GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)
Semester- V

Course Title: Applied Instrumentation
(Course Code: 4351701)

Diploma program in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	5th Semester

1. RATIONALE

Study of Instrumentation & Control engineering covers wide range of knowledge from various other fields of engineering such as chemical, mechanical, electrical, electronics, biomedical and computers. Application of such diversified knowledge in a multidisciplinary branch of instrumentation and control engineering needs to be comprehend by the students during their study. Therefore, this course has been designed in order to equip the students to actual implementation of instrumentation in industry.

2. COMPETENCY ('Program Outcome' according to NBA Terminology)

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:

- **To maintain industrial processes.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

a) CO1: Select appropriate instrument and Utilize instrumentation related documents.
b) CO2: Demonstrate instrument air supply system.
c) CO3: Analyze major industrial applications.
d) CO4: Maintain process instruments.
e) CO5: Practice industrial safety using appropriate instruments.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment 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, **CA** - Continuous Assessment; **ESE** - End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the subcomponents of the COs.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Select appropriate pressure instrument.	1	02
2	Select appropriate flow instrument.	1	02
3	Select appropriate level instrument.	1	02
4	Select appropriate temperature instrument.	1	02
5	Select appropriate control valve.	1	02
6	Investigate given process flow sheet.	1	02
7	Inspect loop using given mechanical flow sheet.	1	02
8	Examine instrument index sheet.	1	02
9	Utilize instrument specification sheet.	1	02
10	Prepare loop wiring diagram.	1	02
11	Troubleshoot panel fault using panel drawings and specifications.	1	02
12	Analyze Plot plan of a unit in industry.	1	02
13	Install an instrument by following installation details.	1	02
14	Prepare a report about special drawings in a plant useful for instrumentation engineers.	1	02
15	Prepare a Purchase requisition to order an instrument.	1	02
16	Select appropriate pressure level for instrument air supply system.	2	02
17	Calculate appropriate size/capacity for an instrument air supply system.	2	02
18	Install Instrument air supply system for low air requirement.	2	02
19	Install Instrument air supply system for large air requirement.	2	02
20	Investigate given Air compressor.	2	02
21	Set loading and unloading of compressor by calibrating a pressure switch.	2	02
22	Justify the need for instrument air dryer.	2	02
23	Investigate the design of refrigerated air dryer.	2	02
24	Inspect the working of heated type desiccant air dryer.	2	02
25	Inspect the working of heatless type desiccant air dryer.	2	02
26	Simulate single element drum level control scheme of Thermal power plant in a simulator.	3	02
27	Simulate two element drum level control scheme of Thermal power plant in a simulator.	3	02
28	Simulate three element drum level control scheme of Thermal	3	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
	power plant in a simulator.		
29	Simulate automatic stop motion control scheme of textile industry in a simulator.	3	02
30	Simulate stretch control scheme of textile industry in a simulator.	3	02
31	Simulate humidity and moisture control scheme of textile industry in a simulator.	3	02
32	Simulate kiln temperature control scheme of cement industry in a simulator.	3	02
33	Simulate Temperature control scheme of a chemical reactor in a simulator.	3	02
34	Simulate Pressure control by vent throttling of a chemical reactor in a simulator.	3	02
35	Simulate cascade control scheme of a chemical reactor in a simulator.	3	02
36	Demonstrate function of each part of Distillation equipment	3	02
37	Simulate column pressure control by throttling condenser water in a simulator.	3	02
38	Demonstrate working of heat exchanger.	3	02
39	Simulate conventional temperature Control scheme of heat exchanger in a simulator.	3	02
40	Simulate Temperature-Pressure Cascade Control scheme of heat exchanger in a simulator.	3	02
41	Simulate Temperature-Flow Cascade Control scheme of heat exchanger in a simulator.	3	02
42	Use the checklist of installation of a new instrument taking care of all safety precautions.	4	02
43	Check out a given flow transmitter.	4	02
44	Check out a given temperature transmitter.	4	02
45	Check out a given control valve.	4	02
46	Replace fuse of an instrument with a higher capacity fuse.	5	02
47	Test a circuit breaker.	5	02
48	Test zener barrier using an electric load.	5	02
49	Simulate plant interlock circuit using a simulator.	5	02
50	Test annunciator in a simulator.	5	02

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list**.***

ii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Ability to Apply gained knowledge	10
2	Ability to Identify and solve engineering problems	10
3	Ability to Prepare experimental setup	10
4	Ability to Work in a team	10
5	Ability to Conduct the experiment	10
6	Ability to Follow safe practices measures	10
7	Ability to Use of engineering tools	10
8	Ability to Communicate effectively	10
9	Ability to Record observations correctly	10
10	Ability to Interpret the result and conclude	10
Total		100

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the Pros is a guide to procure them by the administrators to usher in uniformity of practical in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications.	PrO. No.
1	Instrumentation related documents.	6-15
2	Air compressor	19, 21
3	Multimeter	21, 43-48
4	Air Dryer system model	23-25
5	Process Simulator Software	26-35, 37, 39 -41, 49, 50
6	Distillation column model	36
7	Heat exchanger model	38
8	Flow transmitter	43
9	Temperature transmitter	44

10	Control valve	45
11	Fuse	46
12	Circuit breaker	47
13	Electronic work bench	All
14	Zener diode	48

7. AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and Pros More could be added to fulfil the development of this competency.

a. Positively Influence others as a leader/a team member.
b. Meet the expectations of your superior/teacher/guide.
c. Cooperate your team mates and colleagues.
d. Help worker/staff/personnel nearby you.
e. Obey your higher officials/trainers/guide/manager.
f. Respect more experienced persons in your field.
g. Aid new comers/new joinees in your field.
h. Empathize your coworkers.
i. Tolerate the unpleasant and extreme environment conditions in the field.
j. Follow safety practices while using electrical appliances.
k. Practice environmentally friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

Only the major Underpinning Theory is formulated as higher level UOs of Revised Bloom's taxonomy in order development of the COs and competency is not missed out by the students and teachers. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Major Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics

Unit	Major Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit-I Instruments Selection and Documents Utilization	1a. Describe factors affecting for selection of Pressure Instruments. 1b. Describe factors affecting for selection of Flow Instruments. 1c. Describe factors affecting for selection of Level Instruments. 1d. Describe factors affecting for selection of Temperature Instruments. 1e. Describe factors affecting for selection of Control Valves. 1f. Explain the function of instrumentation related documents listed in topic 1.2.	1.1 Selection of Instruments : 1.1.1 Pressure Instruments 1.1.2 Flow Instruments 1.1.3 Level Instruments 1.1.4 Temperature Instruments 1.1.5 Control Valve 1.2 Instrumentation related Documents: 1.2.1. Process flow sheet 1.2.2. Mechanical flow sheet 1.2.3. Instrument index sheet 1.2.4. Instrument specification sheet 1.2.5. Loop wiring diagram 1.2.6. Panel drawings and specifications 1.2.7. Plot Plans 1.2.8. Installation Details 1.2.9. Special Drawings 1.2.10. Purchase requisitions
Unit-II Instrument Air Supply System	2a. Explain importance of instrument air supply system. 2b. Describe sizing criteria and pressure level for designing of air supply system. 2c. Explain Air supply system for low air requirement with the help of neat diagram. 2d. Explain Air supply system for low air requirement with the help of neat diagram. 2e. Classify air compressors. 2f. With the help of neat sketch, Explain construction and working of positive displacement type of air compressor. 2g. With the help of neat sketch, Explain construction and working of dynamic type of air compressor.	2.1. Introduction to Instrument Air Supply System 2.1.1 Importance 2.1.2 Sizing Criteria 2.1.3 Pressure level 2.2. Instrument Air supply system for low air requirement 2.3. Instrument Air supply system for large air requirement 2.4. Air Compressor 2.4.1. Classification • Positive displacement type • Dynamic type 2.4.2. Compressor control using pressure switch.

Unit	Major Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
	2h. Explain on-off control of air compressor using pressure switch. 2i. Explain need for Instrument Air Dryer. 2j. With the help of neat sketch, explain construction and working of Refrigerated Air Dryer. 2k. With the help of neat sketch, explain construction and working of Heated type Desiccant Air Dryer. 2l. With the help of neat sketch, explain construction and working of Heatless type Desiccant Air Dryer.	2.5. Instrument Air Dryer- 2.5.1. Need for Dryer 2.5.2. Refrigerated Air Dryer 2.5.3. Desiccant Air Dryer • Heated type • Heatless type

Unit	Major Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit III Major Industrial Applications	3a. With the help of neat sketch, explain single element drum level control in thermal power plant. 3b. With the help of neat sketch, explain two element drum level control in thermal power plant. 3c. With the help of neat sketch, explain three element drum level control in thermal power plant. 3d. With the help of neat sketch, explain automatic stop motion control in textile industry. 3e. With the help of neat sketch, explain stretch control in textile industry. 3f. With the help of neat sketch, explain humidity and moisture control in textile industry. 3g.Explain kiln temperature control in cement industry with the help of neat diagram. 3h. Explain temperature control scheme of chemical reactor with neat sketch.	3.1. Thermal power plant 3.1.1 Single element drum level control 3.1.2 Two element drum level control 3.1.3 Three element drum level control 3.2 Textile industry 3.2.1 Automatic stop motion control 3.2.2 Stretch control 3.2.3 Humidity and Moisture control 3.3 Cement industry 3.3.1 Kiln Temperature control 3.4 Chemical Reactor 3.4.1. Temperature control scheme 3.4.2. Cascade control scheme 3.4.3. Pressure control by vent throttling

Unit	Major Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
	3i. Explain cascade control scheme of chemical reactor with neat sketch. 3j. Explain pressure control by vent throttling of chemical reactor with neat sketch. 3k. Describe parts of distillation equipment with the help of neat sketch. 3l. State variables of distillation operation. 3m. Explain column pressure control by throttling condenser water. 3n. State variables and parameters of heat exchanger. 3o. Draw Heat exchanger Symbol and label fluid media symbols in it. 3p. Draw and explain conventional temperature control scheme of heat exchanger. 3q. Draw and explain temperature-pressure cascade scheme of heat exchanger. 3r. Draw and explain temperature-flow cascade scheme of heat exchanger.	3.5 Distillation Process 3.5.1. Distillation equipment 3.5.2. Variables of distillation operation 3.5.3. Column pressure control by throttling condenser water 3.6 Heat Exchanger 3.6.1. Variables and Parameters 3.6.2. Heat exchanger Symbol 3.6.3. Conventional Temperature Control scheme 3.6.4. Temperature-Pressure Cascade scheme 3.6.5. Temperature-Flow Cascade scheme

Unit	Major Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit – IV Industrial Maintenance and checkout procedures	4a. Justify the need for maintenance. 4b. Explain breakdown maintenance. 4c. Explain preventive maintenance. 4d. Explain predictive maintenance. 4e. State checklist for good installation practices. 4f. Describe checkout procedure for flow transmitter. 4g. Describe checkout procedure for temperature transmitter. 4h. Describe checkout procedure for control valve.	4.1. Maintenance 4.1.1. Need for maintenance 4.1.2. Breakdown maintenance 4.1.3. Preventive maintenance 4.1.4. Predictive maintenance 4.2. Checklist of good installation practices 4.3 Typical checkout procedure for following: 4.3.1. Flow Transmitter 4.3.2. Temperature Transmitter 4.3.3. Control Valve

Unit	Major Learning Outcomes ('Course Outcomes' in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit – V Industrial Safety System	5a. Explain Hazardous area classification. 5b. Describe the function of fuse as an electrical safety equipment. 5c. Describe the function of circuit breaker as an electrical safety equipment. 5d. Explain importance of grounding in electrical safety. 5e. Explain intrinsic safety. 5f. Explain importance of zener barriers in electrical safety. 5g. Describe the need for plant interlocks. 5h. Explain simple interlock circuit with the help of neat sketch. 5i. Explain the function of annunciator. 5j. Describe functions of Intelligent Instruments. 5k. With the help of block diagram, explain architecture of Intelligent Instrument.	5.1. Hazardous area classification 5.2. Electrical Safety 5.2.1. Fuse 5.2.2. Circuit breaker 5.2.3. Grounding 5.2.4. Intrinsic safety 5.2.5. Zener barriers 5.3. Plant Interlock 5.3.1 Need for plant interlocks 5.3.2 Simple interlock circuit 5.4. Annunciators 5.5. Intelligent Instruments 5.5.1. Functions 5.5.2. Architecture

***Note**: The UOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	**Instruments Selection and Documents Utilization**	8	2	4	6	12
II	**Instrument Air Supply System**	8	1	4	9	14
III	**Major Industrial Applications**	12	1	3	18	22
IV	**Industrial Maintenance and checkout procedures**	6	4	1	5	10

V	**Industrial Safety System**	8	2	4	6	12
	Total	**42**	**10**	**16**	**44**	**70**

Legends: *R = Remember; U = Understand; A = Apply and above levels (Bloom's revised 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.*

10. SUGGESTED LIST OF 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. Industrial visit for students in order to have an exposure to the real industrial realm.
B. A workshop/seminar where students can have interaction with industry personnel.
C. Student's Presentation of Videos/Animation for different process loops.
D. Model preparation. E.g. prepare model of heated type air dryer.
E. Present a seminar on any one technical topic.
F. Set up practical apparatus on their own during practical under the guidance of faculty.
G. Group Discussion on industrial control scheme.
H. Prepare a poster on any one topic from curriculum.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

i. Display of animation videos of industrial loops.
ii. Arrange industrial visit to nearby process industry.
iii. Compliment student for his/her work done during the practical in order to motivate him/her by student and Instruct him/her remedies to improve his work if required.
iv. Arrange expert lectures of instrumentation engineers working in process industries.
v. Utilize Massive Open Online Courses (MOOCs) to teach various topics/sub-topics.
vi. Research through net i.e. internet based home assignments.
vii. Assign preparation of mini projects.
viii. Guide students to focus on energy savings in industry and home.
ix. Guide students on how to address issues on environment and sustainability.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her at the beginning of the semester. In the first four semesters, the micro-project 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 he/she 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 a dated work diary consisting of individual contributions 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 a micro-project by the end of the semester to develop the industry-oriented COs.

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 process flow sheet of given industrial loop.
b. Collect major instrumentation documents of some nearby industries.
c. Calculate appropriate size of instrument air supply system for given industry.
d. Develop small Air supply system model.
e. Prepare refrigeration type air dryer model.
f. Prepare a model of heated type desiccant air dryer.
g. Prepare a model of heatless type desiccant air dryer.
h. PowerPoint Presentation on major industrial loop.
i. Development and demonstration of Zener barrier circuit on PCB.
j. Prepare plant interlock model.
k. Develop an annunciator circuit for any application.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Books	Author	Publication
1	Instrument Engineer's Handbook Volume-I, Process Measurement and Analysis	Bela G. Liptak	CRC PRESS,
2	Instrument Engineer's Handbook Volume-II, Process Control and Optimization	Bela G. Liptak	CRC, Taylor and Francis.
3	Applied Instrumentation in the Process Industries, Volume II	W.G Andrew & H.B Williams	Gulf Publishing Company
4	Complete Guide to Preventive and Predictive Maintenance	Joel Levitt	Industrial Press
5	Chemical Process Industries	R N Shreeve	Mc Graw Hill

14. List of Software/Learning Websites

i. www.nptel.com
ii. https://instrumentationtools.com
iii. https://www.vlab.co.in/participating-institute-coe-pune

iv. https://vlab.amrita.edu/?sub=1&brch=282&sim=1511&cnt=1

v. http://www.ni.com

15. PO-COMPETENCY-CO MAPPING

Semester V	Applied Instrumentation- (Course Code: 4351701)						
	POs						
Competency & Course Outcomes	**PO 1 Basic & Discipline specific knowledge**	**PO 2 Problem Analysis**	**PO 3 Design/ development of solutions**	**PO 4 Engineering Tools, Experimentation & Testing**	**PO 5 Engineering practices for society, sustainability & environment**	**PO 6 Project Management**	**PO 7 Life-long learning**
Competency	To maintain industrial processes.						
CO1: Select appropriate instrument and Utilize instrumentation related documents.	3	1	-	1	1	-	1
CO2: Demonstrate instrument air supply system	2	1	1	1	1	1	-
CO3: Analyze major industrial applications.	1	3	1	2	2	1	2
CO4: Maintain process instruments.	2	1	1	2	1	2	1
CO5: Practice industrial safety using appropriate instruments.	2	1	1	2	2	1	1

***Legend:** '**3**' for high, '**2**' for medium, '**1**' for low or '**-**' for the relevant correlation of each competency, CO, with PO/ PSO*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Member – Board of Studies (GTU), Electrical and Allied branches

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