Birla Institute of Technology & Science, Pilani
Hyderabad Campus

FIRST SEMESTER 2019-2020

Course Handout Part II

01-08-2019

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 F314**
Course Title : **Process Design Principles I**
Instructor-in-Charge : **Dr. Satyapaul A. Singh**

Scope and Objective of the Course:

This course is designed to bring together the concepts of engineering and economics for chemical plant design and optimization. In the first part of this course in this semester (Process Design Principles I), student can learn how to combine the individual aspects of chemical engineering such as fluid mechanics, mass transfer, heat transfer, chemical reaction engineering, chemical process calculations, thermodynamics, process equipment design etc. for designing of an efficient chemical plant that may be economically feasible. The hierarchy of decisions in synthesis and analysis of a chemical process and its alternatives is initially discussed. Various stages of the chemical process design are addressed step by step such as input-output structure, material and energy balance calculations, design of separation processes and heat integration of the process (or heat exchanger network in the process).

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
- Calculate the unavailable physical properties of substances with the help of group contribution theory
- 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:

T1 – Warren D. Seider, J. D. Seader and Daniel R. Lewin, “Product & process design principles: Synthesis, analysis, and evaluation”, John Wiley & Sons, New York, 2nd Edition (2004).

Reference books:

R1 – Bruce E. Poling, J. M. Prausnitz, John Paul O'Connell, “The properties of gases and liquids”, McGraw Hill, 5th Edition (2001).
R2 – Robin Smith, “Chemical Process: Design and integration”, John Wiley & Sons, New York, 2nd Edition (2016).
R3 – H. Scott Fogler, “Elements of chemical reaction engineering”, PHI Learning Private Ltd, New Delhi, 4th Edition (2006).
R4 – Amiya K. Jana, “Process simulation and control using ASPEN”, PHI Learning Private Ltd, New Delhi, 4th Edition (2012).
R5 – Rudra Prathap, “Getting started with MATLAB: A quick introduction for scientists and engineers”, Oxford University Press, Oxford (2012).

Course Plan:

Lecture No.	Learning objectives	Topics to be covered	Chapter in the Text Book
1 – 3	The design process	Primitive design problems; Steps in designing; Environmental protection; Safety considerations	Ch.1 of T1
4 – 5	Molecular structure design	Computer databanks, Group contribution theory, microsimulations	Ch. 2 of T1 Ch. 2 of R1
6 – 9	Process creation	Preliminary data creation; Experiments; Preliminary process synthesis; Development of base-case scenario, Introduction to ASPEN	Ch.3, 4 of T1
10 – 13	Heuristics for process synthesis	Recalling the process operations in process synthesis: Chemical reaction; Mixing and recycle, Separation temperature, pressure and phase change; Task integration	Ch. 5 of T1
14 – 18	Emphasis on reactor networks	Reactor models, reactor network design	Ch. 6 of T1 Ch. 4 of R2 Ch. 4 of R3
19 – 22	Sequence of Separation Trains	Criteria for selecting the separation methods; Sequencing of ordinary distillation column for separation of near ideal fluid mixtures	Ch.7 of T1
23 – 26	Reactor-separator-recycle networks	Locating separation section with respect to the reactor section, optimal reactor conversion	Ch. 8 of T1
27 – 31	Batch processes	Batch reactors, Batch distillation, Batch crystallization, Batch heating and cooling	Ch. 16 of R2
32 – 35	Introduction to heat exchanger network synthesis	Introduction to HEN synthesis, Advanced HEN synthesis loops and splits; Threshold problems	Ch. 10 of T1 Ch. 17, 18 of R2
36 – 38	Heat & power integration	Data extraction, Heat integration in design	Ch. 10 of T1
39 – 42	Introduction to simulation tools	ASPEN/HYSYS/MATLAB, Material and energy balances using simulation tools	R4 and R5

Evaluation Scheme:

Component	Duration	Weightage (%)	Date & Time	Nature of Component
Mid exam	90 min.	25	3/10, 1.30 -- 3.00 PM	Closed Book
Comprehensive	3 hrs.	45	10/12 FN	Open Book
Assignments		10	TBA	Open Book
Tests	15 min	10		Open Book/ Closed Book
Report based on hands-on training	50 min	10	Tutorial session	Open Book

Chamber Consultation Hour: Will be announced in the classroom (Chamber: **D204**)

Notices: Will be updated in CMS

Make-up Policy: Make-up will be granted only for genuine cases with valid justification and only with prior permission of 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.

Dr. Satyapaul A. Singh

INSTRUCTOR-IN-CHARGE
CHE F314