

Course Code	Course Name	Credits
22PH614	PHYSICS OF SENSORS AND TRANSDUCERS	04

Course Objectives

- To introduce the fundamentals of sensors and transducers.
- To provide the knowledge on the features of sensors and transducers and their principles.
- To demonstrate the principles of sensors and their corresponding functions.
- To analyze the working of electronic instruments and interfacing the sensors/actuator in electronic system.
- To decide the sensors for a specific application and develop the transducers for various applications.

Learning Outcomes

Upon successful completion of this course it is intended that a student will be able to:

- Analyze sensor characteristics: calibration, hysteresis, nonlinearity, resolution, dynamic response, and uncertainty.
- Apply physics principles (capacitance, magnetism, induction, resistance, piezoelectric /pyroelectric effects, Hall effect, thermoelectricity, heat transfer) in sensor design.
- Evaluate detector technologies such as ultrasonic, microwave, optical, pressure, gesture, and tactile sensors.
- Design transducers including proximity detectors, tachometers, gyroscopes, inclinometers, accelerometers, and flow meters.
- Develop specialized transducers for optical, environmental, thermal, chemical, and biological sensing applications.

Unit 1 – Data Acquisition and Sensors (12 Hrs.)

Sensors, Signals, and Systems - Sensor Classification - Mathematical models - Calibration - Computation of parameters - Hysteresis - Nonlinearity - Saturation - Repeatability - Dead - Resolution - Special Properties - Dynamic Characteristics – Uncertainty.

Unit 2 – Physics Principles of Sensing (12 Hrs.)

Capacitance - Magnetism - Induction - Resistance - Piezoelectric Effect - Pyroelectric Effect - Hall Effect - Thermoelectric Effects - Temperature and Thermal Properties of Materials - Heat Transfer.

Unit 3 - Physics of Detectors (12 Hrs.)

Ultrasonic Detectors - Microwave Motion Detectors - Linear Optical Sensors - Optoelectronic Motion Detectors - Optical Presence Sensors - Pressure-Gradient Sensors - Gesture Sensing - Tactile Sensors.

Unit 4 – Transducers I (Principle and Design) (12 Hrs.)

Metal detector - Magneto strictive detector - proximity detector - ablation transducer - cryogenic liquid level transducer - Tachometer - laser gyroscope - Inclinometer - Seismic transducer - piezoelectric accelerometer - pressure sensitive film - vacuum pressure gauge - ultrasonic flow transducer.

Unit 5 - Transducers II (Principle and Design) (12 Hrs.)

Optical microphone - optical hygrometer - oscillating hygrometer - soil moisture - image detector - UV detector - thermal radiation detector - ceramic PTC transducer - chemical transducer - biological transducer.

Reference Books:

1. Fraden, J. (2016). Handbook of Modern Sensors - Physics, Designs, and Applications, (5th Ed.). Springer.

Websites and eLearning Sources:

1. <https://nptel.ac.in/courses/108102191>
2. <https://youtu.be/4nbBAG-848c?si=2VZYthTJOht512GC>
3. https://youtu.be/9mFlZzY4sh8?si=Rqix56_ogF-PYfzJ

COs and Bloom's Taxonomy Mapping – 26PH614

Course Outcomes	On successful completion of this course, students will be able to	BTL
CO1	Recall and explain fundamentals of sensors, signal characteristics, and measurement parameters.	K1, K2
CO2	Apply physical principles such as capacitance, piezoelectricity, and thermoelectric effects in sensing systems.	K3
CO3	Analyze different types of detectors including optical, ultrasonic, and motion sensing devices.	K4
CO4	Analyze the design and working of various transducers used in industrial and scientific applications.	K5
CO5	Evaluate and design advanced sensor and transducer systems for real-world applications.	K6

BTL (Bloom's Taxonomy Level) - K1 – Remembering, K2 – Understanding, K3- Applying, K4 – Analyse, K5- Evaluate and K6 - Create

Relationship Matrix – 26PH614

Course Outcomes	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)						Mean Score of Cos
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	
CO1	3	2	1	1	1	1	2	2	1	1	1	1	1.42
CO2	3	3	2	2	1	1	2	3	2	2	2	1	2.00
CO3	3	3	3	2	2	1	2	3	3	2	2	2	2.33
CO4	3	3	3	3	2	2	2	3	3	3	2	2	2.50
CO5	3	3	3	3	3	2	3	3	3	3	3	2	2.75
Total													2.20

Mean Score: 3- High, 2- Medium/Moderate, 1-Low

