Program Name : **Diploma in Instrumentation / Instrumentation and Control**

Program Code : **IS / IC**

Semester : **Fifth**

Course Title : **Process Instrumentation**

Course Code : **22542**

1. RATIONALE

In Industrial processes, parameters involved are required to be measured, transmitted, recorded and displayed for efficient functioning of process operations. This subject gives a basic understanding about concept, facts, principles and working of various elements of Process Control Systems used in industries. The students can use this knowledge to develop competency to work in various Industrial sectors such as project engineering, maintenance, service and calibration departments.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain Process Control Equipment in Instrumentation Systems.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Identify the elements of process feedback loop.
b. Use transmitters for various applications in process industry.
c. Maintain various process parameters on DAS and recording system.
d. Maintain control Panels for various applications in process industry.
e. Identify hazardous locations in process industry.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

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

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the

course, in all domains of learning in terms of the industry/employer identified competency depicted at the center of this map.

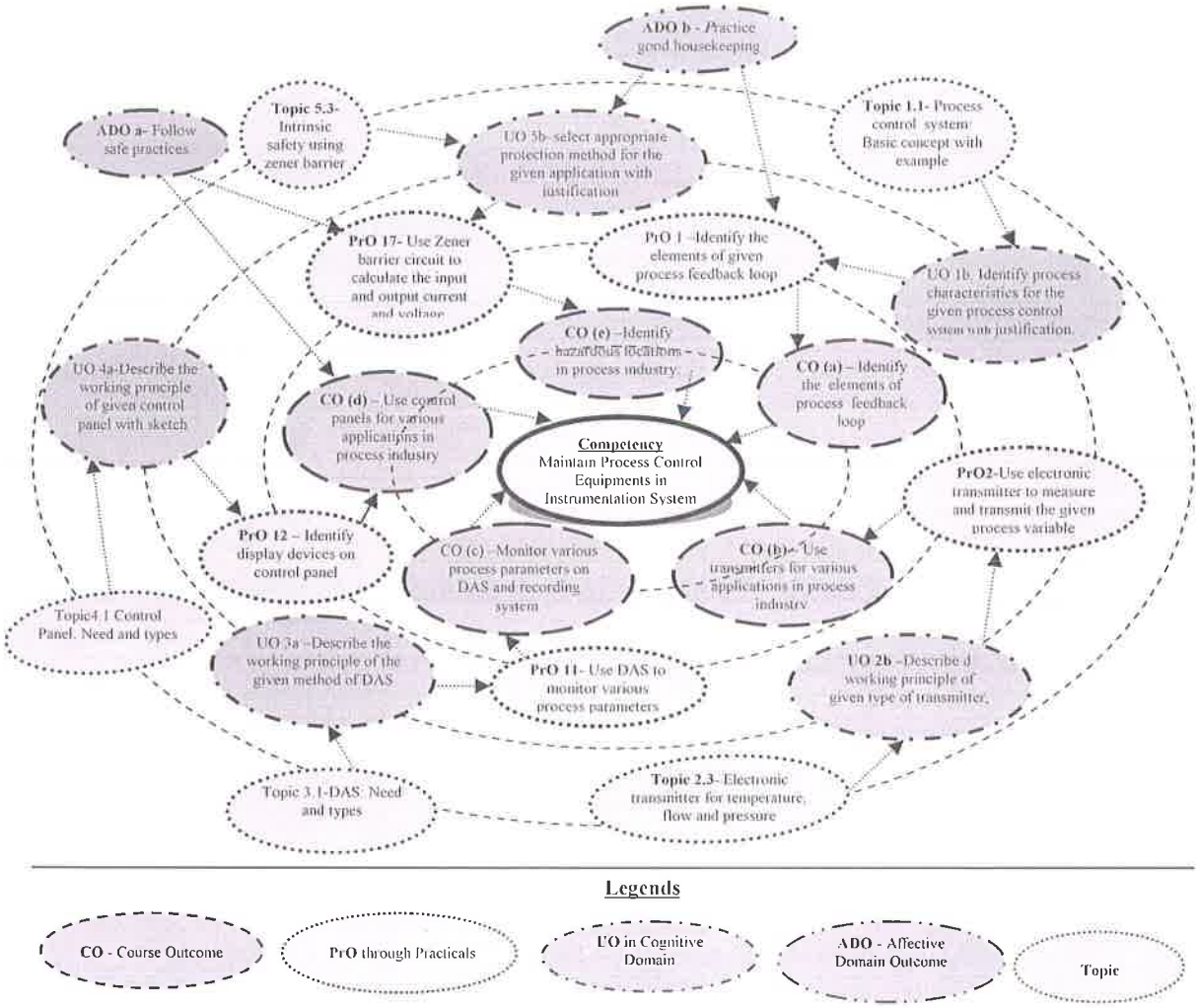

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify the elements of the given process feedback loop	I	02*
2	Use electronic temperature transmitter to measure and transmit the given process variable.	II	02*
3	Use electronic DP transmitter to measure and transmit the given process variable	II	02
4	Calibrate the given temperature transmitter	II	02
5	Calibrate the given DP transmitter	II	02*
6	Use relevant Installation procedure to install the given temperature transmitter in the process loop.	II	02
7	Use relevant Installation procedure to install the given DP transmitter in the process loop.	II	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
8	Use SMART Transmitter to demonstrate the features.	II	02*
9	Use DAS to monitor various process parameters.	III	02*
10	Use Data Logger system to monitor various process parameters.	III	02
11	Use strip chart recorder to plot any one process parameter.	III	02*
12	Identify the display devices on the control Panel.	IV	02*
13	Sketch the typical control room layout.	IV	02
14	Use alarm annunciator to demonstrate the sequence of operations.	IV	02*
15	Use I/P convertor to convert the given standard signal	IV	02*
16	Use P/I convertor to convert the given standard signal	IV	02
17	Use zener barrier circuit to calculate the input and output currents and voltages.	V	02
	Total		**34**

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S.No.	Performance Indicators	Weightage in %
a.	Preparation of experimental set up	20
b.	Setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	Submission of report in time	10
Total		**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.
c. Practice energy conservation.
d. Demonstrate working as a leader/a team member.
e. Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year

- 'Organizing Level' in 2nd year
- 'Characterizing Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Process control loop set up of flow or any other parameter.	1
2	Temperature Transmitter (0 to 100^0c).	2,4,6
3	DP Transmitter (0 to 3750 mmWC) or any other range available in the lab.	3,5,7
4	SMART Transmitter.	8
5	Alarm annunciator (16 window/24 window).	14
6	Data logger (8 channel/ 16 channel).	10
7	Strip chart recorder (Any make).	11
8	Control Panel.	12
9	I/P Converter (Any make) 3 to 15 psig output, 4 to 20 mA input).	15
10	P to I converter (Any make) 3 to 15 psig input, 4 to 20 mA output).	16

8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– I Process Instrumentation System	1a. Identify the element(s) of given process feedback loop, with justification. 1b. Identify process characteristics for the given process control system with justification. 1c. Describe the dynamics of the given process control system. 1d. Differentiate between the process characteristics and process dynamics	1.1 **Process Control System:** Basic concept with example 1.2 **Process Instrumentation:** Concepts, Examples, Benefits 1.3 **Process Characteristics**: Types such as Process equation, Process Load, Transient, Process Lag, self-regulation 1.4 **Process Dynamics:** Types such as Resistance lag, capacitance lag, Dead time, Inertia
Unit– II Signal Transmission and transmitters	2a. Differentiate between the given transmission system. 2b. Describe the working principle of the given type of transmitter(s). 2c. Describe the calibration procedures of the given transmitter 2d. Select the relevant type of transmitter for the given application with justification. 2e. Interpret the hook up installation sketch of the given	2.1 Need and types of signal transmission system. 2.2 Pneumatic transmission system: Standard signal 3-15 psi, Live zero, Flapper Nozzle Mechanism, Pneumatic transmitter: temperature transmitter and DP Transmitter-their diagram and working. 2.3 Electronic transmission system: Standard signal 4-20mA and 0-10V, Live zero, Electronics transmitter for temperature, flow (DP type) and pressure (force balance type).

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	transmitter	diagram and working. 2.4 SMART transmitters: Block diagram, explanation, Salient features. 2.5 Installation of temperature and DP transmitter. 2.6 Calibration of temperature and DP transmitter
Unit-III Data Monitoring and recording Instruments	3a. Describe the working principle of the given type of Data Acquisition system 3b. Describe the working principle of the given Data logger 3c. Describe the working principle of the given type of Recorder 3d. Select the DAS for a given application 3e. Select the recorder for a given application	3.1 DAS: Need, Types (single channel, multichannel), Block diagram, working and Applications. 3.2 Data logger: Block diagram, working and Applications. 3.3 Recorder: Need, Types -Strip Chart (Self Balancing, Potentiometric), X-Y Block diagram, working, specifications and Applications.
Unit IV Control Room Instrumentation	4a Describe the working principle of given control panel with sketch. 4b Differentiate between the given type of control panels 4c Describe the ergonomic considerations of control room. 4d Describe the working principle of given type of convertor with sketch. 4e Describe the working principle of Annunciator with sketch.	4.1 Control panels: Need; Types -Flat, Breakfront, Console; Ergonomic consideration, Documents needed to design the control panel Control room environment: Ergonomic considerations, Control room layout. 4.2 Electro-pneumatic convertors: Current to pressure convertor, Pressure to current convertor, diagram and principle of working of each 4.3 Alarm Annunciator: Working of annunciator, and the operational sequence.
Unit-V Instrumentation in hazardous area	5a. Select the appropriate material for the given hazardous location 5b. Select appropriate protection method for the given application with justification 5c. Select intrinsically safe equipment for hazardous location. 5d. Identify the enclosures for the given hazardous / nonhazardous location with justification.	5.1 Hazardous area: classification according to the materials as per NEC and IEC 5.2 Protection methods- Explosion proof, Intrinsic safety, oil immersion, purging, Nonincendive, increased safety and sealing 5.3 Intrinsic safety technique using passive zener barrier circuit 5.4 Enclosures: IP classification, NEMA types.

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Process Instrumentation System	12	4	4	2	10
II	Signal Transmission and Transmitters	16	4	6	10	20
III	Data Monitoring and recording Instruments	12	4	4	4	12
IV	Control Room Instrumentation	12	4	4	8	16
V	Instrumentation in hazardous area	12	4	4	4	12
Total		**64**	**20**	**22**	**28**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

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. Identify and interpret display devices on different control panels using trainer set up/ in industry
b. Draw control room layout and list out ergonomic considerations
c. Draw the process control loop for the level control system.
d. Draw the process control loop for the temperature control system
e. Survey few process industries and categorize them in appropriate hazardous class.
f. Draw the setup of level measurement using DP transmitter.
g. Perform the experiment of data logger in virtual lab.
h. Sketch the typical control room layout with scale on half imperial size drawing sheet.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

a. Collect the data of 5 industries and list the important control parameters in them.
b. Make a Bill of Material for installation of temperature transmitter. Demonstrate the working of the set up.
c. Make a Bill of Material for installation of DP transmitter. Demonstrate the working of the set up.
d. Assemble control panel for the given application
e. Build annunciator for one process parameter and demonstrate its working.
f. Build intrinsically safe Zener barrier circuit for the given application in hazardous area.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Industrial Instrumentation and control	Singh S.K.	Tata McGraw Hill, New Delhi , 3rd edition ISBN: 978-0070678200
2	Process control Instrumentation Technology	Johnson C.D.	Prentice hall of India, NewDelhi,2015 ISBN: 978-9332549456
3	Instrumentation Engineer's handbook - Process control	Liptak Bela G	Chilton Book company,3rd edition ISBN:978-0801982422
4	Applied Instrumentation in the Process Industries, volume 2	William G.Andrew, WilliamsH.B	Gulf Publishing company,1974 ISBN:978-0872013940
5	Electronics Instruments and Instrumentation Technology	Anand M.M.S	Prentice hall India Learning Pvt. Ltd. New title edition(2004) ISBN: 9788120324541
6	Process Industrial instruments and control Handbook	Considine, Douglas	Tata McGraw Hill, 4th edition ISBN: 978-0070124455

14. SOFTWARE/LEARNING WEBSITES

a. http://www.pc-education.mcmaster.ca/Instrumentation/go_inst.htm
b. https://automationforum.in/t/basics-of-smart-transmitters/3030
c. https://automationforum.in/t/instrumentation-hook-up/3644
d. http://www.hse.gov.uk/comah/sragtech/techmeascontrol.htm
e. https://www.electrical4u.com/alarm-annunciator/
f. https://automationforum.in/t/current-to-pressure-convertion-using-flapper-nozzle-system/2691
g. http://literature.rockwellautomation.com/idc/groups/literature/documents/wp/800-wp004_-en-p.pdf