GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3151705
Semester – V
Subject Name: PROCESS CONTROL

Type of course: Professional Core

Prerequisite: Process Instrumentation, Control Theory, Mathematical Modeling,

Rationale: Process control deals with the science of maintaining the output of a specific process within a desired range. Process control is commonly used for mass production. Due to its precise nature, it enables the automation of industrial processes

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.	TOPIC	HRS
1.	**INTRODUCTION** Introduction to Process Control. Control objectives, servo regulatory control, and classification of process variables.	**2**
2.	**MODELING OF SOME CHEMICAL PROCESS SYSTEMS** Modeling basics, Degree Of Freedom, Mass Balance, Energy Balance equations, linearization of nonlinear systems, Modeling of Level Tank System, Continuous Stirred Tank Heater, Continuous Stirred Tank Reactor, Transfer function.	**6**
3.	**ELEMENTS OF PROCESS CONTROL** Dead time, Interacting and non-interacting systems, self-regulation, inverse response, capacity of process, integrating systems, multi-capacity process.	**4**
4.	**PROCESS IDENTIFICATION** Dynamic behavior of first and second order processes, Obtaining First Order Plus Time Delay (FOPTD) model with Process Reaction curve. Obtaining second order model of processes.	**4**
5.	**COMMON CONTROLLER MODES** Controller Modes, ON OFF, Multi position, time proportional controller, Theory Proportional, Integral and Derivative modes, PI, PD, PID Controller, Electronics Controller implementation,	**8**

	Dynamic Behavior of closed loop systems with P, I, D , PI , PID modes.	
6.	**DISCRETISATION AND IPLEMENTATION ISSUES** Discrete time control mode realization. Velocity and Position algorithm of PID control. Integral windup, anti-windup systems, controller bias, bumps less transfer.	**4**
7.	**TUNING OF CONTROLLERS** Application and tuning, ZN Tuning (Open loop and Closed loop), Performance criteria, Integral criteria,	**4**
8.	**SOME ADVANCE CONTROL TECHNIQUES** Cascade Control, Feed forward Control, ratio Control, Air Fuel Ratio Control for Drum Boilers. Level Control in Drum Boiler, Shrinking and Swelling, Inverse response of Drum Boiler.	**4**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
21	**14**	**14**	**14**	**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.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the need of process control, basic principles of various manufacturing processes and apply engineering knowledge to do problem analysis in process control.	30
CO-2	Define common dynamics of processes found in many industries and model them mathematically.	15
CO-3	Select the proper controller and apply the tuning rules to achieve optimum performance	15
CO-4	Understand , interpret and implement tuning of the controllers using various methods and study about digital controllers	25
CO-5	Select advanced control strategy to enhance the performance	15

Reference Books:

Text Books:

1. G. Stephanopolous, "Chemical Process Control An Introduction to Theory and Practice", Prentice Hall India, August 2000.
2. Surekha Bhanot, "Process Control Principles and Applications", Oxford, 2008 3. C.D. Johnson, "Process Control Instrumentation Technology", Prentice Hall India.
4. Thomas Marlin, "Process Control Designing Processes and Control for Dynamic Performance", Tata MC Graw Hill, 2012.
5. F.G. Shinskey, "Process Control Systems Application Design and Adjustment" 3rd editionn, McGraw Hill International,
6. D. E. Seborg, T.F. Edgar, D. A. Mellichamp, "Process Dynamics and Control", Wiley, 2004

List of Experiments: (Outlines)

1. Introduction to Matlab/Scilab
2. To find Unit step, ramp, impulse response of first and second order system using MATLAB/Scilab.
3. To implement the ON OFF control with op-amp or other equivalent circuits.
4. Software implementation of On OFF controller using 8051 or equivalent.
5. Understanding FOPTD and SOPTD modeling of systems with MATLAB or SCILAB.
6. Implementation of PI controller with op-amp or other equivalent circuit.
7. Implementation of PID controller with op-amp or other equivalent circuit.
8. To study ZN tuning for a given plant/system with MATLAB or SCILAB.
9. Hardware implementation of closed loop systems with any control system trainer.
10. Implementation of P, PI, PID algorithm with microcontrollers like 8051.
11. Implementation of Cascade Control System.
12. Implementation of feed forward control
13. Implementation of Ratio control
14. Study of industrial grade single loop controller (specifications, configuration, testing, calibration)

Design based Problems (DP)/ Open Ended Problem:

To develop a simple control loop for a system using microcontroller or hardware circuit e.g. on off control of heaters/temperature control systems, displaying of the variables on computer screens or LCD screens etc.

Major Equipment:

MATLAB/SCILAB software/control loop trainer, PROTEUS, KEIL or equivalent.