

# GUJARAT TECHNOLOGICAL UNIVERSITY

## MECHATRONICS ENGINEERING (20) ELECTRO MECHANICAL MEASUREMENTS & INSTRUMENTS SUBJECT CODE: 2162005 B.E. 6<sup>th</sup> Semester

**Type of course:** Engineering Science

**Prerequisite:** NA

**Rationale:** Course gives idea about the fundamentals of various terms and techniques of measurements of mechanical and electrical physical quantities. The different instruments used for measurements are discussed.

### Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)		PA (V)		PA (I)		
				PA	ALA	ESE	OEP			
4	0	2	6	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

### Contents:

#### A. Mechanical Measurements

Sr No	Contents	Teaching Hrs	Weightage (%)
1	<b>Basic Concepts:</b> Introduction to Measurements and Instrumentation, Significance of Measurements, Standards of Measurements, Methods of Measurements, Modes of Measurements, Classification of Instruments, Basic Standards and Units, Primary, Secondary and Working Standards, Generalized Measurement Systems and its Functional Elements, Input-Output Configurations of Measuring Instruments and Systems.	05	11.1%
2	<b>Instrument characteristics:</b> Static Performance Characteristics, Dynamic Performance Characteristics, Standard Test-Input, Zero, First and Second Order Instruments, First Order System Responses, Second Order System Responses.	06	13.3%
3	<b>Errors in Measurements:</b> Introduction, Limiting Errors, Types of Errors, Sources of Errors, Statistical Analysis of Test Data, Curve Fitting, Application of Computers for Data Analysis, Selecting an Instrument, Selection of Measurement System.	04	8.8%
4	<b>Speed, Acceleration and Frequency Measurements:</b>	03	6.6%

	Mechanical Tachometer, Electrical Tachometer, Contactless Electrical Tachometers, Piezoelectric Accelerometer, Seismic Acceleration.		
5	<b>Force, Torque &amp; Power Measurements:</b> Load Cells, LVDT, Elastic Force Transducer, Mechanical Torsion Meter, Optical Torsion Meter, Strain Gauge Torsion Meter, Electrical Torsion Meter, Mechanical, Hydraulic and Electrical Dynamometry.	04	8.8%

### B. Electrical Measurements

Sr No	Contents	Teaching Hrs	Weightage (%)
1	<b>Principles of Operation of Following types of Electrical Instruments:</b> Permanent Magnet Moving Coil and Moving Iron type instruments, DC Potentiometers and its applications, Resistance measurement: Different methods for measurement of high, low and medium resistance, Measurement of earth resistance, Introduction to instrument transformers (current transformers and potential transformers).	12	26.6%
2	<b>Sensors and Transducers:</b> Resistance Strain Gauges, Resistive Potentiometers and errors, Thermocouples and Thermoelectric laws, RTDs and Thermistors, Piezoelectric Sensors and loading effects, Inductive and Capacitive Transducers, Signal conditioning of sensors.	05	11.1%
3	<b>Digital Data Acquisition Systems:</b> Basic functional elements of Digital Data Acquisition Systems, Introduction to Data Transmission and Telemetry, Introduction to Digital Signal Processing.	05	11.1%
4	Applications of Sensors in Industrial Applications.	01	2.2%

### Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
40	25	15	10	5	5

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create 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) D. S. Kumar, Mechanical Measurement and Control, Metropolitan Book Co.
- (2) A.K.Sawhney, A course in Electrical and Electronic, Measurement and Instrumentation Dhanpat Rai & Sons
- (3) E. O. Doebelin, Measurement Systems, McGraw Hill International Edition
- (4) R. K. Rajput, Mechanical Measurements and Instrumentation Katson Books
- (5) T. G. Beckwith Mechanical Measurements Narosa Publishing House
- (6) Nakra B.C. and Chaudhry K. K. Instrumentation, Measurement and Analysis Tata McGraw Hill

(7) D. V. S. Murthy Transducers and Instrumentation Prentice Hall of India

**Course Outcomes:**

After successful completion of the course the students shall be able to:

1. Apply the knowledge gained for mechanical and electrical measurements in the field.
2. Design the multidisciplinary instruments for measurement of specific entity.
3. Analyze the measured data/observations collected from the actual application for evaluating the system performance with respect to specifications and standards.

**List of Practical:**

1. To calibrate a bourdon tube pressure gauge using a dead weight gauge tester.
2. To find out the effect of temperature on the kinematic viscosity of a fluid.
3. Calibration of RTD using liquid in glass thermometer.
4. Angular speed measurement of a rotating shaft.
5. Torque measurement using dynamometer.
6. To study the construction and working of PMMC and Moving iron instruments.
7. To extend the range of an ammeters and voltmeters.
8. Calibration of ammeters and voltmeters using DC potentiometers.
9. Measurement and On-Off control of temperature using Thermocouples and Thermistors.
10. Measurement of Force using Load cell.
11. Measurement of Linear displacement with the help of LVDT.

**Design based/open ended problem**

Student may be given a task to design any instrument to measure any parameter. They will be asked to appreciate the use of particular instrument for a specific application.

**Major Equipments:**

1. PMMC and Moving Iron Instruments, DC Potentiometers, Standard Cells, Spotlight Galvanometers, Voltage Ratio Box, Adjustable DC supply and flexible wires.
2. Temperature Sensors and Temperature Calibrators, Heating Elements and Relays.
3. Displacement Sensors (LVDT/RVDT), Strain Gauge Load Cells and Std. Weights.
4. Instrument Transformers, Rheostats, Single and Three phase variacs etc.
5. Redwood viscometer
6. Dead Weight Pressure Gauge
7. Stroboscope

**List of Open Source Software/learning website:**

The website of NPTL may be utilized for additional learning.

**Active learning Assignments (AL) :** Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ part of chapters to groups of students so that the entire syllabus of Electromechanical Measurements & Instruments is covered. The power-point slides should be put up on the web-site of the college/Institute, along with the name of the group, the name of faculty, Department and College on the first slide. The best three works should be sent on [achievements@gtu.edu.in](mailto:achievements@gtu.edu.in).