

Module -1[9 Hours]**University Portion (80%): (8 Hours)**

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. (Bentley: Chapters 1-4)

Module-2**[8 Hours]****University Portion (80%): (7 Hours)**

Sensing elements: Resistive sensing elements: potentiometers, Resistance Temperature Detector (RTD), thermistors, strain gages. Capacitive sensing elements: variable separation, area and dielectric; Inductive sensing elements: variable reluctance and LVDT displacement sensors; Electromagnetic sensing elements: velocity sensors (Bentley: Sections 8.1 to 8.6)

Module-3**[8 Hours]****University Portion (80%):(7 Hours)**

Thermoelectric sensing elements: laws, thermocouple characteristics, installation problems, cold junction compensation. IC temperature sensor Elastic sensing elements: Bourdon tube, bellows, and diaphragms for pressure sensing, force and torque measurement. (Ghosh: Section 10.3 to 10.4)

Module-4**[9 Hours]****University Portion (80%): (8 Hours)**

Signal Conditioning Elements: Deflection bridges: design of resistive and reactive bridges, push-pull configuration for improvement of linearity and sensitivity. Amplifiers: Operational amplifiers-ideal and non-ideal performances, inverting, non-inverting and differential amplifiers, instrumentation amplifier, filters. A.C. carrier systems, phase sensitive demodulators and its applications in instrumentation (Bentley: Sections 9.1 to 9.3; Ghosh: Sections 15.1 and 15.2)

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.*

Reference Books:

1. *Measurement Systems Application and Design- E.O. Doebelin (4/e), McGraw-Hill, International, NY.*
2. *Instrumentation for Engineering Measurements- J.W. Dally, W.F. Riley and K.G. McConnel (2/e), John Wiley, NY, 2003.*
3. *Industrial Instrumentation- T.R. Padmanabhan, Springer, London, 2000.*