



## Shivaji University, Kolhapur

Draft Syllabus for BE (Mechanical)  
 For T. E. (Mech.) –I & II (revised)  
 To be implemented from Academic Year 2004-05  
 As per the following

### T. E. (Mechanical) Part-I (Revised)

Sr. No.	Subject	L	Tut	P	T	PT	TW	P/O	Total
01	Theory of Machine-II	3	--	2 *	5 *	100	25	25	150
02	Heat and Mass Transfer	3	--	2	5	100	25	25	150
03	Mechanical Measurement and Control	3	--	2 *	5 *	100	25	--	125
04	Fluid & Turbo Machinery	3	--	2 *	5 *	100	25	--	125
05	Machine Design-I	3	--	2 *	5 *	100	25	--	125
06	Tool Engineering	3	--	2 *	5 *	100	25	--	125
07	Workshop Practice-V	--	--	2	2	--	25	--	25
08	General Proficiency-II	--	--	2 *	2 *	--	25	--	25
09	Industrial Case Study	--	--	--	--	--	--	--	--
10	CAD/CAM Laboratory-I	--	--	2	2	--	25	--	25
	Total	18	--	12	30	600	225	50	875

\* Practicals will be conducted alternate weeks.

\* Case Study to be carried out after T. E. (Part-I in vacation and it's valuation will be done in T.E. (Part-II)

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# Shivaji University, Kolhapur

## T. E. (Mechanical) Part-II (Revised)

Sr. No.	Subject	L	Tut	P	T	PT	TW	P/O	Total
01	Industrial Management	3	--	2	5	100	25	--	125
02	Metrology and Quality Control	3	--	2	5	100	25	25	150
03	Automatic Control & Fluid system	3	--	2	5	100	25	--	125
04	Energy Engineering	3	--	--	3	100	--	--	100
05	Machine Design-II	3	--	2	5	100	25	25	150
06	Advanced Production Systems	3	--	--	3	100	--	--	100
07	Workshop Practice-VI	--	--	2	2	--	25	25	50
08	CAD/CAM Laboratory-II	--	--	2	2	--	25	25*	50
09	Industrial Case Study	--	--	--	--	--	25	--	25
	Total	18	--	12	30	600	175	100	875

\* Oral Examination based on CAD/CAM Lab-I & II

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# Shivaji University, Kolhapur

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

### 1. 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

### Section -I

#### 1. Toothed Gearing :

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. (05)

#### 2. Gear Trains :

Types of Gear trains- Simple, Compound, Epicyclic, Reverted gear train, Tabular method for finding the speeds of elements in epicyclic gear train, Differential gear box. Equivalent mass and Moment of Inertia applied to gear trains. (05)

#### 3. Kinetic analysis of Mechanisms :

Inertia Force and Torque, D'Alembert's Principle, Dynamically equivalent system, force analysis of reciprocating engine mechanism. Function of flywheel and study of turning moment diagrams. (07)

#### 4. Gyroscope :

Gyroscopic couple, Spinning and Precessional motion, Gyroscopic couple and its effect on i) Aero plane ii) Ship iii) Four-Wheeler iv) Two -Wheeler (03)

### Section -II

#### 5. Balancing :

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. (06)

#### 6. Vibrations :

Basic concepts and definitions, vibration measuring parameters- Displacement, Velocity and acceleration, Free and forced vibrations. Types of damping, Equivalent Springs (04)

**7. Single degree of freedom systems :**

Free vibrations with and without damping (Rectilinear, Torsional & Transverse), degree of damping. Logarithmic decrement, equivalent viscous damping, Coulomb damping. (05)

8. Forced vibrations with viscous damping, magnification factor, frequency response curves, vibration isolation and transmissibility. Whirling of Shafts and Critical speeds (No numerical treatment) (05)

**Term Work**

1. Experiment on Gyroscope.
2. Generation of involute gear tooth profile.
3. Problems on Epicyclic gear train using tabular method.
4. Determination of M.I. by Bi-filar suspension, Trifilar suspension or Compound pendulum.
5. Balancing of rotary masses (Static and Dynamic)
6. Determination of logarithmic decrement (Free Damped Vibrations) .
7. Forced vibration characteristics (Undamped and Damped vibrations)

**Books Recommended**

1. Theory of Machines by Rattan S.S.
2. Theory of Machines by Thomas Bevan.
3. Theory of Machines & Mechanisms by Shigley
4. Mechanism and Machine Theory by Rao, Duggipati.
5. Theory of Machines by Dr. V.P.Singh
6. Mechanical Vibrations by Grover
7. Theory of Machines by Ballaney
8. Theory of Machines by Jagdishlal

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**T.E. (Mech.) Part-I (Revised)****5. Machine Design-I**

Teaching Scheme :

Lectures : 3 Hrs. /Week

Practical : 2 Hrs./Alternate Week

Exam Scheme :

Theory Paper : 100 Marks

Term Work : 25 Marks

**Section -I**

1. Concept of Machine design, Types of loads, Factor of safety- its selection & significance, Theories of elastic failure & their applications, General design procedure, Review & selection of various engineering materials properties & I.S. coding of various materials, Factors governing selection of Engineering materials. (05)

2. Design of machine elements against static loading, knuckle joint, Turn buckle, Levers etc. (04)
3. Types of welded, bolted & riveted joints. Design of welded, Bolted & Riveted joints subjected transverse and Eccentric loads. (05)
4. Design of solid & hollow shafts, transmission & line shafts, splined shafts, Types of couplings, Design of Muff, Rigid flange & Flexible bushed pin type flange coupling, Design of keys & splines. (06)

## Section -II

### 5. Design of Springs :

Various types of springs and their applications, Design of Helical, Compression & Tension springs subjected to static loading. Stresses induced in helical springs. (05)

### 6. Design of Power Screw :

Forms of threads, Design of power screw & nuts, Types of induced stresses efficiency of power screw, self locking and overhauling properties, Introduction to recirculating ball screw. (06)

7. Design of flywheel & pulley – Fundamental equation of motion, Torque analysis, Stresses in flywheel rim & spokes. Design of solid & rimmed flywheels. Design of pulley – Flat & V belt pulley. (05)

8. Selection of flat, V belt & rope drives as per the standard manufactures catalogue. (04)

## Term Work

**Part A :** Assignment based on the following.

- a) One Sheet of A 2 size containing chart/table showing various engineering materials, their composition, properties & applications.
- b) Two problems on design of helical Springs subjected to static load.
- c) One problem each on bolted and welded joints subjected to eccentric loading.

**Part B :** Design , Drawing of the following. (Any Two)

1. Knuckle joint or turn buckle.
2. Rigid or flexible flange coupling.
3. Application of power screw.

**Note :**

- 1) A detail report of design procedure calculation and sketches should be submitted along with A 2 size drawing Sheet containing details & assembly.
- 2) All the assignments should be solved by using standard design procedure using design data book such as PSG design Data book.

**Ref. Books**

- 1) Design of Machine Elements by V.B.Bhandari.
- 2) Machine Design by R.K.Jain.
- 3) Machine Design by Pandya Shah.
- 4) Machine Design Integrated approach by Robert L. Norton.
- 5) Design of Machine Element by J.F. Shigley.
- 6) Design of Machine Element by M.F.Spotts.
- 7) PSG Design data Book.

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**Shivaji University, Kolhapur**  
**T.E. (Mech.) Part-II (Revised)**  
**5. Machine Design-II**

Teaching Scheme :  
 3 Hrs. Lectures /Week  
 2 Hrs. Pract./Week

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

**Section -I**

**1. Design for fluctuating loads :**

Stress concentration - causes & remedies, fluctuating stresses, S-N. diagram under fatigue load, endurance limit, notch sensitivity, endurance strength- modifying factors, design for finite and infinite life under reversed stresses, cumulative damage in fatigue failure, Soderberg and Goodman diagrams, modified Goodman diagram, fatigue design for components under combined stresses such as shafts, and springs. (06)

**2. Interaction of materials, processing and design :**

General principles of designing for manufacture, such as use, manufacture & design functions. Design for casting, forging and machining, design for assembly and designing with plastics. (03)

**3. Gears :**

Design considerations of gears, material selection, types of gear failure. Spur Gear : Gear tooth loads, No. of teeth, face width, strength of gear teeth, static beam strength ( Lewis equation .) Barth equation, dynamic tooth load ( spott's equation ) wear strength (Bucking ham's equation), Estimation of module based on beam strength and wear strength. Gear design for maximum power, Methods of gear lubrication. Construction of gears such as hub, web, arm, rim type etc. (05)

Helical Gears : Formative number of teeth in helical gears, force analysis, beam & wear strength of helical gears, effective load & design of helical gear, Herringbone gears. (03)

**4. Brakes :** Design considerations in brakes, Band, Internal expanding shoe, External contracting long & short shoe. Energy equation. Thermal considerations and rating of brakes. (03)

**Section -II**

**5. Clutches :** Design requirements of friction clutches, selection criteria, torque transmitting capacity of single plate clutch, multiplate clutch, cone clutch and centrifugal clutch (03)

**6. Design of bearings :**

i) Introduction to Tribological consideration in design : Friction, Wear, Lubrication.

(02 )

- ii) Rolling Contact Bearing: 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, Oil seal and packing. (04)
- iii) Sliding contact bearing : Bearing material and their properties : Sintered bearing materials, bearing types and their construction details. (02)
- iv) Hydro-dynamic lubrication : basic theory, thick and thin film lubrication, Reynolds's equation, Sommerfield Number, Design consideration in hydro-dynamic bearings, Raimondi and Boyd method relating bearing variables, Heat balance in journal bearings, Temperature rise, Introduction to hydro static bearings. (03)

#### 7. Design for pressure Vessels :

Thick and thin cylinders, failure criteria of vessels : Lamé's equation, Clavarino's and Birnies equation. Auto frettage and compound cylinders, types of pressure vessels- horizontal and vertical, classification of pressure vessels as per IS : 2825, 1969. Introduction to design of pressure vessels as per IS codes. Shell and end closures. Effect of opening and nozzles in shell and covers, Types of pressure vessel supports. (06)

### Term Work

#### A) Total Two design projects :

A detail design report and A 2 Size sheet containing working drawing of details and assembly of project based on

- a) Pressure Vessel.
- b) Any one of the Braking system or Clutch system
- c) Any other relevant Mech. system.

#### B) Assignments based on

- i) Four problems on fluctuating loads.
- ii) Study of Ball bearing mountings and its selection.
- iii) Two problems on design of gear drives.

### Ref. Books

- 1) Design of Machine Elements by J.E. Shigely
- 2) Engg. Design Material and processing approach by George Dieter.
- 3) Design of Machine Elements by V.B.Bhandari.
- 4) Design of Pressure Vessel by Harvey.
- 5) Process Equipment Design by Sen Bhattacharya.
- 6) PSG Design data Book.
- 7) Bearing Manufacturers Catalogue.
- 8) I.S. Code for Unfired Pressure Vessel I. S. 2825.
- 9) Machine Tool Design Data Book. C.M..T.I., Bangalore.
- 10) Machine Design by Hall, Holowenko, Schaum's outline series

- 11) Process Equipment Design by M.V. Joshi.
- 12) Machine Design by Robert L. Norton.
- 13) Introduction to Tribology by Mujumdar.

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## **T.E. (Mech.) Part-II (Revised)**

### **9. Industrial Case Study**

Teaching Scheme :  
2 Weeks During Vacation After T.E. Part-I  
( To be Done by the Student )

Exam Scheme :  
Term Work : 25 Marks

#### **Objective :**

Students are expected to get exposed with Industrial Working Environment for Two Week duration

#### **Study Topics :**

Any One of the following Topics.

Product Design and Analysis, Process Improvement, Rejection Analysis, Productivity Improvement, Value Engineering, Material Handling, Industrial Engineering, Computer Application, Material Selection, Management Principles & Techniques.

#### **Industries :**

Small, Medium or Large Scale Industries in Manufacturing, Processing, Service Sector, etc.

#### **Reporting :**

Case Study certified by concerned Industries should be submitted on A 4 Size paper Type return in 03 Copies ( about 20 to 25 pages)

#### **Assessment :**

Assessment of the case study report will be done at the end of T.E. Part-II by the concerned Batch Teacher by conducting Oral Examination.

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

### **8. General Proficiency-II**

Teaching Scheme :  
2 Hrs. /Alternate Week

Exam Scheme :  
Term Work : 25 Marks

#### **Purpose :**

To develop presentation skills, Communication Skills by using techniques like Mock Interviews, Use of Computer, Books, News Papers, Journals & Periodicals.

#### **Topics :**

Students are expected to collect information on an article by using various resources. This article is presented by using slide projector, Computer presentation facilities etc.

1. Writing Resume/ Bio data/Letters.
2. Collecting latest information on new products and its Discussion.
3. Analysis of information like balance sheet, Company Profile.
4. Study of various Instruments, Hand Tools.
5. Study of various specifications, Purchase & Sale documents, Telephone bills, Electricity bills, Tax bills, etc.
6. Market Survey Techniques, Advertising & Sales Promotion Techniques.
7. Mock Interviews.
8. Collecting information about latest techniques and presenting the report on the same.

#### **Note :**

1. The Mock Interviews are to be conducted by the batch Teacher along with Training & Placement Officer of the Institute .
2. Reports on the above activities in the form of Journal is to be submitted to the concerned Teacher.

#### **Assessment :**

The Assessment is to be done by the concerned Teacher on the basis of presentation made by the Student on any one of the above topics using modern presentation facilities at the end of the Term and the Journal submitted by him.

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

### **9. Industrial Case Study**

Industrial Case study is to be carried out after T. E. (Part - I), in vacation for two weeks the assessment & valuation in T. E. (Part- II) on basis of points mentioned in T. E. (Part - II) syllabus.

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

### **10. CAD/CAM Lab-I**

Teaching Scheme :  
Practical :2Hrs./Week

Exam Scheme :  
Term Work : 25 Marks

1. One assignment on CAD/CAM definition, its significance in product cycle and automation, Hardware requirements for CAD System.
2. To develop and run ' C ' Programs for following items in Machine Design ( Any Three)
  - a) Design of Knuckle Joint or Turn Buckle.
  - b) Design of Power Screw.
  - c) Design of Bolted or Rivetted Joints.
  - d) Design of Springs.
  - e) Selection of ' V ' belts or Flat belts as per manufacturers catalogue.
3. Solid Modelling using AutoCAD2002 or above ANSYS / NISA / ALGOR / Pro Engg / CATIA / IDEAS or equivalent software- Four assignments on 3 D wire frame/Surface/Solid Modeling using any advanced modeling software mentioned above containing solid models of complicated machine parts and simple 3 D assembly containing 05 parts.

#### **Note :**

1. Term work shall contain minimum 08 assignments as mentioned above
2. Assignment of Term Work shall be done based on internal Oral by Batch Teacher.

### **Reference Books**

1. CAD/CAM by M.P.Grover. and E.W.Zimmer, Prentice Hall of India Pvt. Ltd.,
2. Computer Aided Design by Krishnamorthay & Rajeev, Narora Publication.
3. CAD/CAM –Theory and Practice by Zeid, Tata McGraw Hill.
4. Design of Machine Element by V.B.Bhandari,.
5. CAD/CAM/CIM by P. RadhaKrishna & S. Subramanyan.

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## **T.E. (Mech.) Part-II (Revised)**

### **1. Industrial Management**

Lectures 3 Hrs. per Week  
Practical 2 Hrs. per Week

Theory Paper 100 Marks  
Term Work 25 Marks

#### **Section- I**

##### **1) Business Environment :**

Introduction, Environmental factors influencing business, external environment, General environment, Task environment, business ethics and social responsibility of business. Effect of Globalization. (03)

##### **2) Functions of Management :**

Definition of Management , Management environment.

Planning – Need, Objectives, Strategy, policies, Procedures, Steps in Planning, Decision making , Forecasting.

Organizing -- Process of Organizing importance and principle of organizing, departmentation, Organizational relationship, Authority, Responsibility, Delegation, Span of control.

Staffing -- Nature, Purpose, Scope, Human resource management, Policies, Recruitment procedure training and development, appraisal methods.

Leading -- Communication process, Barriers, remedies, motivation, importance, Theories, Herzberg's theory, Maslow's theory ,McGrager's theory, leadership style.

Controlling- Process, requirement for control Management , accountability. (10)

##### **3) Introduction To Functional Areas Such As**

Marketing :

-- Marketing Concepts –Objective –Types of markets

-- Market Segmentation, Market strategy- 4 AP's of market

-- Market Research, Salesmanship, Advertising. (03)

##### **4) Financial Management :**

Sources of Finance, Financial institutions, financial statements, Balance sheet and P & L Account(Contents only),use and importance, Break even Analysis and its applications, accounting ratios. (02)

##### **5) Personnel Management :**

Functions of personal department, Industrial relations, training & development (02)

#### **Section- II**

##### **6) Cost and Cost Control :**

Classification of cost-Direct material, Direct labour, Direct expenses, Factory overhead, Methods of costing, cost control and cost reduction. (04)

##### **7) Materials Management :**

Definition , Scope, advantages of materials management ,functions of materials management, Purchasing objectives,5-R Principles of purchasing, Functions of Purchase department

,Purchasing cycle, Purchase policy & procedure, Evaluation of Purchase Performance .EOQ. Vendor development . Just in time inventory.

Inventory Control-ABC Analysis, Inventory cost relationships, selective control of inventory-ABC analysis, HML analysis, VED analysis, SDE analysis, FSN analysis etc. MRP, Make or buy decisions. (05)

**8) Engineering Economics :**

Introduction to basic economics terms such as demand and supply, Introduction ,Time value of money, cash flows, depreciation, Types of depreciation, reasons for depreciation ,Methods of computing depreciation, sinking fund method, Declining balance method, Investment decisions for capital assets, evaluation criteria for Investment decisions, Payback period, average rate of return. Benefit cost ratio (BCR).cost accounting. (03)

**9) Industrial Safety:**

Reasons for accidents , prevention of accidents, Promotion of safety mind ness. (02)

**10) EDP and SSI :**

Modern concept of an entrepreneur, Scheumpeter’s and Peter Drucker’s concepts of an entrepreneur. Qualities required to become entrepreneurs. Factors conducive for promoting entrepreneurship reasons for entrepreneurial failure, entrepreneurship development ,Role of Industrial interaction, Schools, training in the development of entrepreneurship

S S I :

Definition of SSI, Procedure to start Small Scale Industry. Institutions of offering assistance to SSI, Incentives offered to SSI, Problems of SSI, Feasibility report writing. (04)

**11) Introduction to E- Commerce :**

Introduction to Management Information System (MIS),Introduction to ISO 9000 procedures. (02)

Note : Numerical treatment to Materials management and cost control topics & accounting ratios.

**Term Work :**

1) Five exercises based on above syllabus.

2) Five case studies on the following.

New product launch Purchasing activities, recruitment procedure, MIS management of Funds, Office communication, Incremental analysis of costs, EDP Leadership style, decision analysis, elements of costing.

**Reference Books**

1. Management – James A.F. Stoner, R. Edward Freeman, Prentice Hall of India New Delhi.
2. Management, Today – Principles and Practice – Gene Burton and Manab Thakur, Tata McGraw Hill Publishing Company, New Delhi.
3. Essentials of Management – Koontz & O’ Donell.
4. Human Behaviour at Work Organisational Behnvior – Keith Davis, Tata McGraw Hill Publishing Company, New Delhi.
5. Business Management – J.P. Bose, S. Talukdar, New Central Agencies (P) Ltd.,
6. Marketing Management – Philip Kotler, Prentice Hall of India New Delhi.

7. Industrial Engineering & Management – O.P. Khanna.
8. Management Information System, Conceptual Foundation – W.S. Jawadekar Venus Prakashan.
9. Total Quality Management – H. Lal.

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

### 3. Mechanical Measurement & Control

Teaching Scheme :

Lectures : 3 Hrs. /Week

Practical : 2 Hrs./Alternate Week

Exam Scheme :

Theory Paper : 100 Marks

Term Work : 25 Marks

#### Section -I

1. Mechanical Measurement : Need of Mechanical Measurement, Instruments, Measurement methods, Generalized measurement system and its functional elements instrument characteristic : static and dynamic and analytical treatment calibration, Classification and various types of transducers. (03)
2. Measurement of Temperature : Importance of temperature measurement, Thermometer, Thermocouple-Principle, types, calibration, RTD, Thermister measurement of low temperature. (02)
3. Measurement of Pressure and Vacuum : Importance of pressure and vacuum measurement, range of high pressure and vacuum, Bourdon tubes, Dead weight pressure gauge tester, Diaphragm gauge, LVDT, Pizo electrical pressure gauge, low vacuum gauges-McLeod gauge, thermal conductivity gauge, Pitot gauge, Ionization gauge. (03)
4. Measurement of angular Speed : Importance of angular speed measurement, mechanical tachometers, Electrical tachometers- Drag cup, Tacho generator, Inductive, capacitive and photo electric pick up, Stroboscope. (03)
5. Measurement of Flow : Importance of flow measurement, Water meter, Turbine meter, Rota meter, Gas flow meter, Hot wire anemometer, drag press flow meter (analytical treatment) (02)
6. Measurement of strain : Classification of strain gauges, principle of electrical strain gauge, gauge factor (analytical treatment) analysis of whetstone's network using strain gauges, types of electrical strain gauges, mounting, application to measure –load/force, torque. (04)
7. Measurement of vibration and Sound : Importance of vibration measurement, classification of vibration measuring instruments, seismic instrument, accelerometer using strain gauges, piezo electric accelerometers, importance of acoustical measurement, sound pressure and power levels, types of microphones- capacitive, crystal, electrodynamics, carbon, sound level meter. (03)

## Section -II

1. Need for control, Manual Vs Automatic Control, advantages of automatic control, Open loop Vs Closed loop control, generalised control system. (02)
2. Mathematical conversation of control components : Helical spring, Viscous damper & their combinations, resistor, inductors, capacitor, series and parallel electrical circuits and mech systems, thermal and fluid systems, direct and inverse analog, grounded chair representation for material system. (03)
3. Block diagram algebra, rules of block diagram algebra, reduction of block diagrams, block diagrams transfer functions representation of speed, temperature & fluid systems, AC & DC Motors. (05)
4. Linearization of nonlinear functions, Linearization of operating curves, Steady state analysis & equilibrium. (04)
5. Modes of Control : a) On Off Control b) Proportional (P) Control c) Integral (I) Control d) Derivative (D) Control e) P + I f) P + D g) P + I + D (including analytical treatment ) (04)
6. Transient Response : Distinct zeros, Repeated zeros, Complex conjugate Zeros, Damping and Natural frequency, General form of transient response, Routh's stability criteria. (02)

## Term Work

1. Temperature measurement using Thermocouple, RTD & Thermistor
2. Preparation of Thermocouple bit and Calibration.
3. Testing of a mechanical pressure gage using Dead weight Pressure Tester.
4. Vacuum measurement using U tube manometer and Mechanical Vacuum Gage.
5. Angular speed measurement using Stroboscope, Photoelectric pick-up, Tachometer or Inductive pick-up tachometer.
6. Flow Measurement using Rotameter / watermeter.
7. Measurement of Bending Strength or Force Using Strain Gauges.
8. Vibration Measurement using Seismic Instrument and acoustic measurement using a sound level meter.
9. Experiment on On Off Temperature Controller.
10. Experiment on DC/AC Motor speed control.
11. Experiment on various modes of control IP, P + I, P + D, P + I + D.
12. Design of Automatic control system with
  - i) Plant layout.
  - ii) Block diagram.
  - iii) Steady state Analysis
  - iv) Design of controller.
 for various control systems like Temp. flow etc.

(Any 08 Experiments 4 from 1 to 8 & 4 from remaining.)  
 (A Journal based on above experiments to be written)

## Text Books

1. Mechanical Measurements and Control by D.S.Kumar.
2. Mechanical Measurements by Sorihi & Dr. Radhakrishnan.
3. Mechanical Measurements by Beckwith & Buck and Roy D. Marangoni, Narora Publishing House, New Delhi.
4. Automatic Control Engineering by F.H. Raven 5<sup>th</sup> Edition. McGraw Hill Student Edition)

## Reference Books

1. Modern Control Engineering by K. Ogata.
2. Control Engineering by B.C. Kuo.

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

#### 2. 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

### Section -I

#### 1. Introduction :

Modes of heat transfer. The laws of heat transfer, Thermal conductivity and coefficient of heat transfer. (02)

2. Simple steady state problems in heat conduction, concept of thermal resistance and conductance Electrical analogy of thermal circuits. General equation of temperature field in three dimensional Cartesian co-ordinate system. Laplace and Poisson;s equations. Deduction of one dimensional steady state conduction equations. Application of above (one dimensional case) equation to the system of plane wall (including composite structure) as well as to the system with radial heat conduction i.e. cylinders & Sphere (including composite structures) steady state conduction one dimensional) through extended surface (fins) of constant cross section. Heat Transfer through fins and fin efficiency and effectiveness. One dimensional steady state heat conduction with uniform heat generation, (plane wall & solid cylinder) critical radius of insulation. Thermal conductivity of engineering materials. Effect of temperature on the conductivity of material. Influence of thermal conductivity variation on the temperature profile and rate of heat conduction for one dimensional steady state system. (for plane wall) Concept of unsteady state heat conduction. Transient heat flow system with negligible internal resistance. (10)

#### 3. Radiation :

Nature of thermal radiation, definitions of absorbtivity, reflectivity, transmissivity, monochromatic emissive power, total emissive power and emissivity. Concept of black body & gray body. Kirchoffe laws, Weins law and Plancks law. Deduction of Stefan

Boltzman equation. Lambert's cosine rule, Intensity of radiation. Energy change 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 for two surfaces which see each other and nothing else. (08)

## Section -II

### 4. Convection :

Nature of convection, free and forced convection, convective heat transfer coefficient (h) and Nusselt number. Knowledge of the methods of evaluation of 'h' dimensional analysis, exact and approximate boundary layer analysis by analogical method (knowledge of boundary layer analysis be only descriptive in nature and must not include derivations or solutions of mathematical equations for any particular cause) Concept of reference temperature, Empirical correlations for forced and free convection as applied to some simple cases of tubes, plates (in different positions) (08)

### 5. Boiling and condensation :

Nucleate and film boiling phenomenon : drop wise and film wise condensation, Nusselt's theory of condensation nature of heat transfer in such phenomenon. (03)

### 6. Heat Exchangers :

Types of Heat exchangers direct transfer type, Storage types, Direct contact types heat exchangers, Tubular heat exchangers, Extended surface heat exchangers. Classification according to flow arrangement. Fouling factor, mean temperature difference, LMTD for parallel flow, counter flow, mean temperature for cross flow, correction factor, special cases. The effectiveness by NTU method, effectiveness of parallel, counter flow and cross flow heat exchangers other design consideration. Heat pipe component and working principle.(Elementary treatment only) (07)

### 7. Introduction to Mass Transfer :

Introduction, modes of mass transfer, analogy between heat and mass transfer. Mass diffusion, (Mass basis/Mole basis/Fick's law of diffusion) (02)

## References

1. Heat Transfer – A Practical approach by – Yunus -A – Cengel ( Tata McGraw Hill)
2. A Text Book on Heat Transfer by Dr. S. P. Sukhatme.
3. Heat Transfer by J.P. Holman , McGraw Hill Book Company, New York.
4. Heat Transfer by Chapman A.J. McGraw Hill Book Company, New York.
5. Heat and Mass Transfer, S.C. Arrora and S. Dokoundwar, Dhanpat Rai and Sons, Delhi.
6. Fundamentals of Heat and Mass Transfer by R.C. Sachdev, Willey Eastern Ltd.,
7. Fundamentals of Heat and Mass Transfer by C.P. Kothandaraman
8. Heat and Mass Transfer by R.K. Rajput, S. Chand & Company Ltd., New Delhi. 110055
9. Heat and Mass Transfer by Dr. D. S. Kumar S.K. Kataria & Sons, Delhi.
10. Heat Transfer by P.K. Nag, Tata McGraw hill Publishing Company Ltd., New Delhi.

## List of Experiments

- Experiment must be set simultaneously and the no. of students in each group working on a setup shall not exceed 05 students.
  - Any 10 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. Experiment of Heat Generation.

### 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.

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

### 6. Tool Engineering

Lectures :3 Hrs./Week

Theory Paper 100 Marks(4 hrs.)

Practical : 2 Hrs./Alternate Week

Term Work:25 Marks

### Section- I

- 1) Theory Of Metal Cutting- Wedge action, Concept of speed, Feed and depth of cut, orthogonal and oblique cutting. Mechanics of metal cutting-Chip formation, Types of chips, cutting ratio, shear plane and shear angle, velocity relationships, force measurement by dynamometers, types and applications of dynamometers, cutting tool materials and their properties.  
Machinability of Metals- Factors affecting, improvement and machinability index.  
Tool life - Types of wear, relationship with cutting parameters, Taylor's equation, improvement measures. Surface finish- Factors affecting, effect of cutting parameters, improvements. Heat generation in machining, its effect on cutting force, tool life and surface finish, types and selection criteria of cutting fluids. (09)

- 2) Tool geometry-Parts, angles and types of single point cutting tools, tool geometry of single point cutting tool, tool geometry of multipoint cutting tools.-drills, milling cutters, reamers. (04)
- 3) Form tools and Automat –Types (Flat, circular, Dovetail) Correction of form tools with and without rake angles, tool layout of single spindle, automat, process sheet ,cam profile, tool layout, calculation of production rate. (07)

## Section- II

- 4) Jigs and Fixtures- Applications ,basic elements, principles and types of locating, clamping and indexing elements, auxiliary elements like tenon, setting lock etc. Type of Jigs and Fixtures-Design consideration of Jigs and fixtures with respect to different operations. (08)
- 5) Press tools – Dies, punches, types of presses , clearances, types of dies, strip layout, calculation of press capacity, center of pressure ,Design consideration for die elements. (06)
- 6) Economic aspect of tooling-Elements of costs, method of costing and cost estimation, depreciation, economic of tooling –Tool selection and tool replacement with respect to small tools. (06)

## Term Work

- 1) Study of tool geometry of single point cutting tool and any one multipoint cutting tool.
- 2) Study and measurement of cutting forces with tool dynamometer.
- 3) Design and Drawing of one die set (Sheet metal).
- 4) Design and drawing of one drilling/reaming/tapping jig.
- 5) Design and drawing of one milling /Lathe Fixture.
- 6) Two industrial visits. 1) for sheet metal 2) for Jigs and fixtures  
Reports of industrial visit is required.

## Reference Books

- 1) Production Technology-HMT –Tata McGraw-Hill Publishing Ltd.
- 2) Metal cutting theory & Tool design- Mr. Arshinnov MIR Publication.
- 3) Fundamentals of Tool Design design-ASTME Publication.
- 4) Tool Design-Donaldson –THM Publication
- 5) Text Book of Production Engg.- P.C. Sharma- S. Chand Publication
- 6) Machine tool Engg.-G.R. Nagarpal- Khanna Publication
- 7) Thoery of Metal Cutting-Sen Bhattacharya
- 8) Production Engg. Design (Tool Design)-S. Chandar & K. Surendra Satya Prakashan, New delhi.
- 9) Production Tooling Equipment-S.A.J.Parsan
- 10) Jigs & Fixtures- Kempster ,ELBS.

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## **T.E. (Mech.) Part-II (Revised)**

### **2. Metrology & Quality Control**

Lectures 3 Hrs. per Week  
Practical 2 Hrs. per Week

Theory Paper 100 Marks  
Oral Exam. 25 Marks

#### **Section -I**

Term Work : 25 Marks

- 1) Measurements : International standards of length-Line and end measurement, Need of measurement, possible errors in measurement, slip gauges. (03)
- 2) Tolerances and gauging : unilateral and bilateral tolerances, Limits, Fits, Types of Fits, IS specifications of limits. Importance of limits, System in mass production, limit gauges used for plain and taper works. (04)
- 3) Magnification : Principles and characteristics of measuring instruments, Mechanical, Optical, electrical, Pneumatic method of magnification, different types of Verniers, Micrometers, Dial gauges, Mechanical and pneumatic, Types of comparators. Use of comparators in inspection. (03)
- 4) Measurement of angles, tapers and radius : Bevel Protractor, Spirit level, Clinometers, angle Decker, standard balls and rollers for angle measurement, angle slip gauges, radius measurement of circular portion, measurement of concave and convex surface radius. - (03)
- 5) Interferometry : Principle of Interferometry and application in checking of flatness, angle and height. (02)
- 6) Straightness and Flatness : Straight edge, use of level beam comparator, autocollimator testing of flatness of surface plate(Theoretical treatment only) (02)
- 7) Surface finish : Types of textures obtained during machine operation, range of C.L.A. value in different operations in numerical assessment of surface finish(B.I.S. Specifications of C.L.A. value)-sample length of different machining operations. Direction of lay, texture,symbols , instruments used in surface finish assessment. (03)

#### **Section -II**

- 8) Measurement of External Threads : Different errors in screw threads, measurement of forms of thread with profile projector, pitch measurement, measurement of thread diameter with standard wire, screw thread micrometer. (03)
- 9) Measurement of Spur Gears : Run out checking, Pitch measurement, profile checking, backlash checking, tooth thickness measurement, alignment checking, errors in gears, checking of composite errors. (03)
- 10) Quality control

A)Concept of Quality and quality control, elements of quality and its growth, purpose, setup, policy and objective,factors controlling and quality of design and conformance, balance between cost and quality and value of quality. Specification of quality ,planning through trial lots and for essential information.

- B) Introduction to topic such as in process quality, quality circles, quality management, total quality control, ISO 9000 and equivalent Indian standards. (05)
- 11) Statistical Quality Control-Importance of statistical method in quality control, measuring of statistical control variables and attributes. Measurement/inspection, different types of control charts (X Bars, R, P. charts) and their constructions and their application. (03)
- 12) Acceptance Sampling- Sampling inspection and percentage inspection, basic concept of sampling inspection, operating characteristic curves, conflicting interests of consumer and producer, producer and consumers risks, AWQL, LTPD, ADGL, single and double sampling plans. (03)
- 13) Recent trends in quality Control-
- 1) CAQC
  - 2) Six Sigma
  - 3) Zero defect
  - 4) T.Q.M.
  - 5) T.Q.C.
  - 6) Non-contact inspection
  - 7) Q.F.D.
  - 8) C.M.M.
  - 9) QUIZEN
  - 10) D.O.P. (Case study)
- (03)

## Term Work

Part-1 – Six experiments based on below referred areas in combination

- 1) Study and use of various Instruments
- 2) Use of comparator
- 3) Screw Thread measurement
- 4) Gear inspection
- 5) Use of Optical profile projector
- 6) Use of Sine bar
- 7) Use of Optical flat
- 8) Use of Standard ball and roller for angle measurement.

Part –2 – Three experiments based on following areas

- 1) X Bar and R chart
- 2) P chart
- 3) O.C. curves
- 4) Study of Quality control techniques

## Reference Books

- 1) Engg. Metrology- I.C. GUPTA
- 2) Practical Engg. Metrology- Sharp K.W.B. Pitman, London
- 3) Statistical quality control-A.L. Grant
- 4) Engg. Metrology-R.K.Jain, Khanna Publicer
- 5) Metrology-Taher
- 6) Statistical Quality control-R.C. Gupta
- 7) I.S. 919/1963
- 8) I.S. 2709/1964

- 9) Engg. Metrology-Hume K.G.,MC Donald,Techincal & Scientific ,London
- 10) Quality Control and Industrial – Duncon A.J.
- 11) Statistical –Taraporwala,Bombay
- 12) Total Quality Management-Dalela
- 13) Statistical quality Control-Mahajan

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## **T.E. (Mech.) Part-II (Revised)**

### **6. Advanced Production System**

Lecture 3 Hrs. per Week

Theory Paper 100 Marks

#### **Section -I**

- 1) Fundamentals of production Systems and automation :  
Types of production, system approach to production, conceptual model of closed loop production system, current trends in manufacturing.  
Automation- Definition, need, types, advantages, limitations, automation strategies.  
Future automated factories. (04)
- 2) Advanced Machine Tools-  
An overview of N.C. and C.N.C.  
DNC-General configuration, types, advantage.  
Adaptive control - Definition, Sources of variability, typical adaptive control systems, advantages. Condition monitoring. (03)
- 3) Group Technology and F.M.S. :  
Group Technology- Part families, PFA, Classification and coding system (OPITZ, MICLASS, CODE and BRISCH) advantages, limitations.  
FMS- Components, work stations, material handling devices, computer control system, automatic storage and retrieval system, applications, advantages. (05)
- 4) Industrial Robots-  
Robot- Definition, basic motions, common configurations, technical features, drive systems, end-effectors, sensors, method of programming, interlocks and work cell control. (04)
- 5) Computer Integrated Manufacturing Systems  
CIMS-Introduction, scope, evaluation, elements, socio-techno-economical justification, steps to implementation, obstacles, limitations. (04)

#### **Section-II**

- 6) Computerized Production System :  
Need for computerization, CIPMS,  
CAPP- Types advantages.  
Material requirement planning (MRP), Manufacturing Resources planning (MRP-II) (06)

- 7) Shop Floor Control & Automatic data collection Techniques :  
 Shop floor control-Introduction, need, phases in SFC  
 Automated data collection system-Automated identification methods, bar code technology, bar code Printers, bar code readers, Data acquisition systems. (05)
- 8) Computer Network & database Management :  
 Computer Network-Hierarchy of computers in production systems, network architecture, Local Area Network(LAN) Manufacturing automation protocols.  
 Database management-database management system(DBMS),DBMS Vs traditional file systems. RDBMS-  
 Distributed database management system-Introduction, importance, hardware design considerations. (05)
- 9) Emerging Technologies-Expert Systems, Computer vision, Simulation, concurrent engineering, multimedia communications. (04)

## Reference Books

1. Automation, Production Systems and Computer Integrated Manufacturing by M.P.Grover (1998 9<sup>th</sup> Print Prentice Hall of India Pvt. Ltd.,
2. The Design & operation of FMS 1<sup>st</sup> Edn.1983 by Dr.Paul G.Ranky IFS Publication Ltd.,
3. Group Technology Production Methods in Manufacturing by C. C. Gallagher, W.A. Knight 1<sup>st</sup> Edn. 1986 Ellis Harwood Ltd.,
4. CAD/CAM by M.P.Groover, E.W. Zimmers 18<sup>th</sup> Print 1999 PHI
5. Introduction to Robotics- Analysis, Systems Application by Saeed B. Niku  
 Pearson Education Pvt. Ltd.,
6. CAD/CAM/CIM by P.Radhakrishnan, S.Subramanyan  
 New age Int. (P) Ltd., Publishers.
7. Machine Tool Design by DR. N.K.Metha 10<sup>th</sup> Reprint 1993Tata McGraw Hill Publisher.
8. Industrial Robotics by Groover, Weiss, Nagel, Odrey TMH International.
9. Principle of Computer Integrated Manufacturing by S.Kant Vajpayee. PHI 1<sup>st</sup> Edn. 1999

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

### **7. Workshop Practice - V**

Practical 2 Hrs. per Week

Term Work 25 Marks

A Job consisting following operation with 5 to 6 components (Composite Job) excluding standard and commercial components. Operations like Turning, Boring, Drilling, Taping, Threading, Milling, Shaping, Taper turning etc

This job is for T.E. (Mech.)-Part –I & II .

Assessment of work done at the end of T.E. (Mech.)-Part-I as a term work of Workshop Practice-V.

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## **T.E. (Mech.) Part-II (Revised)**

### **4. Energy Engineering**

Teaching Scheme :  
Lecture 3 Hrs. per Week

Exam Scheme :  
Theory Paper 100 Marks

#### **Section -I**

1. Introduction :  
Man and Energy, Worlds and India's production and reserves of energy, present and future power position, energy alternatives. (02)
2. Solar Energy : Solar Energy Option : (15)
  - a) Solar radiation and its measurement – Solar radiation data, solar radiation geometry Prediction of availability of solar radiation
  - b) Liquid flat plate collector, general performance analysis with numerical problems, design considerations effect of various parameters on performance, Testing procedure.
  - c) Concentrating collectors – Introduction, cylindrical, parabolic collector, Compound parabolic collector, Central receiver collector.
  - d) Thermal energy storage – Introduction - Sensible, Latent and Chemical storage.
  - e) Solar pond, Solar Air heater, Solar Water heater and other applications of solar energy.
  - f) Solar photo Volatics.
  - g) Bio-conversion, different types of bio-gas plants and Gasifiers.

3. Fuel Cells :

Introduction, Principle and operation of fuel cells, classification and types of fuel. Fuel for fuel cells, performance characteristics of fuel cells, application of fuel cells. (03)

## Section -II

4. Wind Energy :

Introduction, Power of wind energy, conversion systems, types of wind machines. Performance of wind machines with numerical problems, applications and prospects in India. (04)

5. Geothermal Energy – Introduction, types of geothermal resources, methods of harnessing, geothermal energy applications, environmental problems and prospects in India. (03)

6. Tidal Power- Introduction, causes for tide formation, power of tide, tidal power plants, advantages and limitations. (02)

7. Ocean Thermal Energy – Introduction to O.T.E.C., open and closed cycle OTEC systems, prospects in India. (02)

8. Wave Energy – Introduction, power of wave energy, conversion devices. (02)

9. Energy Management - overview, National Energy, Strategy of India. Energy planning, Energy conversion opportunities and measures. (03)

10. Energy Audit – Scope, type and case studies. (04)

## Books Recommended

1. Solar Energy by Dr. S.P.Sukhatme Tata McGraw Hill.
2. Solar Energy by G.D. Rai Khanna Publishers.
3. Non Conventional Energy Sources by G.D.Rai.- Khanna Publishers.
4. Power Plant Engineering by Arora, Domkundwar. Dhanpat Rai & Sons.
5. Energy Policy for India by G.B.Desai.
6. Non Conventional Energy Sources by Bamai & Others.
7. Renewable Energy Sources by Twidal & Weirs.
8. Energy Technology (Non Conventional & Conventional) by S. Rao, Dr. B.B.Parulekar Khanna Publishers.
9. Energy Engineering by R.S. Kulkarni & Karmari.

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## **T.E. (Mech.) Part-II (Revised)**

### **4. Fluid & Turbo Machinery**

Lectures :3 Hrs. per Week  
Practical : 2 Hrs/Alternate Week

Theory Paper :100 Marks  
Term Work : 25 Marks

#### **Section -I**

1. Impulse Water Turbines :  
Euler's equation for work done in Rotodynamic Machines classification of water turbines, Pelton wheel, its construction and working, velocity triangles. Types , Pelton wheel design bucket dimensions, number of buckets, jet diameter, wheel diameter, jet ratio, speed ratio, number of jets, calculation of efficiency, power, discharge etc. Governing of Pelton wheel. (06)
2. Reaction Water Turbines :  
Principle of operation, construction and working of Francis and Kaplan Turbine, effect of modification of velocity triangles on runner shape, draft tube, cavitation calculation of various efficiencies, power, discharge, blade angles, runner dimensions etc. Governing of Francis and Kaplan turbine. Draft tube-types and analysis. (06)
3. Centrifugal Pumps:  
Working principles, Construction, types ,various heads, multistage pumps, velocity triangles, minimum starting speed, cavitation, MPSH and NPSH. Methods of priming calculations of efficiencies, discharge, blade angles, head, power required, impeller dimensions etc. (05)
4. Similarity Principles :  
Model testing, unit quantities, Specific speed of turbine (Pelton wheel, Francis turbine, Kaplan turbine), specific speed of pumps. Prediction of performance at other operating conditions. Performance characteristics of Turbines and pumps. (03)

#### **Section -II**

5. Air compressors:  
Application of compressed air , classification of compressor, reciprocating compressors, construction , work input, necessity of cooling , isothermal efficiency, heat rejected, effect of clearance volume, volumetric efficiency, necessity of multistaging, construction, optimum intermediate pressure for minimum work required, after cooler, free air delivered, air flow measurement, capacity control. Roots blower and vane blower( descriptive treatment) (08)
6. Rotodynamic Air Compressors :  
Centrifugal compressor, velocity diagram.Theory of operation, losses, Adiabatic efficiency, effect of compressibility, diffuser, prewhirl, pressure coefficient, slip factor, performance.  
Axial flow compressors, velocity diagram, degree of reaction, polytropic efficiency, surging, choking, stalling, performance, comparison with centrifugal. (07)
7. Gas turbines :  
Working principles, applications, open, closed cycle and their comparison. Cycle modified to regeneration, reheat, inter cooling performance. Calculation of gas turbine work ratio, efficiency etc. (05)

## Term Work (Alternate Week)

Any Seven experiments.

1. Study and trial on Pelton wheel.
2. Study and trial on Francis/ Kaplan turbine
3. Trial on Centrifugal pump
4. Study and demonstration of reciprocating pump and hydraulic ram
5. Study and trial on reciprocating compressor
6. Study and trial on centrifugal blower
7. Study of hydraulic devices- Intensifier , Accumulator, Hydraulic jacks, press, Crane.
8. Study of other types of pumps- Gear pump, Jet pump, submersible pump, air lift pump

## References

1. Hydraulic Machines by V.P. Vasantdani
2. Fluid flow machines by N.S. Govindrao
3. Turbo machines by S.M. Yahya
4. Fluid power Engineering by D.S. Kumar
5. Steam & gas Turbines by R. Yadav
6. Steam & gas Turbines by V. Ganeshan
7. Thermal Engg. by Kumar vasantdani
8. Thermal Engg. By P.L. Balleny
9. Gas turbines & Compressor by Cohen & Rogers
10. Thermodynamics & Heat Engines – Vol-II by R. Yadav

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## **T.E. (Mech.) Part-II (Revised)**

### **8. CAD/CAM Lab-II**

Teaching Scheme :  
Practical 2 Hrs./Week

Exam Scheme :  
Term Work : 25 Marks  
Oral Exam : 25 Marks  
Oral Exam. based on CAD/CAM LAB-I/II

### **Term Work**

1. Automation in Manufacturing, NC Manufacturing, CNC, DNC, advantages and disadvantages, Product cycle and CAM. One Assignment based on above topic.
2. Fundamentals of part programming, manual part programming, G and M Codes, Subroutines, Canned cycles, do loops. One assignment based on above topic.
3. Developing any four part programs out of the following lathe and milling operations.
  - i) Plain turning and facing .
  - ii) Taper and profile turning.
  - iii) Thread cutting.
  - iv) Plain Milling.
  - v) Key way Milling.
  - vi) Pocket Milling.
4. Industrial visit to study the following CNC systems, w.r.t. Automation, or ATC CNC Machines, or Flexible tooling system. A visit report to be included.

### **Reference Books**

6. CAD/CAM by M.P.Grover. and E.W.Zimmer, Prentice Hall of India Pvt. Ltd.,
7. Computer Aided Design by Krishnamorthay & Rajeev, Narora Publication.
8. CAD/CAM –Theory and Practice by Zeid, Tata McGraw Hill.
9. Design of Machine Element by V.B.Bhandari,.
10. CAD/CAM/CIM by P. RadhaKrishna & S. Subramanyan.

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**T.E. (Mech.) Part-II (Revised)****7. Workshop Practice -VI**

Teaching Scheme :  
Practical 2 Hrs./Week

Exam Scheme :  
Term Work : 25 Marks  
Practical Exam : 25 Marks  
Practical Exam. . : 6 Hrs.

Composite Job incomplete in T.E. (Mechanical) Part-I should be completed during T.E. (Mechanical) Part-II. The Work done during T.E. (Mechanical) Part-II should be assessed as term work for Workshop Practice-VI at the End of Part-II.

Practical Examination of 6 Hrs. duration having 2 to 3 parts on the operations mentioned in Workshop Practice-V, VI.

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**T.E. (Mech.) Part-II (Revised)****3. Automatic Control & Fluid Systems**

Lectures : 3 Hrs./Week  
Practical : 2 Hrs./Week

Theory Paper 100 Marks  
Term Work 25 Marks

**Section- I**

1. Root Locus Method :  
Significance of root locus, Construction, General Procedure (04)
2. State Space Method :  
System representation- direct programming, parallel programming, series programming, General programming, Closed loop system. (04)
3. Frequency Response Method :  
Logarithmic representation, Experimental determination of frequency response, system types, polar plots. (04)
4. Introduction to System Compensation:- Lead compensation, Lag compensation, & Lead-lag compensation (04)
5. Use of Softwares. (e. q. Matlab) for (04)  
i) Root Locus method. ii) State space method. iii) Logarithmic plot.

**Section- II**

1. Fluid Power Systems and Components

Fluid properties, Hydraulic and Pneumatic Systems – Application areas, Merits and Demerits, Comparison with electrical, Mechanical and Hybrid Systems. (03)

2. ISO/ JIC Symbols, Hydraulic system Elements- Strainer/Filter, Pumps, Conductors and connectors, pressure control valves, Direction control valves, Flow control valves. (03)
3. Hydraulic Circuits & Applications, Designing Hydraulic circuit for linear, regenerative, sequence controls. (03)
4. Fluid conditioning Systems & Components – a) Filter b) Strainer c) Lubricators d) Heat Exchangers etc. (02)
5. Fluid Power Control Components for Pressure Flow and Direction. (02)
6. Actuators linear & Rotary including Motors & Fluidics. (03)
7. Fluid Power System Safety & Maintenance. (02)
8. Study of Fluid Power Circuits. (02)

### Term Work

1. Four Assignments Based on Chapters 1 to 4 in Section – I
2. Study of Symbols.
3. Circuit Preparation by using Hydraulic & Pneumatic Trainer Kit.(meter in, meter out, sequencing, synchronising )
4. Circuit Preparation by using Pneumatic Trainer Kit.
5. Study of Fluid Power Pump & Power Packs.
6. Study of Circuits for M/C Tools.
7. Study of Fluidics.
8. An Industrial Visit to Study the Control Systems (For Subjects MMC & Automatic Control) Industrial Visit report to be submitted.

### Reference Books

1. Automatic Control Engineering - F.H.Raven.
2. Hydraulic & Pneumatics – Stewart.
3. Industrial Hydraulic- Piperser.
4. Fluid Power With Applications – Aespostion.
5. Industrial Hydraulic Manual – Vickers.
6. Hyd. System Principles & Maintainance – by S. R. Mujumdar – Tata Mc. Hill.
7. Pneumatic System Principles & Maintainance – by S. R. Mujumdar – Tata Mc. Hill
8. Modern Control Engg. – K. Ogata – 3<sup>rd</sup> Edition 2. Pentice Hall.
9. Automatic Control System – Benjamin C. Kuo. P. H. I. –7<sup>th</sup> Edition.

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T.E.(Mech)/T.E.(Mechanical) Part-I & II/birje

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