I CHE481 Process Design and Optimization

Course Outline

- **Title:** Process Design and Optimization
- **Code number**: CHE 481
- **Semester:** 8th
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills**: CHE 471
- **Learning outcomes:**

  Upon successful completion of the course, the students will be able to

1. Review the elements and strategies of chemical process design
2. Synthesize and analyze a flowsheet using heuristics and process design principles
3. Apply cost estimation and optimization techniques to solve a process design problem

- **Contents**

Unit I: Basics of Chemical Process Design

1.1 Introduction to chemical process design

1.2 Process design considerations

Unit II: Process Flow Diagrams

2.1 Flowsheet symbols

2.2 Block flow diagrams, process flow diagrams, and piping and instrumentation diagrams

2.3 Other process diagrams: Piping isometric diagrams, pictorial diagrams, simulation diagrams, and human-machine interface (HMI) diagrams

2.3 Flowsheet drawing software such as MS Visio and draw.io

Unit III: Flowsheet Synthesis and Analysis

3.1 Guidelines for process design activity and process equipment selection

3.2 Application of process simulation software such as Aspen Plus and Aspen HYSYS in process design synthesis and evaluation

3.3 Various alternate solutions, trivial flowsheet to complex flowsheet development

Unit IV: Cost Estimation of Chemical Processes

4.1 Purchased equipment cost

4.2 Capital cost estimation

4.3 Product cost estimation

4.4 Profitability measures such as net profit, rate of return on investment, and payback period

Unit V: Chemical Process Optimization

5.1 Introduction to optimization, types of optimization, and optimization algorithms

5.2 Process optimization: Structural optimization and parametric optimization

5.3 Optimization solution strategies: Numerical examples on optimization processes such as related to optimum production rates in a plant, cyclic operations, economic pipe diameter, cooling water flowrate, distillation reflux ratio, number of fixed bed reactors in a multibed system, number of effects in a multi-effect evaporator system, etc.

Unit VI: Heat Integration and Pinch Technology

6.1 Introduction to heat integration in a process plant
6.2 Graphical solution for finding pinch point and minimum hot and cold utility requirements
6.3 Table algorithm approach for finding pinch point and minimum hot and cold utility requirements
6.4 Heat exchanger network (HEN) design

- **Teaching-learning Strategies**

1. Lectures by the instructor for clear explanations of the subject matter
2. Problem solving in groups under the instructor's supervision
3. Use of slides, writing screen, software, and videos for teaching augmentation
4. Reading material to students: Slides, hand-outs, and homework problems

Lectures: 3 hours per week

- **Assignments- Types and Number with Calendar**

One or more assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written examination at the mid-point of the semester.

2.	Formative Assessment	25%	It includes classroom participation, attendance, and assignment/s.
3.	Final Assessment	40%	Written examination at the end of semester.

- **Textbooks and Reference-books**

1. Sinnot, R; Towler, G (2020) Chemical Engineering Design, 6th ed. Butterworth-Heinemann.
2. Peters, MS; Timmerhaus, KD; West, RE (2003) Plant Design and Economics for Chemical Engineers, 5th ed. McGraw-Hill.
3. Turton, R; Shaeiwitz, JA; Bhattacharyya, D; Whiting, WB (2018) Analysis, Synthesis, and Design of Chemical Processes, 5th ed. Prentice-Hall.
4. Douglas, JM (1988) Conceptual Design of Chemical Processes. McGraw-Hill.
5. Seider, WD; Lewin, DR; Seader, JD; Widagdo, S; Gani, R; NG, KM (2017) Product and Process Design Principles: Synthesis, Analysis and Evaluation, 4th ed. Wiley.
6. Branan, SM (2005) Rules of Thumb for Chemical Engineers. 4th ed. Elsevier.