Birla Institute of Technology & Science, Pilani
Hyderabad Campus

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

**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 and MATLAB.

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, nonlinear, and differential equations
- 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, 2nd 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:**

| Lecture No. | Learning objectives | Topics to be covered | Chapter(s) in the Text Book |
|---|---|---|---|
| 1-2 | 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 | - |
| 3-9 | Design of Separation towers | Distillation systems: Tower diameter calculations, pressure drop principles, choosing the type of towers, shortcut methods for designing towers | Chapter 19 TB<br>Chapter 9 Ref 2<br>Chapter 11 Ref 3 |
| 10-13 | 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 |
| 14-16 | Process design of Pumps, Compressors & Expanders | Centrifugal pumps, positive displacement pumps, characteristic curves, NPSH and power requirement, pump, compressors and expanders | Chapter 15 TB<br>Chapter 5 Ref 1 |
| 17-19 | Process design of fluid moving devices | Process design of flow meters orifice/venturi and rotameters | Chapter 5 Ref 1 |
| 20-25 | Process optimization | Introduction, problem formulation, type of optimization problems: linear programming, non–linear programming, mixed-integer linear/mom-linear programming.<br>Implementation and solving optimization problems using MS-EXCEL and MATLAB. | Chapter 24 TB<br>Additional reference materials will be provided |
| 26-31 | Design of Heat Exchangers | Introduction, HE equipment, Heat transfer coefficients & Pressure Drop calculations, Shell & tube HE design | Chapter 13 TB<br>Chapter 6 Ref 1 |
| 32-36 | 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<br>Chapter 7 & 8 Ref 4 |

| | | | |
|---|---|---|---|
| 37-40 | 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<br>Chapter 9 & 10 Ref 4 |

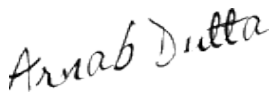
**Evaluation Scheme:**

| Component | Duration | Weightage (%) | Date & Time | Nature of Component |
|---|---|---|---|---|
| Mid-Term Exam | 90 min | 25 | 13/03 - 2.00 - 3.30PM | Open book |
| Comprehensive Exam | 180 min | 40 | 11/05 AN | Closed book (20%)<br>Open book (20%) |
| Assignments (2) | TBA | 20 | 1 before mid-term and 1 after mid-term | Open book |
| Quiz (2) | TBA | 15 | 1 before mid-term and 1 after mid-term | Closed 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 and quizzes.

**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.



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