Birla Institute of Technology & Science, Pilani
Hyderabad Campus

SECOND SEMESTER 2021-2022

Course Handout Part II

Date: 15-01-2022

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : CHE F342
Course Title : PROCESS DYNAMICS & CONTROL
Instructor-in-Charge : JAIDEEP CHATTERJEE

Scope and Objective of the Course:

This course deals with the design of the control systems for chemical processes, using the fundamental concepts of Dynamic Analysis. The course will familiarize the student with a range of analytical and design tools used to analyze dynamic behavior and stability of processes. The course aims to help the student in the selection of the best among the several alternative control configurations possible for a given processing unit or a complete process plant. The course is intended to educate students to a level where they will be equipped to understand, analyze and ultimately design control systems for process plants of today and the future. The course will also introduce the students to the fundamental analytic tools used for process automation.

Course Description: Dynamic modeling and simulation of systems of relevance to Chemical Engineering; analysis of the dynamic behavior of such systems; analysis and design of simple feedback and advanced control loops; Classical feed-back control and estimation of controller parameters; Analytical tools for stability analysis; introduction to modern evolving control strategies.

Textbooks:

T1. Coughanowr, D.R. and Steven E LeBlanc, Process Systems Analysis and Control, 3nd Ed., McGraw-Hill, 2009.
T2. Seborg, D. E., Edgar, T. F. and Mellichamp, D.A., "Process Dynamics and Control", 2nd Ed., John Wiley and Sons, 2004.

Reference books

R1 George Stephanopoulos, Chemical Process Control: An Introduction to Theory and Practice, Prentice Hall, 1984.

Course Plan:

Lecture No.	Learning objectives	Topics to be covered	Chapter in the Text Book
1	Introduction to Process Dynamics	What is Process Dynamics with an example. Introduction to unsteady state modelling	T1-Chap 2
2-4	Laplace Transforms	Laplace Transformations, Application to several types of time functions,	T1-Chap 2
5-7	Inversion by partial fractions	Solution of differential equation using Laplace transforms and Inversion. Roots and Stability of Dynamic systems	T1-Chap 3

Lecture No.	Learning objectives	Topics to be covered	Chapter in the Text Book
8-10	Dynamic behavior of 1st order systems	Development and properties of transfer functions, linearization of non-linear models. Examples of 1st order systems.	T1-Chap. 4-5
11-13	Dynamic behavior of 1st order systems in series	Dynamic Behavior of 1st order systems in series	T1-Chap. 6
14-16	Dynamic response of higher order systems	Dynamic response of higher order systems. 2nd order systems, systems with transportation lag.	T1-Chap. 7
17-19	The Control System	Closing the Loop. Introduction to feedback control. Closed loop transfer functions	T1-Chap. 8
20-21	Control system instrumentation	Transducers, transmitters, final control elements	T1-Chap. 9
22-24	Complete Analysis of a single closed-loop control system	Complete analysis of a single chemical reaction control system by looking at all elements in the loop	T1-Chap. 10
25	Closed loop Transfer functions	Rules for obtaining the Input-output relations for set-point tracking and load rejection	T1-Chap. 11
26-28	Dynamic Response of simple control systems	Effect of process and controller parameters on transient response of a closed loop system for set-point tracking and load rejection.	T1-Chap. 12
29 – 31	Stability Analysis	Analysis of control system stability by Root Locus. Generating root locus plots and Design of Control Systems using Root Locus	T1-Chap. 13 & Chap 14
31-32	Introduction to Frequency Response	Frequency Domain Transfer functions and Bode Plots of various open loop systems	T1-Chap. 15
33-35	Control system Design by frequency Response	Use of Frequency response to determine limits for controller parameters. Gain Margin and Phase margin based determination of controller parameters.	T1-Chap. 16
36-37	Feedforward and ratio control	Ratio control, feed forward controller design based on steady state and dynamics equation, feedforward-feed-back controller	T1-Chap. 17
38-40	Advanced Control Strategies	Cascade control, time-delay compensation, Model Predictive control, adaptive control	T1-Chap. 17
41-42	Process Identification and Controller tuning	Determination of optimal controller parameters and online identification of Process Parameters	T1-Chap. 18

Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of Component
Class Test 1	50	10 %	By 01/03	OB
Mid Semester Eam	90	30 %	15/03 3.30pm to5.00pm	OB
Class Test 2	50	10 %	By 15/04	OB
Assignments (1)	1 week	10 %	By 30/04	OB
Comprehensive Exam.	120	40 %	18/05 AN	OB

Notes:

1. **Closed Book Test:** No reference material of any kind will be permitted inside the exam hall.
2. **Open Book Exam:** Use of any printed / written reference material (books and notebooks) will be permitted inside the exam hall. Use of calculators will be allowed in all exams. No exchange of any material will be allowed.

Chamber Consultation Hour: To be announced in the class.

Notices: All notices related to these courses will be displayed on the CMS system, with email to all registered students

Make-up Policy: Make-up for the Class tests may be granted only when one attends more than 50 % classes and valid justification and with prior permission from the Instructor-in-charge.

Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

JAIDEEP CHATTERJEE
INSTRUCTOR-IN-CHARGE