

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 106 Mathematical Methods in Chemical Engineering II

A. Course Catalogue Description

1. **Course Number:** ChemE 106
2. **Course Title:** Mathematical Methods in Chemical Engineering II
3. **Course Description:** Analytical and numerical solutions of ordinary differential equations; introduction to partial differential equations; applications in chemical engineering
4. **Prerequisite:** ChemE 105 Mathematical Methods in Chemical Engineering I
5. **Corequisite:** Math 23 Elementary Analysis III
6. **Semester Offered:** First Semester
7. **Course Credit:** 3u
8. **Number of Hours:** 2h lec, 3h lab
9. **Meeting Type:** lecture, laboratory
10. **Course Goals:** To introduce analytical or numerical solutions to ordinary and partial differential equations

B. Rationale

This course provides the essential topics to solving ordinary differential equations (ODEs) and partial differential equations (PDEs) that are derived from the analysis of various systems in chemical engineering, such as unsteady heat conduction, reactor performance, etc.

C. Course Outline

1. Course Outcomes (CO)

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

- CO 1.** solve initial value and boundary value problems involving ordinary differential equations analytically;
- CO 2.** discuss the different forms of ordinary and partial differential equations, as encountered in modeling physical phenomena; and
- CO 3.** calculate the approximate solutions of ordinary and partial differential equations using computer-aided numerical methods.

Course Outcomes and Relationship to Program Learning Objectives

Course Outcomes	Program Learning Objectives*				
	A	B	C	D	E
Solve initial value and boundary value problems involving ordinary differential equations analytically					
Discuss the different forms of ordinary and partial differential equations, as encountered in modeling physical phenomena					
Calculate the approximate solutions of ordinary and partial differential equations using computer-aided numerical methods					

- * **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
Analytical solution of basic ordinary differential equations 1. First order differential equations a. Variable separable differential equations b. Exact differential equations c. Solution using integrating factors 2. Special higher-order differential equations 3. Applications in chemical engineering	8	12
Long Examination 1		
Analytical solution of linear ordinary differential equations 1. Higher-order linear differential equations with constant coefficients 2. Systems of linear differential equations with constant coefficients 3. Applications in chemical engineering	6	9
Long Examination 2		
Numerical solutions to initial value problems 1. Single ordinary differential equation 2. Systems of ordinary differential equation 3. Applications in chemical engineering	4	6
Numerical solutions to boundary value problems 1. Single ordinary differential equation 2. Systems of ordinary differential equation 3. Applications in chemical engineering	4	6
Machine Problem 1		

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Lecture Topics	No. of Hours	
	Lec	Lab
Introduction to partial differential equations 1. Introduction 2. Classification of partial differential equations 3. Numerical solution via finite difference method 4. Applications in chemical engineering	10	15
Machine Problem 2		
Total number of hours	32	48

3. Course Coverage

Week	CO	TOPIC	ESSENTIAL/ KEY QUESTIONS	Suggested Teaching and Learning Activities	Suggested Assessment Tools
1-4	1,2	Analytical solution of basic ordinary differential equations 1. First order differential equations a. Variable separable differential equations b. Exact differential equations c. Solution using integrating factors 2. Special higher-order differential equations 3. Applications in chemical engineering	What is an ordinary differential equation? How can an ordinary differential equation be derived from a mass and energy balance problem?	lecture, classwork	problem sets
					Long Examination 1
5-7	1,2	Analytical solution of linear ordinary differential equations 1. Higher-order linear differential equations with constant coefficients 2. Systems of linear differential equations with constant coefficients 3. Applications in chemical engineering	How do you use the method of variable parameters or the method of undetermined coefficients? How do you solve systems of ordinary differential equations?	lecture, classwork	problem sets
					Long Examination 2

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Week	CO	TOPIC	ESSENTIAL/ KEY QUESTIONS	Suggested Teaching and Learning Activities	Suggested Assessment Tools
8-9	3	Numerical solutions to initial value problems 1. Single ordinary differential equation 2. Systems of ordinary differential equation 3. Applications in chemical engineering	How do you set-up the numerical calculations for ordinary differential equations with initial value conditions? What are the limitations of these methods?	lecture, classwork	machine exercise
10-11	3	Numerical solutions to boundary value problems 1. Single ordinary differential equation 2. Systems of ordinary differential equation 3. Applications in chemical engineering	How do you set-up the numerical calculations for ordinary differential equations with boundary value conditions? What are the limitations of these methods?	lecture, classwork	machine exercise
					Machine Problem 1
12-16	3	Introduction to partial differential equations 1. Introduction 2. Classification of partial differential equations 3. Numerical solution via finite difference method 4. Applications in chemical engineering	What are partial differential equations? How can partial differential equations be derived from a mass and energy balance problem?	lecture, classwork	machine exercise
					Machine Problem 2

4. Course Requirements

1. Long examinations (2)
2. Machine problems (2)
3. Problem sets
4. Machine exercises

REFERENCES:

- Chapra, S. C. and Canale, R. P. (2015). *Numerical Methods for Engineers* 7th Ed. NY: McGraw-Hill Education.
- Kreyszig, E. O. (2011). *Advanced Engineering Mathematics* 10th Ed. NJ: John Wiley & Sons, Inc.
- Rainville, Earl D. and Bedient, Phillip E. (2017). *Elementary Differential Equations* 11th Ed. NJ: John Wiley and Sons Inc.
- Rice, R. G. and Do, D. D. (2012). *Applied Mathematics and Modeling for Chemical Engineers* 2nd Ed. NJ: John Wiley & Sons, Inc.
- Villa, R. P. (2014). Developing a predictive model for determining the mechanical properties of CFB fly ash thermoset composite (Master's thesis). University of the Philippines Diliman.