

5 <sup>th</sup> Semester	REI5C003	Instrumentation Devices & Systems	L-T-P 3-0-0	3 CREDITS
-----------------------------	----------	--------------------------------------	----------------	--------------

## Instrumentation Devices & Systems

### Module I:

(5 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. Techniques for dynamic compensation, loading effect, signal and noise in measurement system (Bentley & A. K. Ghosh: Selected portions of Chapters 1 to 4).

### Module II:

(10 hours)

Sensing elements: Transducers and sensors, Resistive sensing elements: potentiometers, Resistance Temperature Detector (RTD), thermistors, strain gages. Capacitive sensing elements: variable separation, area and dielectric; Inductive sensing elements: variable reluctance, LVDT and RVDT displacement sensors; 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 Elastic sensing elements: Bourdon tube, bellows, and diaphragms for pressure sensing, force and torque measurement. (Bentley: Sections 8.1 to 8.6; Ghosh: Section 10.3 to 10.4).

### Module III:

(7 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, and filters. A.C. carrier system, phase sensitive demodulators and its applications in instrumentation. Signal processing elements: A/D conversion: sampling, quantization, and encoding, typical converter (Bentley: Sections 9.1 to 9.3; Gosh: Sections 15.1 and 15.2).

### Module IV:

(10 hours)

Pressure measurement: Manometer for use of pressure measurement, Hall effect transducer, Low pressure measurements. Flow Measurement: Basics of flow measurement; differential pressure flow meters- Pitot tube, Orifice plate, Venturi tube; Rotameter, turbine type flow meter, electromagnetic flow meter. Doppler shift flow meter (Bentley: Sections 12.1 to 12.3.2 and 12.5.1). Temperature measurement: Temperature scale, Change in dimensions-Bimetals, liquid-in-glass thermometers, Filled system thermometers.

**Books:**

- [1] Principles of Measurement Systems- J.P. Bentley (3/e), Pearson Education, NDelhi.
- [2] Introduction to Measurement and Instrumentation- A.K. Ghosh(3/e), PHI Learning.
- [3] Instrumentation for Engineering Measurements- J.W.Dally, W.F.Riley and K.G. McConnell (2/e), John Wiley, NY, 2003.
- [4] Modern Control Technology Components and Systems-C.T.Kilian(3/e), Clengage Learning, New Delhi, 2006.

***Digital Learning Resources:***

Course Name: Industrial Instrumentation  
Course Link: <https://nptel.ac.in/courses/108/105/108105064/>  
Course Instructor: Prof. Alok Barua, IIT Kharagpur