DISCIPLINE SPECIFIC CORE COURSE: Process Control Dynamics (INDSE6B)

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Process Control Dynamics (INDSE6B)	04	03	-	01	Class XII passed with Physics + Mathematics/ Applied Mathematics+ Chemistry / Computer Science/Informatics Practices	Control Systems and Mathematics

Learning Objectives

The Learning Objectives of this course are as follows:

- To study about the importance and application of good instrumentation system for the efficient design of process control loops for process engineering plants
- To teach students about the basic elements of process control including analysis, tuning and design of the control system using tools of differential equations and transfer functions, with the specific focus on PID control strategy
- To help students understand and discuss about the major issues in the control applications in chemical engineering processes with specific attention to reactor and distillation units
- To study additional techniques of frequency response for robust design based on stability margins. Also, to explore other advanced control strategies currently used in the process industries

Learning outcomes

The Learning Outcomes of this course are as follows:

- Understand the importance and application of good instrumentation system for the efficient design of process control loops for process engineering plants
- Know about the basic elements of process control including analysis, tuning and design of the control system using tools of differential equations and transfer functions, with the specific focus on PID control strategy

- Interpret the major issues in the control applications in chemical engineering processes with specific attention to reactor and distillation units
- Understand additional techniques of frequency response for robust design based on stability margins. Also, to explore other advanced control strategies currently used in the process industries

SYLLABUS OF DSE

UNIT – 1 **(12 hours)**

Introduction: Dynamics of Processes, Dead time processes, Inverse response behaviour of processes, Dynamic Behaviour of first and second order systems. Interacting and non-interacting Systems. Batch & Continuous Process, concept of self-regulation, Controller Principle, discontinuous, continuous and composite controller modes/actions (P, I, D, PI, PD and PID), Pneumatic, Hydraulic, Electronic controllers. Need for controller tuning.

UNIT – 2 **(11 hours)**

Controls: Cascade control, Selective control, Ratio Control, Split range control, feed forward control, Feed forward combined with feedback control, Inferential Control, dead time and inverse response compensators, selective control, Adaptive control, Examples from Distillation columns, Chemical Reactors, Heat Exchangers and Boiler.

UNIT – 3 **(11 hours)**

Discrete-State process control: Variables, process specification and event sequence description, Sampling and reconstruction, Transform analysis of sampled-data systems: z transform and its evaluation, inverse z transform, pulse transfer function, stability analysis in z-plane, implementation of digital controller. PLC Block Diagram, Scan cycle, memory organization, addressing, programming.

UNIT – 4 **(11 hours)**

Converters and Actuators: I/P, P/I converters, Final control elements, Pneumatic and electric actuators. Types of control valves, Valve positioner and its importance, Inherent and Installed characteristics of control valves.

Practical component: **(30 hours)**

1. Study of PID controller response and it‟s tuning
2. Study of ON-OFF and Proportional controller responses on temperature loop.
3. Analysis of Flow loop/Level loop/Temperature loop/Pressure loop.
4. Tuning of controllers on a pressure loop.
5. Control valve characteristics with and without positioner.
6. Study of cascade control
7. Study of ratio control/selective control
8. Study of feed forward control

9. Study of pneumatic/ hydraulic controllers
10. Problem solving/Ladder Programming in PLC.

Essential/recommended readings

1. Eckman. D.P, Automatic Process Control, Wiley Eastern Ltd., New Delhi, 1993, Original Edition.
2. Johnson C.D., Process Control Instrument Technology, Prentice Hall Inc. 1988, 7th Edition.
3. Bequette B. W., Process Control Modelling, Design and Simulation, PHI Learning, Original Edition.
4. Ogata K., Discrete Time Control Systems, Pearson Education, 2nd Edition.
5. Kuo B. C. , "Automatic control system", Prentice Hall of India, 2010, 9th Edition.
6. Nagrath I. J. and Gopal M., Control System Engineering, New Age International,2021, 7th Edition.
7. Stephanopoulis G., Chemical Process Control, Prentice Hall of India, New Delhi, 1990, Original Edition.
8. Liptak B.G., Instrument Engineers Handbook, Process Control, Chilton Book Company, 3rd Edition.

Suggestive readings

1. Harriott P., Process Control, Tata McGraw Hill, Edition 1972.
2. Anderson N.A., Instrumentation for Process Measurement and Control, Chilton company 1980, 3rd Edition.
3. Pollard A., Process Control, Heinemann educational books, London, 1971, Original Edition.
4. Smith C.L. and Corripio A. B., Principles and Practice of Automatic Process Control, John Wiley and Sons, New York, 2nd Edition.
5. Shinskey, Process Control Systems, McGraw Hill, Singapore, 1996, 4th Edition.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.