PROCESS DYNAMICS AND CONTROL

ENCH 352

Lecture	**: 3**	**Year : III**
Tutorial	**: 1**	**Part : II**
Practical	**: 3/2**	

Course Objectives:

The objective of this course is to familiarize the students with the basics of dynamic system theory and practices, and to equip them with the tools necessary for control system design and analysis of chemical processes.

1 Introduction (4 hours)

1.1 Concept of process dynamics and control
1.2 Review of Laplace transform methods, Laplace transform of disturbances, and forcing functions
1.3 Solution of ordinary differential equations, development of transfer functions and their properties
1.4 Dynamic model building of simple systems

2 Dynamic Behavior of Open-Loop System (12 hours)

2.1 Response of first and second order system to various forcing functions (Step, pulse, impulse and ramp)
2.2 Examples of first and second order systems (Thermocouple, level tank, U-tube manometer)
2.3 Lumped and distributed parameters
2.4 Interacting and non-interacting processes
2.5 Linearization of nonlinear models
2.6 Inverse response, poles and zeros and their effect
2.7 Processes with time delay
2.8 Approximation of higher-order systems

3 Dynamic Behavior of Closed-Loop System (10 hours)

3.1 Block diagram representation of process systems, closed loop transfer functions
3.2 Classification of controllers (On-off, P, PI and PID) and control strategy
3.3 Response of closed loop feedback control system
3.4 Servo and regulator problems, offset calculation
3.5 Stability analysis of closed loop feedback systems: Characteristic equations, Routh-Hurwitz stability criterion, root locus diagram

4 Frequency Response (7 hours)

4.1 Frequency domain analysis
4.2 Control system design by frequency response
4.3 Gain and phase margin, nyquist stability criterion, bode diagram
4.4 Methods of tuning of controllers

5 Process Applications (12 hours)

5.1 Advanced control strategies: Feed forward, cascade, ratio control, adaptive and inferential control
5.2 Control valves: Types, operation, sizing, characteristics and positioner
5.3 Application to equipment such as distillation-columns, reactors
5.4 Design of control system for complete plants

Tutorial (15 hours)

1. Laplace transform of functions and solutions to ordinary differential equation
2. Numerical problems related to first and second order open loop systems
3. Stability analysis problems of closed loop feedback systems
4. Frequency response analysis and use of bode plots
5. Control system design for complete plants

Practical (22.5 hours)

1. Flow control by manual and pump speed
2. Direct and indirect control of heater temperature by varying heater power
3. Pressure controlled by pump speed and solenoid valve
4. Level control by pump speed and solenoid valve
5. Feedforward and cascade control
6. Characterization of flow properties of control valves: linear, equal percentage, and quick opening

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Mark distribution*
1	4	6
2	12	16
3	10	12
4	7	10
5	12	16
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Coughanowr, D. R., LeBlanc, S. E. (2006). Process systems analysis and control. McGraw-Hill.
2. Stephanopoulos, G. (1984). Chemical process control: Theory and practice. Prentice-Hall (Latest Edition). Prentice-Hall.
3. Seborg, D. E., Edgar, T. F., Mellichamp, D. A. (2004). Process dynamics and control. John Wiley & Sons.
4. Ogunnaike, B. A., Ray, W. H. (1994). Process dynamics, modeling, and control (Latest Edition). Oxford University Press.