GUJARAT TECHNOLOGICAL UNIVERSITY

B. E. SEMESTER: VI

Instrumentation and Control Engineering

Subject Name: **Process Control**
Subject Code: **161702**

Teaching Scheme				Evaluation Scheme		
Theory	**Tutorial**	**Practical**	**Total**	**University Exam (Theory) (E)**	**Mid Sem Exam (Theory) (M)**	**Practical (I)**
4	0	2	6	70	30	50

Sr. No	Course Content	Total Hrs.
1.	**Introduction:** Introduction to Process Control, Control objectives and benefits	4
2.	**Process Dynamics:** **Mathematical Modeling Principles:** Modeling procedure, linearization, Numerical solution of ordinary differential equations (ODE), operating point **Modeling and Analysis for Process Control:** Input-output models and Transfer function, Block diagram, Frequency response **Dynamic behavior of typical processes:** Basic system elements, series structure of simple systems, parallel structure of simple systems, recycle structure, staged processes, multi-input multi-output systems.	8
3.	**The feedback loop:** Process and instrument elements of the feedback loop, block diagram, control performance measures for common input changes, selection of variables for control, approaches to process control	4
4.	**Controller Principles:** **Process characteristics:** Process equation, process load, process lag, self-regulation	8

	Control System Parameters: Error, variable range, control parameter range, control lag, dead time, cycling, classification of controller modes **Discontinuous Controller Modes:** Two position mode, multi-position mode, floating control mode **Continuous Controller Modes:** Proportional control mode, integral control mode, derivative control mode **Composite Control Modes:** Proportional – Integral (PI) control, Proportional – Derivative (PD) control, Proportional – Integral – Derivative (PID) control, Special terminology (proportional band, repeats per minute, rate gain, direct action, reverse action)	
5.	**PID Algorithm:** • Desired features of a feedback control algorithms, • Proportional mode, integral mode, derivative mode, The PID controller, • Analytic expression for a closed-loop response, importance of the PID controller	6
6.	**PID Controller Tuning for Dynamic Performance:** Introduction, Factors in Controller Tuning, Determining Tuning Constants that Give Good Control Performance, Correlation for Tuning Constants, Fine-tuning the Controller Tuning Constants	5
7.	**Stability Analysis and Controller Tuning:** • Introduction, The Concept of Stability, • Stability of Linear System, Stability analysis of linear and linearized systems, stability analysis of control systems: principles, • stability analysis of control systems: the bode method, Controller tuning based on tuning: Zigler – Nichols Closed Loop Method, Controller tuning and stability important interpretation, Zigler – Nichols Open loop method (reaction curve method), summary of other tuning methods.	8

8.	**Cascade Control:** • Introduction, An Example of Cascade Control, • Cascade Design Criteria, Cascade Performance, Controller Algorithm and Tuning, Implementation Issues.	4
9.	**Feedforward Control:** • Introduction, An Example of Feedforward Control, • Feedforward Design Criteria, Feedforward Performance, Controller Algorithm and Tuning, Implementation Issues	4
10.	**Various Control Schemes:** **Ratio Control:** Ratio control, two alternatives, ratio station, applications **Selective and Override Control:** motivation, block diagram, operation, applications **Split Range Control:** motivation, block diagram, operation, applications	5

Text Books:

1. Process Control: Designing Processes and Control for Dynamic Performance by Thomas E. Marlin; Pub: McGraw – Hill, International Edition
2. Process Control: Modeling, Design and Simulation by B. Wayne Bequette; Pub: Prentice – Hall India
3. Process Control Instrumentation Technology by C. D. Johnson; Pub: Prentice – Hall India
4. Instrument Engineers' Handbook (Vol. – II) by B. G. Liptak; Pub: CRC Press

Reference Books:

1. Process Dynamics and Control by Dale E. Seborg, Thomas F. Edger, Duncan A. Mellichamp, Pub: Wiley India
2. Process Control Systems: Application, Design, and Tuning by F. G. Shinskey, Pub: McGraw Hill International Edition
3. Process Control: Principles and Applications by Surekha Bhanot, Pub: Oxford University Press
4. Process Control by Peter Harriot, Pub: Tata - McGraw Hill
5. Principles of Process Control by Patranabis, Pub: Tata - McGraw Hill