The University of Jordan
School of Engineering
Chemical Engineering Department

Program: B.Sc.
Academic Year: (2020 / 2021)
Semester: _____2nd_____

- **CHE 0915571: Chemical Process Design**

- **Course Catalog (2019)***

Evolutionary nature of process design, evolution of conceptual design through process diagrams and flowsheet structure with emphasis on utilities and pipe sizing, synthesis and design of chemical processes by understanding the hierarchy of process design using the onion model; Structure of the chemical process flowsheet; design and optimization of process recycle structure; Sequencing of simple distillation columns; Synthesis and design of heat exchanger networks; Computer applications with emphasis on available flowsheeting packages.

Credit hours	**3**	**Level**	**5**	**Pre-requisite(s)**	**0905482**
Instructor **Prof. Menwer Attarakih**		**Office number** **CHE258**		**Office phone** Ext. 22887	**E-Office Hours** Mon & Wed: 10:00-10:30
Course website: https://elearning.ju.edu.jo/login/index.php **Live Streaming Platform:** Microsoft teams		**E-mail** **m.attarakih@ju.edu.jo**		**Lecture room:** Refer to Registration website	

*2019 Curriculum

- **Textbook:**
  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. 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. Understanding new process flowsheet creation and analyzing exist ones.
2. Understand how to develop process alternatives and generate a base case flowsheet.
3. Improvement and optimization of the bases case structure through heuristic rules and energy integration.

- **Learning Objectives and Intended Learning Outcomes**

Objectives	**Outcomes**
1. Understanding of process design through the evolution of chemical process diagrams (O2)	1.1 Understanding, Drawing & reading different types of chemical process flow diagrams (O2) 1.2 Use of process flow diagrams as an evolutionary tool in process design (O2) 1.3 Critical analysis of different types of process flow diagrams (O2)
2. Utilizing Heuristics to confirm the suitability of process design (O1, O2, O4)	2.1 Applying technical heuristics and short-cut methods (O1, O2, O4) 2.2 Using Tables of technical heuristics and guidelines (O1,O4)
3. Understand & Analyze the HDA process as a standard case study with process description (O1)	3.1 Enhance the ability to understand & critically analyze relatively complex flowsheet (O1) 3.2 Ability to use basic rules for writing process description (O1)

▪ Learning Objectives and Intended Learning Outcomes (Continued)

Objectives	Outcomes
4. Apply process flowsheet simulators to carry out complex M & E balances using given case study (O6)	3.1 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) (6)
5. Basic understanding of process (system) design through process synthesis as an evolutionary process with the help of shortcut calculations, heuristic tables & process simulators (O1,O2,O4,O7)	5.1 Be able to define design objectives, specifications, process capacity & stream factor (1,4) 5.2 Know how to collect data, major data sources and generate data data banks for process design (7) 5.3 Synthesize and analyze chemical processes using the hierarchical approach of process synthesis through understanding (1,2,4): 5.3.1 Batch versus continuous processes 5.3.2 Input/ Output structure of the process 5.3.3 Reactor section: The heart of the Chemical Process 5.3.4 Recycle Structure of the process. 5.3.5 Structure of the separation system 5.3.6 Energy integration 5.4 Be able to generate different process alternatives in a rapid way using shortcut calculations 5.5 Check the suitability & use of heuristics using process simulators 5.6 Use process simulators to analyze and screen process alternatives 5.7 Be able to identify and design the process recycle structure 5.8 Choose and optimize the operating conditions of individual equipment and its interactions in the process flowsheet
6. Understanding heuristic and analytical approaches for sequencing of simple distillation columns (O1,O2)	6.1 Understand the difference between simple and complex distillation columns (1,2) 6.2 Use heuristics for sequencing simple distillation columns in relation to a complete process flowsheet (1,2) 6.3 Discover the possibility of running into conflict when using heuristic rules for sequencing simple distillation columns (1,2) 6.4 Use the approximate Underwood's equation to develop a quantitative tool for sequencing simple distillation columns (1,2)
7. Understand and apply the basic ideas of heat integration and apply the pinch analysis to design and optimize heat-exchanger networks (O1,O2,O4)	7.1 Understand the difference between the performance of individual heat exchanger and Heat Exchanger Network (HEN) (1,2) 7.2 Understand the basic concept of energy integration and the existence of optimal minimum approach temperature in a HEN (1) 7.3 Be able to identify cold & hot streams and extract its data (1,2) 7.4 Minimize utilities consumption using the TI & Cascade diagrams 7.5 Be able to link the first and second laws of thermodynamics to the pinch analysis (1,2) 7.6 Be able to identify the pinch zone in the HEN (1,2) 7.7 Apply the stream matching at minimum utilities and explore different HEN alternatives (1,2) 7.8 Design and analyze the final HEN and project it back on the process flowsheet (1,2) 7.9 Appreciate the heat integrated flowsheet in terms of savings in the EAOC and in terms of flowsheet complexity (1,2,4)
8. Enhance the ability of students for life-long learning and communication skills (O3, O7)	8.1 Enhance students' skills through intensive use of available data resources and short projects with written and oral presentations (3,7)

▪ Topics Covered

Week	Topics	Reference
1- 3	Evolutionary nature of process design using chemical process flow diagrams	Handouts, Textbook, Chap. 1
4	Utilizing Heuristics to confirm the suitability of process design	Handouts, Textbook, Chap. 11
5	Case Study: The HDA process	Handouts, Textbook, Chap. 1, 5
5- 6	Introduction to process flowsheet simulation	Handouts, Ref. 6
6-11	Synthesis and analysis of chemical processes	Handouts, Textbook, Chap. 2, 3, 6
12-13	Introduction to sequencing of simple distillation columns	Handouts, Chap. 11, Ref. 3, 5
14-16	Introduction to design of heat-exchanger networks	Handouts, Textbook, Chap. 15

▪ 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 (scale 1 to 5)

New 1 To 7	O1	O2	O3	O4	O5	O6	O7
Percentage of grades	X	X	X	X			
1	Formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics						
2	Apply engineering design with solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors						
3	An ability to communicate effectively with a range of audiences						
4	An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts						

▪ Relationship to CHE Program Objectives

PEO1	PEO2	PEO3	PEO4	PEO5	PEO6	PEO7	PEO8	PEO9	PEO10	PEO11
√	√	√								

▪ Document Control

Prepared by	Prof. Menwer Attarakih
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