GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: Diploma

Branch: Instrumentation & Control Engineering

Course / Subject Code : DI03017031

Course / Subject Name : Process Instrumentation-I

w. e. f. Academic Year:	2024-25
Semester:	3rd
Category of the Course:	PCC

Prerequisite:	The prerequisites for a Process Instrumentation course in Instrumentation and Control Engineering include a basic understanding of electrical and electronic circuits, sensors and transducers, and measurement principles. Engineering mathematics, and physics.
Rationale:	Process measurement of parameters like pressure, flow, speed, and humidity is essential for ensuring safe, efficient, and consistent operation in industrial systems. These measurements help maintain product quality, control process variables, and prevent equipment failures. Calibration ensures the accuracy and reliability of instruments, supporting compliance with standards and reducing operational errors.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Compare the advantages and limitations of different pressure measuring devices.	R,U,A
02	Select appropriate flow measurement techniques based on the type of fluid flow conditions (e.g., pressure, temperature, viscosity), and system requirements.	R,U
03	Understand various methods and devices for accurately measuring speed in different systems.	R,U
04	Identify appropriate humidity and moisture measurement techniques for different applications based on accuracy, range, and environmental conditions.	U,A
05	Calibrate sensors for measurement of the magnitude of process parameter.	R,U,A

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA(M)	PA(I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1	**Pressure Measurement Techniques**	12	30
	1.1 Importance of Pressure measurement. 1.2 Define types of pressure like static, dynamic, absolute, differential, atmospheric, gauge pressure, vacuum. 1.3. Conversion between various pressure units (e.g., Pascal, bar, atm, psi, mmHg, torr). 1.4. Explain the working principles of following various manometers. • U type, • well type, • inclined type • ring type • Barometer 1.5. Compare following Mechanical Pressure sensing elements based on application, pressure range, sensitivity, and accuracy. • Bellows • Diaphragm • Bourdon Tube • compound gauge **1.**6 Understand the working principles of following electrical pressure sensors and compare its merits and demerits. • LVDT type • strain gauge • Piezo electric type • Capacitance type		

	1.7. Describe optical pressure sensing techniques, such as fiber Bragg grating (FBG) and interferometric methods. **1.8.**Explain working principal of following types of vacuum sensor and compare its merits and demerits •Thermal Conductivity gauge, •Pirani Gauge, •Ionization Gauge •McLeod's gauge 1.9 Understand the working principle of a pressure switch based on preset pressure limits. 1.10 Describe the key components of a dead weight tester. 1.9. Understand the construction and working principle of a differential pressure transmitter.		
2.	**Flow Measurement Techniques**	14	30
	2.1. Importance of flow measurement in industry. 2.2. Define the terminology regarding to flow such as Specific gravity, density, viscosity, compressibility. 2.3. Measurement of flow rate in closed pipe using Bernoulli's theorem. 2.4. Define and distinguish between laminar and turbulent flow based on fluid behavior and characteristics. 2.5. Importance of Reynolds Number. 2.6. Select particular type of following differential flow sensing elements according to their working and application. •Orifice plate •flow nozzle •Venturi tube •Pitot tube •Target. 2.7. Understand the construction and working principle of following flowmeter and state their merits and demerits while selection for application. •variable area flowmeter (e.g., rotameter) •Magnetic flow meters. •Ultrasonic flow meters. •Turbine flow meter. •Thermal flow meter. •Vortex flow meter.		

	•Mass flow meter. **2.8** Understand the operating principle of following positive displacement flow meters. • Piston cylinder type • Nutating disc, • Rotating vane. **2.9** Explain the role of flow switches in process control, safety interlocks, and equipment protection. **2.10** Explain construction and working of Flow Transmitter (Electronic and pneumatic type)		
3.	**Speed Measurement Techniques**	06	12
	3.1. Need for Speed measurement. 3.2. Understand the Principle of Operation following Mechanical tachometer. • Revolution Counter • Resonance tachometer 3.3. Understand the Principle of Operation of following Electrical tachometer. • D.C. tachometer • A.C. tachometer • Magnetic drag(Eddy current) tachometer 3.4 Understand the Principle of Operation of following Contactless Tachometer. • Optical (photo electric) method, • Magnetic Pickup method. 3.5 Explain how stroboscopic effect is used to measure rotational speed.		
4	**Moisture and Humidity Measurement Techniques**	06	12
	4.1 Differentiate between moisture and humidity in various contexts (air, solids, liquids). 4.2 Describe following humidity and moisture measurement techniques for different applications based on accuracy, range, and environmental conditions. •Wet and dry bulb type hygrometer. • Hair hygrometer method • Thin film capacitance type hygrometer method. • Electrolytic hygrometer method • Infrared absorption hygrometer method.		
5	**Instrument Calibration**	**07**	**16**

	5.1 Calibration vs. Re-ranging: Key Difference in the context of instrumentation 5.2 Purpose of zero and span adjustments in analog instruments State effect if they are incorrectly set. 5.3 Importance to record calibration error during calibration testing with suitable example. 5.4 Difference between setting the LRV/URV and performing a digital trim in a (digital) transmitter. 5.5 Calibration procedures steps for linear instruments, non linear instruments and discreate instruments. 5.6 Instrument turndown and its important when selecting a flow or pressure transmitter. 5.7Steps to follow to ensure accurate calibration pressure transmitter in a process plant. 5.8 Perform basic calibration procedures using a dead weight tester for pressure gauge.		
	Total	**45Hrs**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
30	**50**	**20**	**-**	**-**	**-**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

Sr. No	Title of Book	Author	Publication
1.	Process Measurement and Analysis	B. G. Liptak	I.S.A
2.	Industrial Instrumentation	D. P. Eckman	Wiley Eastern Limited
3.	Industrial Instrumentation	S.K. Singh	Tata Mc Graw Hill
4.	Mechanical Measurements	D. S. Kumar	Metropolitan Book Company

5.	Process Instrumentation and Control	A.P.Kulkarni	Nirali Prakashan
6.	Mechanical and Industrial measurements	R.K. Jain	Khanna publication
7.	Industrial Instrumentation	K. Krishnaswamy & S. Vijayachitra,	New Age International
8.	Introduction to Measurements and Instrumentation	Arun K Ghosh	PHI
9.	Applied Instrumentation in Process Industries Vol-3a	William G Adrews	Gulf Publication Company
10	Instrumentation Reference Book 3rd Edition	Walt Boyes	Butterworth-Heinemann publications
11	Principle of Industrial Instrumentation 3rd Edition	D Patranabis	Mc Graw Hill
12	Industrial Instrumentation	D P Eckman	CBS publishers
13	Measurement Systems Application and Design	E O Doeblin D N Manik	Tata Mc Graw Hill
14	A Course in Electrical and Electronic Measurements and Instrumentation	A K Sawhney	Dhanpatrai

(b) Open source software and website:

1. **http://en.wikipedia.org/wiki/Pressure_measurement**
2. **http://www.ni.com/white-paper/13034/en/**
3. **http://www.omega.com/literature/transactions/volume3/pressure.html**
4. **http://en.wikipedia.org/wiki/Flow_measurement**
5. **http://www.pc-education.mcmaster.ca/Instrumentation/flow.htm**
6. **https://instrumentationtools.com/basics-of-pressure-measurement/**
7. **https://instrumentationtools.com/tachometer/**
8. **https://instrumentationtools.com/tachometer/**
9. **https://instrumentationtools.com/calibration-interview-questions-and-answers/**
10. **https://core.ac.uk/download/pdf/25293369.pdf**

Suggested Course Practical List:

Sr. No.	Practical Outcomes (PrOs) (Outcomes' in Psychomotor Domain)	Unit No.	CO	Hrs. required
1.	Measure a given unknown pressure using U-tube Manometer.	I	CO1	02
2.	Measure a given unknown pressure using Well-type Manometer.	I	CO1	02
3.	Perform Pressure Measurement using C-type Bourdon Tube Pressure Gauge.	I	CO1	02
4.	Perform Pressure measurement using bellows type pressure Gauge.	I	CO1	02
5.	Perform Pressure Measurement using Diaphragm type Pressure Gauge.	I	CO1	02
6.	Perform Pressure Measurement using LVDT type pressure Transducer.	I	CO1	02
7.	Perform Pressure Measurement using Strain Gauge type Pressure Transducer.	I	CO1	02
8.	Perform Pressure Measurement using Piezoelectric type Pressure transducer	I	CO1	02
9.	Perform Pressure Measurement using Capacitance type Pressure Transducer.	I	CO1	02
10.	Identify electrical contact configurations used in pressure switches.	I	CO1	02
11.	Demonstrate the operation of pressure switch.	I	CO1	02
12.	Perform Flow Measurement using Orifice Plate.	II	CO2	02
13.	Perform Flow Measurement using Flow Nozzle.	II	CO2	02
14.	Perform Flow Measurement using Venturi Tube.	II	CO2	02
15.	Perform Flow Measurement using Pitot Tube.	II	CO2	02
16.	Perform Flow Measurement using Rota meter.	II	CO2	02
17.	Perform Flow Measurement using Magnetic Flow meter.	II	CO2	02
18.	Perform Flow Measurement using Vortex Flowmeter.	II	CO2	02
19.	Perform Flow Measurement using Turbine Flow meter.	II	CO2	02
20.	Perform Flow Measurement using ultrasonic Flow meter.	II	CO2	02
21.	Measure Speed using Mechanical Tachometer.	III	CO3	02
22.	Measure Speed using A.C. Tachometer.	III	CO3	02

23.	Measure Speed using D. C. Tachometer.	III	CO3	02
24.	Measure Speed using Magnetic Tachometer.	III	CO3	02
25.	Measure Speed using photoelectric	III	CO3	02
26.	Measure Speed using Stroboscope.	III	CO3	02
27.	Perform Humidity Measurement using Hair Hygrometer.	IV	CO4	02
28.	Perform Humidity measurement using dry bulb and wet bulb	IV	CO4	02
29.	Perform Humidity Measurement using Thin Film Capacitance Hygrometer.	IV	CO4	02
30.	Perform Humidity Measurement using Electrolytic Hygrometer.	IV	CO4	02
31.	Perform Humidity measurement using Infrared Absorption Hygrometer.	IV	CO4	02
32.	Calibrate the pressure switch.	V	CO5	02
33.	Calibrate the Flow switch.	V	CO5	02
34.	Calibrate a given pressure gauge using Dead Weight Tester.	V	CO5	02

List of Laboratory/Learning Resources Required:

Sr. No.	Equipment Name with Broad Specifications
1	Function generator (sine, square, triangle etc. with frequency range 10 Hz to 100 kHz)
2	DC power supply (-30 →0→+30 V with at least 1A current capacity)
3	Measuring equipment like CRO (preferably dual channel, 20Mhz)
4	Multi meter
5	Electrical tool kit.
6	Circuit/Trainer board/ Demonstration modules of Manometers
7	Bourdon tube C type, Twisted, Spiral Helical
8	Bellows Metallic and Non metallic
9	Diaphragm Disc, Flat, Corrugated
10	Pressure based Instrument calibration set up

11	Dead Weight Tester
12	Pressure Switches
13	Pressure Gauges bellows type, Bourdon tube type and Diaphragm type
14	Strain Gauge type Pressure Transducer
15	Capacitance type Pressure Transducer
16	LVDT type Pressure Transducer
23	Different types of Flow Elements like Orifice, Venturi Tube, Flow Nozzle
24	Pitot tube flow trainer.
25	Rotameter
26	Magnetic Flow Meter
27	Turbine Flowmeter
28	Vortex Flowmeter
29	Ultrasonic Flow Meter
30	Flow Transmitters
31	Flow Switches.
33	A.C. Tachometer
34	D. C. Tachometer
35	Magnetic Tachometer
36	Photoelectric Tachometer
37	Stroboscopic Tachometer.
38	Hair Hygrometers
39	Wet & Dry Bulb Hygrometers.
40	Electrolytic Hygrometers.
41	Infrared Absorption Hygrometer.

Suggested Project List

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a. Prepare Model for orifice plate flowmeter
b. Prepare Model for venturi flowmeter
c. Prepare Model for nozzle flowmeter
d. Implement Model for pressure switch
e. Prepare a chart or model which shows the detail of pressure, flow, Speed, Humidity/Moisture measuring instrument.
f. Measure the pressure of a fluid in a pipe using a pressure sensor and display the data.

Suggested Activities for Students:

Other than the classroom and laboratory learning, following are the suggested student- related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Industrial visit for students. (Chemical industries, petroleum industries, production industries.) So that students can have exposure to the real industrial realm.

b) Department should arrange a workshop/seminar where students can have Interaction with industry personnel.

c) Videos/Animation for different devices should be shown. Download videos of different industries from various YouTube channels like how it's made, how stuff works and show in class and discuss instrumentation used in that industry.

d) Model making.

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