APPC3005 INSTRUMENTATION DEVICES AND CIRCUITS (3-0-0)

Course Objectives:

1. To introduce the fundamental concepts of measurement systems, their static and dynamic characteristics, and associated errors.
2. To develop understanding of various sensing elements and transducers used for measuring physical parameters.
3. To provide knowledge of elastic, electromagnetic, thermoelectric, and advanced sensing elements along with their applications.
4. To impart skills in signal conditioning techniques including bridges, amplifiers, filters, and demodulation circuits used in instrumentation.

Module I: Elements of a general measurement system; 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. Techniques for dynamic compensation, loading effect, signal and noise in measurement system, and Propagation of errors. (8 Hours)

Module II: Sensing elements: Transducers and sensors, Resistive sensing elements: potentiometers, Resistance Temperature Detector (RTD), Thermistors, strain gauges. Capacitive sensing elements: variable separation, area and dielectric; Inductive sensing elements: variable reluctance, LVDT and RVDT displacement sensors. (7 Hours)

Module III: Electromagnetic sensing elements velocity sensors; ultrasonic, radar, nucleonic type sensing elements, thermoelectric sensing elements: thermocouple laws, characteristics, installation problems, cold junction compensation. IC temperature sensor. (4 Hours)

Module IV: Elastic sensing elements: Bourdon tube, bellows, and diaphragms for pressure sensing, force and torque measurement. Signal Conditioning Elements: Deflection bridges: design of resistive and reactive bridges, push-pull configuration for improvement of linearity and sensitivity. (6 Hours)

Module V: Amplifiers: Operational amplifiers-ideal and non-ideal performances, inverting, noninverting and differential amplifiers, instrumentation amplifier, and filters. A.C. carrier systems, phase-sensitive demodulators and their applications in instrumentation. (5 Hours)

Course Outcomes:

By the end of this course, students will be able to:

CO1 Explain the structure of measurement systems and analyze their static and dynamic characteristics.

CO2 Identify and describe resistive, capacitive, inductive, and thermoelectric sensing elements used in instrumentation.

CO3 Apply principles of electromagnetic, ultrasonic, nucleonic, and IC-based sensors for practical measurement tasks.

CO4 Analyze the use of elastic sensing elements and design resistive/reactive bridge circuits for improved measurement accuracy.

CO5 Apply operational amplifiers, instrumentation amplifiers, filters, and demodulation circuits for signal conditioning in measurement systems.

Text Books:

1. Principles of Measurement Systems- J.P. Bentley (3/e), Pearson Education, New Delhi,2007.
2. Introduction to Measurement and Instrumentation- A.K. Ghosh(3/e), PHI Learning, New Delhi,2009.
3. Transducers and Instrumentation- D.V.S. Murthy (2/e), PHI Learning, New Delhi,2009.

References:

1. Instrumentation for Engineering Measurements- J.W. Dally, W.F. Riley and K.G. McConnel (2/e), John Wiley, NY,2003.
2. Industrial Instrumentation- T.R. Padmanabhan, Springer, London,2000.