

Syllabus of B. Tech. in Mechanical Engineering

Semester IV

ME1401 **MECHANICAL MEASUREMENTS & METROLOGY** (2-1-0)

1. Mechanical Measurements

Introduction: Introduction to measurement & measuring instruments, Generalised measuring system & functional elements, accuracy and precision, units of measurement, static & dynamic performance characteristics of measurement devices, calibration, concept of error, sources of error, statistical analysis of errors. (5 lectures)

Sensors & Transducers: Types of sensors, types of transducers & their characteristics. (3 lectures)

Measurement of displacement & angular velocity (2 lectures)

Measurement of pressure: Gravitational, directing acting, elastic & indirect type pressure transducers. Measurement of very low pressure (3 lectures)

Strain measurement: Types of strain gauges & their working, strain gauge circuits, temperature compensation. Strain rosettes. (3 lectures)

Measurement of force & torque. (2 lectures)

Temperature measurement: By thermometers, bimetallic, thermocouples, thermistors & pyrometers. (2 lectures)

Measurement of Flow: Obstruction meters, variable head meters, hot wire & magnetic meters, ultrasonic flow meters etc. (2 lectures)

Vibration & noise measurement: Seismic instruments, vibration pick-ups & decibel meters. (2 lectures)

Data acquisition system: Introduction to data acquisition systems, single & multi channel systems, data acquisition systems. Input-output devices. (4 lectures)

2. Metrology

Standards of linear measurement, line & end standards. (1 lecture)

System of limits & fits. (1 lecture)

Linear & angular measurements devices & systems. (1 lecture)

Limit gauges & their design.

Measurement of geometric forms like straight, flatness, roundness & circularity. (2 lectures)

Optical projectors, toolmakers microscope, autocollimators. (3 lectures)

Interferometry: principle & use of interferometry, optical flat & interferometers, laser interferometers. (3 lectures)

Comparators: types, working principles & magnification range. (2 lectures)

Measurement of screw threads & gears. (1 lecture)

Surface texture: quantitative evaluation of surfaces roughness & its measurement. (2 lectures)

Introduction to CMM. In-process gauging systems.

Inspection in-process & final inspection. Sampling & 100% inspection. Sampling plans. (2 lectures)

Evaluation of Work Study: Work of F. W. Taylor, Frank & Lillen Gilberth & others. Productivity definition, Means of increasing productivity, Work Study definition. Productivity & work study, Human factor in the application of work study. (8 lectures)

Motion Study: Definition, aims, procedure for method study, selection of jobs, recording techniques, micro motion study, Therbligs, Cyclograph & Chronocyclo-graph, Principles of motion economy, design of work place layout, Analysis in the form of a chart. operation chart, flow chart, flow diagram, String diagram, Man machine chart, Two hand chart, Simo chart. (10 lectures)

Work Measurement (Time Study): Definition, uses, procedure, time study equipment, Performance rating, allowances, Number of cycles to be studied, Determination of standard time, Predetermined Motion Time Systems. (6 lectures)

Job Evaluation: Job evaluation, objectives of job evaluation, Methods of job evaluation, Non-quantitative & quantitative. (5 lectures)

Wages & Incentives: Characteristics of a good wage or incentive system, Methods of wage payment, Concept of wage incentive schemes, financial & non-financial, Halsey premium plan, Merri's Multiple piece rate system. (6 lectures)

Concept of New Techniques: Scheduling through Network C. P. M. & PERT, use of linear programming methods to solve product - mix problems. (5 lectures)

Value Engineering: Concept of value, product life cycle, value engineering approaches, job plan, value tests. (3 lectures)

ME1403

ADVANCED STRENGTH OF MATERIALS

(3-1-0)

Stress and strain in three dimension, theories of yielding, different theories of failure, comparison of theories of failure, yield loci. (6 lectures)

Bending of curved beams in the plain of loading crane hooks, rings and chain links. (7 lectures)

Strain energy due to direct bending, Castig Liano's theorem, applicable to deflection of simply supported beams and cantilever beams due to shear. (5 lectures)

Thick cylinders, radial and hoop stresses, applications of compound stress theories, compound cylinders, thick spherical shell, radial and circumferential stresses. (8 lectures)

Shear center of thin walled open cross flow section shear flow. (4 lectures)

Fatigue, fatigue of metal, Bauschinger's Experiment, strain method of obtaining fatigue ranges, formula connected to stress range, maximum stress and ultimate strength, S-N curve, Gerber's formula, Goodman's law. (6 lectures)

Creep: creep of metals, Mechanism of creep, equilibrium temperature, creep curve, creep rate, prediction of long term properties from short duration list. (3 lectures)

Kinematics: Elements, pairs, mechanisms, four bar chain and its inversions, velocity and acceleration in mechanism, velocity and acceleration diagrams, Klein's construction, Coriolis component, instantaneous centre method, synthesis of mechanism, pantograph, Scott-Russell, Indicator diagram mechanisms, Davis and Ackermann steering mechanism, Hook's joint.

(10 lectures)

Brakes and Dynamometers: Band & Block brakes, braking action, absorption and transmission type dynamometers, Prony, rope and hydraulic dynamometers, Braking systems of automobiles.

(5 lectures)

Inertia Force Analysis: Velocity and acceleration of slider crank and four bar mechanisms, inertia force, piston thrust and forces in connecting rod, turning moment diagram, flywheel.

(6 lectures)

Governors: Simple, Porter, Proell, Hartnell and spring controlled governors, governor effort, power stability, inertia effects.

(5 lectures)

Cams: Types of cams, displacement, velocity and accelerations curves for different cam followers, consideration of pressure angle and wear, analysis of motion of follower for cams with specified contours.

(6 lectures)

Gyroscope: Principles of gyroscopic couple, effect of gyroscopic couple and centrifugal force on vehicle taking a turn, stabilization of sea vessels.

(5 lectures)

Balancing: Balancing of rotating masses in the same and different planes, balancing of reciprocating masses, swaying couple, hammer blow and tractive effort, primary and secondary balancing of a locomotive and internal combustion engines, balancing machines.

(7 lectures)

Importance of manufacturing, economic & technological definition of manufacturing, Survey of manufacturing processes. (2 lectures)

Casting: Basis principal & survey of casting processes. sand casting: patterns, pattern material, allowance, Green and dry sand moulding, moulding methods, moulding sand properties and testing, elements of mould and design considerations. Cores: use, materials and making practice, Die, investment and centrifugal casting processes. Melting practice and concepts in solidification, Inspection and defects analysis. (10 lectures)

Forming: Elastic and plastic deformation, concept of strain-hardening, rolling, forging, extrusion, wire & tube drawing: processes, machines and equipments, parameters and force calculations. (8 lectures)

Sheet-metal working: Role of sheet metal components. Cutting mechanism. Description of cutting processes like blanking, piercing, lancing etc. Description of forming processes: bending cup drawing, coining, embossing etc. basic elements of processes for sheet metal working. Part feeding system. Punch and die clearance and die elements. (10 lectures)

Welding: Principle of welding, soldering, brazing and adhesive bonding. Survey of welding and allied processes. Arc Welding: power sources and consumables. MMAW, TIG & MIG processes and their parameter selection. Resistance Welding: principle and equipments. Spot, projection and seam welding processes, Gas welding and cutting: processes and equipments. (10 lectures)

Powder Metallurgy: Powder manufacturing, compaction and sintering processes. Advantages and application of P/M. (4 lectures)
Manufacturing of plastic components.

Electromagnetic and transformers:

Review of laws of Electromagnetic and Electro-mechanics

Autotransformer: Equivalent circuits and equations shown step-up and step-down operations; Comparison with two winding transformer on the basis of copper losses and volume of copper.

Three-phase transformers, special constructional features - cruciform mitering, alternative winding arrangements, cooling methodology, conservators, breathers, Buchholz relay, Transformer connections, vector phase groups. Phase conversions - 3 to 1, 3 to 2, 3 to 6 and 3 to 12.

Parallel operation of single and three-phase transformers and load sharing; Testing of 3-phase transformers; Special Purpose Transformers: Pulse, Isolation, Welding, Rectifier, High frequency.

DC Machines:

Review of constructional features. Methods of excitation. Armature windings, Power balance, Voltage and torque equations. Operation as generator - Self excitation principles, Armature reaction, Characteristics of generators and motors, Commutation; Starting and speed control including solid state controllers; Braking, Losses, Efficiency; Testing, efficiency and application of DC motors; Parallel operation of generators; Amplidyne and Metadyne.

Poly-phase Synchronous Machines:

Constructional features, Poly-phase Distributed AC Windings: Types, Coil span and winding factors; Excitation systems, e. m. f. equation and harmonic elimination; Interaction between excitation flux and armature m. m. f., equivalent circuit model and phasor diagram for circle diagram; Power angle equations and characteristics. Voltage regulation and affect of AVR; Synchronizing methods, Parallel operation and load sharing, active and reactive power control, operation on infinite bus-bar.

Analysis under sudden short circuit; Transient parameters.

Motoring mode, Transition from motoring to generating mode. Phasor diagram, steady state operating characteristics, V-curves, starting, synchronous condenser, hunting - damper winding effects, speed control including solid state control.

Testing of Synchronous Machines - Stability considerations; Brushless generators, Single-phase generators.

Induction Machines:

Review of basic theory and construction, phasor diagram and equivalent circuits, Torque-speed characteristics, testing and circle diagram. Starting and speed control including solid state controllers.

ME1406-P MECHANICAL MEASUREMENTS & METROLOGY LAB (0-0-3)

List of Experiments (Any Eight)

1. Study of various types of measuring instruments gauges.
2. To measure strain.
3. To measure the "Surface Roughness" of a work piece with the help of Profilometer.
4. Study of various types of Dynamometers & to measure force, torque & power.
5. To study the Pressure measuring devices.
6. Study of various types of temperature measuring devices.
7. Calibration of Thermocouples.
8. Study of various types of Flow-meters.
9. To measure the vibration noise of equipments.
10. To study the application of Sensors & Transducers
11. To measure the Screw Threads & to determine the flatness of the surface.

ME1407-P KINEMATICS OF MACHINE LAB

(0-0-3)

List of Experiments

1. To draw velocity diagram of four bar mechanism.
2. To draw velocity diagram of slider crank mechanism.
3. To draw acceleration diagram of four bar mechanism.
4. To draw displacement diagram, velocity diagram & acceleration diagram of cam follower.
5. To draw a cam profile.
6. Determination of Balancing of masses by graphical method for several unbalanced mass in a same place.

ME1408-P MANUFACTURING SCIENCE I LAB

(0-0-3)

List of Experiments

1. To make a solid pattern casting of Aluminium.
2. To make a hollow pattern casting of alloy.
3. Fan Box with hook.
4. Hexagonal nut with threading.
5. Tungsten Inert Gas Welding (TIG).
6. Metal Inert Gas Welding (MIG).
7. Powder Metallurgy – Compaction of metal powder sintering & testing.

List of Experiments:

Characteristics of DC Machines – motors and generators with different excitation.
Hopkinson's test and Fields test – loss calculations and prediction of performance characteristics.
Speed control of DC motors – conventional and electronics
Determination efficiency of single-phase transformer by using back-to-back test.
Determination efficiency of single-phase transformers by R-L & R-C loads.
Determination of equivalent circuit parameters of a three-phase slip-ring induction motor.
Determination of equivalent circuit parameters of a three-phase squirrel cage induction motor by block rotor test and to draw circle diagram;
Phase conversion using Scott connection and perform load test.
No-load short-circuit and Zero Power Factor (ZPF) tests on a synchronous machine;
Determination of voltage regulation at specified load by (i) EMF, (ii) MMF, (iii) Potier method, (iv) ASA methods and comparison of results; Load angle characteristic and comparison with theoretically predicted results.
V-curves and inverted V-curves of synchronous machines; Comparison with predicted characteristics; Synchronization of three phase alternator with infinite bus bar; Study of variation of excitation and mechanical power input on performance
Slip-test, short circuit and lagging current tests on a salient pole machine and determination of armature parameters; Estimation of voltage regulation at specified loads using Blondel's method; Comparison with results from load test.
Sudden short circuit test and determination of X_c , X^d , $X^{d'}$ and machine time constants.
Determination of X_1 , X_2 , X_0 by fault simulation methods;
Study of Automatic Voltage Regulators (AVR) and from grid to stand alone mode

Debate, Elocution, Extempore, Group Discussion, Panel Discussion, Presentation – Paper & oral, Allegation & clarification, Quiz / Brain Teaser, Survey Report / Project Report / Case Study, Dissertation, Mock Interview, Expository / Argumentative Report & National Service Scheme (NSS).