



GUJARAT TECHNOLOGICAL UNIVERSITY

INSTRUMENTATION & CONTROL ENGINEERING (17)

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 C	Examination Marks				Total Marks
L	T	P		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 1 st & 2 nd 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



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	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.



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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. Doebelin, 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>