

Branch Name:	Mechanical Engineering
Program Code:	ET101
Course Name:	Measurements and Metrology
Course Code:	2ET1010404T
Pre-requisite Course:	Zeal to learn the subject

Course Objectives:

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 and Examination Scheme:

Credit	Teaching Scheme Hours per week				Evaluation Scheme (Marks)								
					Theory (Marks)				Practical (Marks)				Total (Marks)
	L	T	P	Total	SEE		CCA		SEE		CCA		
					Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
03	03	-	-	03	24	60	16	40	-	-	-	-	100

Course Contents:

Sr. No	Topic	Total Hours	Weightage (%)
1	Basic Concepts of Measurement and Metrology: 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. Metrology: Necessity and Objectives of Metrology, Need and Objectives of Inspection, Standards of measurements.	04	10
2	Linear and Angular Measurement: 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. Slip gauges, Telescopic gauge, Bore gauge. Calibration of various linear measuring instruments, Applications, Advantages and Limitations of commonly used linear measuring instruments. Angular Measurement: Introduction, working principle, construction of Bevel protractors, Sine bar, Sine center, 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	09	20

3	Geometrical Forms & Surface Roughness Measurement: Geometrical Forms Measurement: Dial gauges- types, construction and applications. Definition, symbol and measuring method of various geometric tolerances (Straightness, Squareness, Flatness, Parallelism, Perpendicularity, Roundness, Concentricity, Cylindricity, Run out and Ovalityetc.) 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.	05	10
4	Limits, Fit & Tolerances and Comparators: Limits, Fit & Tolerances: Definitions; Tolerance zone and grades, Hole and shaft system, Geometric tolerances, Tylor's principle of gauging, Design of tolerances for various applications; Tolerance analysis in manufacturing and assembly; Role of metrology in Design of Manufacturing. Comparators: Mechanical comparators, Mechanical optical comparators, Electrical comparators, Pneumatic comparators.	04	10
5	Gears and Screw Threads Measurement: Gears Measurement: Gear tooth terminology, Sources of errors in manufacturing of gears, Measurement of tooth thickness: Gear tooth vernier, Constant chord method, Addendum comparator method and Base tangent method, Measurement over roller, Functional gear checking by Parkinson's gear tester. Measurement of tooth profile: Tool maker's microscope or projector, Involute tester, Measurement of pitch, Measurement of run out, Lead and Backlash checking. Measurement of concentricity, Alignment of gears. 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.	08	20
6	Temperature Measurement: 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.	04	10
7	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.	04	10
8	Motion Measurement: Displacement: Resistive potentiometer, Linear variable differential transducer (LVDT), Capacitive transducer, Piezoelectric transducer. Velocity/Speed: Mechanical, Electrical and Photoelectric Tachometers. Acceleration: Piezoelectric accelerometer, Seismic accelerometer, Strain gauge accelerometer	04	10

Reference Books:

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 Publication.

E-Resources:

1. Mechanical Measurements and Metrology by Prof. S P Venkateshan (IIT Madras), NPTEL Course (Link: <https://nptel.ac.in/courses/112/106/112106138/>).
2. Principles of Mechanical Measurement by Prof. Dipankar N Basu (IIT Guwahati), NPTEL Course (Link: <https://nptel.ac.in/courses/112/103/112103261/>).

Course Learning Outcomes (CLO):

CLO	Description	Bloom's Taxonomy Level
CLO1	Explain the basic principles underlying instruments associated errors and their remedies.	2 Understanding
CLO2	Understand importance of accurate and precise measurement in manufacture industries.	1 Remembering
CLO3	Apply the basic concepts learned in developing metrology instruments .	3 Applying 4 Analyze
CLO4	Understand importance of measurements for analysis of other mechanical subjects like production and manufacturing, machine design, industrial engineering, fluid power engineering etc.	2 Understanding 6 Creating
CLO5	Follow the instructions to calibrate and use metrology instruments.	5 Evaluating
CLO6	Select the appropriate instrument for practical applications.	3 Applying

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Program Outcomes (POs)												Program Specific Outcomes(PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CLO1	H	L					M				M	L	L	
CLO2	M		H		M					L	M		M	
CLO3		M	H		H			L			M			
CLO4	H	H			L	M	M	M		L		H	L	
CLO5	M	M			H		L	L	M	M		L		M
CLO6			M		H	L			L			M		L

H: High, M: Medium, L: Low