

**GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT****COURSE CURRICULUM****COURSE TITLE: PROCESS INSTRUMENTATION-I****(Code: 3341703)**

<b>Diploma Programmers in which this course is offered</b>	<b>Semester in which offered</b>
Instrumentation and Control Engineering	4 <sup>th</sup> semester

**1. RATIONALE**

In the present industrial scenario, role of the process instrumentation is becoming more important day by day. More advanced, precise and complex instrumentations are being employed in the industry. Diploma engineers should therefore be able to identify, classify, troubleshoot and maintain the different process instrumentation systems. Therefore, this course has been designed so that students will learn to build, test and wire the different types of process instrumentation required for processing plants mainly for the process parameter such as pressure, flow, speed, humidity / moisture.

**2. COMPETENCY**

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

- **Operate and Maintain different types of process instrumentation systems.**

**3. COURSE OUTCOMES:**

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

- Observe and obtain the accurate reading of process instruments of Pressure, flow, speed, moisture / Humidity in a process plant.
- Correlate between Different types of pressure.
- Specify instrumentation for a given Pressure, flow, speed, moisture / Humidity application.
- Identify, describe and calibrate major instruments of Pressure, flow, speed, moisture / Humidity in a process plant.
- Describe the purpose and function of process instrumentation of Pressure, flow, speed, moisture / Humidity in a process plant.
- Identify the main installed instruments of Pressure, flow, speed, moisture / Humidity in a process plant.
- Identify sub components of the main instruments of Pressure, flow, speed, moisture / Humidity in a process plant.
- Draw schematic diagram of process instrumentation for Pressure, flow, speed, moisture / Humidity in a process plant.

#### 4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	200
3	0	4	7	70	30	40	60	

**Legends:** L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit ESE - End Semester Examination; PA - Progressive Assessment.

#### 5. COURSE DETAILS

Unit	Major Learning Outcomes	Topics and Sub-topics
<b>Unit – I Introduction to measurement</b>	1a. Define Measurement & state its types. 1b. State and explain unit system. 1c. Define Error. 1d. List types of error. Explain each. 1e. List standards of measurement. 1f. Give importance of standards of measurements.	1.1 Introduction to Measurement. 1.2 Fundamental and derived units. 1.3 Error classification. 1.4 Standards of measurements.
<b>Unit – II Pressure Measurement Techniques</b>	2a. State importance of pressure measurement in process industries. 2b. Enlist and define different types of pressure. 2c. List out different pressure measuring units and show relations among them. 2d. Explain working principle and construction for various pressure measuring devices with neat sketch and also with its merits and demerits. (2.4 to 2.8). 2e. List applications for pressure devices (2.4 to 2.10). 2f. Describe pressure switch with schematic diagram. 2g. Describe dead weight tester with schematic diagram. 2h. Explain Pressure Transmitter with neat schematic diagram./block diagram.(2.11 to 2.13).	2.1. Pressure measurement. 2.2. Types of pressure: static, dynamic, absolute, differential, atmospheric, gauge pressure, vacuum. 2.3. Pressure units. 2.4. Manometers : U type, well type, inclined type, ring type, Float type, Barometer 2.5. Pressure sensing elements : Bellows, Diaphragm, Bourdon Tube 2.6. Electrical pressure sensors: - LVDT type, strain gauge, Piezo electric type, Capacitance type. 2.7. Optical type Pressure Transducer. 2.8. Vacuum sensors: - Thermal Conductivity gauge, Pirani Gauge, Ionization Gauge, McLeod's gauge. 2.9. Pressure switch. 2.10. Dead weight tester. 2.11. Pneumatic Differential pressure transmitter 2.12. Electronic differential pressure transmitters: - Capacitive and Strain Gauge

Unit	Major Learning Outcomes	Topics and Sub-topics
		type. 2.13.Smart/Intelligent Pressure Transmitter.
<b>Unit – III Flow Measurement Techniques</b>	3a. State importance of flow measurement in process industries. 3b. Define terminologies and characteristics for flow measurement (3.2) 3c. Define Reynolds's number. 3d. Enlist and define different types of Flow (Turbulent and Laminar Flow ) 3e. Derive Bernoulli's theorem with flow equation for incompressible fluids. 3f. Explain pressure profile through orifice plate drawing schematic diagram. 3g. Enlist units of flow measurement. 3h. Classify flow measuring methods. 3i. Factors consideration for flow meter selection. 3j. Explain detail construction for Orifice plate, flow nozzle, Venturi tube. Pitot tube. 3k. Explain working principle and construction for target flow meter. 3l. Explain working principle with construction for various flow measuring devices (3.6 to 3.13). 3m. List out merits and demerits of flow measuring devices.(3.5 to 3.13). 3n. List out applications of flow measuring devices.(3.5 to 3.13) 3o. Enlist types of venturi tube. 3p. State the rules for Installation of head flow meters. 3q. Enlist types of flow switch. 3r. Describe flow switch. 3s. Explain Differential Pressure type flow Transmitter with neat schematic diagram./block diagram. 3t. State need of Square root extractor in flow measurement.	3.1.Introduction to flow measurement. 3.2.Flow measurement terminologies: specific gravity, density, viscosity, compressibility, effect of pressure and temperature on flow measurement. 3.3.Measurement of flow rate in closed pipe using Bernoulli's theorem. 3.4.Turbulent and Laminar Flow, Reynolds's number. 3.5.Differential Flow sensing elements: Orifice plate, flow nozzle, Venturi tube. Pitot tube, Target. 3.6.Variable area meter: Rotameter. 3.7.Magnetic flow meters. 3.8.Ultrasonic flow meters. 3.9.Turbine flow meter. 3.10.Thermal flow meter. 3.11.Vortex flow meter. 3.12.Mass flow meter. 3.13.Positive displacement meters: Piston cylinder type, Nutating disc, Rotating vane. 3.14.Flow switches. 3.15.Flow transmitters (Pneumatic and Electronic).

Unit	Major Learning Outcomes	Topics and Sub-topics
	3u. Enlist calibration methods for flow measurement.(liquid, gas)	
<b>Unit – IV SPEED Measurement Techniques</b>	4a. Define speed with units and classify it. 4b. List and explain speed measurement methods (4.2to4.5). 4c. List industrial application of tachometers.	4.1.Introduction to Speed measurement. 4.2.Mechanical tachometer: Revolution Counter, Resonance. 4.3.Electrical tachometer: D.C. tachometer, A. C. tachometer, Induction sensor tachometer, Magnetic tachometer (Eddy current). 4.4.Optical method: photo electric method. 4.5.Stroboscopic tachometer.
<b>Unit – V Moisture And Humidity Measurement Techniques</b>	5a. Define Moisture and Humidity with units. 5b. Define terminologies for humidity: relative humidity, absolute humidity, dew point, specific humidity, and hygrometer. 5c. Importance of moisture and humidity measurement in process industries. 5d. Explain different hygrometer with schematic diagram (5.2 to 5.6).	5.1.Introduction to Moisture and Humidity. 5.2.Wet and dry bulb type hygrometer. 5.3. Hair hygrometer method 5.4.Thin film capacitance type hygrometer method. 5.5.Electrolytic hygrometer method 5.6.Infrared absorption hygrometer method.

## 6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to measurement	04	2	4	1	07
II	Pressure Measurement Techniques	12	6	10	5	21
III	Flow Measurement Techniques	16	8	14	6	28
IV	Speed Measurement Techniques	05	2	3	2	07
V	Moisture And Humidity Measurement Techniques	05	2	3	2	07
	Total	42	20	34	16	70

**Legends:** R = Remembrance; U = Understanding; A = Application 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.

## 7. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills (**outcomes in psychomotor and affective domain**) so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

***Note:** Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.*

*Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.*

S. No.	Unit No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs. required
1	II	Measure a given unknown pressure using U-tube Manometer.	02
2	II	Measure a given unknown pressure using Well-type Manometer.	02
3	II	Measure Pressure Measurement using C-type Bourdon Tube Pressure Gauge.	02
4	II	Measure Pressure Measurement using Bellows type Pressure Gauge.	02
5	II	Measure Pressure Measurement using Diaphragm type Pressure Gauge.	02
6	II	Test and calibrate a given pressure gauge using Dead Weight Tester.	02
7	II	Measure Pressure Measurement using LVDT type Pressure Transducer.	02
8	II	Measure Pressure Measurement using Strain Gauge type Pressure Transducer.	02
9	II	Measure Pressure Measurement using Peizo-electric type Pressure Transducer.	02
10	II	Measure Pressure Measurement using Capacitance type Pressure Transducer.	02
11	II	Test and Calibrate Capacitive type Differential Pressure Transmitter.	02
12	II	Identify electrical contact configurations used in pressure switches.	02
13	II	Demonstrate the operation of pressure switch.	02
14	III	Measure Flow using Orifice Plate.	02
15	III	Measure Flow using Flow Nozzle.	02
16	III	Measure Flow using Venturi Tube	02
17	III	Measure Flow using Pitot Tube.	02
18	III	Measure Flow using Rotameter.	02
19	III	Measure Flow using Magnetic Flow meter.	02
20	III	Measure Flow using Vortex Flow meter.	02
21	III	Measure Flow using Turbine Flow meter.	02
22	III	Measure Flow using ultrasonic Flow meter.	02
23	IV	Measure Speed using Mechanical Tachometer.	02
24	IV	Measure Speed using A.C. Tachometer.	02

25	IV	Measure Speed using D. C. Tachometer.	02
26	IV	Measure Speed using Magnetic Tachometer.	02
27	V	Measure Humidity using Hair Hygrometer.	02
28	V	Measure Humidity using Wet & Dry Bulb Hygrometer.	02
29	V	Measure Humidity using Thin film Capacitance Hygrometer.	02
30	V	Measure Humidity using Electrolytic Hygrometer.	02
31	V	Measure Humidity using Infrared Absorption Hygrometer.	02
<b>Total</b>			<b>62</b>

## 8. SUGGESTED LIST OF STUDENT ACTIVITIES

- Industrial Visit for students (chemical industries, petroleum industries, production industries)
- Small technical projects based on theory topic.

## 9. SPECIAL INSTRUCTIONAL STRATEGIES

Videos/Animation for different devices should be shown.  
Seminar on relevant topics.

## 10. SUGGESTED LEARNING RESOURCES

### A) List of Books

S. 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 and S. Vijayachitra,	New Age International Publication.

### B) List of Major Equipment/ Instrument with Broad Specifications

- Function generator( sine, square, triangle etc. with frequency range 10 Hz to 100 kHz)
- DC power supply ( -30 →0→+30 V with at least 1A current capacity)
- Measuring equipments like CRO ( preferably dual channel, 20Mhz)
- Multi meter
- Electrical tool kit.
- Circuit/Trainer board/ Demonstration modules of Manometers
- Dead Weight Tester,
- Pressure Switches,
- Pressure Gauges,
- Strain Gauge type Pressure Transducer
- Capacitance type Pressure Transducer

- LVDT type Pressure Transducer
- Electronic differential pressure transmitters
- Pneumatic Differential pressure transmitter
- Smart/Intelligent Pressure Transmitter
- Universal Calibrator
- Air Compressor
- Pirani Gauge
- Ionisation Gauge
- Different types of Flow Elements like Orifice
- Venturi Tube
- Flow Nozzle
- Pitot tube flow trainer.
- Rotameter
- Magnetic Flow Meter
- Ultrasonic Flow Meter
- Flow Transmitters
- Flow Totalizers
- Flow counter.
- Flow Switches.
- Contact & Non-contact type Tachometers
- A.C. Tachometer
- D. C. Tachometer
- Magnetic Tachometer
- Photoelectric Tachometer
- Stroboscopic Tachometer.
- Hair Hygrometers
- Wet & Dry Bulb Hygrometers.
- Electrolytic Hygrometers.
- Infrared Absorption Hygrometer.

**B) List of Software/Learning Websites**

- i. [http://en.wikipedia.org/wiki/Pressure\\_measurement](http://en.wikipedia.org/wiki/Pressure_measurement)
- ii. <http://www.ni.com/white-paper/13034/en/>
- iii. <http://www.omega.com/literature/transactions/volume3/pressure.html>
- iv. [http://en.wikipedia.org/wiki/Flow\\_measurement](http://en.wikipedia.org/wiki/Flow_measurement)
- v. <http://www.pc-education.mcmaster.ca/Instrumentation/flow.htm>

**11. COURSE CURRICULUM DEVELOPMENT COMMITTEE**

**Faculty Members from Polytechnics**

- **Prof. R. J. Dhruv** Sr. Lecturer , A.V.P.T.I. Rajkot
- **Prof. S. Z. Shyara** Sr. Lecturer , A.V.P.T.I. Rajkot
- **Prof. R. P. Raiyani** I/C H.O.D I.C Christ Polytechnic Institute, Rajkot
- **Prof. H. P. Patel** Lecturer, Government Polytechnic, Ahmedabad.

**Coordinator and Faculty Members from NITTTR Bhopal**

- **Prof. (Mrs.) Susan S. Mathew**, Associate Professor, Department of Electrical and Electronics Engineering.
- **Prof. Joshua Earnest**, Professor, Department of Electrical and Electronics Engineering.