GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3141901

Semester IV
MECHANICAL MEASUREMENT AND METROLOGY

Type of course: Basic Science

Prerequisite: Nil

Rationale:
Measurement and Metrology deals with the application of science in Mechanical Engineering. It provides a means of assessing the suitability of measuring instruments, their calibration, and the quality control of manufactured products.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Hrs
1	**Introduction to Metrology, Linear and Angular Measurement:** Definition, objectives and concept of metrology, Need of inspection, Principles, process, methods of measurement, Classification and selection of measuring instruments and systems. Accuracy, precision and errors in measurement. System of measurement, Material Standard, Wavelength Standards, Subdivision of standards, Line and End standards, Classification of standards and Traceability, calibration of End bars, standardization. Slip gauges- Indian standards on slip gauge, method of selection of slip gauge, stack of slip gauge, adjustable slip gauge, wringing of slip gauge, care of slip gauge, slip gauge accessories, problems on building of slip gauges (M87, M112). Measurement of angles- sine bar, sine center, angle gauges, optical instruments for angular measurements, Auto collimator-applications for measuring straightness and squareness.	12
2	**System of Limits, Fits, Tolerance and Gauging:** Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly, limits of size, Indian standards, concept of limits of size and tolerances, definition of fits, hole basis system, shaft basis system, types of fits and their designation (IS 919-1963), geometric tolerance, position-tolerances. Classification of gauges, brief concept of design of gauges (Taylor's principles), Wear allowance on	12

	gauges, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials. **Comparators:** Functional requirements, classification, mechanical- Johnson Mikrokator, sigma comparators, dial indicator, electrical- principles, , LVDT, Pneumatic- back pressure gauges, Solex comparators and optical comparators- Zeiss ultra-optimeter.	
3	**Measurement of screw thread and gear:** Terminology of screw threads, measurement of major diameter, minor diameter, pitch, angle and effective diameter of screw threads by 2-wire and 3- wire methods, best size wire. Screw thread gauges, Tool maker's microscope. Gear tooth terminology, tooth thickness measurement using constant chord method, addendum comparator method and base tangent method, measurement of pitch, concentricity, run out, and involute profile. Gear roll tester for composite error.	**10**
4	**Measurement systems and basic concepts of measurement methods:** Definition, significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system response-time delay. Errors in measurement, classification of errors. Transducers, transfer efficiency, primary and secondary transducers, electrical, mechanical, electronic transducers, advantages of each type transducers. **Intermediate modifying and terminating devices:** Mechanical systems, inherent problems, electrical intermediate modifying devices, input circuitry, ballast circuit, electronic amplifiers. Terminating devices, Cathode ray oscilloscope, Oscillographs. **Advances in metrology:** Basic concepts of lasers, advantages of lasers, laser interferometers, types, applications. Basic concepts of Coordinate Measuring Machines constructional features, applications.	**12**
5	**Force, Torque, Pressure, Strain and temperature Measurement:** Direct methods and indirect method, force measuring instruments Torque measuring instruments, Types of dynamometers, Absorption dynamometer, Prony brake and rope brake dynamometer, and power measuring instruments. Pressure measurement, principle, pitot tube, pressure gauges, pressure transducers, use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge. Theory of strain gauges, types, electrical resistance strain gauge, preparation and mounting of strain gauges, gauge factor, methods of strain measurement. Temperature Compensation, Wheatstone bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors. Resistance thermometers, thermocouple, law of thermocouple, materials used for construction, pyrometer, optical pyrometer.	**14**

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Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	10	35	0	40	0

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Reference Books:

1. Engineering Metrology and Measurements, Bentley, Pearson Education
2. Metrology and Measurement, Anand Bewoor & Vinay Kulkarni McGraw-Hill
3. Mechanical Measurements and Instrumentations, Er. R K Rajput, Kataria Publication(KATSON)
4. Mechanical Measurement and Metrology by R K Jain, Khanna Publisher Mechanical Measurement & Control by D.S. Kumar.
5. Industrial Instrumentation & Control by S K Singh, McGrawHill
6. Engineering Metrology and Measurement, N V Raghavendra and Krishnamurthy, Oxford University Press

Course Outcomes:

Students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	summarize various methods and terms used in mechanical measurements and metrology.	10
CO-2	measure mechanical quantities like Force, Temperature, Pressure, Velocity, Acceleration, Strain and Torque.	40
CO-3	apply concepts of metrology for gears, threads and surface finish.	35
CO-4	utilize various precision machines working based on Laser technology and coordinate measuring methods.	15

List of Experiments:

1. Basic understanding of measurements and metrology: concepts, application, advantage and future aspects
2. Performance on linear and angular measurements and check different characteristics of measurements
3. Performance on temperature measurements and check different characteristics of measurements and also do calibration
4. Performance on pressure measurements and check different characteristics of measurements and also do calibration

5. Performance on stress, strain and force measurements and check different characteristics of measurements and also do calibration
6. Performance on Speed/Velocity, acceleration measurements.
7. Performance on surface measurements.
8. Performance on measurements of gears and screw threads.

Major Equipment:

1. Temperature and pressure Measurements Equipments/Devices/Sensors.
2. Stress/Strain/Force Measurements Equipments/Devices/Sensors.
3. Surface Measurements Equipments/Devices/Sensors
4. Linear/Angular Measurements Equipments/Devices/Sensors
5. Resistive Potentiometer, Tachometers, Piezoelectric Accelerometer
6. Gears/Screw Threads Measurements Equipments/Devices/Sensors
7. Miscellaneous measurements equipments

List of Open Source Software/learning website:

1. http://nptel.ac.in/courses/112106138