ETPE3002 SENSORS & TRANSDUCERS (3-0-0)

Course Objectives:

This course provides comprehensive knowledge of sensors and transducers, covering static/dynamic characteristics, calibration, and error analysis. Students will study resistive, capacitive, inductive, and advanced sensors (piezoelectric, electrochemical), learn signal conditioning techniques, and implement smart sensor systems with digital interfaces for real-time industrial applications.

Module-I: (07 hours)

Static Characteristics: systematic characteristics, statistical characteristics, calibration; Dynamic characteristics of measurement systems: transfer functions of typical sensing elements, step, and frequency response of first and second order elements, and dynamic error in measurement systems.

Module-II: (08 hours)

Techniques for dynamic compensation: loading effect, signal and noise in measurement system, Propagation of errors. Elastic sensing elements: Bourdon tube, bellows, and diaphragms; force and torque measurement. Basics of Flow Measurement: Pitot-Static Tube, Flow-Obstruction Elements, Centrifugal Force Element, Static Vane Elements, Rotating Vane Systems, Rotameter Float System, Thermoelectric sensing elements: thermocouple laws, characteristics, installation problems, cold junction compensation

Module-III: (08 hours)

Transducers and sensors: Resistive sensing elements: potentiometers, Resistance Temperature Detector (RTD), Thermistors, strain gauges and associated bridge circuits. Capacitive sensing elements: variable separation, area and dielectric; Inductive sensing elements: variable reluctance, LVDT and RVDT displacement sensors; Electromagnetic sensing elements, push-pull configuration for improvement of linearity.

Module-IV: (07 hours)

Piezoelectric sensor: Piezoresistive Sensor, Instrumentation amplifier, Electrochemical sensor: Ion selective electrodes, Electrochemical gas sensor, chemically sensitive Field Effect Transistors, Hall Sensor, IC temperature sensor. Introduction smart sensors, digital sensors with interfacing fundamentals, and their applications.

Course Outcomes:

At the end of the course, a student will be able to:

CO1: Characterize measurement system and elastic sensors for accurate calibration.
CO2: Analyze resistive, capacitive, inductive, and electromagnetic sensors using signal conditioning.
CO3: Evaluate advanced sensors like piezoelectric and electrochemical for industrial applications.
CO4: Implement smart sensor systems with instrumentation amplifiers and digital interfaces for real-time monitoring.

Text Book:

1. Principles of Measurement Systems-J.P. Bentley (3/e), Pearson Education, New Delhi.
2. Introduction to Measurement and Instrumentation-A.K.Ghosh (3/e), PHI Learning, New Delhi.
3. Measurement Systems Application and Design- E.O. Doeblin (4/e), McGraw-Hill, International, NY.
4. Morris, A. S., &Langari, R, Measurement and Instrumentation: Theory and Application (3rd ed.), Elsevier, 2020.

Reference Book:

1. Transducers and Instrumentation-D.V.S. Murthy(2/e), PHI Learning, New Delhi.
2. Instrumentation for Engineering Measurements-J.W. Dally, W.F. Riley and K. G. McConnel (2/e), John Wiley, NY.
3. Sensor Technology Handbook, Jon S. Wilson—Newnes, 2004.
4. Jacob Fraden, Handbook of Modern Sensors: Physics, Designs, and Applications, Springer.