



National University of Engineering (UNI)

School of Civil Engineering
Syllabus 2026-II

1. COURSE

MA212. Ordinary Differential Equations (Mandatory)

2. GENERAL INFORMATION

2.1 Course	: MA212. Ordinary Differential Equations
2.2 Semester	: 6 th Semester.
2.3 Credits	: 6
2.4 Hours	: 4 HT; 4 HP;
2.5 Duration of the period	: 16 weeks
2.6 Type of course	: Mandatory
2.7 Learning modality	: Face to face
2.8 Prerequisites	: MA211. Calculus IV. (4 th Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

The Ordinary Differential Equations course provides the mathematical tools to analyze systems that evolve with respect to a single independent variable. It focuses on the modeling of dynamic systems through first-order equations, higher-order equations, and systems of equations, using both analytical and numerical methods. It is fundamental for the understanding of mechanics, electrical circuits, and population models.

5. GOALS

- Solve first-order and higher-order ordinary differential equations using analytical methods.
- Apply the Laplace transform to solve initial value problems involving discontinuous functions.
- Analyze the stability of linear and nonlinear systems of differential equations.
- Implement numerical methods for approximating solutions in complex models.

6. COMPETENCES

ABET-1) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (Familiarity)

7. TOPICS

Unit 1: First-Order Ordinary Differential Equations (ODEs) (20 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Modeling with first-order equations: growth, mixtures, and cooling	• Solve linear first-order ODEs using integrating factors [Usage]
Readings : [BDM17], [Zil18]	

Unit 2: Higher-Order Differential Equations and Systems (ODEs) (40 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Definition and properties of the Laplace Transform; inverse transforms and translation theorems • Derivatives of a transform and convolution integrals	• Apply the Laplace transform method to solve linear engineering ODEs with initial conditions [Usage] • Model a damped mechanical oscillator or RLC circuit as a second-order linear ODE [Usage] • Analyze the stability and transient response of engineering systems described by systems of ODEs [Assessment] • Formulate state-space representations for multi-variable engineering dynamic systems [Usage]
Readings : [BDM17], [Zil18]	

Unit 3: Numerical Methods for ODEs and PDEs (36 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Phase portraits and linearization of nonlinear engineering systems • Stability of critical points and nonlinear systems	• Implement a fourth-order Runge-Kutta integrator for a mechanical vibration problem [Usage] • Determine the region of absolute stability for an explicit time-stepping scheme [Assessment] • Discretize the 2D heat equation using finite differences and set up the resulting linear system [Usage] • Compare finite difference and finite element approaches for solving an engineering PDE [Assessment]
Readings : [BDM17], [Zil18]	

8. WORKPLAN

8.1 Methodology

Individual and team participation is encouraged to present their ideas, motivating them with additional points in the different stages of the course evaluation.

8.2 Theory Sessions

The theory sessions are held in master classes with activities including active learning and roleplay to allow students to internalize the concepts.

8.3 Practical Sessions

The practical sessions are held in class where a series of exercises and/or practical concepts are developed through problem solving, problem solving, specific exercises and/or in application contexts.

9. EVALUATION SYSTEM

***** EVALUATION MISSING *****

10. BASIC BIBLIOGRAPHY

- [BDM17] William E. Boyce, Richard C. DiPrima, and Douglas B. Meade. *Ecuaciones Diferenciales y Problemas con Valores en la Frontera*. 11th. Limusa Wiley, 2017.
- [Zil18] Dennis G. Zill. *Ecuaciones Diferenciales con Aplicaciones de Modelado*. 11th. Cengage Learning, 2018.