



**SECOND SEMESTER 2022-2023**

Course Handout Part II

Date: 16-01-2023

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 F343  
*Course Title* : Process Design Principles-II  
*Instructor-in-Charge* : Dr. Arnab Dutta  
*Instructor* : Dr. Satyapaul A. Singh

**Scope and Objective of the Course:**

Process Design Principles-II course deals with the understanding of detailed process design coupled with process economics. Cost estimation of chemical engineering processes is an important metric to assess the viability of any chemical process. The purpose of this course is to introduce the students to detailed design and economical aspects of different chemical engineering operations. The course encompasses design procedures and sizing of chemical engineering equipment, costing and profitability analysis of chemical process, and introduction to optimization concepts pertaining to chemical process. The student will also be exposed to the ASPEN software, which will be used for assisting in material and energy balance calculations, sizing and designing equipment (heat exchangers, pumps, compressors, reactors, etc.).

On completion of this course, students should be able to appreciate the following **learning outcomes**:

- Apply mass and energy balance principles to design chemical engineering equipment
- Apply the role of thermodynamics to understand the process feasibility
- Importance of solving system of linear equations, nonlinear equations, ODEs and PDEs
- Perform economic calculations for different chemical process equipment and evaluate profitability metrics of a chemical process
- Understand the concept of optimization in the context of chemical process design

**Textbooks:**

1. W. D. Seider, J. D. Seader, and D. R. Lewin, "Product & Process Design Principles: Synthesis, Analysis, and Evaluation", John Wiley & Sons, New York, 3rd Edition, I.S.V. [Reprint: 2017]

**Reference books**

1. S. B. Thakore, B. I. Bhatt, "Introduction to Process Engineering & Design", McGraw Hill Publications.
2. R. Smith, "Chemical Process: Design and integration", John Wiley & Sons, New York, 2<sup>nd</sup> Edition.
3. G. Towler, R. Sinnott, "Chemical Engineering Design", Butterworth-Heinemann Publications.
4. R. Turton, R. C. Bailie, W. B. Whiting, J. A. Shaeiwitz, D. Bhattacharyya, "Analysis, Synthesis, and Design of Chemical Processes", Prentice Hall Publications.

**Course Plan:**

<b>Lecture No.</b>	<b>Learning objectives</b>	<b>Topics to be covered</b>	<b>Chapter(s) in the Text Book</b>
1-3	Introduction to Course	Recap of process design principles learnt in PDP-1 and general introduction to the major topics of PDP-2, importance of cost estimation in chemical engineering plant design	-
4-9	Design of Heat Exchangers	Introduction, HE equipment, Heat transfer coefficients & Pressure Drop calculations, Shell & tube HE design and simulation on ASPEN	Chapter 13 TB Chapter 6 Ref 1
10-12	Process design of piping	Optimum pipe size calculation, recommended fluid velocities in pipe pressure drop in pipes, fittings and valves, fluid moving devices flow meters	Chapter 5 Ref 1
13-17	Process design of Pumps, Compressors & Expanders	Centrifugal pumps, positive displacement pumps, characteristic curves, NPSH and power requirement, pump, compressors and expanders models in ASPEN simulator	Chapter 15 TB Chapter 5 Ref 1
18-20	Process design of fluid moving devices	Process design of flow meters orifice/venturi and rotameters	Chapter 5 Ref 1
21-25	Design of Separation towers	Distillation systems: Tower diameter calculations, pressure drop principles, choosing the type of towers, shortcut methods and rigorous methods for designing towers with simulator	Chapter 19 TB Chapter 9 Ref 2 Chapter 11 Ref 3
26-30	Cost accounting, Capital costs, and Annual costs	Cost indexes, six-tenths factor, Estimation of purchase cost for chemical process equipment (heat exchangers, pumps, compressors, tower, etc.), capital cost, operating costs, revenue, and total annualized cost.	Chapter 22 & 23 TB Chapter 7 & 8 Ref 4
31-34	Profitability measures, cash flows, and depreciation	Return on investments, payback period, annualized costs, time value of money, cash flows, depreciation, net present value, investors rate of return.	Chapter 23 TB Chapter 9 & 10 Ref 4
35-40	Process optimization	Introduction, problem formulation, type of optimization problems: linear programming, mixed-integer linear programming, non-linear programming. Implementation and solving optimization problems using MS-	Chapter 24 TB Additional reference materials will be provided

		EXCEL and MATLAB.	
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### Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of Component
Mid-Term Exam	90 min	25	13/03 4.00 - 5.30PM	Open book
Comprehensive Exam	180 min	35	09/05 AN	Closed book (15%) Open book (20%)
Assignments (3)	TBA	25	TBA	Open book
Continuous Assessment	TBA	15	TBA	Open book

**Chamber Consultation Hour:** TBA

**Make-up Policy:** Make-up is granted only for genuine cases with valid justifications at the discretion of the IC. A prior permission from the IC is required. Decision of the IC will be final.

There will be NO provision for Make-up w.r.t. assignments, continuous assessments, and tutorial sessions.

**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.

*Arnab Dutta*

**Dr. Arnab Dutta**  
**Instructor-in-charge**  
**CHE F343**