GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: PROCESS INSTRUMENTATION-II
(COURSE CODE: 3351702)

Diploma Programmers in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	5th 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, select , troubleshoot and maintain the different process instrumentation systems. Therefore, this course has been designed so that students will learn to build and test the different types of process instrumentation system required for the parameters such as temperature, level, force, torque, vibration etc.

2. LIST OF 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 out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Selects measurement method for a process parameter by process instruments for temperature level, vibration, force and torque in a process plant.
ii. Specify instrumentation for temperature level, vibration, force and torque application.
iii. Identify, describe and Calibrate major instruments for temperature, level, vibration, force and torque in a process plant.
iv. Test & maintain the components of the main types instruments for temperature level, vibration, force and torque in a process plant.
v. Draw schematic diagram of process instrumentation for temperature level, vibration, force and torque 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	
3	0	4	7	70	30	40	60	200

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 (In cognitive domain)	Topics and Sub-topics
Unit – I Temperature Measurement Techniques	1a. Define heat, temperature. 1b. List various temperature scales and relate them. 1c. Enlist types of expansion thermometer. 1d. Enlist application, merits and demerits of expansion thermometer. 1e. Explain construction and working of following filled system thermometers: (1) Class I (2) Class II (3) Class III (4) Class V. 1f. Enlist applications, merits and demerits of filled system thermometers 1g. List sources of error in filled system thermometry. 1h. Explain head effect, radiation effect, immersion effect and dip effect. 1i. Describe Seebeck effect, Peltier effect and Thomson effect. 1j. State and explain thermoelectric laws. 1k. Describe protection, installation and importance of thermowell in thermometry 1l. State positive and negative extension wires used in following type of thermocouples: B, E, J, K, R, S, and T 1m.. Explain cold junction compensation method used in thermocouple. 1n. Enlist methods used for forming thermocouples ends. 1o. Define thermopile. 1p. State the criteria for selection of thermocouple. 1q.Classify various thermocouples as per ANSI standard 1r. Describe the output of thermocouple (mV) converted to corresponding temperature value using thermocouple calibration table. 1s. Describe construction of	1.1 Introduction: Heat, Temperature 1.2 Temperature scales. 1.3 Expansion thermometer 1.3.1 Solid Expansion Thermometer •Bimetallic thermometer ➢Spiral Bimetal element ➢ Helix Bimetal element 1.3.2 Liquid Expansion Thermometer- Mercury in Glass type. 1.4 Filled system thermometer 1.4.1 Class I-Liquid Filled Systems 1.4.2 Class II- Vapour Systems 1.4.3 Class III- Gas Filled Systems 1.4.4 Class V- Mercury Filled Systems 1.5 Thermocouples 1.5.1 Principle: Seebeck, Peltier, Thomson effect 1.5.2 Thermoelectric laws 1.5.3 Cold junction compensation 1.5.4 Thermowell 1.5.5 Thermocouple extension wires 1.5.6 Thermocouples selection criteria 1.6 Resistance Temperature Detector Industrial RTD 1.6.1 2-wire RTD 1.6.2 3-wire RTD 1.6.3 4-wire RTD 1.7 Thermistors 1.8 Integrated Circuit (IC) based Temperature sensors 1.9 Non-contact type thermometry 1.9.1 Radiation pyrometer 1.9.2 Optical pyrometer 1.9.3 Optical Fibre Thermometry 1.9.4 Ultrasonic thermometry 1.9.5 Laser thermometry 1.10 Temperature switches and thermostats

Unit	Major Learning Outcomes (In cognitive domain)	Topics and Sub-topics
	Industrial RTD. 1t. Explain resistance measuring circuit of RTD.(2-wire, 3-wire, 4-wire bridge circuit) 1u. State the need of lead wire compensation in RTD. 1v.Describe temperature measuring bridge circuit using thermistor. 1w. Describe performance of a thermistor. (Resistance-temperature graph). 1x. Compare output response of RTD, Thermistor and Thermocouple with sketch. 1y. Explain Integrated Circuit (IC) based temperature sensors. 1z.Define emissivity, Black body concept, Stefan Boltzmann Law. 1aa. Explain construction and working of non-contact type of thermometry(1.9.1 to 1.9.5) 1bb. State merits and demerits of non-contact type thermometer. 1cc. List sources of error in Non-contact type thermometry. 1dd. Describe operation of Temperature switches and thermostats.	
Unit – II Level Measurement Techniques	2a State units, importance of level measurement in process Industries 2b Classify methods of level measurement. 2c Describe working and construction of level measurement method (2.2 to 2.7). 2d Enlist Applications for various level measuring methods (2.2 to 2.7) 2e State merits and demerit of various level measuring methods(2.2 to 2.7) 2f Describe working and construction of various levels switches (2.8)	2.1Level measurement: Importance and Units. 2.2 Level measurement methods: 2.2.1Direct methods •Bob and Tape method •Sight glass method 2.2.2Indirect methods •Pressure gauge type •Air bellows. 2.3Capacitance type level measurement and Radiation type level measurement 2.4Differential pressure type level measurement 2.5 Ultrasonic level detector. 2.6 Laser Level Sensors 2.7 Optical Level detector 2.8 Level switches: 2.8.1 Float type level switch 2.8.2 Displacer level switch 2.8.3 conductivity level switch

Unit	Major Learning Outcomes (In cognitive domain)	Topics and Sub-topics
Unit – III Temperature and level Transmitters	3a Define transmitter. 3b Explain electronic temperature transmitter with neat schematic diagram. 3c List Differential pressure type level transmitters. 3d Explain working and construction of pressure type level transmitter with neat sketch (3.2.1-3.2.2). 3e Enlist applications of transmitters. 3f Describe concept of Zero suppression and Elevation for level transmitter.	3.1Electronic temperature transmitters 3.2 Level transmitter 3.2.1Differential pressure type level transmitter •Pneumatic type •Electronic type 3.2.2 Extended diaphragm level transmitter
Unit IV Force And Torque Measurement Techniques	4a Define Force and Torque 4b State units of Force and Torque 4c Explain working and construction of listed force transducers. 4d Explain working and construction of listed torque transducers.	4.1Force 4.1.1Elastic force meters. 4.1.2Load cells 4.2Torque 4.2.1 Strain gauge torsion meter 4.2.2 Electrical torsion meter 4.2.3 Mechanical torsion meter.
Unit – V Vibration Measurement Techniques	5a Define vibration 5b Explain working and construction of vibration sensor (5.2) 5c Enlist applications of vibration sensors (5.2) 5d Enlist merits and demerits of vibration sensors (5.2)	5.1 Vibration. 5.2 Vibration Sensors: 5.2.1. Mass spring seismic sensor 5.2.2 Piezo-electric sensor

6. SUGGESTED SPECIFICATION TABLE WITH HOURS and MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Temperature Measurement Techniques	14	4	12	5	21
II	Level Measurement Techniques	14	4	12	5	21
III	Temperature and level Transmitters	08	0	10	4	14
IV	Force And Torque Measurement Techniques	04	2	6	2	10
V	Vibration Measurement Techniques	02	0	2	2	04
	Total	**42**	**10**	**42**	**18**	**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.

Sr. No.	Unit No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs. required
1	I	Use liquid in glass type filled system thermometers	02
2	I	Perform temperature measurement using expansion thermometer.	02
3	I	Measure temperature of given medium using given thermocouple with the help of corresponding thermocouple table.(Conversion of millivolt to temperature)	02
4	I	Verify the law of intermediate metal for available type of thermocouple.	02
5	I	Test the effect of reference junction temperature on given thermocouple.	02
6	I	Convert output of thermocouple (mV) into temperature(˚C) using corresponding thermocouple calibration table	02
7	I	Measure the temperature using RTD and Test.	02
8	I	Calculate temperature co-efficient of resistance using RTD	02
9	I	Measure the temperature using Thermistors and Plot the characteristic curve.	02
10	I	Measure the temperature using IC temperature sensor.	02
11	I	Measure the temperature of heating element using Optical Pyrometer.	02
12	I	Measure the temperature of heating element using radiation Pyrometer.	02
13	I	Measure the temperature using fiber Optic thermometer.	02

Sr. No.	Unit No.	Practical Exercises (Outcomes' in Psychomotor Domain)	Hrs. required
14	I	Measure the temperature using thermometer	02
15	I	Measure the temperature using thermometer	02
16	I	Test the operation of temperature switch at given temp	02
17	II	Measure the level of the tank with the help of the Sight glass	02
18	II	Measure the level of the tank with the help of the pressure gauge.	02
19	II	Measure level with the capacitance type transducer.	02
20	II	Test for the float type level switch	02
21	II	Use displacer level switch for given range & Test	02
22	II	Use capacitance type level switch for given range & Test	02
23	III	Use Electronic Temperature transmitters for given range & Test.	02
24	III	Use differential pressure type level transmitter for given range & Test.	02
25	IV	Measure torsion by electrical torsion meter	02
26	IV	Use load cell and test for perfomance	02
27	V	Measure vibration by vibration analyser.	02
* **Note: These experiments can be either conducted using hardware from covering all the Units .**		Total	54

8. SUGGESTED LIST OF STUDENT ACTIVITIES

i. Industrial Visit for students (chemical industries, petroleum industries, production industries)

ii. Small technical projects based on theory topic.

9. SPECIAL INSTRUCTIONAL STRATEGIES

i. Videos/Animation for different devices should be shown.

ii. Seminar on relevant topics.

10. SUGGESTED LEARNING RESOURCES

A) List of Books

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

6.	Mechanical and Industrial measurements	Jain, R.K.	Khanna publication, New Delhi
7.	Industrial Instrumentation	Krishnaswamy, K. and S. Vijayachitra,	New Age International Publication, New Delhi

B) List of Major Equipment/ Instrument with Broad Specifications

i. Function generator(sine, square, triangle etc. with frequency range 10 Hz to 100 kHz)
ii. DC power supply (-30 →0→+30 V with at least 1A current capacity)
iii. Measuring equipments like CRO (preferably dual channel, 20Mhz)
iv. Multi meter
v. Electrical tool kit.
vi. Circuit/Trainer board/ Demonstration modules of Thermocouples , RTDs, Thermistors, IC temperature sensor.
vii. Temperature Switches, Optical Pyrometer, Radiation Pyrometer
viii. Sight Glass type Level Indicator
ix. Pressure Gauge type Level Indicator
x. Float type , Displacer type and Capacitance type Level Switches
xi. Fiber Optic Thermometer, Ultrasonic Thermometer, Laser Thermometer
xii. Capacitance type Level Transducer
xiii. Electronic Temperature transmitters
xiv. Differential pressure type Level Transmitter
xv. Universal Calibrator
xvi. Air Compressor
xvii. Load Cell
xviii. Vibration Analyzer
xix. Electrical Torsion Meter
xx. metal detector
xxi. ultrasonic flaw detector

C) List of Software/Learning Websites

i. http://www.pc-education.mcmaster.ca/Instrumentation/temperature.
ii. http://www.pc-education.mcmaster.ca/Instrumentation/level.
iii. http://www.dugantech.com/Product_Group-Temperature/Technical%20Articles/TE Criteria%20for%20Selection%20of%20RTD%20or%20TC%20industrial%20apps.pdf
iv. books.google.co.in/books?isbn=8122416691
v. Capacitive Displacement/Vibration Measurement Sensor Products
vi. Eddy-Current Displacement/Vibration Measurement Sensor Products

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** 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. (Dr) Joshua Earnest.** Professor, Department of Electrical and Electronics Engineering
- **Prof. (Dr) N. P. Patidar.** Professor, Department of Electrical and Electronics Engineering