GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Electrical Engineering
SUBJECT NAME: Industrial Instrumentation
SUBJECT CODE: 2170913
B.E. 7th SEMESTER

Type of course: Electrical Engineering

Prerequisite: NA

Rationale: Sound knowledge about various techniques used for the measurement of industrial parameters is essential for the student of engineering. This subject provides the knowledge of measurement of velocity, displacement, viscosity, temperature using various types of sensors and related circuits.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	Viva	PA (I)	
3	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1.	**Transducers:** Introduction to instrumentation system, static and dynamic characteristics of an instrumentation system, Principles and classification of transducers, Electrical transducers, basic requirements of transducers	04	10
2.	**Strain Gauge and Strain Measurement:** Factors affecting strain measurements, Types of strain gauges, theory of operation of resistive strain gauge, gauge factor, types of electrical strain gauges, strain gauge materials, gauging techniques and other factors, strain gauge circuits and temperature compensation, applications of strain gauges.	06	12
3.	**Displacement Measurement:** Resistive potentiometer (Linear, circular and helical), L.V.D.T., R.V.D.T. and their characteristics, variable inductance and capacitance transducers, Piezo electrical transducers-output equations and equivalent circuit, Hall effect devices and Proximity	06	12

	sensors, Large displacement measurement using synchros and resolvers, Shaft encoders.		
4.	**Forces and Torque Measurement:** Load cells and their applications, various methods for torque measurement. Use of torque wrenches	05	10
5.	**Pressure Measurement:** Mechanical devices like Diaphragm, Bellows, and Bourdon tube for pressure measurement, Variable inductance and capacitance transducers, Piezo electric transducers, L.V.D.T. for measurement of pressure, Low pressure and vacuum pressure measurement using Pirani gauge, McLeod gauge, Ionization gauge, Pressure gauge calibration.	06	12
6.	**Flow Measurement:** Differential pressure meter like Orifice plate, Venturi tube, flow nozzle, Pitot tube, Rotameter, Turbine flow meter, Electro magnetic flow meter, hot wire anemometer, Ultrasonic flow meter.	05	10
7.	**Level Measurement:** Resistive, inductive and capacitive techniques for level measurement, Ultrasonic and radiation methods, Air purge system (Bubbler method).	04	8
8.	**Temperature Measurement:** Resistance type temperature sensors – RTD & Thermister, Thermocouples & Thermopiles, Laws of thermocouple – Fabrication of industrial thermocouples – Signal conditioning of thermocouples output - Radiation methods of temperature measurement – Radiation fundamentals – Total radiation & selective radiation pyrometers – Optical pyrometer – Two colour radiation pyrometers	06	14
9.	**Digital Data Acquisition systems & control:** Use of signal conditioners, scanners, signal converters, recorders, display devices, A/D & D/A circuits in digital data acquisition. Instrumentation systems. Types of Instrumentation systems. Components of an analog Instrumentation Data – Acquisition system. Multiplexing systems. Uses of Data Acquisition systems. Use of Recorders in Digital systems. Digital Recording systems. Modern Digital Data Acquisition system. Analog Multiplexed operation, operation of sample Hold circuits.	06	12

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
10	**30**	**20**	**20**	**10**	**10**

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. Industrial Instrumentation & Control by S. K. Singh.TMH Publication
2. Electrical and Electronics Measurement and Instrumentation, By A. K. Shawney, Dhanpatrai & sons publications.
3. Measurement Systems – Application and Design By E.O. Doebelin, TMH Publication
4. Principles of Industrial Instrumentation, D Patranabis, 3rd edition, Mc Graw hill
5. Mechanical & Industrial Measurements by R. K. Jain, Khanna pub

Course Outcome:

The theory lectures and practical should be planned in such a manner that students can acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

After learning the course the students should be able to:

1. Select a transducer based on its operating characteristics for the required application.
2. Check various available techniques available and select appropriate to obtain satisfactory task for the parameter to be measured.
3. Know advantages and limitations of selected techniques.
4. Interpret the measurement results and cause of any possible error.

Laboratory Work:
Directions for Laboratory work:
- The list of experiments is given as a sample.
- Minimum 10 experiments should be carried out.
- Similar laboratory work fulfilling the objectives can also be considered.
- As far as possible, **printed manual should be preferred** so that students can concentrate in laboratory experiments and related study.

List of Experiments:

1. To study the measurement of weight using Strain gauge.
2. To study the measurement of linear displacement using Linear Variable Differential Transformer (LVDT).
3. To Study the measurement and control of temperature using Resistance Temperature Detector (RTD).
4. To Study the measurement and control of temperature using Thermocouple.
5. To Study the measurement and control of temperature using Thermistor.
6. To study the measurement of flow using Ultrasonic Flow meter.
7. To study the measurement of speed using Decoder.
8. To study the measurement of torque.
9. To study the measurement of force using Piezoelectric transducer.
10. To study Measurement of flow using Electromagnetic flow-meter.

Design based Problems (DP)/Open Ended Problem:

1. Select appropriate transducer for the measurement of specified parameter.
2. Design appropriate circuit that can be used for transducer.
3. Select calibration and compensation circuit to get accurate result.
4. Obtain operating characteristics and find the error.
5. Integrate above to design a project that can be used for complete measurement of specific parameter in industry.

Major Equipment:

1. 4 ½ digit Digital Multimeter
2. Various transducers and their trainer kit.
3. Digital Oscilloscope
4. Any one simulation software (Open source software preferred) : Scilab/Matlab and Simulink toolbox.

List of Open Source Software/learning website:
1. http://www.electrical4u.com/
2. http://nptel.ac.in

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.