The University of Jordan

School of Engineering

Chemical Engineering Department

1. COURSE CODE AND NAME

(0905211) Chemical Engineering Principles I

2. CLASS SCHEDULE

3 Credits Hours

3. INSTRUCTOR

- **Dr. Hatem Alsyouri**
- **Office location**: CHE Department
- **Email address**: alsyouri@ju.edu.jo
- **Lecture times**: **Section 1**: Sun/Tue/Thu 8:30-9:20; **Section 2**: Sun/Tue/Thu 10:30-11:20
- **Office hours**: Sun/Tue/Thu 9:30 – 10:30, Mon/Wed 2:00-3:00

4. TEXTBOOK

Elementary Principles of Chemical Processes. By: Richard M. Felder, Ronald W. Rousseau, & Lisa G. Bullard. 4th edition, 2017, Wiley & Sons, Inc.

Additional References

D.M. Himmelblau and J.B. Riggs, Basic Principles and Calculations in Chemical Engineering, 7th Ed., Prentice Hall.

5. WEBSITE

- https://eacademic.ju.edu.jo/Alsyouri/default.aspx
- Your e-learning account (https://elearning.ju.edu.jo/)

6. COURSE INFORMATION

a. **Catalog description**: The scope of chemical engineering, chemical processes units and dimensions, conversion of units. Systems of units, dimensional homogeneity, process data representation data analysis, processes and process variables, process representation and flow sheeting. Introduction to material balances, degrees of freedom analysis, material balances for single and multiple non-reactive systems, material balance for reactive systems. Ideal Gases, real gases: compressibility and equation of states. Single component and two-phase systems (vapor pressure). Gas-liquid systems. The phase rule and vapor-liquid equilibria. Liquids and gases in equilibrium with solids.

b. **Prerequisite:** (0303101) General Chemistry 1

c. **Course classification**: Mandatory course in the B.Sc. program.

7. COURSE LEARNING OUTCOMES (LOS)

Upon successful completion of the course, the student should be able to:

1. Identify and apply different systems of units to classify engineering quantities and perform accurate unit conversions with dimensional consistency and homogeneity. (SO1)
2. Perform numerical estimations and data validation using scientific notation, significant figures, and statistical tools including mean and variance. (SO1)
3. Define and calculate key process variables including mass, volume, density, specific gravity, flow rate, composition, pressure, and temperature using appropriate unit systems and conversions. (SO1)
4. Determine and analyze mixture composition using mole and mass fractions, concentration, and average molecular weight calculations. (SO1)

5. Classify chemical processes as continuous, batch, or semi-batch and as reactive or non-reactive. (SO1, SO2).
6. Construct and label process flowcharts from verbal process descriptions and identify all relevant process variables. (SO1, SO2)
7. Perform degree-of-freedom analysis to determine the number of independent equations required for solving a process. (SO1)
8. Write and solve material balance equations for single-unit and multiple-unit reactive and non-reactive processes in continuous and batch operations. (SO1, SO2)
9. Understand the significance of recycle, bypass, and purge streams and solve material balance equations for reactive and non-reactive processes that include these streams in single- and multiphase systems. (SO1, SO2)
10. Understand combustion reactions and chemistry, determine theoretical and excess air requirements, and apply material balance principles to combustion systems. (SO1, SO2)
11. Obtain and utilize physical property data for liquids, solids, and gases from reliable sources such as databases, handbooks, correlations, and experimental or literature data. (SO1)
12. Perform pressure–volume–temperature calculations for ideal and non-ideal gases using appropriate equations of state and gas property charts. (SO1)
13. Understand phase diagrams and vapor-pressure relationships for single- and multicomponent systems and apply these concepts using Gibbs phase rule. (SO1)
14. Analyze multiphase equilibrium behavior in gas–liquid, liquid–liquid, and solid–liquid systems using appropriate laws, data, and graphical representations. (SO1)
15. Integrate multiphase equilibrium concepts into material balance calculations involving phase change and multiple phases. (SO1, SO2).

Related Chemical Engineering Program Student Outcomes (SOs) - ABET

SO1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

SO2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

8. Course Topics

Topic	# of Weeks
CHAPTER 2: Introduction to Chemical Engineering Calculations	1.5
CHAPTER 3: Process and Process Variables	1.5
CHAPTER 4: Fundamentals of Material Balances	6
CHAPTER 5: Single-Phase Systems	2
CHAPTER 6: Multiphase Systems	3

9. POLICIES AND PROCEDURES

- Students are expected to attend each class session and they are responsible for all material, announcements, and schedule changes discussed in class. The university policy regarding attendance will be strictly adhered.
- All cases of academic dishonesty will be handled in accordance with university policies and regulations.
- You are encouraged to use computer software such as EXCEL, MATLAB, or POLYMATH to perform the required computations and to represent your findings in graphs or tables.

10. INSTRUCTIONAL METHODS

Lectures, class discussions, and in-class problem solving

11. ASSESSMENT & GRADING

Assessment	*Weight*
Assignments (x2)	20%
Midterm	30%
Final exam	50%
Total	**100%**

12. CONTRIBUTION OF COURSE TO MEETING THE PROFESSIONAL COMPONENT

This course contributes to building the fundamental concepts in fluid mechanics and its applications in Chemical Engineering.

13. RELATIONSHIP TO PROGRAM STUDENT OUTCOMES (SOs)

SO1	SO2	SO3	SO4	SO5	SO6	SO7
✓	✓					

14. COURSE WEEKLY CALENDAR

DATE	CLASS TOPIC & DESCRIPTION	REFERENCE IN THE TEXTBOOK	LEARNING OUTCOMES / (ABET OUTCOMES)	ASSIGNMENT/TASK
WEEK 1 (05 OCT – 09 OCT)	**Lec 1** Introduction & Syllabus Review **Lec 2** **CHAPTER 2: Introduction to Chemical Engineering Calculations** 2.1 Units and Dimensions 2.2 Systems of Units **Lec 3** 2.3 Conversion of Units	Syllabus Chapter 2	1 (1)	Review book sections Check announcements and files posted on Moodle continuously *Suggested problems* **(3rd Editon)** Sections 2.1-2.3: 1-4, 6, 7
WEEK 2 (12 OCT – 16 OCT)	**Lec 1:** 2.4 Force and Weight 2.5 Numerical Calculation and Estimation a. Scientific notation, 2.6-Dimensional Homogeneity **Lec2:** Problem Solving on Chapter 2 **Lec3:** **CHAPTER 3: Process and Process Variables** Introd to Process and Process Variables 3.1 Mass and Volume	Chapter 2 Chapter 3	1, 2 (1) 3 (1)	*Suggested problems* Sections 2.4: 8, 9, 11, 12, 15 Sections 2.5: 16, 17, 20* Sections 2.6: 21-24
WEEK 3 (19 OCT – 23 OCT)	**Lec1:** 3.2 Flow rate 3.3 Chemical composition a. Moles & molecular weight **Lec2:**	Chapter 3	3, 4 (1)	*Suggested problems* Sections 3.1-3.3: 1-5, 8*, 10

	3.3 Contd.| Chemical composition b. Mass & mole fractions, and avg. molecular weight. c. Concentration **Lec 3:** 3.4 Pressure 3.5 Temperature			11*, 14, 17, 19, 22, 23*, 28, 31* Sections 3.4, 3.5: 32-35, 39, 41, 42 48, 51, 52
WEEK 4 (26 OCT – 30 OCT)	**Lec 1:** **CHAPTER 4: Fundamentals of Material Balances** 4.1 Process Classification 4.2 Balances a. The General Balance Equation b. Balances on Cont. Steady-State Processes c. Integral Balances on Batch Processes **Lec2:** 4.3 Material Balance Calculations a. Flowcharts **Lec 3:** 4.3 Contd.| Material Balance Calculations b. Flowchart Scaling and Basis of Calculation c. Balancing a Process	Chapter 4	5, 6 (1, 2)	*Suggested problems* Sections 4.1-4.3a: 1-4 Announce ICA1
WEEK 5 (02 NOV – 06 NOV)	**Lec 1:** **In-Class Assignment 1 (Chapters 2 and 3)** **Lec 2:** 4.3 Contd.| Material Balance Calculations d. Degree-of-freedom analysis e. General procedure for single-unit process **LEC 3** Problem Solving	Chapter 4	7 (1) 8 (1, 2)	*Suggested problems* Section 4.3b-e: 6, 7, 10, 11, 13, 16, 17, 19, 27* ***ICA1 (10%)***
WEEK 6 (09 NOV – 13 NOV)	**Lec 1:** 4.4 Balances on multiple-unit Processes **Lec 2** Problem Solving **Lec 3** 4.5 Recycle and Bypass	Chapter 4	8, 9 (1, 2)	*Suggested problems* Section 4.4: 28, 30, 31* Sections 4.5: 32, 35, 36
WEEK 7 (16 NOV – 20 NOV)	**Lec 1** 4.6 Chemical Reaction Stoichiometry a. Stoichiometry b. Limiting and excess reactants, Fractional conversion, and Extent of reaction. **Lec 2** 4.7 Balances on Reactive Processes a. Balances on Molecular species & Atomic species (reading only) b. Independent Equations, Independent species and Independent Reactions d. Atomic species Balances **Lec 3** Problem Solving	Chapter 4	8, 9 (1, 2)	*Suggested problems* Section 4.6: 39, 42, 43 Sections 4.7: a-e: 49, 51, 55* f: 56, 57 g: 60, 61
WEEK 8 (23 NOV – 27 NOV)	**Lec 1** 4.7 cont. | Balances on Reactive Processes e. Extent of Reaction f. Product separation and recycle g. Purging **Lec 2**	Chapter 4	8, 9 (1, 2)	**MIDTERM EXAMS PERIOD** ***Midterm (30%)***

	Revision and PS **LEC 3** **Midterm Exam** **23 NOV (SUN) - MIDTERM EXAMS BEGIN**			
WEEK 9 (30 NOV – 04 DEC)	**Lec 1** 4.8 Combustion Reactions a. Combustion chemistry b. Theoretical and Excess Air **Lec 2** 4.8 cont. | Combustion Reactions c. Material balances on combustion reactors **Lec 3:** Problem Solving **24 MAR (THU) – MIDTERM EXAMS END**	Chapter 4	10 (1, 2)	*Suggested problems* *Section 4.8:* 64, 65, 68, 71, 74, 77
WEEK 10 (07 DEC – 11 DEC)	**Lec 1** **CHAPTER 5: Single-Phase Systems** 5.1. Liquid and solid densities 5.2. Ideal Gases a. The ideal gas equation of state **Lec 2** 5.2. cont. | Ideal Gases b. Standard temperature and pressure **LEC 3** 5.2. cont. | Ideal Gases c. Ideal gas mixtures **07 DEC (SUN) –START REGIST FOR SP 2026**	Chapter 5	11, 12 (1)	*Suggested problems* Section 5.1 1, 2, 4 Section 5.2 a,b: 5, 7-9, 12, 14 c: 16, 18, 20, 22*, 25, 27, 30, 34*, 35, 39, 47
WEEK 11 (14 DEC – 18 DEC)	**Lec 1** 5.3 Equations of State for Non-Ideal Gases (brief of no-ideality and EOS models) **Lec 2** 5.4 The compressibility factor equation of state a. Compressibility factor tables b. The law of corresponding states and compressibility charts **Lec 3** Problem Solving	Chapter 5	12 (1)	*Suggested problems* Sections 5.4 ab: 64, 66, 69*, 73
WEEK 12 (21 DEC – 25 DEC)	**Lec 1:** **CHAPTER 6: Multiphase Systems** 6.1 Single component phase equilibrium a. Phase diagram b. Estimation of vapor pressures **Lec 2** 6.2 Gibs Phase Rule 6.3 Gas-Liquid Systems: One condensable component **Lec 3:** No Lecture (Christmas break) **25 DEC (THU)– CHRISTMAS DAY**	Chapter 6	13 (1)	*Suggested problems* Section 6.1: 2, 3, 6*, 7, 8 Sections 6.2 and 6.3: 9, 10, 12, 18, 19, 22, 25, 26, 29, 33, 35, 39, 41
WEEK 13 (28 DEC – 01 JAN)	**Lec 1:** **In-Class Assignment 2 (Chapters 5 and 6.1)** **Lec 2:** 6.4 Multicomponent Gas-Liquid Systems a. Vapor-liquid equilibrium data b. Raoult's law and Henry's law **Lec 3:** No Lecture (New year break)	Chapter 6	14 (1)	*Suggested problems* Section 6.4 a: 43 b: 45, 46, 49, 50 ***ICA2 (10%)***

	01 JAN (THU)– NEW YEAR BREAK			
WEEK 14 (04 JAN – 08 JAN)	**Lec 1** 6.4 cont. | Multicomponent Gas-Liquid Systems c. Vapor-liquid equilibrium calculations for ideal solutions d. Graphical representations of vapor-liquid equilibrium (reading) **Lec 2** 6.5 Solutions of Solids in Liquids a. Solubility and Saturation b. Solid Solubilities and Hydrated Salts **LEC 3** Problem Solving	Chapter 6	15 (1, 2)	*Suggested problems* Section 6.4c 52, 54, 56, 59, 61*, 63* Section 6.5 ab: 74, 75, 77, 79, 80, 81*
WEEK 15 (11 JAN – 15 JAN)	**REVISION FOR FINAL EXAM** **Lec 1** Revision **Lec 2** No lecture **LEC 3** No lecture **12 JAN (MON)– CLASSES END** **13 JAN (TUE)– WITHDRAWAL ENDS**	Revision		
	14 JAN (WED)– FINAL EXAMS BEGIN			**FINAL EXAMS WEEKS**
WEEK 16 (18 JAN – 22 JAN)	**FINAL EXAMS**			
WEEK 17 (25 JAN – 29 MAY)	**26 JAN (MON) - FINAL EXAMS END** **27 JAN (TUE) – GRADE SUBM. TO FACULTY** **28 JAN (WED) – GRADE SUBM. TO REGISTR.**			
WEEK 18 (01 FEB – 05 FEB)	**01 FEB (SUN) – 07 FEB (SAT) - FACULTY MEMBERS' VACATION**			

Note: *The instructor has the right to amend the content of this syllabus and keep students informed about the updates. The most updated syllabus is on Moodle.*

Date 25-10-2025