The University of Jordan
School of Engineering
Chemical Engineering Department

Program: B.Sc.
Academic Year: (/)
Semester:_____

- **CHE 0935582: Chemical Plant Design**
- **Course Catalog (2024)**

Standards and codes for preparing PFD and P&ID; material and energy balances on the flowsheet level using modern principles of computer-aided flowsheeting; estimation of footprint of major pieces of equipment using shortcut design methods, heuristic tables and process simulators through a case study approach; material of construction; three and two-dimensional plant layout with safety considerations; site location; economic analysis of chemical processes: Methods for estimation of fixed capital cost and cost of manufacturing; profitability analysis; introduction to process optimization; use of computer-aided tools for rapid equipment sizing, cost estimation and economic analysis.

Credit hours	**3**	**Level**	**5**	**Pre-requisite(s)**	**0915571, 0905482**
Instructor **Prof. Menwer Attarakih**		**Office number** **CHE258**		**Office phone** Ext. 22887	
Course website: UJ E-learning https://elearning.ju.edu.jo/login/index.php **Live Streaming Platform:** Microsoft teams		**E-mail** **m.attarakih@ju.edu.jo**		**Place** Refer to Registration website	

- **Textbooks:**
  1. R. Turton, J. Shaeiwitz, D. Bhattacharyya, W. B. Whiting (2018). Analysis, synthesis and design of chemical processes, 5th Ed., Prentice Hall, PTR, New Jersey.
  2. M. S. Peters, K. D. Timmerhaus and E. W. Ronald, (2003). Plant Design and Economics for Chemical Engineers. 5th Ed., New York, Mcgraw-Hill, Inc.
  3. Instructor Handouts.
- **References:**
  1. Biegler, L. T., Grossmann, I. E. and Westerberg, A. W. (1997). Systematic methods of chemical process design. New Jersy, Prentice-Hall Inc. .
  2. Coulson, J. M. & Richardson, J. F. (2003). Chemical engineering (vol. 6), Pergamon Press, Oxford.
  3. Douglas, J. M. (1988). Conceptual process design of chemical processes, McGraw-Hill Book Co., New York.
  4. Smith, R. (2005). Chemical process design and integration, John Wiley & Sons, New York.
  5. Seider, W. D., Seader, J. D. & Lewin, D. R. (1999). Process design principles, John Wiley & Sons, New York.
  6. CAPE OPEN TO CAPE OPEN Simulation Environment: http://www.cocosimulator.org/
- **Goals:**
  1. Review and use of ASME Symbols in constructing and understanding chemical process flow diagrams.
  2. Use of computer-aided principles to perform M&E balances at flowsheet level.
  3. Estimation of footprint of major pieces of equipment.
  4. Use of basic principles of plant layout.
  5. Use of methods of cost estimation and profitability analysis.
  6. Apply basic methods of process optimization.

Learning Objectives and Intended Learning Outcomes

Objectives	Outcomes
1. Quick Review of chemical process flow diagrams[1] (O2,O3)	1.1 Understanding symbols and drawing, reading different types of chemical process flow diagrams (PFD & P & ID) (2,3)
2. Brief Introduction to DME and HDA case studies (O1,O2)	2.1 Enhance the ability to understand & critically analyze relatively complex flowsheets (1, 2) 2.2 Ability to use basic rules for writing process description (k)
3. M & E Balances at flowsheet level: An introduction to computer-aided flowsheeting (O1,O2)	3.1 Understanding the basics of graph theory and signal flow graphs 3.2 Gaining sufficient skills to simplify PFD to signal flow graph 3.3 Understanding the Sequential Modular Approach (SMA)

▪ Learning Objectives and Intended Learning Outcomes (Continued)

Objectives	Outcomes
M & E Balances at flowsheet level: An introduction to computer-aided flowsheeting (O1, O2,O7)	3.4 Understand the recycle problem and how it complicates the Material & Energy Balances and prevents the use of the SMA (1) 3.5 Understand how to recover the SMA in the presence of the recycle problem by tearing the recycle streams(1,2) 3.6 Choosing of tear streams and sequence of calculations in the presence of recycle problem (1) 3.7 Understanding the Equation Oriented Approach (EOA) for solving Material & Energy Balances at flowsheet level to overcome the recycle problem (1,2) 3.8 Recognize the advantages & disadvantages of SMA & EOA (2) 3.9 Use of Heuristics to overcome convergence problems using process simulators in the presence of recycles (2) 3.10 Case study: Solving and simulation of relatively complex recycle problem (1, 2) 3.11 Developing basic skills to use available commercial and free simulators at single unit and flowsheet levels (e.g. CAPE OPEN TO CAPE OPEN Simulation Environment) (1,2,7)
4. Plant layout and site location: An application to DME Case Study (O1,O2,O7)	4.1 Understand the DME Case study (1) 4.2 Understand and apply Principles of plant layout with safety considerations (1, 2) 4.3 Apply minimum equipment spacing to ensure economical, flexible & safe plant operation (1, 2) 4.4 Three-dimensional plant representation (2) 4.5 Types of plant layouts: Level-grade and vertically mounted plant layout (1,2) 4.6 Develop essential skills to develop and draw plant layout with an application to DME process (1, 2) 4.7 Understand the principal factors affecting plant site location and learn how to choose plant site location (2, 7)
5. Selection of major piece of equipment and estimation of its footprint with intensive use of heuristic tables and shortcut methods: An application to the DME Process (O1, O2)	5.1 Be able to select and rate process pumps (1) 5.2 Be able to select and design process vessels using shortcut methods (1,2) 5.3 Be able to select and design heat exchangers using shortcut methods(1,2) 5.4 Be able to differentiate and select different types of reboilers (1,2) 5.5 Be able to select and design reactors (packed bed reactor) (1,2) 5.6 Be able to design sieve tray distillation columns using shortcut methods (1,2) 5.7 Be able to select MOC and set corrosion allowance for pressure vessels (1,2)
6. Reasons for elevating major pieces of equipment (O1,O2)	6.1 Developing a basic heuristic rule for the elevation of benzene distillation column in the HDA process (1,2) 6.2 Minimum elevation of Barometric & surface condensers (1,2) 6.3 Minimum elevation of Thermosyphon reboilers (1,2)

- **Learning Objectives and Intended Learning Outcomes (Continued)**

Objectives	Outcomes
7. Cost estimation & Economic analysis of chemical processes: An application to the benzene distillation column in the HDA of toluene (O1,O2,O4)	7.1 Be able to estimate the fixed capital cost of a chemical process (1,2) 7.2 Be able to estimate the cost of manufacturing (1,2) 7.3 Be able to carry out Profitability analysis & use of common economic indicators (1,2,7)
8. Introduction to process optimization (O1,O2)	8.1 Understand objective functions related to chemical processes (1, 2) 8.2 Understand single & multivariable optimization (1,2) 8.3 Understand Linear & Nonlinear Programming (1,2) 8.4 Understand Profile optimization (1,2) 8.5 Understand Structural Optimization (1,2)
9. Enhance the ability of students for life-long learning and communication skills (O7)	9.1 Enhance students' skills through intensive use of available data resources and short projects with written and oral presentations (7)

- **Topics Covered**

Week	Topics	Reference
1	Review of chemical process flow diagrams & Brief Introduction to DME and HDA case studies	Handouts, Textbook (1), Chap. 1, Appendix B
2-4	M & E Balances at flowsheet level: An introduction to computer-aided flowsheeting	Handouts, Ref. (4)
5	Case Study: The DME process	Handouts, Textbook, Appendix B
6- 7	Plant layout and site location: An application to DME Case Study	Handouts, Textbook (1), Chap. 1, Ref. (2)
8-11	Selection of major piece of equipment and estimation of its footprint with intensive use of heuristic tables and shortcut methods: An application to the DME Process	Handouts, Textbook, Ref. (2, 4),
12	Reasons for elevating major pieces of equipment	Handouts, Chap. 1, Ref. (1)
12-15	Cost estimation & Economic analysis of chemical processes	Handouts, Textbook, Chap. 7, 8, 9
15-16	Introduction to process optimization	Handouts, Textbook, Chap. 14

- **Evaluation**

Evaluation Tool	Weight	Date
Midterm Exam	30	Will be announced by the department
Short exams	12-15	Will be arranged between the 5th and 16th weeks
Homework & Presentations	5-8	To be arranged one week after the assignment
Final Exam	50	Will be announced by the University

- **Relationship to Program Outcomes (1-5)**

New ABET 1 To 7	1	2	3	4	5	6	7
	X	X	X	X			X

- **Relationship to CHE Program Objectives**

PEO1	PEO2	PEO3	PEO4							
√	√	√								

- **Document Control**

Prepared by	Prof. Dr. Menwer Attarakih
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