

Subject Code: 1ET1010404	Subject Title: Mechanical Measurement and Metrology
Pre-requisite Subject	Zeal to learn the subject

Course Objective:

This course will help student to

1. To introduce various techniques and instrumentation used in mechanical measurement and metrology.
2. To help students to learn, select and use different measuring instruments for measuring the qualitative and quantitative characteristics of different mechanical objects.
3. To help students to learn how to measure various parameters/quantities which are associated with the practical objects by selecting proper instruments and to take corrective action for minimizing and eliminating deviations.
4. To implant the awareness in students to calibrate the measuring instruments as per national and international standards for accurate measurement of the quantity.

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				Total (T+P)
Lecture	Tutorial	Practical	Credit	Theory		Practical		
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
3	-	2	4	70	30	30	20	150

Subject Contents			
Sr. No.	Topic	Total Hours	Weight (%)
01	<p>Basic Concepts of Mechanical Measurement and Metrology Mechanical Measurement: Necessity and Objectives of mechanical measurement, Methods and Modes of measurement, Generalized block diagram of measuring systems, Static and Dynamic performance characteristics of measuring instruments, Calibration, Sources of error in measurement, Classification and Elimination of errors.</p> <p>Metrology: Necessity and Objectives of Metrology, Need and Objectives of Inspection, Standards of measurements.</p>	04	09
02	<p>Linear Measurement Introduction, working principle, construction and least count of Vernier calliper, Vernier height gauge, Vernier depth gauge, Micrometers, Sources of errors and Precautions to be taken for all, Miscellaneous linear measuring Instruments: Slip gauges, Telescopic gauge, Bore gauge. Calibration of various linear measuring instruments, Applications, Advantages and Limitations of commonly used linear measuring instruments.</p>	05	11

03	<p>Angular Measurement Introduction, working principle, construction of Bevel protractors, Sine bar, Sine centre, Angle gauges, Spirit level, Clinometer, Auto-Collimator, Angle dekkor, Sources of errors and precautions to be taken for all, Applications, Advantages and Limitations of commonly used angular measuring instruments, Measurement of taper shafts and holes.</p>	05	11
04	<p>Measurement of Geometrical Forms Dial indicator/gauge: types, construction, working, applications, Geometrical forms measurement methods: Straightness, Flatness, Squareness, Roundness etc.</p>	03	07
05	<p>Surface Roughness Measurement Terminology used for surface roughness, Surface texture evaluation methods: Centre Line Average (CLA), Root Mean Square (RMS) and Peak to valley height, Construction, working and applications of direct measurement instrument methods: Stylus probe profilometers, Talysurf surface roughness tester and Tomlinson surface tester, Other methods for measuring surface roughness: Tracer type profilograph, Pneumatic method, Mecrin Instrument, Light Interference microscope, Surface roughness symbol interpretation.</p>	05	11
06	<p>Gear and Screw thread Measurement Gear measurement: Terminology, Errors in manufactured gears, Measurement of gear for run out, lead, backlash checking, alignment of gear teeth, Gear tooth thickness measurement methods: Gear tooth vernier calliper, Constant chord method, Base tangent micrometer, Measurement over roller, Functional gear checking by Parkinson's gear tester. Screw thread measurement: Different thread elements, Forms of thread, Errors in threads, Measurement of external major and minor diameters, Measurement of effective or pitch diameter by thread micrometer, one, two and three wire methods, Best wire size and its correction, Measurement of internal thread elements.</p>	06	13
07	<p>Limit Gauges and Comparators Limit Gauges: Interchangeability, Selective assembly, Limit gauges types, Taylor's principle, Design of limit gauges. Comparators: Mechanical comparators, Mechanical optical comparators, Electrical comparators, Pneumatic comparators.</p>	04	09
08	<p>Force, Torque and Power Measurement Force: Strain gauge load cell, Cantilever beams, Proving rings, differential transformers. Torque: Gravity balance method, Mechanical torsion meter, Optical torsion meter, Electrical torsion meter, Strain gauge torsion meter. Power: Prony brake dynamometer, Rope brake dynamometer, Hydraulic dynamometer, Eddy current dynamometer, Torsion bar dynamometer, Servo-controlled dynamometer.</p>	05	11

09	<p>Motion Measurement</p> <p>Displacement: Resistive potentiometer, Linear variable differential transducer (LVDT), Capacitive transducer, Piezoelectric transducer.</p> <p>Velocity/Speed: Mechanical, Electrical and Photoelectric Tachometers.</p> <p>Acceleration: Piezoelectric accelerometer, Seismic accelerometer, Strain gauge accelerometer</p>	04	09
10	<p>Temperature Measurement</p> <p>Temperature scales, Temperature measurement by mechanical effects: Liquid in glass thermometer, Bimetallic strip, Pressure thermometers, Temperature measurement by electrical effects: Thermistor, Thermocouple, Resistance Temperature Detector (RTD), Pyrometers, Calibration of temperature measuring instruments.</p>	04	09

Course Outcome:

The student will be able to

1. Explain the basic principles underlying instruments associated errors and their remedies.
2. Understand importance of accurate and precise measurement in manufacture industries.
3. Apply the basic concepts learned in developing metrology instruments.
4. Understand importance of measurements for analysis of other mechanical subjects like Production and Manufacturing, Machine Design, Industrial Engineering, Fluid Power Engineering etc.
5. Follow the instructions to calibrate and use metrology instruments.
6. Select the appropriate instrument for practical applications.

List of References:

1. Mahajan M. "A Text Book of Metrology", Dhanpat Rai Publications, New Delhi
2. Kumar D.S. "Mechanical Measurement and Control", Metropolitan book Co.
3. Jain R.K. "A Text Book of Engineering Metrology", Khanna Publisher
4. Doebelin E.O. "Measurement Systems", McGraw-Hill, 2004
5. Holman J.P. "Experimental Methods for Engineers", Tata McGraw Hill publications
6. Rajput R.K. "Mechanical measurement and instrumentation", S.K. Kataria & Sons
7. Gupta I.C. "A Text book of Engineering Metrology", Dhanpat Rai Publications
8. Sawhney A.K. "A course in Mechanical Measurements and Instrumentation", Dhanpat Rai Publications

Website:

1. www.sciencedirect.com
2. www.ocw.mit.edu
3. www.nptl.ac.in

List of Practical:

1. Measurement of external, internal and depth dimensions by vernier calliper and dial vernier calliper
2. Measurement of external and internal dimensions by outside micrometer and inside micrometer
3. Measurement of various dimensions by height gauge and depth gauge
4. Measurement of internal dimensions by telescopic gauge and Demonstrate use of slip gauges/gauge blocks
5. Calibration of vernier calliper and micrometer using gauge blocks/slip gauges as standard
6. Measurement of angle by bevel protector
7. Measurement of angle by sine bar and slip gauges
8. Measurement of roundness using dial gauge combination and draw polar diagram
9. Measurement of straightness by wedge method and Flatness measurement by dial gauge
10. Measure the gear tooth thickness of spur gear with the help of gear tooth vernier calliper
11. Measure the different elements of screw thread by screw thread micrometer
12. Demonstration of surface roughness measurement
13. Calibration of pressure gauge using dead weight gauge tester
14. Demonstration of temperature measuring instruments
15. Demonstrate the use of various limit gauges, feeler gauge, radius gauge, thread pitch gauge etc.

Note: At least ten practical should be covered in laboratory work from the above suggested list.