# GUJARAT TECHNOLOGICAL UNIVERSITY, GUJARAT

## COURSE CURRICULUM
## COURSE TITLE: APPLIED INSTRUMENTATION
## (COURSE CODE: 3361701)

| **Diploma Programme in which this course is offered** | **Semester in which offered** |
|---|---|
| Instrumentation and Control Engineering | Sixth |

## 1. RATIONALE

The ultimate success of any plant control system rests on the ability of instrument experts to make proper application of components and system and on the ability of maintenance people to keep them calibrated and work safely. This course is essential in order to prepare future instrumentation personals for these tasks.

## 2. COMPETENCIES

The course content should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competencies:

- **Operate and maintain different types of instrument air supply systems and plant interlock system.**
- **Select, install and maintain various instrumentation & control systems for various process industries**.

## 3. COURSE OUTCOMES

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

i Select appropriate instruments according to process application requirement.
ii Utilize instrument drawings during installation and commissioning of plant.
iii Design a plant interlock circuit.
iv Design an instrument air supply system for plant.
v Test and maintain major control loops of cement, textile and power plant.
vi Design, test and maintain major control loops for heat exchanger, chemical reactors and distillation columns.

## 4. TEACHING AND EXAMINATION SCHEME

| **Teaching Scheme (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 CONTENT DETAILS

| Unit | Major Learning Outcomes (in cognitive domain) | Topics and Sub-topics |
|---|---|---|
| **Unit – I Selection, Installation and Commissioning of Instruments.** | 1a Describe factors affecting for selection of pressure instruments.<br>1b Describe factors affecting for selection of flow instruments.<br>1c Describe factors affecting for selection of level instruments.<br>1d Describe factors affecting for selection of temperature instruments.<br>1e Describe factors affecting for selection of Control Valves. | 1.1 Factors affecting for selection of :<br>1.1.1 Pressure Instruments<br>1.1.2 Flow Instruments<br>1.1.3 Level Instruments<br>1.1.4 Temperature Instruments<br>1.1.5 Control Valve |
| | 1f Justify the need for instrumentation related documents listed in topic 1.2. | 1.2 Instrumentation related documents :<br>Process flow sheets, Mechanical flow sheets, Instrument index sheet, Loop wiring diagram, Panel drawings and specifications, Plot plans, Installation details |
| | 1g State the checklist of good installation practices.<br>1h Describe typical checkout procedure for flow transmitter.<br>1i Describe typical checkout procedure for temperature transmitter.<br>1j Describe typical checkout procedure for control valve. | 1.3 Checklist of good installation practices<br>1.4 Typical Check out procedure for:<br>- Flow transmitter<br>- Temperature transmitter<br>- Control valve |
| **Unit-II Instrument Air Supply System** | 2a Describe sizing criteria and pressure level for designing of air supply system.<br>2b Draw and explain Air supply system for low air requirement.<br>2c Draw and explain Air supply system for large air requirement. | 2.1 Sizing criteria and pressure level for air supply system<br>2.2 Supply System for low air requirement<br>2.3 Supply System for large air requirement |
| | 2d Explain construction and working of any one type of positive displacement type compressor.<br>2e Describe Compressor controls. | 2.4 Compressor systems<br>2.4.1 Positive displacement type<br>2.4.2 Compressor controls |

| | | |
|---|---|---|
| | 2f Justify the need for dryers.(State necessity of dryer)<br>2g Classify dryers. Explain desiccant dryers in detail.<br>2h Explain operation of heated type of desiccant dryers.<br>2i Explain operation of heatless type of desiccant dryers | 2.5 Dryers<br>2.5.1 Types of dryers- Refrigeration and Desiccant(Heated and Heatless)<br>2.5.2 Necessity of dryers |
| **Unit-III Industrial Control Schemes and Plant Interlocks** | 3a Describe automatic stop motion control in textile industry<br>3b Describe Humidity and moisture control in textile industry.<br>3c Describe Stretch control in textile industry. | 3.1 Textile industry<br>3.1.1 Automatic stop motion control<br>3.1.2 Humidity and moisture control<br>3.1.3 Stretch control |
| | 3d Explain kiln temperature control system in cement industry | 3.2 Cement Industry - Kiln temperature control |
| | 3e Explain single element Drum level control in thermal power plant.<br>3f Explain two element Drum level controls in thermal power plant.<br>3g Explain three element Drum level controls in thermal power plant. | 3.3 Thermal power plant<br>3.3.1 Drum level control- single element, two element and three element. |
| | 3h Justify the need for plant interlocks.<br>3i Describe the working of any one plant interlock circuit with neat diagram. | 3.4 Need for plant interlocks<br>3.5 Simple plant interlock circuit |
| **Unit-IV Heat Exchanger & Chemical Reactors** | 4a State and explain heat exchanger variables and draw its symbol.<br>4b Explain conventional heat exchanger control scheme.<br>4c Explain Temperature – Pressure cascade loop of heat exchanger.<br>4d Explain Temperature – Flow cascade loop of steam reboiler. | 4.1 Heat Exchanger variables and symbol.<br>4.2 Conventional Heat Exchanger Control Scheme.<br>4.3 Temperature-Pressure cascade loop in heat exchanger.<br>4.4 Temperature-flow cascade loop of steam reboilers. |

| | | |
|---|---|---|
| | 4e Draw and Explain Temperature control scheme for chemical reactor.<br>4f Explain cascade loop scheme for temperature control in chemical reactor.<br>4g Explain Split range control of multiple coolants in chemical reactor.<br>4h Explain Reactor pressure control by throttling flow of vent gas. | 4.5 Temperature control in a chemical reactor.<br>4.6 Cascade loop for temperature control in a reactor.<br>4.7 Split range control of multiple coolants in a reactor.<br>4.8 Reactor pressure control by vent throttling |
| **Unit-V Distillation Column Schemes** | 5a List out variables for distillation column.<br>5b Explain pressure control of Distillation column by throttling condenser water.<br>5c Explain temperature control of Distillation column by heat control to reboiler.<br>5d Explain temperature control of Distillation column by reflux flow control.<br>5e Explain Feed flow control scheme of Distillation column.<br>5f Explain Cascade control of feed to second column. | 5.1 Variables for distillation column operation.<br>5.2 Distillation column pressure control by throttling condenser water.<br>5.3 Distillation column temperature control by heat control to reboiler.<br>5.4 Distillation column temperature control by reflux flow control.<br>5.5 Feed flow control scheme of Distillation column.<br>5.6 Cascade control of feed to second column. |

## 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 | Selection, Installation and Commissioning of Instruments. | 12 | 2 | 5 | 11 | 18 |
| II | Instrument Air Supply System | 7 | 2 | 4 | 6 | 12 |
| III | Industrial Control Schemes and Plant Interlocks | 8 | 2 | 4 | 8 | 14 |
| IV | Heat Exchanger & Chemical Reactors | 8 | 2 | 4 | 8 | 14 |
| V | Distillation Column Schemes | 7 | 2 | 4 | 6 | 12 |
| **TOTAL** | | **42** | **10** | **21** | **39** | **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.

## 7. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical 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. However, if these practical 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 | Practical Exercise (Outcomes in psychomotor domain) | Approx. Hours Required |
|---|---|---|---|
| 1 | I | Select appropriate pressure instrument. | 2 |
| 2 | I | Select appropriate flow instrument. | 2 |
| 3 | I | Select appropriate level instrument. | 2 |
| 4 | I | Select appropriate temperature instrument. | 2 |
| 5 | I | Select appropriate type of control valve. | 2 |
| 6 | I | Use the checklist of installation of a new instrument taking care of all safety precautions. | 2 |
| 7 | I | Check out a given flow transmitter prior to commissioning. | 2 |
| 8 | I | Check out temperature transmitter. | 2 |
| 9 | I | Check out control valve. | 2 |
| 10 | II | Select proper pressure level and size of compressor for instrument air supply system. | 2 |
| 11 | III | Simulate automatic stop motion control process of textile industry in a simulator. | 4 |
| 12 | III | Simulate Humidity and moisture control of textile industry in a simulator. | 4 |
| 13 | III | Simulate Stretch control of textile industry in a simulator. | 4 |
| 14 | III | Simulate kiln temperature control of cement industry in a simulator. | 4 |
| 15 | III | Simulate single element drum level control system in a simulator. | 4 |
| 16 | III | Simulate two element drum level control system in a simulator. | 4 |
| 17 | III | Simulate three element drum level control system in a simulator. | 4 |
| 18 | III | Program interlocks circuit in plc simulator. | 4 |
| 19 | IV | Simulate Conventional Heat Exchanger Control scheme in a control simulator. | 4 |
| 20 | IV | Simulate Temperature-Pressure cascade loop on steam heater in | 4 |

| S. No. | Unit | Practical Exercise (Outcomes in psychomotor domain) | Approx. Hours Required |
|---|---|---|---|
| | | a control simulator. | |
| 21 | IV | Simulate Temperature-flow cascade loop on steam heater in a control simulator. | 4 |
| 22 | IV | Simulate Temperature control in a chemical reactor in a control simulator. | 4 |
| 23 | IV | Simulate Cascade loop for temperature control of reactor in a control simulator. | 4 |
| 24 | IV | Simulate Split range control of multiple coolants of reactor in a control simulator. | 4 |
| 25 | IV | Simulate Reactor pressure control by vent throttling in a control simulator. | 4 |
| 26 | V | Simulate Distillation column pressure control by throttling condenser water in a control simulator. | 4 |
| 27 | V | Simulate Distillation column temperature control by heat control to reboiler in a control simulator. | 4 |
| 28 | V | Simulate Distillation column temperature control by reflux flow control in a control simulator. | 4 |
| 29 | V | Simulate Feed flow control scheme of Distillation column in a control simulator. | 4 |
| 30 | V | Simulate Cascade control of feed to second column in a control simulator. | 4 |
| 31 | V | Simulate column pressure control scheme in a control simulator. | 4 |
| **Total Hours** | | | **104** |

**Note:** Perform any of the practical exercises from above list for total of minimum 56 hours depending upon the availability of resources so that skills matching with the most of the outcomes of every unit are included.

## 8. SUGGESTED LIST OF STUDENT ACTIVITIES:

i Present a seminar on any one technical topic.
ii Set up practical apparatus on their own during practical under the guidance of faculty.
iii Debate on merits and demerits of current industrial control scheme.
iv Prepare a poster on any one topic from curriculum.

## 9. SPECIAL INSTRUCTIONAL STRATEGIES (If any):

i Display animation videos of industrial loops.
ii Arrange visit to nearby industry to observe real-time loops.
iii Facilitate the students to set up practical apparatus on their own.
iv 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.
v Arrange expert lectures of instrumentation engineers working in process industries.

## 10. SUGGESTED LEARNING RESOURCES

### A.) Books

| Sr No. | Title of Book | Author | Publication |
|---|---|---|---|
| 1 | Instrument Engineers Handbook | Bela G Liptak | Chilton book company, Radnor, Pennsylvania,3rd edition |
| 2 | Applied Instrumentation in the process industries | W G Andrews, H B Williams | Gulf Publishing Company. |
| 3 | Chemical Process Industries | R N Shreeve | McGraw-Hill, 3rd edition |
| 4 | Chemical Engineering | Dryden | |

### B.) Major Equipment/Instruments:

i Control Valve
ii Compressor
iii Multimeter
iv Current Source
v Voltage Source,
vi Different types of pressure measuring instruments, Different types of flow measuring instruments,Different types of temperature measuring instruments, Different types of level measuring instruments,
vii Chemical reactor model,
viii distillation column model,
ix Heat exchanger model.

### C.) Software/Learning Websites

i books.google.co.in
ii en.wikipedia.org
iii www.britannica.com

## 11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

**Faculty Members from Polytechnics**

- **Prof. R J Dhruv**, Sr. Lecturer (I/C HOD) in IC, AVPTI, Rajkot
- **Prof. R. P. Raiyani**, I/C HOD, Christ Polytechnic Institute, Rajkot
- **Prof. (Smt.) S K Raval**, Lecturer in IC, Government Polytechnic, Ahmedabad
- **Prof. M J Dehlvi**, Lecturer in IC , Government Polytechnic, Gandhinagar

**Coordinator and Faculty Member from NITTTR Bhopal**

- **Dr. Joshua Earnest,** Professor, Department of Electrical and Electronics Engineering
- **Dr Shashi Kant Gupta**, Professor and Coordinator for State of Gujarat