

GUJARAT TECHNOLOGICAL UNIVERSITY

B. E. SEMESTER: VI

Bio-Technology

Subject Name: **Instrumentation and Process Control**

Subject Code: **160404**

Teaching Scheme				Evaluation Scheme		
Theory	Tutorial	Practical	Total	University Exam (Theory) (E)	Mid Sem Exam (Theory) (M)	Practical (I)
4	0	3	7	70	30	50

Process Control:

Sr. No	Course Content	Total Hrs.
1.	Introduction : Steady State System Process Control Feedback control, transient response, proportional control. Integral control, block diagram, parts of control system.	2
2.	Laplace Transforms: Definition, transform of simple functions, ramp functions, sine function, solutions of differential equations. Inversion of transform function Final value and initial value of theorems, translation of transforms of unit impulse functions, transforms of integral.	5
3.	Response of First Order Systems : Mercury thermometer, transient response of step functions sinusoidal input, impulse functions.	5
4.	Physical examples of first order systems : Liquid level, mixing process RC circuit, linearization.	4
5.	Response of first order system in series : Non interacting system of liquid level generalization of several non-interacting systems in series, interacting systems.	1
6.	Second order systems : Development of transfer functions, damped vibrator, liquid manometer, Thermometer in thermo pocket, step response of $e < 1$, $e > 1$, $e = 1$, Overshoot decay ratio rise time response time, period of oscillation, natural period of oscillation, impulse response, impulse response for $e < 1$, $e > 1$, $e = 1$, sinusoidal response, transportation lag.	4

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.	3
8.	Controllers and final control elements : Control valve, proportional controlling, on off control, proportional integral (PI) control, proportional derivative (PD) control, proportion for addition of integral and derivative modes, block diagram of chemical reactor control system.	5
9.	Closed loop transfer functions : Standard block diagram symbols, overall transfer function for change in load, overall transfer function for multiloop control system.	3
10.	Transient response of simple control systems : Proportional control for Set point change (Servo Problem), Proportional integral 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.	5
11.	Stability : Concept of stability, definition of stability (linear system), stability criterion characteristic equation, Routh test for stability, Routh array theorems of Routh test, Nnyquist stability criterion.	4
12.	Frequency response analysis : Fortunate circumstance transportation lag, bode diagrams, first order system first order system in series, graphical rules for Bode diagrams.	4
13.	Control system design by frequency response : Tank temperature control systems, Bode stability criterion, ziegler Nicholas controller settings, transient response phase margin, magnitude ratio, phase shift open loop bode diagrams of various. Controllers	4
14.	Controller Mechanism : Actual v/s Ideal controller, electrical controller mechanism PI, PD & PID controllers phase angle plots, integral controllers, pneumatic controller mechanism, analysis, PI control, PD control, PID control, relay, bellows, hydraulic controller mechanism, hydraulic integral controller hydraulic power supply, hydraulic proportional integral control.	2

15.	Setting of different modes of controllers : Frequency response Bode plots controller Tuning based on Bode plots Nyquist diagram , Root locus method Reaction curve method Reaction curve method Search techniques.	1
16.	Final control element : Pneumatic actuators, Electro pneumatic valve control valve characteristics, linear type non-linear of decreasing sensitivity and equal percentage type control valve characteristics linear percentage type control valve .	1
17.	Control of complex processes : Control of distillation tower interaction of control system choice of different modes of control, cascade control feed forward control combined feed forward feedback system dead time compensation control of heat exchanger.	1

Process Measurement:

Sr. No	Course Content	Total Hrs.
1.	Introduction : Elements of Instruments, Parts of Instruments, static and dynamic characteristics.	0.5
2.	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 admittent effect head effect, method of compensation Thermoelectric temp. measurement: Thermocouples laws of thermoelectricity material of construction of lead circuit for various measurement situations null potentiometer circuit for Various measurement situations null potentiometer circuit. Resistance thermometer: materials for bulb circuits, null bridge deflection resistance thermometers, optical pyrometers errors in optical pyrometers.	2
3.	Pressure Measurement : Liquid column manometer enlarged lag manometer well manometer inclined tube manometer bellows diagram pressure elements bell differential pressure gauge slack and corrugated diaphragm liquid seals, volumetric seals, steam gauge syphon, purge systems. Vacuum Measurement: Ionization gauge, large bulb mcLeod gauge, pirani vacuum gauge, thermocouple vacuum gauge, installation of pressure measuring instruments.	2

4.	Liquid level measurement: Direct measurement, float and tap, float and shaft, hydraulic remote transmission, bubbler system, diaphragm system, air trap system, differential pressure manometer, float and spring, pneumatic balance, displacement float, magnetic float gauge, sonic type detector, nuclear radiation detector, oscillator type detector, electrode, system, photo electric cell system, measurement of solid, fixed point devices.	2
5.	Flow measurement: Head flow meter, orifice plate, installation and orientation of head flow meter, flow nozzle, venturi tube, differential pressure meter, electric type head flow meter, bellows type meter, rotameter, piston type area meter, positive displacement meter, design, installation and calculation of orifice plate, velocity approach factor, flow meters for corrosive fluid, mutating piston meter, dallatube meter, gas flow meter, weirs and flames, electromagnetic flow meter.	1
6.	Density Measurement: Liquid level method, displacement meters, hydrometer.	0.5
7.	Viscosity measurement: Viscosity meter, continuous viscosity meters, capillary type viscometers, rotating bowl type viscometer.	0.5
8.	Humidity measurement: Psychometer method, wet bulb and dry bulb thermometer, hygrometer method, dead point method, electrolytic water analyzer.	0.5
9.	pH Measurement: electrode for pH measurement, calomel reference electrode, measuring circuits.	0.5
10.	Gas analysis: Thermal conductivity cell, resistance bridge, chromatography, paramagnetic oxygen analyzer, chemical adsorption type infra red adsorption type chromatography.	0.5

Practical and Term Work:

Instrumentation and Process Control favors Experiments based on the above topics for Study of response of first order system second order system Integral controller differential pressure cell. Calibration of flow measuring Temperature measuring, pressure measuring instruments. Experiments based on gas analyzers like chromatograph measurement of density viscosity humidity pH etc. Study of two position control U tube manometer.

Text Books:

[A]Process Control

1. “ Process System Analysis & Control” , Coughanower And Keppel, Mcgraw Hill Book Company

[B]Process Measurement

2. “ Industrial Instrumentation”, Donald Eeckman , John Wiley & Sons Inc. New York.

Reference Books:

1. “Automatic Process Control” Donald Eeckman
2. “Instrumentation” Kerk And Pimbai
3. “Automatic Process Control For Chemical Engineers” Norman H. Ceaglske.
4. “ Process Control” A. Pollard, Hoinemanm Education Books London