



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: Post Graduate Degree

Branch: Chemical Engineer

Course/Subject Code: ME01030051

Course/Subject Name: Advanced Process Control

W.E.F.Academic Year:	A.Y. 2024-25
Semester:	1 st Semester
Category of the Course:	PEC

Prerequisite:	Undergraduate-level Process Control course Strong foundation in mathematics (calculus, linear algebra, differential equations) Basic knowledge of control systems theory
Rationale:	This course explores advanced concepts and methodologies in process control, focusing on the design, analysis, and implementation of control systems for complex industrial processes. The first part of this subject deals with the fundamentals of process control and the Z-transform which is a powerful mathematical tool used in the analysis and design of discrete-time control systems. The second part emphasize on Feedback and Advanced Control systems. The third part introduces the Multiple-Input, Multiple-Output (MIMO) system and some case studies explaining the design of control systems for complete plants.

Course Outcome:

After Completion of the Course, Student will be able to:

No.	Course Outcomes
01	Understand the industrial application of control system.
02	Learn and apply the complex control techniques in chemical process.
03	Design linear and nonlinear advanced control system.
04	Solve problem for control system design of complete chemical plant.

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+(PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR		C	Theory		Tutorial/ Practical	
			ESE (E)		PA/ CA (M)	PA/CA(I)	ESE (V)	
3	0	2	4	70	30	20	30	150



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Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	Review of Classical Control Concepts: Review of Laplace Transform and Transfer Functions, Stability Analysis, Frequency Domain Analysis, PID Control and Tuning Methods.	4	15
2.	Introduction to Advanced Control concepts: Compensatory control system, Feedback control of systems with large dead-time. Deadtime compensation. Control system with inverse response. Multiple loop control systems- Cascade control, Selective control system, Split range control system. Feed forward control, Ratio control, Feed forward-Feedback control, Adaptive control, Inferential Control.	15	25
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	25
4.	Multiple-Input, Multiple-Output(MIMO) Systems: Introduction to MIMO systems, Design equations for MIMO control systems, Degrees of freedom and number of controlled and manipulated variables, Generation of alternative loop configurations, Extension to interacting systems.	6	15
5.	Analysis of Nonlinear Control Systems: Examples of nonlinear Systems, Methods of Phase-Plane analysis.	5	10
6.	Design of control systems for complete plant: Case Studies	5	10
	Total	45	100

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
7	21	28	07	03	04

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)



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References/Suggested Learning Resources:

(a) Books:

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

(b) Open-source software and website:

1. Students can refer to video lectures available on the websites including NPTEL lecture series.
2. Students can refer to the CDs available with some reference books for the solution of problems using software's/spreadsheets. Students can develop their own programs/spreadsheets for the solution of problems.
3. MIT Open course lecture on Process Control

Suggested Course Practical List: List of Laboratory experiments:

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

List of Laboratory/ Learning Resources Required:

1. Pneumatic control valve
2. Instruments for measurement of level, Temperature and Pressure



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3. PID control Trainer with SCADA Software
4. MATLAB/SCILAB

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