

# Instrumentation Systems(304209)

## Teaching Scheme:

Lectures:3 Hrs/ Week

## Examination Scheme:

In Semester Assessment:

Phase I : 30

End Semester Examination:

Phase II: 70

## Course Objectives:

- To provide a basic understanding of instrumentation and general Instrumentation systems.
- Explain the operation/working of different sensors
- To get fundamental knowledge of sensors and transducers and their operating principles, for measurement of mechanical parameters.
- To impart interdisciplinary knowledge regarding transducers, pneumatic actuators, hydraulic actuators.
- Describe advantages, disadvantages, and applications of limit switches, photoelectric sensors, inductive sensors, capacitive sensors, and ultrasonic sensors
- Transform a temperature reading among different scales.
- Explain the operation of pressure, flow, and level transducers in context with applications.
- Understand the concept of final control elements in various applications

## Course Outcomes:

After successfully completing the course students will be able to

- Applications and selection of sensors/transducers for particular application.
- Describe the various types of sensors including thermal, mechanical, electrical, electromechanical and optical sensors.
- Select appropriate transducers and instrumentation system components for a specific application.
- Design and development of temperature/pressure/flow etc measurement systems.
- Select appropriate Switches and final control elements for a specific application.
- Selection of communication protocol and smart sensors for particular application.

## Unit I : Basics of Instrumentation Systems

**6L**

General Configuration and functional description of measuring instruments, static and dynamic characteristics of instruments, errors in instrumentation systems, active and passive transducers and their classification, fundamental standards and units for common physical parameters.

## **Unit II : Position, Motion, Pressure and Force Sensors**

**6L**

Position and motion sensing: Potentiometers, LVDT, proximity sensors (inductive, capacitive and optical), absolute and incremental optical encoders, piezoelectric accelerometer. Pressure Sensors: Diaphragms, capsules, bellows and bourdon tube. LVDT as secondary transducer to measure pressure. Stress, Strain and Force: Strain Gauges and load cell.

## **Unit III : Temperature, Flow and Level Sensing**

**6L**

Temperature: Resistance temperature detectors, thermistors, thermocouples and pyrometers. Level: Ultrasonic, Capacitance probe type, Hydrostatic pressure and Nuclear level detection techniques. Flow Rate: Bernoulli Equation, Differential head type flow meters ( orifice, venturi tube and flow nozzle), Pitot static tube, Variable area type flow meter – rotameter, vortex shedding, electromagnetic, ultrasonic flow meters.

## **Unit IV : Semiconductor, MEMS and SMART Sensors**

**6L**

Semiconductor temperature sensing – LM75 block diagram, temperature compensated integrated phototransistor, Magnetic field sensors – Hall effect and magneto-resistive elements (MRE), magneto-transistors, piezoelectric (PZT) sensors and actuators. Microelectromechanical systems (MEMS) - Bulk micromachining, micro-machined absolute pressure sensor, Surface micromachining-Hot wire anemometer micro-miniature temperature sensor, surface micro-machined accelerometer, micro-resonator, SMART sensors.

## **Unit V : Data Acquisition, Bus Standards and Protocols**

**6L**

Multichannel data logging and computer based data acquisition system – RS 232C standard, IEEE 488 bus, I2C bus, HART protocol, Fieldbus technology - Foundation Field bus and Profibus. Signal converters such as V/I, I/V, I/P, P/I for data acquisition interfacing.

## **Unit VI : Actuators and Final Control Elements**

**6L**

Pneumatic and hydraulic actuators- Directional control valves, Pressure control valves, Cylinders, Process control valves - Electrical actuators- Mechanical switches, Solid state switches, Solenoids, DC motors, AC motors and Stepper motors.

### **Text Books**

1. W. Bolton; “ Mechatronics, Electronic Control Systems in Mechanical and Electrical Engineering ”; Pearson Education; 3rd Edition
2. William C. Dunn, “Introduction to Instrumentation, Sensors, and Process Control” , Artech House Sensors Library.

### **Reference Books**

1. Curtis Johnson; “ Process Control Instrumentation Technology ”; Prentice Hall of India Pvt. Ltd.; 7th Edition
2. Ernest O. Doebelin; “Measurement System Application and Design ”; Mc-Graw Hill; 5th Edition
3. David G. Alciatore, Michael B Hestand; “ Introduction to Mechatronics and Measurement System ”; Tata McGraw Hill
4. C.S. Rangan, G.R. Sarma, V.S.V. Mani; “ Instrumentation Devices and Systems ”; Tata McGraw Hill; 2nd Edition.