GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3141709
Semester – IV
Subject Name: Principle of Measurement Science

Type of course: Basic Science

Prerequisite: There is no prerequisite knowledge required for this course.

Rationale: Industrial Instrumentation is a unique part of industry that deals with the measuring of variables that influence materials production and equipment during the development of a product. Every Instrument engineers have to deal with various types of Instruments in the working environment. This course describes the working principles of these measuring instruments**.**

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

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment

Content:

Sr. No.	Content	Total Hrs
1	**INTRODUCTION OF MEASUREMENTS**: Definition of Instrumentation. -Static Characteristic: Accuracy, Precision, Resolution, Sensitivity, Scale, Threshold, Hysteresis, Drift, Dead Zone, Repeatability, Linearity, etc. - Dynamic Characteristic: Speed of Response, Lag errors, Fidelity, Response of 1st & 2nd order system. - Types of errors etc., - Terminology and Specifications of Instruments, - Measurement Standards: Time, Frequency, Voltage, Current, 3-15 psi etc., ANSI, ASME, ADA, BS, DIN, CSMR, FCI, API, ISI, and Introduction Reliability and safety.	**5**
2	**Transducers:** Classification Electrical Transducer – Resistance, Capacitance, Inductance Type, Piezoelectric, Transduction, etc. Mechanical Transducers, Selection of Transducer	**5**
3	**TEMPERATURE MEASUREMENT**: Types, Selection, Installation, Calibration Temperature measurement using physical parameter -Electrical type temperature sensor-RTD, RTD resistance measurement with Wheatstone Bridge Circuits: two-wire circuit, three-wire circuit, four-wire measurement circuit, RTD resistance measurement with Constant Current Source. -Thermistor -Thermocouples-laws of thermocouple-fabrication of industrial	**10**

	thermocouples-signal conditioning -cold junction compensation-special techniques for measuring high temperature using thermocouples-Radiation methods of temperature measurement	
4	**PRESSURE MEASUREMENT**: Types, Selection, Installation, Calibration , Units of pressure –manometers -different types -elastic type pressure gauges -Bourdon tube bellows-diaphragms -Bell Gauge -Measurement of pressure using Electrical transducer as secondary transducer -vacuum pressure measurement -Mechanical gauges -Mcleod gauge -thermal conductivity gauges-Ionization gauge cold cathode and hot cathode types. Differential pressure measurement -flapper-nozzle assembly. Piston type pressure measurement; Dead Weight Piston Gauges	**10**
5	**LEVEL MEASUREMENT**: Types, Selection, Installation, Calibration, Electrical methods -Resistive, Inductive & Capacitive -Measurement of Level using Gamma rays -Ultrasonic Methods -Measurement of Liquid level using Float type -Displacer type -Air-Purge system, Solid Level measurement -Hydrostatic types. Level Switches.	**10**
6	**FLOW MEASUREMENT**: Types, Selection, Installation, Calibration, Types of flow; Units of flow -volumetric and mass flow; Importance of flow measurement, Mechanical Flow meters: Variable head type flow meters -variable area flow meters, Mass flow meters, Electrical flow meters -EM flow meter -turbine flow meter -Ultrasonic flow meter -Vortex flow meter -Direct and Indirect methods -open-channel & solid flow measurement -Flow Meter Selection and Designs.	**10**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
21	**21**	**21**	**7**	**7**	**7**

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. Instrument Engineers' Handbook: Process Measurement and Analysis by B. G Liptak.
2. Handbook of Applied Instrumentation by D. M. Considine and Sidney David Ross, McGraw – Hill Publication.
3. Encyclopedia of Instrumentation and Control by D. M. Considine, Kriege Publication Co.
4. Instrumentation Reference Book by Walt Boyes, Butterworth – Heinemann Publisher.

5. Introduction to Instrumentation and Control by A. K. Ghosh, 4th edition, PHI publications
6. Industrial Instrumentation by K. Krishnaswamy and S. Vijayachitra, New Age International Publication.
7. Measurement Systems: Application and Design by E. D. Doeblin, McGraw – Hill Publication

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Explain basic concept in measurement of temperature, level, pressure and flow sensors	30
CO-2	Interpret various measurement terms, errors and identify sensor and their relevant specification	35
CO-3	Analyze the performance of Temperature, pressure, level, flow sensor and their relevant application related to industry.	35

List of Experiments:

1. Characterization of Thermocouples.(J/T/K/R/S)
   Equipment: Oven, thermocouples, Multimeter, thermocouple reference table, Thermocouple
2. Characterization of RTD (PT100)
   Equipment: Oven, PT100 probe, RTD simulator, Temperature indicator, Multimeter
3. Measurement of flow using rotameter
   Equipment: Rotameter
4. measurement of flow using DP cell
   Equipment: Differential Pressure Transmitter, or Manometer etc.
5. Flow coefficient of Orifice:
   Orifice installed in a pipe of a liquid fluid, Manometer or DPT.
6. Flow Coefficient of Venturi:
   Venturi installed in a pipe of a liquid fluid, Manometer or DPT.
7. Measurement of Level using Capacitance type of Level Sensor
8. Calibration of pressure gauge using dead weight pressure tester and preparation of report
   Equipment: Dead weight pressure tester setup, Standard weight set.

Major Equipment:

Specified with list of experiments: Dead weight tester, universal calibrator, Temperature bath, Voltage/ current Simulator, RTD/ Thermocouple calibrators, Flow meters, etc.

List of Open Source Software/learning website:

1. http://nptel.ac.in/video.php?subjectId=108105064
2. http://www.onlinevideolecture.com/electrical-engineering/nptel-iit-kharagpur/industrial-instrumentation/?course_id=514
3. https://www.isa.org