GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering (Part Time)
Subject Code: 2961103

Semester – VI
Subject Name: Sensors and Transducers

Type of course: Professional Elective Course

Prerequisite: Knowledge of Analog circuit, Electronic Measurement

Rationale: Introduce students to the principle of various Transducers, their construction, applications and principles of operation, standards and units of measurements. Provide students with opportunities to develop basic skills in the design of electronic equipment.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Introduction to Electronics Measurement and Instrumentation:** Transducers and sensors- Static and Dynamic Characteristics Static characteristics: Accuracy, repeatability, reproducibility, range/span, linearity, threshold, sensitivity, resolution, hysteresis, precision, drift etc. Dynamic characteristics: Speed of response, settling time, fidelity, lag etc. Errors: Types of errors, statistical analysis, probability of errors, limiting errors, performance measures of sensors Classification of sensors, Sensor calibration techniques	6
2	**Temperature Sensors:** Resistance Vs Temperature characteristics for different materials, Thermistors, Thermocouples - thermoelectric effects for thermocouples, thermocouple tables, RTD, Other Thermal Sensors. Radiation temperature sensors, Pyro-electric type Temperature Sensor	3
3	**Motion, Proximity And Ranging Sensors:** Motion Sensors – Potentiometers, Resolver, Encoders – Optical, LVDT – RVDT, Accelerometer, Proximity Sensors - Magnetic, Inductive, Capacitive, Optical, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).	5
4	**Pressure, Force, Displacement And Weight Measurement, Magnetic Sensor:** Capacitive and inductive transducers, Piezo-electric sensors, Tactile sensor, Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor	6
5	**Flow Measurement, Power Measurement, Optical Sensors:** Flow Measurement - Magnetic and ultrasonic flow meter, Power Measurement - Electrodynamometer type of wattmeter and power factor meter, Single-phase induction and Electronic energy meters, Optical Sensors - Photo conductive cell, photo voltaic, Photo resistive, IR sensor, LDR,	6

	Fiber optic sensors	
6	**Special Sensors:** GPS, Bluetooth, Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors. Touch screen sensor, Heading Sensors – Compass, Gyroscope, Inclinometers, Applications of sensors in drone	4
7	**Analog Signal Conditioning:** Signal conditioning, Loading effects, Bridges for measurement techniques, Wheatstone, Wein, Kelvin's, Maxwell bridge and Hey bridge, Applications of Attenuators, Amplifiers and Passive filters in signal conditioning, Op-amp based signal conditioning circuits, Inverting and Non-Inverting Amplifiers, Linearization, Differential amplifiers and Instrumentation amplifiers.	6
8	**Digital Signal Conditioning:** Digital measuring techniques, Sample and Hold Circuits, Comparator, Buffers, D/A Conversion and A/D Conversion, Weighted Resistor DAC, R-2R ladder DAC, Dual Slope, Parallel-comparator Successive Approximation ADC techniques, Single channel and multi-channel Data Acquisition System (DAS).	6

Reference Books:

1. Rangan & Mani "Instrumentation: Devices and Systems", McGraw Hill
2. Curtis D. Johnson, "Process Control Instrumentation Technology", Prentice Hall India
3. Ernest O Doebelin, "Measurement Systems – Applications and Design", Tata McGraw-Hill, 2009.
4. D.V.S. Murty, "Transducers and Instrumentation", Prentice Hall India.
5. Helfrick Albert D. and Cooper W. D., "Modern Electronic Instrumentation and Measurement Techniques", Prentice Hall India.
6. Patranabis D, "Sensors and Transducers", 2nd Edition, PHI, New Delhi, 2010.
7. Kalsi H. S. "Electronic Instrumentation", Tata McGraw-Hill Education.
8. Shawhney A. K. "A Course In Electrical and Electronics Measurements and Instrumentation", DhanpatRai& Sons, 11th Ed., 1999.
9. Bell David A. "Electronic Instrumentation and Measurements", PHI / Pearson Education.
10. Sensors and Signal Conditioning By Ramón Pallás-Areny, John G. Webster, Wiley Interscience

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the principles of various sensors and transducers for measurement and instrumentation.	30
CO-2	Evaluate various measurements techniques for industrial applications	30
CO-3	Apply signal conditioning for measurements	20
CO-4	Implement the principles and signal conditioning for measurement for real life applications.	20

Suggested List of Experiments:

Sr.No.	Experiment Title
1.	To find the value of unknown resistor using Wheatstone bridge
2.	To find the value of unknown capacitance and inductance using Maxwell's bridge
3.	Design signal conditioning circuit using Op-Amp and temperature sensor
4.	Verify characteristic of RTD and find out sensitivity
5.	Verify characteristic of Thermocouple and design signal conditioning circuit
6.	Verify characteristic of variable resistor transducer (strain gauge).
7.	Measurement of distance using LVDT plot ac and dc characteristics
8.	Interface Load Cell with Arduino and display weight
9.	Interface accelerometer with Arduino
10.	Interface gyroscope with Arduino
11.	Interface Tilt Sensor with Arduino
12.	Presentation on latest topics

Faculty may carry out additional experiments based on resources available in the laboratory

Open Source Platform:

https://www.tinkercad.com/

NPTEL Course:

https://nptel.ac.in/courses/108/108/108108147/