Power of wind, Basic components of 'WECS', Classification of WEC systems., Horizontal axis machines, Vertical axis machines, Advantages & Disadvantages of WECS, Application of wind energy.  
(Numerical treatment)

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### **7. Other Non- Conventional Energy Sources :**

**(05)**

Geothermal energy – Introduction, Types of geothermal resources, Methods of Harnessing. Tidal energy- components of tidal power plant, single basin system, Double basin system, Advantages & Disadvantages of tidal energy. Ocean thermal energy – Introduction, open & closed systems. Wave Energy – wave energy, energy conversion devices- High pressure accumulator wave machines, Dolphin type wave machine, Dam Atoll wave machine.

### **8. Energy Audit & Energy Conservation :**

**(05)**

Energy Audit - Definition & objective of Energy audit, Energy flow diagram, Energy Audit Instruments; Duties and responsibilities of energy auditors, Duties and responsibilities of energy managers. Energy Conservation- Introduction, energy conservation act 2001 & its feature, energy conservation in industries – Chemical industry, Cement industry & Sugar industry. Energy conservation in house hold & commercial sectors.

### **Term Work**

#### **Group - I: Any two Experiment from Expt. No. 1 to 3**

1. Solar radiation & its measurement
2. Test on solar water heater
3. Efficiency measurement of standalone solar P-V system
4. Study of components of windmill
5. Identifying & measuring the parameters of a solar PV module in the field

#### **Group - II: Minimum Six Assignments based on following topics -**

1. Study of solar collectors
2. Study of solar thermal applications- solar water heating, space heating, power
3. Study of solar pond / solar photovoltaic
4. Study of Biogas plants
5. Study of instruments of a power plant water purity, PH meter, Gas analysis, Measurement of smoke & dust.
6. Study of various pollution control devices
7. Study of various Energy storage devices.

#### **Group - III**

1. The report based on any Industrial Visit to renewable energy appliances or power generation transmission station.

#### **Books Recommended**

1. Generation of electrical energy – B.R.Gupta, S.Chand & co. ltd.
2. A course in Power Plant Engineering – Arora Domkundwar ,Dhanpat Rai & co.
3. Solar Energy – S.P.Sukhatme, Tata mcgraw hill co.
4. Solar Energy – G.D.Rai, Khanna Publisher.
5. Energy Technology – S.Rao & Dr.B.B.Purulekar, Khanna publishers.
6. Power Plant Engineering – P.K.Nag, Tata mcgraw hill publishing co.
7. Power Plant Technology – M. M. El Wakil.
8. Power Plant Engineering – R. K. Rajput
9. Berau of Energy efficiency Manual



**TE (Mech) Part- II**  
**Professional Elective – II**  
**5.3 Tool Engineering**

**Teaching Scheme :**  
**Lectures : 3 / week**  
**Practicals : 2 hrs./ week/ batch**

**Examination Scheme :**  
**Theory : 4 hrs. 100 marks**  
**Term work -25 marks**

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**Course Objectives**

1. To enlighten the students about the basics in mechanics of cutting & non cutting operations.
2. To explain the concepts, principles & practices in designing various tools .
3. To explain the students about the basics in economics of cutting & non cutting operations.
4. To explain the concepts, principles & practices in designing various toolings.

**Course Outcomes**

1. Students are able to do the calculations involved in the mechanics & economics of operations.
2. Students are able to design & draw the tools & toolings for the given situation & operation.
3. Students are able to conceive & develop solutions, devices, contrivances to overcome present problems of the real world.

**SECTION - I**

**1. Theory of Metal cutting**

- |  |     |
|--|-----|
| a) Orthogonal cutting & Oblique cutting, Force analysis for orthogonal cutting   | (1) |
| b) Chip formation, types of chips, wedge action, shear plane angle, cutting ratio, shear stress & strain, velocity relationship, Merchant's theory, Merchant's circle & force relationship | (3) |
| c) Tool dynamometers- types, applications.   | (1) |
| d) Machinability Index, factors affecting machinability  | (1) |
| e) Tool life- Flank & crater wear, effect of variables on tool life, Taylor's equation of tool life  | (2) |
| f) Coolants- Heat generation, types of coolants.   | (1) |
| g) Tool Materials  | (1) |

**2. Press Tools**

- |  |     |
|--|-----|
| a) Elements of press tools, types of dies, types of operations.  | (2) |
| b) Design of die for cutting operation, mechanics of shearing, cutting force estimation, punch & die clearance, stock strip lay out, design of punches & die block functioning & place of other elements. Centre of pressure, selection of die set & press | (5) |
| c) Design of drawing dies, determination of blank size, no. of draws, stage wise component drawing, drawing radii, clearance, estimation of drawing force, time & power  | (2) |
| d) Types of Bending dies, related estimates  | (1) |
-



## SECTION –II

### 3. Geometry & Nomenclature of cutting tools

- a) Single point cutting tools- Geometry & Tool signature as per ASA system & ORS system, effect of geometry on tool life, cutting force, surface finish. (2)
- b) Types of Multipoint cutting tools like Milling cutters, Drills, Broaches, Reamers (2)

### 4. Design of Jigs & Fixtures

- a) Introduction, necessity & applications, basic concepts (1)
- b) Location & clamping systems- Principle, types, applications (2)
- c) Design of Jigs- Principles of Jig design, types & applications, types of bushes & selection, use of standard parts, design procedure & drawing. (4)
- d) Design of Fixtures- Principles of Fixture design, standard elements & types of fixtures, design of milling fixtures. (4)

### 5. Economics of Tooling

- a) Elements of cost: methods of depreciation (1)
- b) Estimation of total cost & sales price (1)
- c) Break- even analysis for equipment selection (1)
- d) Economics of small tool selection, equipment replacement (1)
- e) Economic Order Quantity for Batch production (1)

### TERM WORK

#### (Minimum Six of the following )

1. Study of cutting tools : Classification, Nomenclature, Geometry
2. Exercise on Theory of metal cutting.
3. Demonstration of Lathe tool & Drill tool dynamometer & calculation of cutting forces.
4. Exercises on Mechanics & Economics of Machining & Tooling
5. Sheet on Press tool design- Cutting & drawing operation, necessary calculation
6. Sheet on Jig design- Exercise & drawing
7. Sheet on Fixture design- Exercise & drawing
8. Industrial visit

### RECOMMENDED BOOKS:

#### TEXT BOOKS

1. Text Book of Production Engineering – P.C.Sharma (S.Chand Publication)
2. Machine Tool Engineering – G.R. Nagpal (khanna Publication)
3. Press Tools – P.H.Joshi (S.Chand Publication)
4. Jigs & Fixtures - P.H.Joshi (S.Chand Publication)

#### REFERENCE BOOKS

1. Metal cutting Theory & tool design- Mr. Arshinnov (MIR Publication)
2. Fundamentals of Tool design- ASTME Publication
3. Tool design – Donaldson (TMH Publication)
4. Jig & Fixture Design – Kempster (ELBS Publication)
5. Die Design Fundamentals-J.R.Paquin



**TE (Mech) Part- II**  
**Professional Elective – II**  
**5.4 Mechanical Vibration**

**Teaching Scheme:**  
**Lectures: - 3Hrs/week**  
**Practical: - 2hr/week**

**Examination Scheme:**  
**Theory – 100 Marks**  
**Oral – 25 Marks**

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**Course Objective:**

1. To familiarize the student with the underlying concepts of linear mechanical vibrations.
2. To introduce the concept of the free and forced responses of various single and multiple degree-of-freedom (DOF) systems.
3. To introduce the method of analysis for free and forced response of DOF systems.

**Course outcome:**

1. Students will understand the various aspects related to mechanical vibrations.
2. Students will develop the ability to analyze the problem related to mechanical vibration.

**SECTION – I**

**1. Basic Concepts of Vibration:**

**(05)**

- Vibration and oscillation, causes and effects of vibrations,
- Vibration parameters – spring, mass, damper,
- Types of damping and damping systems,
- Motion – periodic, non periodic, harmonic, non- harmonic,
- Degree of freedom,
- Static equilibrium position,
- Natural Frequency and mode shape,
- Vibration classification,
- Steps involved in vibration analysis. (3)

**2 Single Degree of Freedom System**

**(06)**

- Introduction
- Equation of motion for free and forced vibration,
- Free Vibration Response of un-damped and damped system,
- Free vibration with viscous and coulomb damping
- Response of single DOF system to Harmonic and periodic excitation,
- Forced Vibration Response of un-damped and damped system,

**3 Two Degree of Freedom System**

**(06)**

- Introduction,
- Equation of motion for free and forced vibration,
- Free Vibration analysis of an un-damped and damped system,
- Forced Vibration Response of un-damped and damped system,

**4 Multi Degree of Freedom System**

**(05)**

- Introduction,
  - Equation of motion for free and forced vibration,
  - Free Vibration analysis of an un-damped and damped system,
-





-Forced Vibration Response of un-damped and damped system,

## SECTION – II

### 5 Nonlinear Vibrations (05)

- Introduction
- Linear and non-linear vibrations
- Systems with non-linear elastic properties,
- Free vibrations of system with non-linear elasticity and damping,

### 6 Random Vibration (05)

- Introduction
- Introduction to Random variable and random processes,
- Probability distribution, Mean Square values and standard deviation,
- probability density function,
- Wide band and Narrow band processes Power spectral Density

### 7. Vibration Control (05)

- Introduction
- Vibration isolation
- Vibration absorbers (Tuned and Un-Tuned)
- Control of natural frequency,
- Vibration dampers

### 8. Vibration Measurement (05)

- Introduction
- Vibration measuring parameters- Displacement, Velocity and acceleration
- Vibration measuring devices: Accelerometers, Vibration exciters, FFT analyzer,
- Introduction to signal analysis : Time domain & Frequency domain analysis of signals.

#### Term Work:-

At least eight assignments/experiments based on above topics.

#### Text Books :-

- 1 .Mechanical Vibrations: G K Grover.
- 2.Mechanical Vibrations : J P Den Hartog ,McGraw Hill.
3. Theory of Vibrations with Applications: W T Thomson CBS Publishers Delhi

#### Reference Books:-

- 1 .Mechanical Vibrations : S S. Rao Addison-Wesley Publishing Co.
- 2 .Fundamentals of Vibration : Leonard Meirovitch , McGraw Hill International Edison.
- 3 .Principles of Vibration Control : Ashok Kumar Mallik, Affiliated East-West Press.
- 4.Mechanical Vibrations : A H Church ,John Wiley & Sons Inc
- 5 .Mechanical Vibration Analysis: Srinivasan ,McGraw Hill.
- 6.Mechanical Vibrations :V.P.Singh.



**TE (Mech) Part- II**  
**6.0 Advanced Computing Techniques – II**  
**(MATLAB)**

**Teaching Scheme**

**Theory: 1 hour a week**

**Practical: 2 hours a week**

**Examination Scheme**

**University Exam: Nil**

**Term Work : 25 Marks**

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**Course Objectives:**

1. To learn the basic syntax MATLAB and use mathematical functions in MATLAB.
2. To make students familiar with the general programming concepts of MATLAB such as variables branching, loops and functions.
3. To make the students familiar with the scope and applications 2D and 3D graphs in MATLAB.
4. To make the students solve simple Image Processing tasks and transfer functions using MATLAB.

**Course Outcomes:**

A student who has successfully completed this course must be able to accomplish the following tasks;

1. Solve mathematical problems using Matlab and Plot 2D and 3D curves for mathematical functions.
2. Solve differential and algebraic equations using symbolic math toolbox.
3. Write simple Matlab Code for simple Image processing problems.
4. Use Simulink to solve elementary control problems

**1.Introduction :**

**(01)**

Installing Matlab in Windows and Linux, command window, command history window, workspace window, array window, current directory.

**2. Scalars and Vectors and Matrices:**

**(02)**

Scalar functions and vector functions, relational operations on vectors, logical operations on vectors, arithmetic operations on matrices, basic matrix operations such as inverse, triangular form, transpose and Eigen values.



**3.Mathematical Functions and operations: (03)**

Elementary mathematical functions, logical functions, trigonometric functions, hyperbolic functions, complex numbers, creating polynomials finding root of polynomials, numerical integration.

**4.General Programming: (02)**

Variables, arithmetic, relational and logical operators, input – output, branching & conditional statements, arrays, m files script files, function files, arguments.

**5.Graphical Plotting: (02)**

2D plots, 3D plots, line and polygon plotting animations, customization and manipulation of graphics.

**6.Symbolic Math Toolbox: (02)**

Calculus, simplification and substitutions, variable precision arithmetic, solving linear algebraic equations, solving differential equations

**7.Image Processing Toolbox: (01)**

Fundamentals of Image Processing, basic image processing functions such arithmetic, filters, edge detection, noise removal

**8.Simulink: (01)**

Basic control theory, defining and simulating transfer functions in Simulink.

## Termwork

### Computing Assignments

- 1) Exercises on Vector Operations.
  - 2) Exercises on Matrix Operations
  - 3) Exercises on branching and conditional statements.
  - 4) Assignment on User Defined Functions using m files.
  - 5) Exercises involving 2D plots.
  - 6) Exercises involving 3D plot.
-



- 7) Exercises on algebraic and differential equations using the symbolic math toolbox.
- 8) Exercises on filtering and image arithmetic using the image processing toolbox.
- 9) Exercises on transfer functions using Simulink.
- 10) A complex problem involving several functions and operations.

### **Text Books:**

<b>Sr. No</b>	<b>Title</b>	<b>Author / Authors</b>	<b>Publisher</b>
1	Getting Started with Matlab	RudraPratap	Oxford University Press
2	Matlab: An Introduction with Applications	Amos Gilat	Wiley
3	A guide to Matlab: For Beginners and Experience Users	Hunt and Others	Cambridge University Press

### **List of Reference Books:**

<b>Sr. No</b>	<b>Title</b>	<b>Author / Authors</b>	<b>Publisher</b>
1	Matlab and its Applications in Engineering	Bansal	Pearson
2	Matlab and Simulink for Engineer's	Agam Kumar Tyagi	Oxford University Press
3	Mastering Matlab 7	Duane Hanselman	Pearson
4	Matrix and Liner Algebra Aided with Matlab	DattaKanti	PHI
5	Modeling and Simulation using Matlab Simulink	Shailendra Jain	Wiley



**TE (Mech) Part- II**  
**6.0 Advanced Computing Techniques – II**  
**(SCILAB)**

**Course Objectives:**

1. To learn the basic syntax Scilab and use the mathematical functions in Scilab.
2. To make students familiar with the general programming concepts of Scilab such as variables branching, loops and functions.
3. To make the students familiar the scope and applications 2D and 3D graphs in SCILAB.
4. To develop simple codes for Statistics and Image Processing.

**Course Outcomes:**

A student who has successfully completed this course must be able to accomplish the following tasks;

1. Solve mathematical problems using Scilab and Plot 2D and 3D curves for mathematical problems.
2. Write Scilab code for various statistical applications.
3. Write Scilab Code for simple Image processing problems.
4. Use Scicos to solve simple transfer function control problems.

**1.Introduction: (01)**

Installing Scilab in Windows and Linux, history of Scilab, Scilab vs. Matlab, working directory, Scilab commands, menu bar, and toolboxes.

**2. Scalars and Vectors and Matrices: (02)**

Mathematical operations on vectors, relational operations on vectors, logical operations on vectors, arithmetic operations on matrices, basic matrix operations such as inverse, triangular form, transpose and Eigen values

**3.Mathematical Functions and operations: (03)**

Elementary mathematical functions, logical functions, functions on scalars, trigonometric functions, hyperbolic functions, complex umbers, creating polynomials finding root of polynomials

**4.General Programming: (02)**

Variables, arithmetic, relational and logical operators, input – output, branching & conditional statements, scripts, functions, and user defined functions.



### **5. Graphical Plotting:**

**(02)**

Menus, executing menus from command line, code linking, dialog boxes. 2D plots, 3D plots, line and polygon plotting, rectangle plotting and arc plotting.

### **6. Statistical Operations:**

**(02)**

Basic statistical functions, distributions, correlation, central moment, covariance, frequencies and percentiles, Fischer test, sampling, Labostat toolbox.

### **7. Image Processing:**

**(01)**

Fundamentals of Image Processing, basic image processing functions such arithmetic, filters, edge detection, noise removal

### **8. Scicos Toolbox:**

**(01)**

Basic control theory, defining and simulating transfer functions.

## **Termwork**

### **Computing Assignments**

1. Exercises on Vector Operations.
2. Exercises on Matrix Operations
3. Exercises on branching and conditional statements.
4. Assignment on User Defined Functions and scripts.
5. Exercises involving 2D plots.
6. Exercises involving 3D plot.
7. Exercises on statistics.
8. Exercises on filtering and image arithmetic using the image processing toolbox.
9. Exercises on transfer functions using Scicos
10. A complex problem involving several functions and operations.



### Text Books:

Sr. No	Title	Author / Authors	Publisher
1	SCILAB	HemaRamchandran	S. Chand
2	SCILAB by Example	M. Affouf	Paperback
3	Programming with SCILAB	Vinu Das	New Age International

### List of Reference Books:

Sr. No	Title	Author / Authors	Publisher
1	Modelling and Simulation in SCILAB/SCICOS	Stephen Cambell	Springer
2	Engineering and Scientific Computing with SCILAB	Claude Gomez	Birkhauser
3	SCILAB: Introduction, applications and more	Gaby Alez	Websters
4	Scilab	Jesse Russel	Bookvika
5	Scilab	Lambert Surhone	BetaScript



**T.E. (Mechanical) Part – II**  
**7.0 Workshop Practice – V**

**Teaching Scheme**  
**Practical:** 2hrs/week

**Examination Scheme**  
**Term- Work – 25 Marks**  
**Practical Examination-50Marks**

Practical Exam duration- 6 Hrs.

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**Course Objective:**

- v) To make the students aware with various skills involved in manufacturing & Assembly.
- vi) To develop skills to operate different machine tools.
- vii) To make the students aware of limits, fits & tolerance while manufacturing assembly.
- viii) To make students aware of operation sequence, speed feed selection for different materials & operations

**Course Outcomes:**

- i) To create confidence amongst the students in Production / manufacturing activities.
- ii) Students should get experience about manual skills required to perform machining operations.
- iii) To create confidence in students while designing limits, fits & tolerances during manufacturing.
- iv) To create awareness in students regarding time management, work study, method study & tool engineering

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1. A composite job consisting of three components machined from **Φ32 mm MS bar**.

(Excluding commercial components) requiring minimum five operations listed below:

- 1. Turning
  - 2. Drilling
  - 3. Boring
  - 4. Hand tapping
  - 5. Milling
  - 6. Internal & External V-threading
  - 7. Grinding
- 
-





2. The components of the composite job shall carry at least two specified close tolerance operations. In addition to the above, following operations are to be demonstrated during the term. (These are not to be included in the job operations for term work & exams.)

1. Shaping
2. Slotting
3. Grinding
4. Form Turning
5. Knurling
6. Grooving

4. Journal should contain detailed process sheet of above job.

5. Assessment of Workshop Practice-IV-Term work shall be done for 50 % Work or one major Component & Workshop Practice-V-Term work shall be done for remaining work at the end of T.E. (Mech.) Part II.

6. Practical examination of 6 Hrs. duration having component of 2 to 3 parts.

**Note:** Material specification for practical work & examination is raw material  $\Phi 32\text{mm MS bar}$ .

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**Books:**

1. Workshop Technology (Volume II) by Raghuvanshi.
2. Workshop Technology (Volume II) by HajraChowdhary.
3. Workshop Technology (Volume II) by W.A.J.Chapman.

**Reference Books:**

1. Production Technology by P.C.Sharma.
2. Production Technology – HMT Handbook.
3. Production Technology (Volume II) by Gupte-Patel.
4. HGerling, All About Machine Tools, New Age International, 1995.



## T.E. (Mechanical), Semester - II

### Self Learning (Technical)

**Teaching Scheme:-- Nil**

**Examination Scheme: Nil**

**Term Work – 50 Marks**

#### **Course Objective:**

- i) To develop the ability for self study
- i) To make the students acquainted with various skills involved in presenting a data.
- ii) Student is expected to understand & analyze the basic problems in engineering.

#### **Course Outcomes:**

- i) Outcome is to create confidence amongst the students in the field of engineering.
- ii) Students should get experience about case study.

#### **1. Mini Project/Case study: 30 Marks**

A mini project /case study is expected to be on a state of the art technical topic, related to Mechanical Engineering discipline. Every individual or a group of maximum two students shall work on a area/topic, selected or assigned from any engineering/allied/applied fields, for the academic or industrial interest.

The task may be like:

- A work/task can be completed using software tools like CAD tools, MALAB SCILAB, AUTOLISP, or any Programming Languages.
- Animation, simulation oriented task.
- Making a prototype, working model, attachment/extension to machine tool/equipment.
- Design of element, mechanism, product, subassembly etc.
- Experimentation with critical task like using IC engine, Hydraulic trainer circuit, Vibration analysis or using any working experimental set-up.

Such similar kind of task/case in the field of Mech. Engg., can be taken for mini project.

# For this mini project the report should be prepared and student has to present it and demonstration to the expert panel appointed by HOD.

The Term work marks will be allotted as per the following :

- i) Report 10 Marks
- ii) Theme/content, Presentation and question-answer : 20 Marks

#### **2. A) Paper Presentation 20 Marks**

OR

#### **B) Seminar 20 Marks**



### **A) Paper Presentation :**

A research paper is expected to be on a state of the art technical topic, related to Mechanical Engineering discipline. Every individual or a group of maximum two students shall work on a area/topic, selected or assigned from any engineering/allied/applied fields, for the academic or industrial interest. Student shall work on a recent/advanced topic, recent development/research work, may be selected by them or assigned from any engineering/allied/applied fields, for the academic or industrial interest. The student shall prepare the research paper and participate/submit for any competition/conference may be of university level/state level/national level/international level. The student has to produce the proof for the same in the form of certificate of selection/attendance/paper presentation, at the competition/conference, a copy of souvenir/proceeding etc.

For this the report including research paper should be prepared and student has to present it to the expert panel appointed by HOD.

The Term work marks will be allotted as per the following:

- i) Research paper: 10 Marks
- ii) Presentation and question-answer: 10 Marks

### **B) Seminar:**

A seminar is expected to be on a state of the art technical topic, related to Mechanical Engineering discipline. Every individual student shall work on a recent topic selected or assigned from any engineering/allied/applied fields for the seminar of academic or industrial interest. It is expected that the student may collect information on a topic which is not covered in curriculum of the under graduate course. Student has to refer hand book, latest research papers, research journals, reference books, proceeding of conference through library or internet and record of references considered for seminar is too preserved in hard copy or soft copy, which shall be produced at the time of seminar. The seminar report & its presentation are to be based on content material, mainly collected & analyzed from above. The report of seminar should be submitted in printed volume (about 10-20 pages) duly certified by guide. The student should deliver a seminar talk at least for 20 minutes based on the work done by him/her. The performance will be judged by expert panel appointed by HOD. Presentation shall be made with help of Power point (Guidelines)-

- a. Preferably each slide shall have plain white or faint yellow or navy blue or maroon colored back ground with contrast matching font.
- b. Each slide shall be numbered and header - footer shall be added similar to report.
- c. Figure / Graph / Table shall be labeled with Figure No. / Graph No. / Table No. and with reference nos. Shown in seminar report
- d. Only brief points are to be highlighted on slides
- e. Points are not to be read directly from slide at the time of presentation.
- f. Presentation shall be based on Figure, Graph, Table, Charts and points etc.
- g. First slide shall be identical to cover page of report.
- h. Second slide should contain introduction / abstract of seminar and content of presentation with bullets.
- i. Third slide shall focus on literature review.
- j. Fourth slide on wards core content of presentation shall be discussed.
- l. Slides at the end shall consist of merits, demerits, future scope, conclusion and references.

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**The Term work marks for seminar will be allotted as per the following**



- i) Seminar Report : 08 Marks
- iii) Presentation and question-answer : 12 Marks

### **Recommended Books:**

#### **Text Books :**

1. Communication Skills for Engineers –S. Mishra, C. Muralikrishna, Pearson Education.
2. Professional Communication Skills -Pravil S. R. Bhatia, S. Chand and Co., New Delhi.
3. Soft Skills, know Yourself & Know the world-Dr.K.Alex.S. Chand & Company Ltd., N. Delhi.
4. Awaken the Giant Within: Tony Robbins HarperCollins Publishers, ISBN-139780743409384

#### **Reference Books:**

1. Entrepreneur Development by Vasant Desai, Himalaya Publication
2. Thinks and Grow Rich: Napoleon Hill, Ebury Publishing, ISBN 9781407029252
3. Change Your Thoughts, Change Your Life: Wayne Dyer, Hay House India, ISBN-139788189988050
4. Habits of Highly Effective People: Stephen Covey Pocket Books, ISBN-13
5. Organizational Behaviour-Fred Luthans, McGraw Hill.