**SECOND SEMESTER 2023-2024**

# Course Handout Part II

Date: 09-01-2024

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 : Prof. VIKRANTH KUMAR SURASANI

**Scope and Objective of the Course:**

This course deals with the design of the control systems for chemical processes, not as a mathematical problem, but as an engineering task with all its attractive challenges and practical shortcomings using the fundamental concepts of process dynamics as the basis. The course aims to help the student in the selection of the best among the several alternative control configurations usually possible for a given processing unit or a complete plant. Finally the course will familiarize the student with a plethora of analytical tools and design methodologies to be understood before attempting the process control problems. **Course Description:** Dynamic modeling and simulation of momentum, energy, mass transfer and reacting systems; analysis of the dynamic behavior of lumped and distributed parameter systems; analysis and design of simple feedback and advanced control systems; design of control systems with multiple input and multiple output; introduction to computer control.

**Textbooks:**

1. Seborg, D. E., Edgar, T. F. and Mellichamp, D.A., “Process Dynamics and Control”, 2nd Ed., John Wiley and Sons, 2004.
2. B. Wayne Bequette, “Process Control: Modeling, Design and Simulation” Prentice-Hall. Inc

**Reference books**

1. Coughanowr, D.R., Process Systems Analysis and Control, 2nd Ed., McGraw-Hill, 1991.
2. George Stephanopoulos, Chemical Process Control: An Introduction to Theory and Practice, Prentice Hall, 1984.
3. Babu, B V and Others Chemical Engg Lab Manual Notes EDD, 2006.

**Course Plan:**

| Lecture No. | Learning objectives | Topics to be covered | Chapter in the Text Book |
| --- | --- | --- | --- |
| 1-2 | Introduction to process control | Need of process control, process control strategies, process control activities | T1-Chap 1,  T2-Chap 1 |
| 3-5 | Theoretical models of chemical process | Modeling principles, dynamic models, degrees of freedom analysis, solution of dynamic models | T1-Chap 2  T2:-Chap 2 |
| 6 | Laplace Transforms | Solution of differential equation | T1-Chap 3  T2-Chap 3 |
| 7-8 | Transfer functions | Development and properties of transfer functions, linearization of non-linear models, | T1-Chap. 4  T2-Chap. 3 |
| 9-11 | First and second order processes | Response of first and second order processes | T1-Chap. 5  T2-Chap. 3 |
| 12-14 | Dynamics response of more complicated systems | Dynamic response of higher order systems | T1-Chap. 6  T2-Chap. 3 |
| 15-16 | Development of empirical models from empirical data | Model development using non-linear regression, fitting first and second order models, neural network model, discrete time models, identification of systems | T1-Chap. 7  T2-Chap. 4 |
| 17-19 | Feedback control | Concept & type of feedback control, block diagram representation, response of it, PID controller | T1-Chap. 8  T2-Chap. 5 |
| 20 | Control system instrumentation | Transducers, transmitters, final control elements | T1-Chap. 9 |
| 21-22 | Overview of Control system design | Influence of process design on process control, degrees of freedom for process control, Selection of variables | T1-Chap. 10 |
| 23-24 | Dynamic behavior and stability of closed loop system | Closed loop representation, transfer functions, stability analysis | T1-Chap. 11  T2-Chap. 6 |
| 25-26 | PID controller design and tuning | Performance criterion, controller tuning relations | T1-Chap. 12  T2-Chap. 6 |
| 27-31 | Frequency response analysis | Bode, Nyquist, Gain and Phase margin, closed-loop frequency response, stability of closed loop system; Matlab control tool box. | T1-Chap. 14  T2-Chap. 7 |
| 32-35 | Feedforward and ratio control | Ratio control, feed forward controller design based on steady state and dynamics equation, feedforward-feed-back controller | T1-Chap. 10  T2-Chap. 15 |
| 36-39 | Enhanced single-loop control | Cascade control, time-delay compensation, inferential control, adaptive control | T1-Chap. 16  T2-Chap. 10 |

**Evaluation Scheme:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Component** | **Duration**  **(min)** | **Weightage**  **(%)** | **Date & Time** | **Nature of Component** |
| Midterm | 90 | 25% | 14/03 - 9.30 - 11.00AM | CB |
| Class Tests | -- | 15% |  | CB |
| Assignments | -- | 15% |  | OB |
| Comprehensive Exam. | 180 | 40% | 13/05 FN | 20% OB+20% CB |

**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. Computers/mobile of any kind will not be allowed inside the exam hall. Use of calculators will be allowed in all exams. No exchange of any material will be allowed.
3. The tutorial sessions will be conducted in the CAD Laboratory for accommodating **MATLAB & Simulink.**

**Chamber Consultation Hour:** To be announced in the class.

**Notices:** All notices related to these courses will be displayed on the Notice Board of Chem. Engg. Dept. or CMS

**Make-up Policy:** Make-up for the test (test-1 and test-2) may be granted only when one attends more than 80% 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.

**INSTRUCTOR-IN-CHARGE**