**Process Dynamics and Control**

**1.1** Course Number: CH342

**1.2** Contact Hours: 3-1-2 Credits: 13

**1.3** Semester-offered:3rd Year- Even

**1.4** Prerequisite: Nil

**1.5** Syllabus Committee Members: Dr Vivek Kumar, Dr Rakesh Kumar

**2. Objective:** The objective of this course is to familiarize the students with the basics of dynamical system theory and practices, and to equip them with the tools necessary for control system design and analysis.

**3. Course Content:**

Unit wise distribution of content and number of lectures

| Unit | Topics | Sub-topic | Lectures |
|---|---|---|---|
| 1 | Introduction to Process Control | Application of process control in chemical industries, Process variables, Selection of suitable control and manipulated variables, Dynamic models of representative process, Degree of freedom analysis | 5 |
| 2 | Basic elements of Dynamic analysis | Laplace Transform and their properties, Solution of ODE, Development of Transfer Functions and their properties, Linearization of nonlinear models | 4 |
| 4 | Dynamic Behavior of Open-Loop System | Response of first order system to various forcing functions, Interacting and non-interacting processes, Response of second order system to various forcing functions, Inverse Response, Poles and zeros and their effect, Processes with time delay, Approximation of higher-order systems | 8 |
| 5 | Dynamic Response of Closed-Loop System | Classification of controllers (on-off, P, PI and PID) and control strategy, Response of closed loop feedback control system, Servo and regulator problems, Offset, Selection of mode of control action | 6 |
| 6 | Stability Analysis of Feedback system | Block diagram representation, Closed-loop Transfer Functions, Stability analysis of closed | 7 |

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|---|---|---|---|
| | | loop feedback system, The characteristic equation, Routh-Hurwitz stability criterion, Root locus diagram | |
| 7 | Frequency Response Analysis and Feedback Controller | Phase margin and gain margin, Bode stability criterion, Nyquist stability criterion, PID controller design and tuning | 6 |
| 8 | Advanced Control Systems | Cascade control, Inferential control, Ratio control, Selective control etc., Introduction to MIMO systems | 4 |
| 9 | Laboratory Classes | There will be 8-10 experiment designed based on the theory covered in the lectures. | 2 hours/ week |
| | | **Total** | **Lecture: 40** |

## 4. Readings

**4.1** Text Books:

1. D.E. Seborg, T.F. Edgar, and D.A. Mellichamp, Process Dynamics and Control, 2nd Ed., John Wiley & Sons Inc., New York.
2. G. Stephanopolous, Chemical Process Control- Theory and Practice, Prentice-Hall, New Delhi

**4.2** Reference Books:

1. D.R. Coughanowr and S. E. LeBlanc, Process Systems Analysis and Control, Mc Graw Hill, III Edition.
2. B. A. Ogunnaike and W. H. Ray, Process Dynamics, Modeling and Control, Oxford University Press, New York, 1994

**5.** **Outcome of the Course:** The student will learn about Mathematical modeling of dynamic systems in general and representative chemical process in particular; Analysis of dynamic behavior of open and closed loop control system; Evaluate stability and other characteristics relevant to process control; Design a control system using feedback control techniques; get introduced to Feedforward, Cascade, and other advance control techniques.