GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3151709
Semester – V
Subject Name: PROCESS INSTRUMENTATION

Type of course: Professional Elective

Prerequisite: Control System Components, Measurement

Rationale: Process instrumentation is about the measurement of process parameters and its control. Instrumentation is a collective term for measuring instruments that are used for indicating, measuring and recording physical quantities. Instrumentation system includes control panel, valves, signal conditioners and transmitters.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**BASICS OF INSTRUMENTATION :** -Introduction -Instrument symbols & Tag numbering system -Organization of instrumentation dept.	**04**
2	**CONTROL CENTERS & PANELS** - 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	**06**
3	**INSTRUMENT AIR SYSTEM** - Sizing criteria, pressure level, air supply source, - Compressor systems, positive displacement compressors, dynamic compressors, non lubricated compressor, compressor cooling, compressor Control 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	**06**

4	**CONTROL VALVES** - 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) **PRESSURE RELEIVING DEVICES** - Relief valve, Safety valves and Rupture discs	**06**
5	**SIGNAL CONVERTING ELEMENTS :** - Pneumatic to electrical convertors, Electric to Pneumatic convertors, Voltage to Current convertor, Current to Voltage convertor, Frequency to voltage & Voltage to Frequency convertor	**04**
6	**INDICATOR RECORDERS AND ANNUNCIATORS :** -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.	**04**
7	**TRANSMITTER:** -Pneumatic Transmitter- Force balance & Motion Balance -Electronic Transmitter- 2- wire & 4-wire system - Smart Transmitter	**04**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
21	**21**	**21**	**7**	**-**	**-**

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, 3rd 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 Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Explain basic fundamentals of instrumentation and Control room design	20
CO-2	Select and employ control system components like transmitters, converters, safety valves for process loop setup	30
CO-3	Perform maintenance & calibration of final control elements and telemetry systems	15
CO-4	Identify the Plant hazards, select safety devices and apply protection methods for risk management	15
CO-5	Apply relevant concept to design and analyse the process and instrumentation diagram (P&ID) for project engineering of process plants	20

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, hand wheel 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 positioned and other accessories, I/P converters, Customized control panel, etc. along with standard test and calibrating devices.