GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160620
SUBJECT NAME: INSTRUMENTATION AND SENSORS
SEMESTER- VI

Type of course: Program Elective

Prerequisite: Basic Electrical Engineering

Rationale: The objective of this Course is to understand instrumentation, sensor theory and technology, data acquisition, digital signal processing, damage detection algorithm, life time analysis and decision making. This course introduces theoretical and practical principles of design of sensor systems. The topics include: transducer characteristics for acoustic, current, temperature, pressure, electric, magnetic, gravity, salinity, concentration of contaminants, velocity, heatflow, and optical devices, limitations on these devices imposed by building/structure/pavement environments, signal conditioning and recording, noise sensitivity and sampling limitations and standards. Lectures will cover the principles of state-of-the-art systems being used in physical infrastructure/bridges/buildings/pavements, etc.

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)	
2	0	2	3	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Module 1*: Fundamentals of Measurement, Sensing and Instrumentation*:** Definition of measurement and instrumentation, physical variables, common types of sensors; Describe the function of these sensors; Use appropriate terminology to discuss sensor applications and qualitatively interpret signals from a known sensor type, types of instrumentation, Sensor Specifics, Permanent installations, Temporary installations.	**10**	25%
2	**Module 2*: Sensor Installation and Operations*** : Predict the response of sensors to various inputs, Construct a conceptual instrumentation and monitoring program, Describe the order and methodology for sensor installation, Differentiate between types of sensors and their modes of operation and measurement ,Approach to Planning and Monitoring Programs, Define target, Sensor selection, Sensor siting, Sensor Installation &Configuration, Sensor design, Measurement uncertainty.	**15**	**30%**
3	**Module 3*: Data Analysis and Interpretation*** : Fundamental statistical concepts, Data reduction and interpretation, Piezometer, Inclinometer, Strain gauge, etc. Time domain signal processing, Discrete signals, Signals and noise and a few examples of statistical information to calculate Average value (mean), standard deviation, median, mode, range.	**10**	**25%**

4	**Module 4*: Frequency Domain Signal Processing and Analysis*** : Explain the need for frequency domain analysis and its principles, Draw conclusions about physical processes based on analysis of sensor data, Combine signals in a meaningful way to gain deeper insight into physical phenomena, Basic concepts in frequency domain signal processing and analysis, Fourier Transform, FFT (Fast Fourier Transform), Example problems: Noise reduction with filters, Leakage, Frequency resolution. Case Study.	**10**	**20%**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15 %	**15 %**	**20 %**	**20%**	**15 %**	**15 %**

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 .Alan S Morris (2001), Measurement and Instrumentation Principles, 3rd/e, Butterworth Hienemann

2. David A. Bell (2007), Electronic Instrumentation and Measurements 2nd/e, Oxford Press

3. S. Tumanski (2006), Principle of Electrical Measurement, Taylor & Francis

4. Ilya Gertsbakh (2010), Measurement Theory for Engineers, Springer

Course Outcomes: After learning the course the students should be able to:

Sr. No.	Course Outcome	Weightage
CO-1	Specify the requirements in the calibration of sensors and instruments	25%
CO-2	Suggest proper sensor technologies for specific applications	35%
CO-3	Design and set up measurement systems and do the studies	20%
CO-4	Analyze the errors during measurements	20%

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List of Experiments:

1. Instrumentation of typical civil engineering members/structures/structural elements
2. Use of different sensors, strain gauges, inclinometers and their performance characteristics
3 .Errors during the measurement process
4. Calibration of measuring sensors and instruments
5 .Measurement of noise
6 .Analog Signal processing
7. Digital Signal Processing
8. Demonstration & use of sensor technologies