DETAILS OF THE COURSE

Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
22MET201	**Fluid Mechanics**	**4**	**3**	**1**	**0**	**0**

PREREQUISITE : Calculus, Physics, Engineering Mechanics, Engineering Thermodynamics

COURSE OUTCOMES

After attending the course, the student will be able to demonstrate following skills which would be evaluated though various assessments

CO1	Understand the basic principles and identify the governing equations applicable to the engineering problems involving fluids
CO2	Understand and solve problems involving fluid kinematics
CO3	Solve engineering problems involving fluid at rest or relative equilibrium
CO4	Solve engineering problems involving fluid flow over submerged bodies
CO5	Solve engineering problems involving internal fluid flow
CO6	Solve engineering problems involving model studies

COURSE CONTENTS

- Properties of fluid; classification of fluids; fluid pressure and its measurement; pressure variation in fluids; manometers; hydrostatic force on surfaces; buoyancy and floatation; fluids in relative equilibrium.

- Principles of fluid flow; Eulerian and Lagrangian description of fluid flow; velocity and acceleration of a fluid particle; types of fluid flow; flow visualization; Reynolds transport theorem; vorticity and circulation; inviscid and potential flows.

- Basic techniques for fluid flow analysis; equations in integral form for a control volume, Bernoulli equation and its applications; equations in differential form, Continuity equation and its applications; linear and angular momentum, and their application.

- Theory of boundary layer; boundary layer equations and thickness of boundary layer; separation of boundary layer, controlling methods; flow over submerged bodies, flat surface, sphere, cylinder, airfoil.

- Viscous internal flows; flow through orifices; laminar and turbulent pipe flow; energy losses in pipe flows, series and parallel pipe flows, water hammer, pipe networks; laminar flow in circular pipes, annulus, channels, porous media; pipe flows, developing and developed internal flows; turbulent flows in smooth and rough pipes.

- Dimensional analysis; common dimensionless groups; modelling and similitude, types of similarity and similarity laws; model studies.

References-

Text Books/ Reference books-

1. Fluid Mechanics, F. M. White, McGraw Hill, 2017.
2. Introduction to Fluid Mechanics, Fox and McDonald, Wiley, 2011.
3. Engineering Fluid Mechanics, K.L. Kumar, S. Chand 2016.
4. Fluid Mechanics, Streeter and Wiley, McGraw Hill, 2010.
5. Fluid Mechanics, A. K. Jain, Khanna Publishers, 2004.

Online/E resources

1. NPTEL, Introduction to Fluid Mechanics, IIT Kharagpur, Dr. Suman Chakraborty (https://nptel.ac.in/courses/112105269)
2. NPTEL, Fluid Mechanics, IIT Guwahati, Dr. Subhashisa Dutta (https://nptel.ac.in/courses/105103192)

DETAILS OF THE COURSE

Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
22MET202	**Kinematics of Machines**	**3**	**2**	**1**	**0**	**0**

PREREQUISITE : Engineering Mechanics

COURSE OUTCOMES

CO1	Understand the fundamentals of the theory of kinematics and dynamics of machines
CO2	Kinematic design graphically
CO3	Analyze the motion characteristics of the machine analytically, graphically or computationally
CO4	Analyze CAM motion programs and design of Cam
CO5	Understand gear terminology and kinematics and analyze motion

COURSE CONTENTS

Kinematics Fundamentals: Types of Motions, Degree of Freedom, Links, Joints, and Kinematic Chains, Kinematic diagrams, Determination of degree in freedom of planar and spatial mechanisms, Linkage, mechanisms and Structures, Number synthesis, Paradoxes, Isomers, Inversions-Four bar chains, Single slider crank chain, Double slider crank chain and applications, Linkages of more than four bars-Fivebar, sixbar.

Graphical linkage synthesis: Synthesis-Function, Path, and motion generation, Limiting conditions, Dimensional Synthesis- two and three positions, Quick return mechanisms- fourbar and sixbar, Cognates, Straight line mechanisms, dwell mechanisms, Coupler Curves, design with coupler cuves.

Kinematic Analysis: Position: Graphical and analytical analysis, Vector loo equations for four bar linkages, Circuits and Branches. Velocity and Acceleration: General velocity and acceleration equations, components of acceleration, Graphical velocity and acceleration analysis, Velocity analysis using instant centres, Centrodes, Kennedy theorem.

CAM: Terminology, SVAJ diagrams, Motion programs-Uniform velocity, parabolic, simple harmonic, cycloidal, polynomial functions, Sizing the cam.

Gears and Gear Trains: Fundamental law of gearing, Involutes, Gear tooth Nomenclature, Interference and Undercutting, Contact ratio, Gear Types-Spur, Helical Bevel and Worm, Gear Trains- Simple, Compound, Planetary, Analysis using Equations and Tabular method, Applications.

Text Books/ Reference Books

1. Kinematics and Dynamics of Machinery, First Edition in SI, R.L. Norton, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2016
2. Theory of Machines, 4 Edition, S. S. Rattan, Tata McGraw-Hill, 2014.
3. Theory of Mechanisms & Machines by Amitabha Ghosh, Asok Kumar Mallik, Affiliated East-West Press Pvt Ltd, 2000
4. Theory of Machines and Mechanisms (India Edition) by John J. Uicker Jr., Gordon R. Pennock and Joseph E. Shigley, Oxford University Press, 2014
5. Kinematics, Dynamics and Design of Machinery by by Kenneth J. Waldron , Gary L. Kinzel, Wiley India Pvt Ltd, 2016

Online/E Resources

1. NPTEL: Theory of Mechanisms by Prof. Sujatha Srinivasan, IIT Madras
2. NPTEL: Kinematics of Mechanisms and Machines by, Prof. A. Dasgupta, IIT Kharagpur

DETAILS OF THE COURSE:

Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
22MET203	**Materials Science and Engineering**	**3**	**3**	**0**	**0**	**0**

PREREQUISITE: None

COURSE OUTCOMES:

On successful completion of the course, the student should be able to:

CO1	Understand engineering materials classification and their structural geometries. He/she may apply the crystallography of metallic solids and evaluate their structural-related behavior.
CO2	Understand the basic mechanism of deformations in metal and analyze their deformation behavior. He/she would be able to understand strengthening mechanisms.
CO3	Analyze the mechanical behavior of the metals and their evaluation/quantification through various test methods.
CO4	Understand the basic mechanism that drives phase transformation (specifically freezing of metals) as applied to various binary alloy systems, case hardening methods, and heat treatment processes.

COURSE CONTENTS

Historical perspective and development of materials; Engineering structures, relationship between processing – structure – properties – performance, Challenges in material selection, factors aiding material selection, classification of engineering materials.

Crystallography of solids, crystal structures and Bravais lattices in 3D packing, Bravais lattices in 2D packing; Miller indices of directions/planes with family of symmetry related directions/planes, Miller- Bravais indices in cubic, tetragonal system, hexagonal systems, etc., Inter-planner spacing, Weiss Zone Law, linear and planner densities, X-ray diffraction

Packing in metallic solids or crystalline solids with parameters like packing efficiency, theoretical density, effective number of atoms/cells, coordination number, inter-atomic distance, edge length, etc.; Triangular, tetrahedral, octahedral, and cubic voids in FCC/BCC/HCP packing and their positions; Single crystals solids, polycrystalline solid, microstructure, amorphous solids.

Defects in solids: Classification and description of defects (based on dimensionality) like point defect (vacancies, interstitial, substitutional, Frenkel, Schottky, etc.), line or dislocation defect (edge, screw and mixed dislocations); surface defects (homophase like stacking fault, twin boundary, grain boundary, etc., and hetrophase boundary [like free surfaces, solid/liquid interface, phase boundary etc.); volume defect (like voids, foreign particles, inclusions, etc.); Dislocation density, Frank-Read source, Slip systems in FCC, BCC, HCP, etc.

Strengthening mechanisms: Work or Strain hardening, Solid solution hardening, Grain size hardening, Precipitation hardening, Annealing of cod worked of metal: recovery, recrystallization, grain growth

Mechanical behavior of solids: Tensile behavior, Creep behavior, Fatigue behavior, Fracture behavior, Impact behavior, Non-destructive testing of materials.

Structure of alloy: Solid solutions and inter-metallic compounds; Interstitial and substitutional solid solutions; Hume Rothery Rule of solid solubility limit; Substitutional solid solutions: Ordered and Random; Primary and intermediate

Phase diagram: Concept nad its classification, Gibbs phase rule, Binary alloy system like Isomorphous systems (Cu-Ni alloy system), and Eutectic systems (Pb-Sn system, Fe-C system), Microstructure evolution and phase diagram parameters; Overview of various grades of ferrous alloys like grades of hypo/hyper eutectoid steel, Cast Iron.

Phase transformation, TTT diagram and heat treatment processes: Concept of various phase transformations, concept of nucleation & growth, development of TTT diagram, TTT diagram of Eutectoid steel or various heat treatment processes like Annealing, Normalizing, Austempering, Tempering, Quenching. Details of Microstructure evolution, TTT diagram of hypo/hyper Eutectoid steels, TTT diagram of alloy steels; Concept of hardenability and its difference with hardness, effect of alloying on hardenability

Diffusion: Concept of diffusion, Adolf Ficks law; Steady and unsteady diffusion; Interstitial and substitutional diffusion; Mechanism of atomic diffusion; Diffusion paths (lattice diffusion, surface diffusion, grain boundary diffusion, dislocation diffusions); Application of diffusion in case hardening methods.

TEXTBOOKS/ REFERENCE BOOKS (Title, Authors, Publisher & Year):-

1. Materials Science, V Raghavan, PHI Learning Private Ltd.
2. Materials Science and Engineering, WD Callister and adapted by R Balasubramaniam, Wiley India (P) Ltd.
3. Mechanical Behaviour of Materials, Thomas H Courtney, Mc Graw Hill Eduction (India) Private Ltd.
4. Donald R. Askeland, Pradeep P. Phule, Wendelin J. Wright,"The Science and Engineering of Materials", 6th Edition, Cengage Learning, 2006.

ONLINE/E RESOURCES: https://nptel.ac.in

DETAILS OF THE COURSE:

Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
22MET204	**Mechanical Measurements & Metrology**	**3**	**3**	**0**	**0**	**0**

PREREQUISITE: Product Realization through Manufacturing

COURSE OUTCOMES:

CO1	Understand the principles of metrology and the importance of measurements in industry.
CO2	Apply measurement error analysis and uncertainty calculations to ensure measurement accuracy and reliability.
CO3	Use various measuring instruments for dimensional, surface, and form measurements, including micrometers, calipers, gauges, and profilometers etc.
CO4	Apply calibration methods and traceability requirements to ensure measurement accuracy and reliability.
CO5	Develop an ability of problem solving and decision making by identifying and analyzing the cause for variation and recommend suitable corrective actions for quality improvement

COURSE CONTENTS

Unit I : Basic Concepts of Measurements – Introduction to Measurement and Measuring Instruments, Methods of Measurement, Modes of Measurement, Generalized Measuring System and Functional Elements, Instruments and its Classifications, Sensors & Transducer and its Classification, Data Acquisition (DAQ) and data loggers, Static and Dynamic Performance Characteristics of Measurement Devices, Sources of Error in Measurement, Classification and Elimination of Errors, Uncertainty in Measurements. Need for Measurement - Precision and Accuracy - Reliability - Errors in Measurements - Causes – Types; Measurement of Engineering Components – Limits, Fits and Tolerances.

Unit II : Linear Measurement – Surface Plate, V-blocks, Scaled Instruments, Vernier, Micrometer, Slip Gauges. Angular Measurement – Protractor, Sine Bar, Angle Gauges, Clinometer, Autocollimator. Comparators – Types of Comparators, Mechanical Comparators, Mechanical–Optical Comparator, Electricals Comparator, Pneumatic Comparators.

Unit III : Optical Measurement and Interferometry – Optical Measurement Techniques, Interferometers, Metrology of Gears and Screw Threads. Metrology of Surface Finish – Methods of Measuring Surface Finish, Stylus Probe Instruments, Pneumatic Methods, Light Interference Microscopes. Miscellaneous Metrology – Precision Instrumentation Based on Laser Principles, Coordinate Measuring Machines, Machine Tool Metrology.

Unit IV: Mechanical Measurements – Introduction, Functional Elements of Measurement Systems, Transducers, Classification of Transducers. Measurement of Force – Direct Methods, Load Cells, Cantilever Beams, Proving Rings, Linear Variable Differential Transformers. Measurement of Torque – Torsion-bar Dynamometer, Servo-controlled Dynamometer, Absorption Dynamometer.

Measurement of Strain – Mechanical Strain Gauges, Electrical Strain Gauges, Methods of Strain Measurement.

Unit V : Temperature Measurement – Methods of Temperature Measurement, Expansion thermometers: Bi-metallic, Liquid in glass; Filled System Thermometers; Electrical Temperature Measuring Instrument: Thermocouples, RTD, Thermistors; Pyrometers; Calibration of Temperature Measuring Instruments. Pressure Measurement – Pressure Measurement Scales, Methods of Pressure Measurement, Classification of Pressure Measuring Devices, Gravitation-type manometers, Mechanical displacement-type manometers, Elastic pressure transducers, Electrical pressure transducers, Low-pressure measurement gauges. Flow Measurement – Rotameter, Electromagnetic Flow Meter, Ultrasonic Flow Meter, Turbine Flow Meter, Hot Wire Anemometer, Laser Doppler Anemometer.

Text Books/ Reference books-

1. Metrology for Engineers by Gaylor, Shotbolt, Sharp
2. Mechanical Measurements by Thomas G. Beckwith , 6E Book
3. J. P. Holman, “Experimental Methods for Engineers”, 8th Edition, McGraw-Hill Series in Mechanical Engineering).
4. S. P. Venkateshan, “Mechanical Measurements”, 2nd Edition, John Wiley & Sons Ltd.
5. N.V. Raghavendra and L. Krishnamurthy, “Engineering Metrology and Measurements”, Oxford University Press.

DETAILS OF THE COURSE

Course Code	Course Title	Credits	L	T	P	Studio
22MET205	**Solid Mechanics**	**4**	**3**	**1**	**0**	**0**

PREREQUISITE: Engineering Mechanics

COURSE OUTCOMES:

CO1	Understand the concepts of internal forces (including SFD and BMD), force equilibrium, deformation, stress, strain, differential equilibrium equations, strain-displacement and constitutive (i.e., stress-strain) relationships for deformable bodies.
CO2	Construct Mohr circle for plane stress and plane strain conditions, and analyse for principal stresses and strains, and their directions
CO3	Apply the concepts of mechanics of deformable bodies to analyze basic structural elements such as bar, beam, shaft, and column.
CO4	Understand and apply the concepts of yielding criteria for the analysis of ductile material.

COURSE CONTENTS:

Introduction to mechanics of deformable bodies: Analysis of deformable bodies, uniaxial loading & deformation, statically determinate & indeterminate situations, Castigliano's theorem.

Stress & Strain: Introduction, stress, plane stress, equilibrium of an element in plane stress, Mohr circle representation of a plane stress, general state of stress, Analysis of deformations, strain components, relation between strain & displacement, strain component associated with arbitrary set of axes, Mohr circle representation of plane strain, general state of strain.

Stress-Strain-Temperature relations: Introduction, tensile test, idealization of stress strain curve, elastic stress strain relation, Thermal strain, complete equations of elasticity, strain energy in an elastic body, Thin pressure vessels, factor of safety and yielding criteria.

Torsion: Introduction, geometry of deformation of a twisted circular shaft, stress strain relations, equilibrium requirements, stresses & deformations in twisted elastic circular shaft, torsion of elastic hollow circular shaft, combined stresses, strain energy due to torsion, yielding in torsion**.**

Stresses due to bending: Introduction, deformation in pure bending, stress-strain relations, equilibrium requirements, stresses & deformations in pure bending Stresses due to shear force and bending moment, combined stresses, strain energy due to bending, yielding in bending

Deflections due to bending: Introduction, moment-curvature-relations, integration of moment-curvature relations, superposition, Load-deflection differential equation, Energy Methods

Stability of equilibrium: Buckling: Introduction, elastic stability, examples of instability, elastic stability of flexible columns

TEXT BOOKS/ REFERENCE BOOKS

1. An Introduction to Mechanics of Solids by S. H. Crandall et al., McGraw-Hill International editions, 2017.
2. Engineering Mechanics of Solids by E P Popov and T A Balan, Pearson Education, 2012.
3. Introduction to Solid Mechanics by I. H. Shames, 2nd Edition, 2009, Prentice Hall of India Private Ltd. New Delhi.
4. Mechanics of Materials; F. P. Beer, E. R. Johnston and J. T. DeWolf, 2019, McGraw-Hill International Edition.

Details of the Course

Course Code	Course Title	Credits	L	T	P	Studio
22MEP206	**Computer-Aided Machine Drawing**	**2**	**0**	**0**	**4**	**0**

Prerequisite: Engineering Drawing and Sketching

Course Outcomes:

CO1	Understand the production drawing of a given object.
CO2	Identify and describe different standards, symbols, fits, and tolerances used in the drawing.
CO3	Create 2D drawings and 3D models of the machine components using the software.
CO4	Create assembly drawings of machine components using the software.

Course Contents:

Introduction to Machine Drawing: Principle of projection, methods of projection, first angle projection, third angle projection, Code of practice for Engineering Drawing, BIS code of practice, specifications, type of machine drawing, production drawing, assembly drawing, list of parts or bill of materials.

Introduction to computer-aided drawing: Elements of Computer Aided Drawing, CAD software.

Fits and Tolerances: Geometrical tolerances, terminology for geometrical tolerances, selection of tolerances, representation of geometrical tolerances. Fits: Nomenclature, Classification of fits, Systems of fits and tolerances, Designation, Selection of fits. Representation of fits, surface-roughness, surface-roughness representation on drawing.

2D Drawing: Draw commands: line, spline, polygon, rectangle, arc, circle, ellipse, undo, hatch, point, tangent etc. Modify commands: move, rotate, copy, mirror, array, erase, fillet, chamfer, offset, trim, etc.
Conversion of pictorial projections into orthographic projections, dimensioning, sectional views: Rules and conventions of sectioning, full sectional, half sectional, partial sectional and revolved sectional views of simple machine parts such as Bearings, Bush bearing, Plummer block, Valves, Safety and non-return valves. Nomenclature of threads, conventional representation of threads, hexagonal and square headed bolts and nuts, locking arrangements of nuts, various types of machine screws and set screws, Foundation bolts.

3D Geometric Modeling: Sketcher, Datum planes, Holes, Part modeling, Extrude, Revolve, Sweep, Loft, Blend, Fillet, Pattern, Chamfer, Round, Mirror etc. practice for simple 3D drawings.
3D modeling of machine components: nut and bolt, screw, keys, step shaft, pulley, spur gear, helical gear etc.

Assembly Drawings: Types assembly drawings - Accepted norms for assembly drawings, sequence of assembly drawing preparation.
Assembly of Engine parts: Piston: Connecting rod, crank shaft, cam shaft, piston ring etc.
Assembly of lathe machine parts: Tail stock, Head stock assembly, Tool post and carriage. Valves: Stop valves, Safety valves, feed-check valves, Pressure relief valves, and flow and direction control valves. Joints: pin joint or knuckle joint, cotter joints, Couplings: muff coupling, split muff coupling, flanged coupling, protected type flanged coupling, universal coupling or Hook's joint, Oldham's coupling. Miscellaneous assemblies: ball bearings, Vices, Screw jack, Stuffing box and crosshead.

Text Books/ Reference Books

1. Machine Drawing, Bhatt N.D., Charotar Publishing House, 2022
2. Machine Drawing, Narayana K.L., Kannaiah P., and Reddy K.V., New Age International Pvt Ltd., 2016
3. Machine Drawing, Sidheswar N., Kannaiah P, and Sastry V. V. S., Tata McGraw Hill, 2014
4. Machine Drawing, John K.C., and Varghese P.I., PHI Publication, 2009

DETAILS OF THE COURSE

Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
22MEP207	**Fluid Mechanics Laboratory**	**1**	**0**	**0**	**2**	**0**

PREREQUISITE : Measurements and Instrumentation, Fluid Mechanics, and laboratory course of Physics.

COURSE OUTCOMES: Students who successfully complete this course will have an ability to:

CO1	Identify, name, and characterize flow patterns and regimes
CO2	Measure fluid pressure and relate it to flow velocity.
CO3	Demonstrate practical understanding of friction losses in internal flows.
CO4	Demonstrate the ability to write clear lab reports
CO5	Compare the results of analytical models introduced in lecture to the actual behaviour of real fluid flows and draw correct and sustainable conclusions.

COURSE CONTENTS

- To measure losses due to friction in pipes
- To measure discharge through Venturi meter, orifice meter and Rotameter.
- To verify Bernoulli's Equation Experimentally.
- To determine Reynold's number and hence the type of flow either laminar or turbulent.
- To determine the loss of head due to pipe fittings at different flow rates
- To determine loss coefficient for the pipe fittings.
- To measure the solid liquid contact angle of surface.
- To determine the hydrostatic force and center of pressure.

Text Books/ Reference Books

1. Lab Manuals

DETAILS OF THE COURSE:

Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
22MEP208	**Materials Science and Engineering Lab**	**1**	**0**	**0**	**2**	**0**

PREREQUISITE: Basic knowledge of material science and engineering theory.

COURSE OUTCOMES:
On successful completion of the course, the student should be able to:

CO1	To determine and evaluate the wear and co-efficient of friction of a standard specimen.
CO2	To examine the microstructural behavior of materials under microscope by understanding examination procedure.
CO3	To evaluate mechanical properties like tensile/compressive strength, shear stress, toughness, and bending stress of a specimen necessary for material selection design and development.
CO4	Ability to analyze various heat treatment methods for a given specimen to observe mechanical properties and grain size.

COURSE CONTENTS

- To study the behavior of the given material under tensile load and to determine the following: Percentage elongation in length, b. Percentage reduction in area, c. Working stress or permissible stress or safe stress Young"s modulus, e. Yield stress, f. Ultimate stress or Maximum tensile stress g. Breaking stress or Failure stress
- Compare the Tensile strength before and after heat treatment of the selected metals when subjected to uniaxial tensile loading
- To determine the shear strength of the given standard specimen under single and double shear.
- To study the behavior of the given material under Compressive load and to determine the following: a. Modulus of elasticity, b. Maximum Compressive strength or ultimate stress, c. Percentage Decrease in length and Percentage Increase in area
- Compare the compressive strength before and after heat treatment
- To Conduct bending test for the given specimen and to determine the following: a. Modulus of elasticity b. Modulus of Rupture or flexure modulus (maximum bending stress at failure using bending equation).
- To study procedure of specimen preparation for microscopic examination and to carry out a micro structural examination of different materials
- To determine the Impact strength (Specific impact factor) through Izod test
- To determine the Impact strength (Specific impact factor) through Charpy test
- To determine the Rockwell hardness number of the given Specimen using "Rockwell Hardness tester"
- To determine the Brinell hardness number of the given Specimen using Brinell hardness tester

Text Books/ Reference Books

1. Lab Manuals

DETAILS OF THE COURSE

Course Code	Course Title	Credits	Lecture	Tutorial	Practical	Studio
22MEP209	**Mechanical Measurements & Metrology Laboratory**	**1**	**0**	**0**	**2**	**0**

PREREQUISITE : Product Realization through Manufacturing

COURSE OUTCOMES

CO1	Understand the principles of metrology and the importance of measurements in industry.
CO2	Use various measuring instruments for dimensional, surface, and form measurements, including micrometers, calipers, gauges, profilometers, surface roughness tester, coordinate measuring machine.
CO3	Apply measurement error analysis and uncertainty calculations to ensure measurement accuracy and reliability.
CO4	Apply calibration methods and traceability requirements to ensure measurement accuracy and reliability.

COURSE CONTENTS

- To study about the basics of the engineering metrology and measurements.
- To study calibration of micrometer using slip gauge.
- To measure length measurement with various types of vernier
- To measure the height/depth of the object using vernier height gauge/depth gauge.
- To study various measuring instruments like, radius gauge, Screw pitch gauge and Go/No-go gauge like Snap gauge, Plain plug gauge and Thread plug gauge, Wire gauge, feeler gauge.
- To measure the angle of given specimen by Vernier Bevel Protractor.
- To measure gear parameters for the given spur gear by gear tooth Vernier.
- To measure the characteristic of weight using Load Cell.
- To measure the surface roughness of the given specimen using Surface Roughness Tester / Profilometer.
- To measure the thread parameter of given screw thread using profile projector.
- To measure the temperature and vibration using data acquisition system.
- To measure the various parameters of an object using coordinate measuring machine.

TEXT BOOKS/ REFERENCE BOOKS (Title, Authors, Publisher & Year):-

1. Metrology for Engineers by Gaylor, Shotbolt, Sharp
2. Mechanical Measurements by Thomas G. Beckwith , 6E Book
3. J. P. Holman, “Experimental Methods for Engineers”, 8th Edition, McGraw-Hill Series in Mechanical Engineering).
4. S. P. Venkateshan, “Mechanical Measurements”, 2nd Edition, John Wiley & Sons Ltd.