

# GUJARAT TECHNOLOGICAL UNIVERSITY

## INSTRUMENTATION & CONTROL ENGINEERING (17)

### CONTROL SYSTEM COMPONENTS

**SUBJECT CODE:** 2151704

B.E. 5<sup>th</sup> SEMESTER

**Type of course:** Core (Compulsory)

**Prerequisite:** Basic principles and laws of physics

**Rationale:** Today, plants are being built using the latest available electronic hardware, computer controls and advanced control concept; others are built with appropriate hardware for future conversion to computer control; and still others are built with conventional hardware (pneumatic or electronic) that would require, expensive modifications to convert to computer to control. Students of instrumentation & control engineering should understand the working, lay out and other aspects of equipment/system widely used in industries.

#### Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P		Theory Marks			Practical Marks			
			ESE (E)	PA (M)		ESE (V)		PA (I)		
PA	ALA	ESE		OEP						
4	0	2	6	70	20	10	20	10	20	150

#### Content:

Sr. No.	Content	Total Hrs	% Weightage
<b>1</b>	<b>BASICS OF INSTRUMENTATION :</b> -Introduction -Instrument symbols & Tag numbering system -Organization of instrumentation dept.	<b>04</b>	8
<b>2</b>	<b>CONTROL CENTERS &amp; PANELS</b> - Electric Power Systems, Instrument Power Requirements, Instrument Power Distribution, Control Room Lighting, Communication Systems, Electrical Classifications, - Control Panel Types, Flat face Panels, Breakfront Panels, Consoles, Comparison Of Panel Types, Panel Layout, Face Layout, Rear Layout, Auxiliary Racks & Cabinets, Panel Piping & Tubing, - Air Headers, Tubing Runs, Panel Wiring, Nameplates & Tags, Painting, Graphic Displays - Control Room Layout Panel, Human engineering, Panel enclosure standard - Bid Specifications, Panel Inspections, Control center inspection	<b>08</b>	16
<b>3</b>	<b>INSTRUMENT AIR SYSTEM</b> - Sizing criteria, pressure level, air supply source, - Compressor systems, positive displacement compressors, dynamic compressors, non lubricated compressor, compressor cooling, compressor control	<b>08</b>	16

	- Oil removal, general considerations, refrigeration type, necessity for dryers, desiccant type - Design guideline criteria, distribution systems, general layout, Header & branch sizing, materials, take off & valving, control room air supply, case purging for electrical area classification.		
<b>4</b>	<b>CONTROL VALVES</b> - Valve Terminology, Valve Capacity, Valve rangeability, - Valve type based on body Design: Globe Bodies, Angle, Needle, Ball, Eccentric Rotating, Plug, Butterfly, Diaphragm, Pinch, Drag - Flow Characteristic, Trim Design, Mechanical Feature - Actuator, Pneumatic Types, Electric Types, Electro Hydraulic Types - Positioner- Pneumatic, Electro Pneumatic, Positioner Features & accessories, - Control Valve Accessories. - Testing procedure of control valve - CV and Rangeability (Valve sizing- initial level)  <b>PRESSURE RELIEVING DEVICES</b> - Relief valve, Safety valves and Rupture discs	<b>12</b>	22
<b>5</b>	<b>SAFETY AND PROTECTIVE DEVICES IN INSTRUMENTATION:</b> -Hazardous area and Classification, -Protection methods - Purging, Explosion proof, Intrinsic safe instrumentation	<b>06</b>	11
<b>6</b>	<b>SIGNAL CONVERTING ELEMENTS :</b> - Pneumatic to electrical convertors, Electric to Pneumatic convertors, Voltage to Current convertor, Current to Voltage convertor, Frequency to voltage & Voltage to Frequency convertor	<b>06</b>	11
<b>7</b>	<b>INDICATOR RECORDERS AND ANNUNCIATORS :</b> -Indicators :Types of Indicators for various applications -Recorders : Types of recorders and It's merits and demerits, -Annunciators: Function ,sequences displays , types, - Microprocessor for recording, announcing and indicating purpose.	<b>04</b>	8
<b>8</b>	<b>TRANSMITTER:</b> -Pneumatic Transmitter- Force balance & Motion Balance -Electronic Transmitter- 2- wire & 4-wire system - Smart Transmitter	<b>04</b>	8

**Suggested Specification table with Marks (Theory):**

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level
<b>21</b>	<b>21</b>	<b>21</b>	<b>7</b>	-	-

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create 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.

## Reference Books:

- (1) William Andrews: Applied Instrumentation in Process Industry Vol. I & II, Gulf Book Co.P. (1994).
- (2) B. G. Liptak: Process Control, Instrumentation Engineering hand book , Chilton Book Company, 3<sup>rd</sup> edition,
- (3) Curtis Johnson, "Process Control and Instrumentation Technology, Prentice-Hall of India Fourth ed., 1997
- (4) E.O. Doebelin, "Measurement Systems", McGraw Hill, Fourth ed., 1990

## Course Outcome:

- (1) After learning the course the students should be able to learn basic principles of converters, control valves, etc pressure and flow sensors.
- (2) Student should be able to configure transmitters, converters, etc
- (3) Students should be able to test and calibrate various process loop components
- (4) Students will be able to understand the scope of instrument engineers in any process industries
- (5) Students will come to know the layout, structure, protection methods, etc. for instruments and various systems.

## List of Experiments and Design based Problems (DP)/Open Ended Problem:

1. Study of Basic instrumentation symbols
2. Study of Tag numbering system
3. Study of various control panel type with their front and rear layouts
4. Study of instrument air system
5. Study of various enclosure types (NEMA standards) used for instrument system
6. Understanding of hazardous area classification and required protection method by specifying a sample product (Chemical/Petrochemical/Paper/Pulp/Sugar/Agro/Steel/Power, etc.)
7. Study of Control valve characteristics and calculating Cv for linear, quick opening and equal percentage control valve
8. Study of various part of control valves including actuators and other accessories like positioner, handwheel, etc.
9. Study of flapper-nozzle system used in pneumatic transmitter/ controllers/ indicators
10. Study of working and testing of indicators and recorders used to monitor various parameters
11. Study of alarm annunciator and its various sequences
12. Study of working and calibration of transmitters using standard calibrating device
13. Study of working principle and calibration of current to pneumatic converter
14. Study of P/I, I/V, V/I, F/V and V/F converters

**Students should be taken for at least one industrial visit of medium scale/ large scale industry to give them exposure towards the topics discussed in the subject.**

## Major Equipment:

Charts for tag numbering system and standard symbols, Relevant ISA standards, Field instruments like transmitters, Control valve trainer, Control valve with positioner and other accessories, I/P converters, Customized control panel, etc. along with standard test and calibrating devices.

## List of Open Source Software/learning website:

<http://nptel.ac.in/video.php?subjectId=108105064>

[http://www.onlinevideolecture.com/electrical-engineering/nptel-iit-kharagpur/industrial-instrumentation/?course\\_id=514](http://www.onlinevideolecture.com/electrical-engineering/nptel-iit-kharagpur/industrial-instrumentation/?course_id=514)

<https://www.isa.org>

**ACTIVE LEARNING ASSIGNMENTS:** Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.