GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3134103
Semester – III
Subject Name: Sensor and Instrumentation

Type of course: Engineering

Prerequisite: Zeal to learn the subject

Rationale: This course is useful to understand the concepts of measurement technology and to learn the applications of various sensors. Fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development are also part of this course.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Introduction: Sensor classification, Sensor characteristics: Transfer function, calibration, hysteresis, non-linearity, repeatability, resolution, dynamic impedance, excitation, dynamic characteristics, reliability, etc, Basics of Measurement, Classification of errors, Error analysis, Static and dynamic characteristics of transducers, Performance measures of sensors, Sensor calibration techniques, Sensor Output Signal Types.	8
2	Physical Principles of Sensing: Electric charges, fields and potentials; Capacitance; Magnetism; Induction; Resistance; Piezoelectric effect; pyroelectric effect; Hall effects; seeback and Peltier effects; Sound waves; Temperature and thermal properties of materials; Heat transfer; Light	7
3	Motion, proximity and ranging sensors: Motion Sensors, Potentiometers, Resolver, Encoders, Optical, Magnetic, Inductive, Capacitive, LVDT, RVDT, Synchro, Microsyn, Accelerometer, GPS, Bluetooth, Range Sensors. RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR)	7
4	Force, magnetic and heading sensors: Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor; Heading Sensors – Compass, Gyroscope, Inclinometers.	8
5	Optical, pressure and temperature sensors: Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors-flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.	7

6	Signal conditioning and DAQ systems: Amplification, Filtering, Sample and Hold circuits; Data Acquisition: Single channel and multichannel data acquisition, Data logging; Applications: Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.	6
7	Interface Electronic Circuits: Input Characteristics of Interface Circuits, Amplifiers, Excitation Circuits, Analog to Digital Converters, Direct Digitization and Processing, Bridge Circuits, Data Transmission, Batteries for Low Power Sensors	6

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
30	**30**	**20**	**10**	**5**	**5**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. J. Fraden, Handbook of Modern Sensors:Physical, Designs, and Applications, AIP Press, Springer
2. D. Patranabis, Sensors and Transducers, PHI Publication, New Delhi
3. Mechatronics- Ganesh S. Hegde, Published by University Science Press (An imprint of Laxmi Publication Private Limited)
4. John G. Webster (Editor-in-Chief), Measurement, Instrumentation and Sensors Handbook, CRC Press

Course Outcomes:

After learning the course the students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the concept of sensors and it's characteristics.	35
CO-2	Understand the practical approach in design of technology based on different sensors	35
CO-3	Integrate working of sensors and actuators with computer for data acquisition and characterizing purpose	30

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List of Experiments:

1. Introduction to LabVIEW or any other software available for data acquisition.
2. Programming using addition, subtraction, multiplication and division tools available with the software to manipulate the sensor data acquired.
3. Study of different data types available with the software to handle various inputs trough interfacing devices.
4. Handling mathematical formulas and presenting the outputs with the help of different graphs.
5. Understanding Boolean operator for 'AND' and 'OR' operation of logical sensors such as switches, which gives output in the form of 'ON' or 'OFF'.
6. Display random numbers between any two given numbers on Y-axis of X-Y graph with the interval of time on X-axis (0-1 sec) to understand the sampling rate of a given sensor to acquire data.
7. Data acquisition and taking the running average of the data acquired.
8. Interface strain gauge/sonar sensor with computer for data acquisition and characterize the sensor for its input and output.
9. Interface pressure/temperature sensor with computer for data acquisition and characterize the sensor for its input and output.
10. Interface encoder/capacitive sensor with computer for data acquisition and characterize the sensor for its input and output.

Major Equipment:

Various sensors, Interfacing devices for data communication and acquisition, Appropriate software (MATLAB, LabVIEW, etc.) compatible with interfacing device

List of Open Source Software/learning website:

NPTEL website; Demo versions of MATLAB and LabVIEW are available for limited periods. Student versions are also available free of cost