18 APR 2018 CC/ 28 MAY 2018 UC

DEPARTMENT OF CHEMICAL ENGINEERING
College of Engineering
University of the Philippines Diliman, Quezon City

COURSE SYLLABUS
ChemE 2 Elementary Chemical Engineering

A. Course Catalogue Description

1. **Course Number:** ChemE 2
2. **Course Title:** Elementary Chemical Engineering
3. **Course Description:** Introduction to chemical engineering calculations; elementary mass and energy balances for common unit operations and unit processes
4. **Prerequisite:** none
5. **Semester Offered:** First Semester and Second Semester
6. **Course Credit:** 3u
7. **Number of Hours:** 3h
8. **Meeting Type:** lecture
9. **Course Stipulation:** for non-chemical engineering students
10. **Course Goals:** To introduce the concept of material and energy balance in basic chemical engineering processes to non-chemical engineering students and to discuss how to identify common unit operations and essential process variables in chemical process industries

B. Rationale

This is an introductory course on chemical engineering calculations for non-chemical engineering students. The course discusses how chemical engineers apply the principles of mass balance, energy balance and unit operations to the design of industrial processes, and also teaches non-chemical engineering students how these concepts can also be applied in other systems as well as in everyday life.

C. Course Outline

1. Course Outcomes (CO)

Upon completion of the course, students must be able to:

- **CO 1.** apply principles in mathematics, chemistry and physics to set up and solve mass and energy balance equations in basic chemical engineering problems;
- **CO 2.** solve problems related to other disciplines using basic chemical engineering principles;
- **CO 3.** discuss common unit operations and processes in the chemical industry; and
- **CO 4.** identify the professional and ethical responsibilities of chemical engineers as fellow engineers.

2. Course Content

Lecture Topics	No. of Hours
Introduction to the chemical engineering profession 1. History and scope of chemical engineering 2. Chemical engineering law and ethics 3. Chemical process industries	3
Chemical processes 1. Process diagrams 2. Unit operations	3
Engineering calculations 1. Units and dimensions 2. Operation and conversion 3. Dimensional consistency and dimensionless quantities	3
Process variables 1. Mass and volume 2. Density and specific gravity 3. Mole 4. Flow rates 5. Chemical composition 6. Basis	3
Material balance for non-reacting systems 1. General material balance equation 2. Steady-state process 3. Mixing 4. Evaporation 5. Distillation 6. Crystallization 7. Solid-liquid extraction 8. Gas absorption 9. Recycle and bypass 10. Multiple-unit operations	6
Long Examination 1	
Material balance for reacting systems 1. Chemical reaction stoichiometry 2. Conversion, yield, and selectivity 3. Combustion reactions	12
Long Examination 2	
Ideal/non-ideal gas relationships 1. Ideal gas equation of state (EOS) 2. Material balance involving ideal gas mixtures 3. Compressibility factor 4. van der Waals EOS	6
Phase phenomena 1. Pure substance 2. Phases and phase changes 3. PVT diagrams 4. Property tables	3

Lecture Topics	No. of Hours
Basic energy balance concepts 1. Work, heat, energy 2. System, surroundings, boundary 3. State, equilibrium, process 4. Internal energy and enthalpy 5. Heat capacity	3
Energy balance for closed and open systems 1. First Law of Thermodynamics 2. General energy balance equation 3. Energy balance for closed systems 4. Energy balance for open systems	6
Long Examination 3	
Term Paper	
Final Examination	
Total number of hours	**48**

3. Course Coverage

Week	CO	TOPIC	ESSENTIAL/ KEY QUESTIONS	Suggested Teaching and Learning Activities	Suggested Assessment Tools
1	4	**Introduction to the chemical engineering profession** 1. History and scope of chemical engineering 2. Chemical engineering law and ethics 3. Chemical process industries	What is Chemical Engineering? What does a chemical engineer do?	lecture	homework
2	3	**Chemical processes** 1. Process diagrams 2. Unit operations	What are chemical processes? How are processes represented? What are different unit operations?	lecture	homework
3	1,2	**Engineering calculations** 1. Units and dimensions 2. Operation and conversion 3. Dimensional consistency and dimensionless quantities	What are the different units of relevant physical quantities? What are dimensionless variables? How are data represented and analyzed to describe a process?	lecture, seatwork	homework
4	1,2	**Process variables** 1. Mass and volume 2. Density and specific gravity 3. Mole 4. Flow rates 5. Chemical composition 6. Basis	What are the main variables that define a chemical process? What is a basis?	lecture, seatwork	homework

18 APR 2018 CC/ 28 MAY 2018 UC

Week	CO	TOPIC	ESSENTIAL/ KEY QUESTIONS	Suggested Teaching and Learning Activities	Suggested Assessment Tools
5-6	1,3	**Material balance for non-reacting systems** 1. General material balance equation 2. Steady-state process 3. Mixing 4. Evaporation 5. Distillation 6. Crystallization 7. Solid-liquid extraction 8. Gas absorption 9. Recycle and bypass 10. Multiple-unit operations	What is the general balance equation? How are mass balance calculations performed for different unit operations?	lecture, seatwork	homework, problem set
					Long Examination 1
7-10	1,3	**Material balance for reacting systems** 1. Chemical reaction stoichiometry 2. Conversion, yield, and selectivity 3. Combustion reactions	How are mass balance calculations performed in processes involving chemical reactions?	lecture, seatwork	homework, problem set
					Long Examination 2
11-12	1	**Ideal/non-ideal gas relationships** 1. Ideal gas equation of state (EOS) 2. Material balance involving ideal gas mixtures 3. Compressibility factor 4. van der Waals EOS	What is an ideal gas? How is a generalized compressibility chart used? How does a van der Waals gas differ from an ideal gas?	lecture, seatwork	homework, problem set
13	1	**Phase phenomena** 1. Pure substance 2. Phases and phase changes 3. PVT diagrams 4. Property tables	What is a pure substance? How are phases and phase change processes illustrated in PVT diagrams?	lecture	homework,
14	1,2	**Basic energy balance concepts** 1. Work, heat, energy 2. System, surroundings, boundary 3. State, equilibrium, process 4. Internal energy and enthalpy 5. Heat capacity	What is the scope of thermodynamics? How are the different forms of energies calculated? How are systems and surroundings defined? What are the different thermodynamic processes?	lecture, seatwork	homework

Week	CO	TOPIC	ESSENTIAL/ KEY QUESTIONS	Suggested Teaching and Learning Activities	Suggested Assessment Tools
15-16	1,2	**Energy balance for closed and open systems** 1. First Law of Thermodynamics 2. General energy balance equation 3. Energy balance for closed systems 4. Energy balance for open systems	What is the First Law of Thermodynamics? How are energy balance calculations performed in closed and open systems?	lecture, seatwork	homework, problem set
					Long Examination 3
					Term Paper
					Final Examination

4. Course Requirements

1. Long examinations (3)
2. Final examination
3. Term paper
4. Homework
5. Problem sets

REFERENCES:

Felder, R. M. and Rousseau, R. W. (2016). *Elementary Principles of Chemical Processes* 4th Ed. New Jersey: John Wiley and Sons, Inc.

Himmelblau, D. M. (2012). *Basic Principles and Calculations in Chemical Engineering* 8th Ed. NJ: Prentice-Hall.

Hipple, J. (2017). *Chemical Engineering for Non-Chemical Engineers*. NJ: John Wiley and Sons, Inc.

Jose, W. I. (2011). *Introductory Concepts in Chemical Engineering*. Manila.

Olaño, S., et al. (2006). *Chemical Engineering Law Primer*. Manila: Merriam and Webster.

Theodore, L. (2014). *Chemical Engineering: The Essential Reference*. NY: McGraw-Hill Education.