Course code	Course Name	L-T-P-Credits	Year of Introduction
CH302	PROCESS DYNAMICS AND CONTROL	3-1-0-4	2016

Prerequisite: Nil

Course Objectives

- To impart the basic concepts of mathematical modeling and Laplace transforms for dynamic study
- To impart fundamentals of controls for chemical processes like block diagram development & reduction, stability analysis, tuning etc.

Syllabus

Laplace transform and its properties –dynamics of first order systems – systems in series - dynamics of second order systems –closed loop systems – block diagram – types of controllers - Transient response of simple control systems-stability analysis- Frequency response methods- Controller tuning-industrial control system

Expected Outcome

At the end of the course the students will be able to

i. determine transfer function for simple chemical process systems
ii. develop control system block diagram and reduce a given block diagram to input/output transfer function model
iii. analyze the stability of open loop and closed loop systems
iv. tune the controller

References:

1. Albert C L & Coggan D A (Ed.)., Fundamentals of Industrial Control, ISA, 1992
2. Bhgade S.S, Nageshwar G.D., Process Dynamics and Control, PHI Learning Pvt. Ltd.
3. Ceaglske N.H., Automatic Process Control for Chemical Engineers, John Wiley & Sons, NY, 1956
4. Coughanewr D.P., Process System Analysis & Control, McGraw Hill
5. Eckman D.P., Principles of Industrial Process Control, John Wiley & Sons Inc, NY (1946)
6. Harriot P., Process Control, Tata McGraw Hill
7. Stephanopoulose G., Chemical Process Control, An Introduction to Theory & Practice, Prentice Hall of India
8. Tsai T.H., Lane J.W. & Lom C.S., Modern Control Techniques for the Processing Industries, CRC Press; 1 edition (April 15, 1986)

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to process dynamics and control - definition of terms - Laplace transform - transform of simple functions - derivatives and integral - properties of Laplace transforms - final value theorem - initial value theorem - transition of transforms and functions – examples - inversion by partial fraction - solution of differential equations - qualitative nature of solutions - linear open loop systems - first order systems - mercury thermometer,	10	15%

	liquid level and mixing processes - response of these towards different types of forcing functions		
II	Systems in series - interacting and non-interacting types and generalization of results. Linear open loop second order systems - mercury thermometer in a well and manometer - impulse and step response of under damped, critically damped and over damped system, their derivation	8	15%
FIRST INTERNAL EXAMINATION			
III	Controllers - types, basic principles and transfer functions - the flapper nozzle assembly - pneumatic & electronic controllers - PID, PI and PD (derivation excluded). Closed loop system – feedback control- servo and regulator problems - block diagram development - block diagram reduction	10	15%
IV	Transient response of simple control systems - step response and offset - introduction to stability of linear systems - Routh-Hurwitz criterion for stability - root locus technique - plotting the root locus diagram - transportation lag and its effect on root locus diagram	9	15%
SECOND INTERNAL EXAMINATION			
V	Introduction to frequency response - substitution rule – Nyquist diagram, Nyquist stability criteria. Bode diagram for first order systems - first order systems in series - second order systems - bode stability criterion, gain margin and phase margin	10	20%
VI	Controller tuning- Ziegler-Nichols method - reaction curve method - comparison of closed loop responses for different controller settings. Supervisory control and data acquisition (SCADA) – distributed control system (DCS)	9	20%
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum Marks: 100 Exam Duration: 3 Hours

Part A : There shall be **Three questions** uniformly covering Modules 1 and 2, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in each main question with a total of 15 marks for all the subdivisions put together. (2 x15= 30 Marks)

Part B: There shall be **Three questions** uniformly covering Modules 3 and 4, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in each main question with a total of 15 marks for all the subdivisions put together. (2 x15= 30 Marks)

Part C: There shall be **Three questions** uniformly covering Modules 5 and 6, each carrying 20 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in eachmain question with a total of 20 marks for all the subdivisions put together. (2 x20= 40 Marks)