GUJARAT TECHNOLOGICAL UNIVERSITY

PRODUCTION ENGINEERING(25)

METROLOGY AND MEASUREMENT

SUBJECT CODE: 2142503

B.E. 4th SEMESTER

Type of course: Under Graduate level

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. A product that is not manufactured according to metrological specifications will have to incur heavy costs of comply with the specifications later. Any compromise in quality creates rapid negative sentiments in the market and cost of recovering the original market position would be quite high. Hence, an organization should strive towards a ZERO – DEFECT regime in order to survive in a highly competitive market, ensuring this aspect of manufacturing is the responsibility of a quality control engineer, who must be completely familiar with measurements and metrology and also their limitations.

By educating in the area of Measurement and Metrology students will enable to seek employment in engineering upon graduation while, at the same time, provide a firm foundation for the pursuit of graduate studies in engineering.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Introduction to Measurements:** Generalized Measurement system, static & dynamic characteristics of instruments, types of measurement system , Instrumental error & its analysis, etc.	03	7%
2	**Measurement of Force, Torque and Strain:** Force measurement: load cells, cantilever beams, proving rings, differential transformers. Measurement of torque: Torsion bar dynamometer, servo controlled dynamometer, absorption dynamometers. Power Measurements. Measurement of strain: Mechanical strain gauges, electrical strain gauges, strain gauge: materials, gauge factors, theory of strain gauges and method of measurement, bridge arrangement, temperature compensation.	06	14%

3	**Displacement, Velocity/Speed, and Acceleration, Measurement:** Working principal of Resistive Potentiometer, Linear variable differential transducers, Electro Magnetic Transducers, Mechanical, Electrical and Photoelectric Tachometers, Piezoelectric Accelerometer, Seismic Accelerometer,	**04**	7%
4	**Temperature measurement:** Temperature Measuring Devices: Thermocouples, Resistance Temperature Detectors, Thermistor, Liquid in glass Thermometers, Pressure Thermometers, Pyrometer, Bimetallic strip. Calibration of temperature measuring devices, Numerical Examples on Flow Measurement.	**04**	12%
5	**Metrology:** Basics of Metrology, Need for Inspection, Accuracy and Precision, Objectives, Standards of measurements.	**02**	4%
6	**Linear and angular measurements:** Working principle , constriction , Measurement prouder, error and elimination, limitations and calibration of different linear and Angular measur instruments.	**07**	15%
7	**Metrology of Gears and screw threads:** 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 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:** Errors in threads, screw thread gauges, measurement of element of the external and internal threads, thread calliper gauges.	**06**	12%
8	**Metrology of Surface finish:** Surface Metrology Concepts and terminology, Analysis of surface traces, Specification of surface Texture characteristics, and Method of measuring surface finish: Stylus system of measurement, Stylus probe instruments, Wave length, frequency and cut off, other methods for measuring surface roughness: Pneumatic method, Light Interference microscopes, Mecrin Instruments.	**06**	12%
9	**Comparators:** Functional Requirements, Classification, Mechanical Comparators, Mechanical Optical Comparators, Electrical Comparators, Pneumatic Comparators.	**03**	7%
10	**Miscellaneous Metrology:** Precision Instrumentation based on Laser Principals, Coordinate measuring machines: Structure, Modes of Operation, Probe, Operation and applications. Optical Measuring Techniques: Tool Maker's Microscope, Profile Projector, Optical Square. Basics of Optical Interference and Interferometry, Optoelectronic measurements,	**04**	10%
	Total Hours	**45**	100%

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	U Level	A Level	N Level	E Level
14	21	14	14	07

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

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table

Reference Books:

1. Engineering Metrology and Measurement, N V Raghavendra and Krishnamurthy, Oxford University Press,
2. Engineering Metrology and Measurements, Bentley, Pearson Education
3. Theory and Design for Mechanical Measurements, 3rd Edition, Richard S Figliola, Donald E Beasley, Wiley India
4. Metrology and Measurement, Anand Bewoor & Vinay Kulkarni McGraw-Hill
5. Doebelin's Measurement Systems Ernest Doebelin, Dhanesh Manik McGraw-Hill
6. Instrumentation, Measurement and Analysis, B.C. Nakra, K.K. Chaudhry McGraw-Hill
7. A Text book of Engineering Metrology, I C Gupta, Dhanpat Rai Publications
8. A course in Mechanical Measurements and Instrumentation, A K Sawhney, Dhanpat Rai Publications
9. Mechanical Measurements and Instrumentations, Er. R K Rajput, Kataria Publication(KATSON)
10. Mechanical Measurement and Metrology by R K Jain, Khanna PublisherMechanical Measurement & Control by D.S. Kumar.
11. Industrial Instrumentation & Control by S K Singh, McGrawHill
12. Mechanical Measurements by Beckwith & Buck, Narosa publishing House

Course Outcome:

After learning the course the students should be able to:

1. Students will describe basic concepts of Metrology
2. Students will select linear measuring instrument for measurement of various components
3. Students select angular and taper measurement devices for measurement of various components
4. Students will discriminate between various screws by measuring their dimensions
5. Students will separate different gears through measurement of various dimensions of gears
6. Students will discriminate capabilities of machining process by measuring surface finish of the component produced
7. Students will evaluate quality of surface produced using various methods
8. Students will describe basic concepts of mechanical measurement and errors in measurements.
9. Students will select appropriate temperature measuring device for various applications
10. Students will describe methods of measurement for various quantities like force, torque, power, displacement, velocity/seed and acceleration

List of Experiments:

Following experiments are suggested for Laboratory work

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 Temperature 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

Important Note:

80 % From above suggested laboratory work should be covered and remaining 20 % is as per facility available at Department.

Design based Problems (DP)/Open Ended Problem:

All above performance are to be carried out in the laboratory and students will prepare experiments and note down reading and conclusion. The can prepare for calibration and compare results with existing and with alternate methods of measurements. At least 5 open ended problems are proposed for better understanding the subject and to apply real life application. The projects are listed below:

1. Calibration of temperature measuring devices
2. Design and prepare for strain/force/torque measurements experiments
3. Setup preparation and experiments on linear and angular measurements
4. Experiment for gear and screw thread measurements
5. Setup preparation and experiments on Displacement, Speed/Velocity and acceleration measurement

Major Equipment:

1. Temperature 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

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.