GUJARAT TECHNOLOGICAL UNIVERSITY
B. E. SEMESTER: V
CHEMICAL ENGINEERING

Subject Name: **Instrumentation & Process Control**
Subject Code: **150504**

Teaching Scheme				Evaluation Scheme		
Theory	**Tutorial**	**Practical**	**Total**	**University Exam (Theory) (E)**	**Mid Sem Exam (Theory) (M)**	**Internal Assessment (I)**
3	0	3	6	70	30	50

Sr. No.	Course content
1.	**Introduction of Process Control :** Steady state system, Process control, Feedback control, Transient response, Proportional control, Integral control, Block diagram, Parts of control system.
2.	**Laplace Transforms:** Definition, Transforms of simple functions, Ramp functions, Sine functions, Solutions of differential equations. Inversions of transform function by partial fractions, qualitative nature of solutions, Final value and initial value theorems, Translation of transforms, Transforms of unit impulse functions, Transforms of integral.
3.	**Response of First Order Systems:** Mercury thermometer, Transient response of step functions, Sinusoidal input, Impulse functions.
4.	**Physical Examples of First Order Systems:** Liquid level, Mixing process, RC circuit, linearization.
5.	**Response of First Order System in Series:** Non-interacting system of liquid level, Generalization of several non-interacting systems in series, Interacting systems.
6.	**Second Order Systems:** Development of transfer functions, Damped vibrator, Liquid manometer, Thermometer in thermo pocket, Step response & impulse response for zeta<1, zeta>1&=1, Overshoot, Decay ratio, Rise time, Response time, Period of oscillation, Natural period of oscillation, Sinusoidal response, Transportation lag.
7.	**The Control Systems:** Block diagram, Negative and positive feedback, Servo problem v/s regulator problems, Development of block diagrams, Process measuring element, Controller, Final control

	element.
8.	**Controllers and Final Control Elements:** Control valve, Proportional controlling, On-off control, Proportional integral (PI) control, Proportional derivative (PD) control, Proportional integral derivative (PID) control, Motivation for addition of integral and derivative modes, Block diagram of chemical reactor control system.
9.	**Closed Loop Transfer Functions:** Standard block diagram symbols, Overall transfer function for single loop system, Overall transfer function for change in load, Overall transfer function for multiloop control system.
10.	**Transient Response of Simple Control Systems:** Proportional control for Set point change (Servo Problem), Proportional control for load change (Regulator Problem), Proportional integral control for load change, Proportional Integral control for set point change, Proportional control for system with measurement lag.
11.	**Stability:** Concept of stability, Definition of stability (linear system), Stability criterion, Characteristic equation, Routh test for stability, Routh array theorems of rough test, Nyquist stability criterion.
12.	**Frequency Response analysis:** Fortunate circumstances, Transportation lag, Bode diagrams, First order system, First order system in series, Graphical rules for Bode diagrams.
13.	**Controller Mechanism:** Actual v/s Ideal controller, Pneumatic controller mechanism of proportional control, PI control, PD control, PID control.
14.	Control valve characteristics.
15.	P & I Diagrams (Piping & Instrumentation diagram): Symbols, P&I Diagram of reactors, Distillation column, Shell & tube heat exchanger, etc.
16.	**Introduction of Process Measurement:** Elements of instruments, Parts of instruments, Static and dynamic characteristics.
17.	**Temperature Measurement:** Scales, Expansion thermometers like constant volume gas, Mercury in glass, Bimetallic, Filled system thermometer like pressure spring thermometer, Static accuracy of thermometer, Response of thermometer, Dip effect in thermometer, Errors in thermometer of liquid and gas filled type like cross ambient effect, Head effect, Methods of compensation, Thermoelectric temperature measurement: Thermo couples, Laws of thermo electricity, Pyrometers: Laws of radiation, Radiation energy distribution, Radiation receiving element, Radiation pyrometer, Photo electric pyrometers, Optical pyrometers, Errors in optical pyrometers.
18.	**Pressure Measurement:** Liquid column manometer, Enlarged lag manometer, Inclined tube manometer, Ring

	manometer, Tilting U tube manometer, Bourdon gauge, Bellows, Bellows differential pressure gauge, Vacuum Measurement: Ionization gauge, Pirani vacuum gauge, Thermocouple vacuum gauge.
19.	**Liquid Level Measurement:** Direct measurement, Float and tap, Float and shaft, Hydraulic remote transmission, Bubbler system, Diaphragm & air trap system, Differential pressure manometer, Float and spring pneumatic balance, Displacement float, Magnetic float gauge.
20.	**Flow Measurement:** Head flow meter, Orifice plate, Flow nozzle, Venturi tube pitot tube, Differential pressure meter, Electric type head flow meter, Bellows type meter, Rotameter, Piston type area meter, Positive displacement meter.

Practical and Term Work:

Experiments based on the above topics.

Reference Books:

1. "Process System Analysis & Control", Coughanower and Kappel, Mc-Graw Hill Book Company.
2. "Process Control", A. Pollard, Hoinemanm Educational Books London.
3. "Industrial Instrumentation", Donald .P. Eckman, John Wiley & Sons Inc, New York.
4. Automatic Process Control", Donald .P. Eckman.
5. Applied Instrumentation for process industries (Gulf Published company Vol.- 1,2,3,4 by W.C. Andrews.