Birla Institute of Technology & Science, Pilani
Hyderabad Campus

SECOND SEMESTER 2019-2020

Course Handout Part II

Date: 06-01-2020

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. Satyapaul A. Singh

Scope and Objective of the Course:

Process Design Principles-II course is all about coupling chemical engineering principles to the principles of economics. Cost estimation of chemical engineering processes is a key decision variable for selection and designing of chemical engineering plants. The purpose of this course is to introduce the students to the detailed design and economical aspects of chemical engineering processes and operations. After a few topics covering the detailed design procedures and sizing of chemical engineering equipment, a thorough description of costing and profitability analysis would be covered and finally optimization of flow sheets would be dealt with. ASPEN Plus software will be used for assisting in material and energy balance calculations, sizing and designing equipment (heat exchangers, pumps, compressors, towers, reactors).

At the end of the course, the student should be able to:

- Apply the known energy and mass balance principles to design the equipment
- Apply the role of thermodynamics to understand the process feasibility
- Understand importance of solving the system of linear equations, nonlinear equations, ODEs and PDEs
- Develop the process flow diagram for an industrial process and simulate using the tools available in the department

Textbooks:

1. Seider W.D., Seader J.D. & Lewin D.R., "Product and Process Design principles: Synthesis, Analysis and Evaluation", John Wiley & Sons, Inc., 2nd edition.

Reference books

1. S. B. Thakore, B. I. Bhatt, "Introduction to Process Engineering & Design", McGraw Hill Publications
2. Mc Cabe and Smith., 'Unit Operation of Chemical Engineering', McGraw Hill Publications
3. Max. Peters, K Timmerhaus and Ronal West, "Plant Design and Economics for Chemical Engineers" McGraw Hill

Course Plan:

Lecture No.	Learning objectives	Topics to be covered	Chapter 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	-
3-7	Design of Heat Exchangers	Introduction, HE equipment, Heat transfer coefficients & Pressure Drop calculations, Shell & tube HE design and simulation on ASPEN	Chap 13 TB Chap 6 Ref 1
8-10	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
11-14	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
15-16	Process design of fluid moving devices	Process design of flow meters orifice/venturi and rotameters	Chapter 5 Ref 1
17-20	Design of Separation towers (Distillation, Absorption and Extraction)	Distillation systems: Tower diameter calculations, pressure drop principles, choosing the type of towers, shortcut methods and rigorous methods for designing towers with simulator	Chapter 8, 9 Ref 1
21-23	Introduction to cost estimation, cost accounting, cost indexes Estimation of Capital Investment costs	Accounting: Debits & Credits, balance sheets, cash flow statement, cost indexes, six-tenths factor, capital investment for commodity chemicals Direct, indirect and other investment costs, estimation of capital investment using different methods.	Chapter 16 TB Chapter 6 Ref 3
24-26	Purchase costs of process Equipment	Purchase costs of pumps, fans, compressors, heat exchangers and pressure vessels, adsorption, agitators, evaporators, extractors, size reduction and solid liquid separation equipment, storage vessels and vacuum systems	Chapter 16 TB Chapter 6 Ref 3
27-29	Estimation of	Estimate cost of feedstock and utilities, waste	Chapter 17

	Annual costs and annual revenues and working capital	processing, overhead costs, depreciation to estimate total production cost, estimation of working capital and total capital investment	TB
30-32	Profitability measures, cash flows and depreciation	Return on investments, payback period, annualized costs, estimate selling price of products, time value of money, Interest rates, Compute cash flows to project net present value and investors rate of return, inflation	Chapter 17 TB Chapter 8 Ref 3
33-40	Optimization of flow sheets	Introduction, general formulation, linear programming, non –linear programming with single variable, NLP for more variables, optimization algorithms.	Chapter 18 TB
41-42	Product design	Steps involved in designing configured industrial systems like solar desalinators, fuel cells, hand warmers etc	Chapter 19 TB

Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of Component
Mid Term Exam	90 min	25	4/3 9.00 - 10.30AM	CB
Tests	20 min	10	--	CB & OB
Assignments + ASPEN Project on detailed design	Variable	15	TBA	OB
Tutorials training and report submission	50 min	10	ASPEN tool is required. Please allot the CAD lab facility for tutorials.	OB
Comprehensive Exam	3 hrs	40	06/05 AN	OB

Minimum Performance % for grading: 20%

Chamber Consultation Hour: Every Monday 4 PM (D204)

Notices: All notices/announcements will be communicated through CMS.

Make-up Policy: Make-up is granted only for genuine cases with valid justification. A prior permission from the Instructor-in- charge is required.

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. SATYAPAUL A. SINGH
INSTRUCTOR-IN-CHARGE