

## ME- 5001 TURBO MACHINERY

**Unit I:** Energy transfer in turbo machines: application of first and second laws of thermodynamics to turbo machines, moment of momentum equation and Euler turbine equation, principles of impulse and reaction machines, degree of reaction, energy equation for relative velocities, one dimensional analysis only.

**Unit II:** Steam turbines: impulse staging, velocity and pressure compounding, utilization factor, analysis for optimum U.F Curtis stage, and Rateau stage, include qualitative analysis, effect of blade and nozzle losses on vane efficiency, stage efficiency, analysis for optimum efficiency, mass flow and blade height. Reactions staging: Parson's stages, degree of reaction, nozzle efficiency, velocity coefficient, stator efficiency, carry over efficiency, stage efficiency, vane efficiency, conditions for optimum efficiency, speed ratio, axial thrust, reheat factor in turbines, problem of radial equilibrium, free and forced vortex types of flow, flow with constant reaction, governing and performance characteristics of steam turbines.

**Unit III:** Water turbines: Classification, Pelton, Francis and Kaplan turbines, vector diagrams and work-done, draft tubes, governing of water turbines. Centrifugal Pumps: classification, advantage over reciprocating type, definition of mano-metric head, gross head, static head, vector diagram and work done. Performance and characteristics: Application of dimensional analysis and similarity to water turbines and centrifugal pumps, unit and specific quantities, selection of machines, Hydraulic, volumetric, mechanical and overall efficiencies, Main and operating characteristics of the machines, cavitations.

**Unit IV:** Rotary Fans, Blowers and Compressors: Classification based on pressure rise, centrifugal and axial flow machines. Centrifugal Blowers Vane shape, velocity triangle, degree of reactions, slip coefficient, size and speed of machine, vane shape and stresses, efficiency, characteristics, fan laws and characteristics. Centrifugal Compressor - Vector diagrams, work done, temp and pressure ratio, slip factor, work input factor, pressure coefficient, Dimensions of inlet eye, impeller and diffuser. Axial flow Compressors- Vector diagrams, work done factor, temp and pressure ratio, degree of reaction, Dimensional Analysis, Characteristics, surging, Polytrophic and isentropic efficiencies.

**Unit V:** Power Transmitting turbo machines: Application and general theory, their torque ratio, speed ratio, slip and efficiency, velocity diagrams, fluid coupling and Torque converter, characteristics, Positive displacement machines and turbo machines, their distinction. Positive displacement pumps with fixed and variable displacements, Hydrostatic systems hydraulic intensifier, accumulator, press and crane.

### References:

1. Venkanna BK; turbomachinery; PHI
2. Shepherd DG; Turbo machinery
3. Csanady; Turbo machines
4. Kadambi V Manohar Prasad; An introduction to EC Vol.3- Turbo machinery; Wiley Eastern Delhi
5. Bansal R. K; Fluid Mechanics & Fluid Machines;
6. Rogers Cohen & Sarvan Multo Gas Turbine Theory
7. Kearton W. J; Steam Turbine: Theory & Practice

## **ME- 5002 MECHANICAL MEASUREMENT & CONTROL**

**Unit-I:** Basic Concepts of Measurement: General measurement system; Experimental test plan: variables, parameters, noise and interference, replication and repetition; Calibration: Static calibration, dynamic calibration, static sensitivity, range, accuracy, precision and bias errors, sequential and random tests; Presenting data: Rectangular coordinate format, semi-log, full-log formats. Measurement System Behavior: General model for a dynamic measurement system and its special cases: zero order, first order, and second order system, determination of time constant and settling time, phase linearity.

**Unit-II:** Statistics: Least square regression analysis and data outlier detection; Normal distribution and concept of standard deviation of the mean in finite data set, Uncertainty Analysis: Measurement errors; error sources: calibration, data acquisition, data reduction; Design stage uncertainty analysis; combining elemental errors; Bias & Precision errors; Error propagation, Higher order uncertainty analysis.

**Unit-III:** Temperature Measurement: Temperature standards, Temperature scales; Thermometry based on thermal expansion: Liquid in glass thermometers, Bimetallic Thermometers; Electrical resistance thermometry: Resistance Temperature Detectors, Thermistors; Thermoelectric Temperature Measurement: Temperature measurement with thermocouples, thermocouple standards. Pressure and Velocity Measurement: Relative pressure scales, pressure reference instruments, barometer, manometer, deadweight tester, pressure gauges and transducers, total and static pressure measurement in moving fluids Flow measurement: Pressure differential meters: Orifice meter, Venturi meter, roto-meter.

**Unit-IV:** Strain Measurement: Stress and strain, resistance strain gauges, gauge factor, strain gauge electrical circuits, multiple gauge bridge, bridge constant, apparent strain and temperature compensation, bending compensation. Motion, Force and Torque Measurement: Displacement measurement: Potentiometers, Linear variable differential transformers, rotary variable differential transformer; Velocity measurement: moving coil transducers; angular velocity measurement: electromagnetic techniques, stroboscopic measurement; Force measurement: load cells, piezoelectric load cells; Torque measurement: measurement of torque on rotating shafts, Power estimation from rotational speed and torque.

**Unit-V:** Introduction to control systems: Examples of control systems. Open loop and closed loop control, Mathematical modeling of dynamic systems: Transfer function, impulse response function, block diagram of closed loop system, block diagram reduction, Transient and steady state response analyses: First order systems, unit step and unit impulse response of first order systems, second order systems, unit step and unit impulse response of second order systems, transient response specifications, modeling of mechanical systems, modeling of electrical systems, signal flow graphs, modeling of fluid systems, liquid level systems, hydraulic systems, modeling of thermal systems.

### **References:**

1. Nakra and Chowdhry; Measurement and Control; TMH
2. Figiola RS & Beasley DE; Theory and Design for Mechanical Measurements; 3e John Wiley
3. Katsuhiko Ogata; Modern Control Engineering, 4e Pearson Education, New Delhi
4. Gopal; Control Systems Principles and Design; Tata McGraw Hill, New Delhi.
5. Backwith and Buck; Mechanical Measurements.
6. Swahney; Metrology and Instrumentation;

List of Experiment (Expandable)( Measurement & control):

- 1- Study of various temperature measuring devices; thermo couple, RTD, gas thermo meters.
- 2- Measuring velocity of fluid flow by Ventura meter/ orifice meter/ pitot-tube.
- 3- Measuring torque and power generated by a prime mover by using pony brake dynamometer.
- 4- Study of various pressure measuring devices like manometers, mercury in glass pressure gauge.
- 5- To develop a measuring device for fluid level measurement

## **ME- 5003 DESIGN OF MACHINE ELEMENTS**

Note: PSG Design data book and/ or Mahadevan and Reddy's Mechanical design data book are to be provided/ permitted in exam hall (duly verified by authority)

**Unit I:** Engineering Design; Steps in designing, design process and role of designer, iteration. preliminary design, detail design. Conceptual Design; abstraction, modeling of an engineering problem; iconic, analog and symbolic Embodiment Design; steps, rules and principles, design for quality and cost. Design for safety, Concept & evaluation of factor of safety

**Unit II:** Shafts: Design of shaft under combined bending, twisting and axial loading; shock and fatigue factors, design for rigidity; Design of shaft subjected to dynamic load; Design of keys and shaft couplings.

**Unit III :** Design of Belt, Rope and Chain Drives: Methods of power transmission, selection and design of flat belt and pulley; Selection of V-belts and sheave design; Design of chain drives, roller chain and its selection; Rope drives, design of rope drives, hoist ropes.

**Unit IV** Brakes & Clutches: Materials for friction surface, uniform pressure and uniform wear theories, Design of friction clutches: Disk , plate clutches, cone & centrifugal clutches. Design of brakes: Rope, band & block brake, Internal expanding brakes, Disk brakes.

**Unit V:**Design of Gears Force analysis of gear tooth, modes of failure, beam strength, Lewis equation, form factor, formative gear and virtual number of teeth; Gear materials; Surface strength and wear of teeth; strength against wear; Design of straight tooth spur and Helical Gears. Application of bevel, formative gear and virtual number of teeth; Force analysis; Lewis equation for bevel gears; Strength against wear; Design of bevel gear.

### **References:**

1. Shingley J.E; Machine Design; TMH
2. Wentzell Timothy H; Machine Design; Cengage learning
3. Mubeen; Machine Design; Khanna Publisher
4. Bhandari V B ,Design of Machine elements . TMH
- 5 Sharma & Agrawal; Machine Design; Kataria & sons
- 6 Maleev; Machine Design;

List of Experiment (Pl. expand it):

Designing and sketching of components contained in the syllabus

## **ME- 5004 DYNAMICS OF MACHINES**

**Unit 1:** Dynamics of Engine Mechanisms: Displacement, velocity and acceleration of piston; turning moment on crankshaft, turning moment diagram; fluctuation of crankshaft speed, analysis of flywheel.

**Unit 2:** Governor Mechanisms: Types of governors, characteristics of centrifugal governors, gravity and spring controlled centrifugal governors, hunting of centrifugal governors, inertia governors.

**Unit 3:** Balancing of Inertia Forces and Moments in Machines: Balancing of rotating masses, two plane balancing, determination of balancing masses (graphical and analytical methods), balancing of rotors, balancing of internal combustion engines (single cylinder engines, in-line engines, V-twin engines, radial engines, Lanchester technique of engine balancing.

**Unit 4:** Friction: Frictional torque in pivots and collars by uniform pressure and uniform wear rate criteria. Boundary and fluid film lubrication, friction in journal and thrust bearings, concept of friction circle and axis, rolling friction. Clutches: Single plate and multi plate clutches, Cone clutches.

**Unit 5:** Brakes: Band brake, block brakes, Internal and external shoe brakes, braking of vehicles. Dynamometer: Different types and their applications. Dynamic Analysis of Cams: Response of un-damped cam mechanism (analytical method), follower response analysis by phase-plane method, jump and cross-over shock.

### **References:**

1. Ambekar, AG; Mechanism and Machine Theory; PHI
2. Rattan SS; Theory of machines; TMH
3. Sharma and Purohit; Design of Machine elements; PHI
4. Bevan; Theory of Machines;
5. Ghosh and Mallik; Theory of Mechanisms and Machines; Affiliated East-West Press, Delhi
6. Norton RL; kinematics and dynamics of machinery; TMH
7. Grover; Mechanical Vibrations
8. Balaney; Theory of Machines by
9. Theory of Vibrations by Thomson

### **List of Experiment (Pl. expand it):**

- 1- Study of various models of governors.
- 2- Study of gyroscopic motion and calculation of value of gyroscopic couple.
- 3- Study of various types of Cams and followers and drawing the cam profile with the help of test kit.
- 4- Study of various first order vibration systems.
- 5- To study working of friction clutches using models

## **ELECTIVE I -ME- 5005 (1) ENTREPRENEURSHIP AND MANAGEMENT CONCEPTS**

### **Entrepreneurship and Management Concepts**

**Unit-I:** System Concepts: Types, definition & characteristics; supra & subsystems, key component; boundary & interface complexity; feedback (pull) & feed forward (push) controls, open flexible-adaptive system, computer as closed system, law of requisite variety; system coupling, stresses and entropy; functional & cross functional system; Steven Alter's nine element work system model and its comparison with IPO (input-processing-output) model, structure and performance of work systems leading to customer delight.

**Unit-II:** Management: Importance, definition and functions; schools of theories, knowledge driven learning organization and e-business; environment, uncertainty and adaptability; corporate culture, difficulties and levels of planning, BCG matrix, SWOT analysis, steps in decision making, structured and unstructured decision; dimensions of organizations, size/specialization, behavior formalization, authority centralization, departmentalization, span and line of control, technology and Minzberg organization typology, line, staff & matrix organization, coordination by task force, business process reengineering and process of change management, HR planning placement and training, MIS; attitudes and personality trait, overlap and differences between leader & manager, leadership grid, motivation, Maslow's need hierarchy and Herzberg two factor theory, expectation theory, learning process, team work and stress management.

**Unit-III:** Marketing: Importance, definition, core concepts of need want and demand, exchange & relationships, product value, cost and satisfaction (goods and services ) marketing environment; selling, marketing and societal marketing concepts; four P's, product, price, placement, promotion; consumer, business and industrial market, market targeting, advertising, publicity, CRM and market research. Finance: Nature and scope, forms of business ownerships, balance sheet, profit and loss account, fund flow and cash flow statements, breakeven point (BEP) and financial ratio analysis, pay-back period, NPV and capital budgeting.

**Unit-IV:** Productivity and Operations: Productivity, standard of living and happiness, types of productivity, operations (goods and services) Vs project management, production processes and layouts, steps in method improvement, time measurement, rating and various allowances; standard time and its utility, predetermined motion and time method, product and process specification, TQM, cost of quality, introduction to lean manufacturing (JIT), QFD, TPM & six sigma quality.

**Unit V:** Entrepreneurship : Definition and concepts, characteristics, comparison with manager, classification, theories of entrepreneur, socio, economic, cultural and psychological; entrepreneur traits and behavior, roles in economic growth, employment, social stability, export promotion and indigenization, creating a venture, opportunity analysis competitive and technical factors, sources of funds, entrepreneur development program.

### **References:**

- 1- Daft R; The new era of management; Cengage.
- 2- Bhat Anil, Arya kumar; Management: Principles ,Processes and Practices; Oxford higher edu.
- 3- Davis & Olson; Management Information System; TMH
- 4- Steven Alter; Information systems, Pearson,
- 5- Kotler P; Marketing management;
- 6- Khan, Jain; Financial Management;
- 7-ILO; Work study; ILO.

## **ELECTIVE I -ME- 5005 (2) METROLOGY & INSPECTION**

**Unit 1** Introduction to metrology: Definition, types, need of inspection, terminologies, methods of measurement, selection of instruments, measurement errors, units, Measurement standards, calibration, statistical concepts in metrology Linear metrology: Steel rule, calipers, vernier caliper, vernier height gauge, vernier depth gauge, micrometers, universal caliper

**Unit 2** Limits fits and tolerances : Interchangeability, selective assembly, limits, fit and tolerances, limit gauging, design of limit gauges, computer aided tolerancing  
Measurement of straightness, flatness, squareness, parallelism, roundness and cylindricity, non-contact profiling systems

**Unit 3** Measurement of surface finish: Introduction, terminology, specifying roughness on drawings, surface roughness parameters, factors affecting surface roughness, ideal surface roughness, roughness measurement methods, precautions in measurement, surface microscopy, surface finish softwares.

Screw thread metrology: Introduction, screw thread terminology, screw thread measurement.

**Unit 4** Gear measurement: Introduction, types of gears, gear terminology, errors in gears, advanced measurement of spur gear.

Miscellaneous measurements: Taper measurement, angle measurement, radius measurement

Interferometry: Principle of interference, interference bands, interference patterns, flatness interferometer, Gauge length interferometer

**Unit 5** Comparator: Features of comparators, classification of comparators, different comparators, advanced comparators, thread comparators. Advanced Metrology : Advanced measuring machines, CNC systems, Laser vision, In-process gauging, 3D metrology, metrology softwares

### **References :**

1. Engineering Metrology - K.J. Hume, Macdonald and Co.(publisher) London
2. The Springer handbook of metrology and Testing, Czichos (Ed), 2011
3. The Metrology Hand book- Jay. L.Bucher (ed), American Society for Quality, 2004
4. Industrial Metrology - Smith GT, 2002,Spinger
5. Hand book of industrial metrology - John W. Greve, Frank W. Wilson, PHI - New Delhi
6. Engineering Metrology - D.M.Anthony, Pergamon Press
7. Dimensional Metrology - Khare MK, OXFORD-IBH Publishers

## **ELECTIVE I -ME- 5005 (3) ENGINEERING ECONOMICS & MANAGEMENT**

**UNIT I:** Demand Utility and indifference curves, Approach to Analysis of demand, elasticity of demand, Measure of demand elasticity, Factors of Production, Advertising elasticity, Marginalism

**UNIT II** Laws of Return and costs, price and output determination under perfect competition, monopoly, monopolistic, competition, oligopoly, Depreciation and methods for its determination.

**UNIT III** Functions of central and commercial banks Inflation, Deflation, Stagflation, Direct and Indirect Taxes, Monetary and cycles, New economic policy, Liberalization, Globalization, Privatization, Market friendly state. Fiscal policy of the government, Meaning and phases of business.

**UNIT IV** Definition, Nature and scope of management, Functions of management- Planning, organizing, Directing, Controlling, Communicating **UNIT V** Meaning of marketing management, Concept of marketing, Marketing Mix, Administrative and cost plus pricing, Channel of distribution, Advertising and sales promotion.

**UNIT V** Meaning, Nature and scope of financial management, Brief outline of profit and loss account, Balance sheet, Budget and their importance, Ratio Analysis, Principles of costing.

### **REFERENCES:-**

- 1) Modern Economics by H.L.Ahuja
- 2) Modern economics theory by K.K.Dewett
- 3) Monetary economics by M.L.Seth
- 4) Industrial Management by L.K.Chopde,A.M.Sheikh
- 5) Business organization and management by S.A.Sherlekar
- 6) Managerial economics by joel dean
- 7) Managerial economics by Pylee

## **ELECTIVE I -ME- 5005 (4) MECHATRONICS**

**UNIT - 1 INTRODUCTION:** Definition of Mechatronics, Multi-disciplinary scenario, origins. Evaluation of Mechatronics, An over view of mechatronics, Design of mechatronics system. Measurements system and function of main elements of measurement systems. Need for mechatronics in industries. Objectives, advantages and disadvantages of mechatronics. Microprocessor based controllers. Principle of working of engine management system, automatic washing machine.

**UNIT - 2 REVIEW OF TRANSDUCERS AND SENSORS:** Definition and classification of transducers. Definition and classification of sensors. Principle of working and applications of light sensors, proximity sensors and Hall effect sensors. **MICROPROCESSOR:** Introduction, Microprocessor based digital control. Digital number system, binary and hexadecimal number system, Logic functions, Data word representation basic Elements of control systems.

**UNIT 3 : MICROPROCESSOR ARCHITECTURE:** 8085A processor architecture Terminology- such as, CPU, memory and address, ALU, assembler, data, registers, Fetch cycle, write cycle, state, bus interrupts. Micro controllers - difference between microprocessor and micro controllers. Requirements for control and their implementation in micro controllers. Classification of micro controllers.

### **Unit 4**

**ELECTRICAL ACTUATORS:** Actuator and actuator system. Classifications of actuator system with examples. Mechanical switches. Concept of bouncing Methods of Preventing bouncing of mechanical switches. Solenoids, Relays. Solid state switches - Diodes, Thyristors, Triacs, Transistors, Darlington pair. Electrical actuator. Principle, construction and working of AC, DC motors, stepper motors, permanent motors, servomotors, Servo systems and control

**HYDRAULIC ACTUATORS:** Valves - Classifications, Pressure Control Valves - Pressure relief valves, Pressure regulating/reducing valves, Pressure sequence valve. Flow control valves - Principle, needle valve, globe valve. Direction control valve -sliding spool valve, solenoid operated.

**Unit 5 : SINGLE CONDITIONING:** Concept, necessity, op-amps, protection, filtering, wheat stone bridge - Digital Signals - Multiplexer. Data acquisition - Introduction to digital signal processing - Concepts and different methods.

### **REFERENCE BOOKS:**

1. Mechatronics - Principles, Concepts and applications - Nitaigour and Premchand, Mahalik - Tata McGraw Hill -2003
2. Mechatronics - W. Bolton, Pearson Education Asia -2<sup>nd</sup> Edition, 2001.
3. Introduction to mechatronics and measurement systems -David G. Alciatore & Michel BiHstand - Tata McGraw Hill -2000
4. Mechatronics - H.D. Ramachandra - Sudha Publication -2003
5. Mechatronics by HMT Ltd. - Tata McGrawHill -2000.
6. Mechatronics System design by Devadas Shetty and Richard A. Kark - Thomas Learning -1997.
7. Mechatronics an Introduction by Robert H Bishop - CRC
8. Mechatronics systems Fundamentals by Rolf Isermann - Springer