ELECTRONICS FOR SENSOR DESIGN

Course Objectives

1. To introduce the fundamental principles, characteristics, and classifications of sensors and transducers used in engineering applications.
2. To develop an understanding of thermal, magnetic, and radiation sensing mechanisms and their practical implementations.
3. To explain the operating principles and performance parameters of electromechanical, electrochemical, and smart sensors.
4. To familiarize students with signal conditioning, data communication, and interface standards used in modern sensor systems.
5. To enable students to analyze and select appropriate sensors for industrial, automotive, aerospace, biomedical, and environmental monitoring applications.

UNIT – I: Sensors / Transducers (6 hours)

Principles, Classification, Parameters, Characteristics, Environmental Parameters (EP), Characterization Electromechanical Sensors: Introduction, Resistive Potentiometer, Strain Gauge, Resistance Strain Gauge, Semiconductor Strain Gauges. Inductive Sensors: Sensitivity and Linearity of the Sensor – Types. Capacitive Sensors: Electrostatic Transducer, Force/Stress Sensors Using Quartz Resonator, Ultrasonic Sensors.

UNIT – II: Thermal Sensors

Introduction, Gas thermometric Sensors, Thermal Expansion Type Thermometric Sensors, Acoustic Temperature Sensor, Dielectric Constant and Refractive Index thermo sensors, Helium Low Temperature Thermometer, Nuclear Thermometer, Magnetic Thermometer, Resistance Change Type Thermometric Sensors, Thermo emf Sensors, Junction Semiconductor Types, Thermal Radiation Sensors, Quartz Crystal Thermoelectric Sensors, NQR Thermometry, Spectroscopic Thermometry, Noise Thermometry, Heat Flux Sensors.

UNIT – III: Magnetic Sensors

Introduction, Sensors and the Principles Behind, Magneto-resistive Sensors, Anisotropic Magneto resistive Sensing, Semiconductor Magneto resistors, Hall Effect and Sensors, Inductance and Eddy Current Sensors, Angular/Rotary Movement Transducers, Synchros.

UNIT – IV: Radiation Sensors

Introduction, Basic Characteristics, Types of Photo resistors/Photo detectors, X-ray and Nuclear Radiation Sensors, Fibre Optic Sensors, Electro analytical Sensors: The Electrochemical Cell, The Cell Potential – Standard Hydrogen Electrode (SHE), Liquid Junction and Other Potentials, Polarization, Concentration Polarization, Reference Electrodes, Sensor Electrodes, Electro ceramics in Gas Media.

UNIT – V: Smart Sensors

Introduction, Primary Sensors, Excitation, Amplification, Filters, Converters, Compensation, Information Coding/Processing, Data Communication, Standards for Smart Sensor Interface, the Automation Sensors – Applications: Introduction, On-board Automobile Sensors (Automotive Sensors), Home Appliance Sensors, Aerospace Sensors, Sensors for Manufacturing, Sensors for environmental Monitoring.

Course Outcomes

After successful completion of the course, students will be able to:

CO1: Explain the operating principles, characteristics, and performance parameters of various sensors and transducers including resistive, inductive, and capacitive sensors.

CO2: Analyze the working principles and applications of thermal sensors used for temperature and heat-flux measurements.
CO3: Evaluate the performance of magnetic sensors, Hall-effect sensors, magneto-resistive sensors, and rotary motion transducers for measurement systems.
CO4: Demonstrate understanding of radiation, fiber-optic, and electrochemical sensors and their use in scientific and industrial applications.
CO5: Design and select smart sensor systems incorporating signal conditioning, data acquisition, communication interfaces, and automation applications for real-world engineering problems.

Textbooks:

1. "Sensors and Transducers - D. Patranabis" –PHI Learning Private Limited., 2003. 2.
2. Introduction to sensors- John veteline, aravindraghu, CRC press, 2011.

References:

1. Sensors and Actuators, D. Patranabis, 2nd Ed., PHI, 2013
2. 2. Make sensors: Terokarvinen, kemo, karvinen and villeyvaltokari, 1st edition,maker.
3. Sensors handbook- Sabriesoloman, 2nd Ed. TMH, 2009