CHEMICAL PLANT DESIGN
ENCH 412

Lecture: 3 **Year: IV**
Tutorial: 1 **Part: I**
Practical: 1.5

Course Objectives:
The objective of this course is to identify design components of a chemical plant and utilities and to learn how to decide plant location and site selection with considerations on design constraints including environmental and safety regulations. This course also enables students to design a double tube, shell and tube heat exchanger, evaporator and packed column.

1. Overview of Chemical Plant Design (4 hours)
- 1.1. Overall design considerations, Project life cycle
- 1.2. Conceptual Process Design and Simulation, Design documentation
- 1.3. Optimum design, Role of chemical engineer in Engineering, Procurement and Construction (EPC) projects
- 1.4. Plant design philosophy, Failure scenario and design solutions

2. Utilities and Offsite Systems Design (8 hours)
- 2.1. Design considerations for process utilities, equipment selection and sizing
- 2.2. Design considerations for compressed air distribution, Water Treatment Plant (WTP) and Effluent Treatment Plant (ETP)
- 2.3. Steam system design and condensate recovery, insulation and cladding design
- 2.4. Design of control system for plant

3. Scale-Up, Revamping and Debottlenecking (4 hours)
- 3.1. Scale-Up Challenges, Laboratory to Pilot Scale
- 3.2. Optimization objectives: profit maximization, energy minimization
- 3.3. Revamping Strategies: Capacity expansion, Energy reduction, Feedstock change
- 3.4. Debottlenecking, Debottleneck identification via simulation

4. Design of Heat Transfer Equipment (12 hours)
- 4.1. Design criteria and procedure for heat transfer equipment and its classification
- 4.2. Process and mechanical design of heat exchanger
- 4.3. Process and mechanical design of condenser
- 4.4. Design considerations for reboilers and evaporator

5. Design of Mass Transfer Equipment (7 hours)
- 5.1. Design criteria and procedure for packed column
- 5.2. Types of packing, Selection criteria for appropriate packing material

5.3. Process design of packed bed, Preparation of General Arrangement (GA) drawing
5.4. Calculation of packed bed height and diameter

6. Case Study: Processing Facility Design (10 hours)

6.1. Process considerations, food processing equipment, hygienic design
6.2. Factory infrastructure, site considerations, design principles, construction techniques
6.3. Computers in the design of food-manufacturing facility,
6.4. Design of: utilities and services, effluent treatment, control and monitoring system

Tutorial (15 hours)

1 Mind-mapping design considerations to establish the basis of plant design.
2 Performing sizing calculations for heat transfer and mass transfer equipment.
3 Analyzing a case study on debottlenecking.
4 Preparing a techno-economic report for factory design.

Practical (22.5 hours)

1. Development of process flow diagrams and piping and instrumentation diagrams using computer-aided design software
2. Optimization of temperature to analyze its impact on conversion and profit
3. Estimating cooling water requirements and sizing utility loads
4. Estimating capital expenditure using the factored method and preparing an operating cost sheet
5. Conduction of a simplified hazard and operability study on one process unit
6. Preparation of a preliminary plot plan in computer-aided design software
7. Compiling and presenting a final design report covering process flow diagrams, utility summaries, costing summaries, safety reviews and optimization results

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks
1	4	6
2	8	10
3	4	6
4	12	16
5	7	10
6	10	12
Total	**45**	**60**

*There may be minor deviation in mark distribution.

References:

1. Baker, C. G. J. (2013). Handbook of food factory design. Springer.
2. Moran, S. (2019). An applied guide to process and plant design (Latest ed.). IChemE.
3. Peters, M. S., Timmerhaus, K. D., & West, R. E. (2003). Plant design and economics for chemical engineers (Latest ed.). McGraw-Hill.
4. Sinnott, R. K. (2005). Chemical engineering design: Chemical engineering (Latest ed.). Elsevier / Butterworth-Heinemann.