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 102 Chemical Engineering Process Analysis II

A. Course Catalogue Description

1. **Course Number:** ChemE 102
2. **Course Title:** Chemical Engineering Process Analysis II
3. **Course Description:** Energy balances in unit operations and unit processes; mass and energy balances in industrial processes
4. **Prerequisite:** ChemE 101 Chemical Engineering Process Analysis I
5. **Semester Offered:** Second 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 energy balance in different chemical engineering processes and to discuss how to perform mass and energy balance calculations in industrial processes

B. Rationale

This course is a continuation of the mass balance discussions in ChemE 101 Chemical Engineering Process Analysis II. It focuses on two main topics: (1) principles of energy balance and (2) the application of mass and energy balances in the analysis of industrial chemical processes. The course enables students to develop their skills in performing mass and energy balance calculations to quantify mass-energy interactions in the engineering design of any industrial chemical process.

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;
- **CO 2.** identify the unit processes and operations involved in chemical industries;
- **CO 3.** perform mass and energy balance calculations on industrial processes;
- **CO 4.** communicate effectively through discussions and presentations of solutions to problems;
- **CO 5.** recognize that mass and energy balances are the starting point of all chemical engineering work; and
- **CO 6.** utilize existing methods and tools to solve mass and energy balance problems.

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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 and energy balance equations	■				
Identify the unit processes and operations involved in chemical industries	■	■			
Perform mass and energy balance calculations on industrial processes	■				
Communicate effectively through discussions and presentations of solutions to problems		■			
Recognize that mass and energy balances are the starting point of all chemical engineering work		■			■
Utilize existing methods and tools to solve mass and energy balance 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
ENERGY BALANCE		
Introduction to the First Law of Thermodynamics 1. Internal energy, enthalpy and heat capacity 2. Energy balance for closed and open systems 3. Mechanical energy balance	6	9
Calculation of heat effects 1. Sensible heat 2. Latent heat of pure substances 3. Heats of reaction	4	6
Long Examination 1		
Heat effects of industrial reactions	2	3
Combustion of solid fuels 1. Types of solid fuels 2. Solid Fuel Analysis (Proximate and Ultimate) 3. Heating values 4. Coal conversion processes	4	6
Long Examination 2		

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Lecture Topics	No. of Hours	
	Lec	Lab
INDUSTRIAL STOICHIOMETRY		
Sulfur compounds 1. Sources of sulfur 2. Overview of sulfur processes 3. Burning of raw sulfur 4. Roasting of pyrites 5. Bisulfites and sulfates 6. Sulfuric acid production	6	9
Long Examination 3		
Nitrogen compounds 1. Sources of nitrogen 2. Overview of nitrogen processes 3. Ammonia synthesis 4. Ammonia oxidation 5. Nitric acid production	6	9
Lime and cement 1. Sources of lime and cement 2. Calcination process	4	6
Long Examination 4		
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
1-3	1,2	**Introduction to the First Law of Thermodynamics** 1. Internal energy, enthalpy and heat capacity 2. Energy balance for closed and open systems 3. Mechanical energy balance	What are the definitions of internal energy, enthalpy, and heat capacity? How is energy exchanged between a system and its surroundings? How is the energy balance equation set up for different unit operations?	lecture, computational laboratory	problem set
4-5	1,2	**Calculation of heat effects** 1. Sensible heat 2. Latent heat of pure substances 3. Heats of reaction	How is energy transformed during a chemical process? How are energy balance calculations performed for different unit operations?	lecture, computational laboratory	problem set
					Long Examination 1

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Week	CO	TOPIC	ESSENTIAL/ KEY QUESTIONS	Suggested Teaching and Learning Activities	Suggested Assessment Tools
6	4, 5,6	**Heat effects of industrial reactions**	How are energy balance calculations performed for processes involving chemical reactions?	lecture, computational laboratory	problem set
7-8	1,3,4, 6	**Combustion of solid fuels** 1. Types of solid fuels 2. Solid Fuel Analysis (Proximate and Ultimate) 3. Heating values 4. Coal conversion processes	How are mass and energy balance calculations performed for processes involving the combustion of solid fuels? What are the current and developing industrial processes in coal conversion technology?	lecture, computational laboratory	problem set
					Long Examination 2
9-11	1,3,4, 6	**Sulfur compounds** 1. Sources of sulfur 2. Overview of sulfur processes 3. Burning of raw sulfur 4. Roasting of pyrites 5. Bisulfites and sulfates 6. Sulfuric acid production	How are mass and energy balance calculations performed for the production of sulfates, bisulfites and sulfuric acid?	lecture, computational laboratory	problem set
					Long Examination 3
12-14	1,3,4, 6	**Nitrogen compounds** 1. Sources of nitrogen 2. Overview of nitrogen processes 3. Ammonia synthesis 4. Ammonia oxidation 5. Nitric acid production	How are mass and energy balance calculations performed for the production of ammonia and nitric acid?	lecture, computational laboratory	problem set
15-16	1,3,4, 6	**Lime and cement** 1. Sources of lime and cement 2. Calcination process	How are mass and energy balance calculations performed for the production of cement?	lecture, computational laboratory	problem set
					Long Examination 4
					Final Examination

4. Course Requirements

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

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

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

Smith, J. M., Van Ness, H. C., and Abbott, M. M. (2018). *Introduction to Chemical Engineering Thermodynamics* 8th Ed. McGraw-Hill, New York.

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