GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering
Subject Code: 3723009
Semester – II
Subject Name: Advanced Process Control

Type of course: Chemical Engineering

Prerequisite: Basics of Process Control at undergraduate level.

Rationale: Advanced process control is concerned with the usage of techniques for control of digital systems, systems operating under constraints, optimal control that takes into account control efforts and control of multivariate processes.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Topics	Teaching Hrs.
1	**Introduction:** Laplace Transforms. Review of dynamic behavior of linear systems. Linearization. Transportation lag. Control system design for linear closed loop systems. Studies on system stability.	4
2	**Analysis and Design of Advanced Control Systems:** Compensatory control system, Feedback control of systems with large dead time. Dead time compensation. Control system with inverse response. Multiple loop control systems- Cascade control, Selective control system, Split range control system. Feedforward control, Ratio control, Feedforward-Feedback control, Adaptive control, Inferential Control.	20
3	**Discrete- Time control systems**: Sampling and Z- transforms. Inversion of Z-Transform. Hold elements. Laplace transform of the impulse-modulated function. General conditions for stability. Open-Loop and Closed-Loop response, Stability analysis of discrete-time control systems.	10
4	**Multiple-Input, Multiple-Output (MIMO) Systems:** Introduction to MIMO systems, Design questions for MIMO control systems, Degrees of freedom and number of controlled and manipulated variables, Generation of alternative loop configurations, Extension to interacting systems.	8
5	**Analysis of Nonlinear Control Systems:** Examples of nonlinear Systems, Methods of Phase-Plane analysis.	7
6	**Design of control systems for complete plant:** Case Studies	5

Reference Books:

1. Chemical Process Control: George Stephanopoulos, Prentice Hall India Pvt. Ltd.
2. Process Systems Analysis and Control: Donald Coughanowr, McGraw-Hill, Inc.
3. Process Control and Instrumentation: Prof. R. P. Vyas, Central Techno Publications, Nagpur
4. Process Dynamics and Control: D. E. Seborg, T. F. Edgar, D. A. Mellichamp, Wiley.

5. Control System Design: Graham C. Goodwin, Stefan F. Graebe, Mario E. Salgado, Prentice Hall

Course Outcome:

Sr. No.	CO statement	Marks % weightage
CO-1	Analyze and design advanced control systems. Linear and non-linear systems	
CO-2	Understand industrial applications of control theory.	
CO-3	Learn the complex control techniques.	
CO-4	Identify, formulate and solve problems for control system design of complete chemical plant.	

List of Experiments:

1. Determination of response/behavior of linear control systems.
2. Dynamic behavior of a Pneumatic control valve
3. Temperature control using PID controller
4. Flow control using PID controller
5. Cascade control using PID controller
6. Level control using PID controller
7. Characterization of a control valve
8. Tuning of controller parameters
9. Dynamics of higher order systems
10. Minor course projects

Major Equipments:

1. Pneumatic Control Valve
2. PID controllers
3. Control trainers
4. MATLAB/SCILAB

List of Open Source Software/learning website:

1. NPTEL lecture series
2. Literature available on Process Control
3. MIT Open course lecture on Process Control