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 101 Chemical Engineering Process Analysis I

A. Course Catalogue Description

1. **Course Number:** ChemE 101
2. **Course Title:** Chemical Engineering Process Analysis I
3. **Course Description:** Problem-solving techniques in solving chemical engineering problems; mass balances in unit operations and unit processes; principles of phase equilibrium as applied to unit operations
4. **Prerequisite:** none
5. **Semester Offered:** First Semester
6. **Course Credit:** 3u
7. **Number of Hours:** 2h lec, 3h lab
8. **Meeting Type:** lecture, laboratory
9. **Course Goals:** To introduce the concept of material balance in different chemical engineering processes (reactive, non-reactive, single-phase, multi-phase) and to discuss how to identify essential process variables and how to interpret process data in tabular and graphical representations

B. Rationale

This course is focuses on the fundamentals of chemical engineering calculations, which is the foundation of chemical engineering design. The discussion focuses primarily on the principles of mass balance and its application to the analysis of unit operations and unit processes.

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 balance equations in chemical engineering problems;
- **CO 2.** analyze experimental data from chemical engineering literature;
- **CO 3.** solve problems using basic chemical engineering concepts and principles in solving problems related to other disciplines;
- **CO 4.** communicate effectively through discussions and presentations to material balance problems;
- **CO 5.** identify the impact of chemical engineering solutions in the context of the needs of the society;
- **CO 6.** recognize that mass balance is the starting point of all chemical engineering work;
- **CO 7.** utilize existing methods and tools to solve mass balance problems; and
- **CO 8.** develop the skill of estimation and intelligent guess in solving problems.

Course Outcomes and Relationship to Program Learning Objectives

Course Outcomes	Program Learning Objectives*				
	A	B	C	D	E
Apply principles in mathematics, chemistry and physics to set up and solve mass balance equations in chemical engineering problems	■				
Analyze experimental data from chemical engineering literature	■	■			
Solve problems using basic chemical engineering concepts and principles in solving problems related to other disciplines	■	■			
Communicate effectively through discussions and presentations to material balance problems		■			
Identify the impact of chemical engineering solutions in the context of the needs of the society	■	■			■
Recognize that mass balance is the starting point of all chemical engineering work and is a key component in life-long learning		■		■	
Utilize existing methods and tools to solve mass and energy balance problems	■				
Develop the skill of estimation and intelligent guess in solving problems	■				

* **A** Equip students with strong technical education in chemical engineering necessary to succeed in their chosen careers and to become responsive citizens.
B Develop the students' ability to effectively communicate technical information to any audience.
C Train students to function in multidisciplinary teams, manage projects, and take leadership roles in their respective fields.
D Engage students in research, innovation, and life-long learning to identify opportunities, and address issues and challenges in their respective spheres of influence.
E Instill in students a strong commitment to the ethical practice of their profession; to health, safety, and environment; and to service to society.

2. Course Content

Lecture Topics	No. of Hours	
	Lec	Lab
Introduction to chemical engineering calculations 1. Units and dimensions 2. Systems of units 3. Force and weight 4. Dimensional homogeneity 5. Dimensionless quantities 6. Process data representation and analysis	2	3
Process variables 1. Basis 2. Mass and volume 3. Flow rate 4. Chemical composition 5. Pressure	4	6

Lecture Topics	No. of Hours	
	Lec	Lab
6. Temperature		
Material balance for non-reacting systems 1. General material balance equation 2. Steady-state process 3. Mixing; inverse lever arm rule 4. Evaporation and distillation 5. Absorption and stripping 6. Bypass and recycle 7. Multiple-unit operation	8	12
Long Examination 1		
Material balance for reacting systems 1. Chemical reaction stoichiometry 2. Conversion and yield 3. Combustion: gaseous and liquid fuels 4. Purge	10	15
Long Examination 2		
Phase equilibria 1. Gibbs phase rule 2. Vapor-liquid equilibrium (VLE); Raoult's law a. VLE charts and equations b. Bubble-point and dew-point calculations 3. Systems involving condensable and non-condensable fluids; Henry's law a. Air-water system; humidity charts b. Humidification, dehumidification, drying, cooling/heating of air 4. Liquid-liquid equilibrium: use of the ternary diagram 5. Solid-liquid equilibrium: use of solubility data	8	12
Long Examination 3		
Final Examination		
Total number of hours	**32**	**48**

3. Course Coverage

Week	CO	TOPIC	ESSENTIAL/ KEY QUESTIONS	Suggested Teaching and Learning Activities	Suggested Assessment Tools
1	2,3,8	**Introduction to chemical engineering calculations** 1. Units and dimensions 2. Systems of units 3. Force and weight 4. Dimensional homogeneity 5. Dimensionless quantities 6. Process data representation and analysis	What are the different units of relevant physical quantities? What are dimensionless variables? How are data represented and analyzed to describe a process?	lecture, computational laboratory, classwork	problem set/ seatwork
2-3	3,5,8	**Process variables** 1. Basis 2. Mass and volume 3. Flow rate 4. Chemical composition 5. Pressure 6. Temperature	What are the main variables that define a chemical process?	lecture, computational laboratory, classwork	problem set/ seatwork

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Week	CO	TOPIC	ESSENTIAL/ KEY QUESTIONS	Suggested Teaching and Learning Activities	Suggested Assessment Tools
4-7	1,4, 6,7	**Material balance for non-reacting systems** 1. General material balance equation 2. Steady-state process 3. Mixing; inverse lever arm rule 4. Evaporation and distillation 5. Absorption and stripping 6. Bypass and recycle 7. Multiple-unit operation	What is a basis? What is the general balance equation? How are mass balance calculations performed for different unit operations?	lecture, computational laboratory, classwork	problem set/ seatwork
					Long Examination 1
8-12	1,4, 6,7	**Material balance for reacting systems** 1. Chemical reaction stoichiometry 2. Conversion and yield 3. Combustion: gaseous and liquid fuels 4. Purge	How are mass balance calculations performed in processes involving chemical reactions?	lecture, computational laboratory, classwork	problem set/ seatwork
					Long Examination 2
13-16	1,2,3	**Phase equilibria** 1. Gibbs phase rule 2. Vapor-liquid equilibrium (VLE); Raoult's law a. VLE charts and equations b. Bubble-point and dew-point calculations 3. Systems involving condensable and non-condensable fluids; Henry's law a. Air-water system; humidity charts b. Humidification, dehumidification, drying, cooling/ heating of air 4. Liquid-liquid equilibrium: use of the ternary diagram 5. Solid-liquid equilibrium: use of solubility data	What is the phase rule? What is phase equilibrium? How is mass balance performed in processes involving two-phase equilibrium? How is mass balance performed in processes involving a condensable vapor and a non-condensable gas?	lecture, computational laboratory, classwork	problem set/ seatwork
					Long Examination 3
					Final Examination

4. Course Requirements

1. Long examinations (3)
2. Final examination
3. Seatwork
4. 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.