



National University of Engineering (UNI)
School of Civil Engineering
Syllabus 2026-II

1. COURSE

MA211. Calculus IV (Mandatory)

2. GENERAL INFORMATION

- 2.1 Course** : MA211. Calculus IV
2.2 Semester : 4th Semester.
2.3 Credits : 5
2.4 Hours : 3 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 :
 - MA210. Calculus III. (3rd Sem)
 - MA121. Linear Algebra I. (3rd Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

This course covers ordinary differential equations, an introduction to partial differential equations, and asymptotic and perturbation methods, extending the multivariable calculus foundations built in previous courses. It develops the analytical tools needed to model and solve differential equations arising in physics and engineering, and to approximate the solutions of problems that cannot be solved in closed form.

5. GOALS

- Solve first-order ordinary differential equations and model physical systems with them.
- Solve higher-order linear ordinary differential equations and systems of ODEs.
- Classify and solve elementary partial differential equations using separation of variables and Fourier methods.
- Construct asymptotic expansions and apply regular and singular perturbation methods to approximate solutions.

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) (30 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• First-order equations: separable, linear, and exact forms	• Solve linear first-order ODEs using integrating factors [Usage]
Readings : [BDM17], [Ste16]	

Unit 2: Higher-Order Differential Equations and Systems (ODEs) (20 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
- Linear higher-order equations with constant coefficients - Systems of first-order linear ODEs and state-space formulation - Laplace transform method for solving engineering ODEs with initial conditions - Modeling of mass-spring-damper, RLC circuits, and heat conduction with ODEs	- 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]	

Unit 3: Partial Differential Equations (PDEs) (16 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
- Separation of variables for heat and wave equations in engineering geometries - Laplace transform methods applied to initial-boundary value problems - Classification of PDEs: elliptic, parabolic, and hyperbolic types and their physical significance - Formulation and physical interpretation of boundary conditions in engineering problems - Green's functions and boundary value problems for advanced engineering analysis	- Apply separation of variables to solve the 1D heat conduction and wave equations [Usage] - Classify a given PDE and select the appropriate analytical or numerical solution approach [Assessment] - Formulate boundary conditions for a heat transfer or stress analysis problem [Assessment] - Derive the governing PDE for steady-state heat conduction using Fourier's law [Usage]
Readings : [Str08], [Ste16]	

Unit 4: Asymptotic Analysis and Perturbation Methods (4 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
- Asymptotic expansions and the Landau order symbols (O, o, $\sim$) - Regular perturbation theory for algebraic equations and ODEs - Singular perturbation theory and matched asymptotic expansions (boundary layers) - Method of multiple scales and the WKB approximation	- Construct a regular perturbation expansion for an ODE with a small parameter [Familiarity] - Apply matched asymptotic expansions to solve singular perturbation problems with boundary layers [Usage]
Readings : [BO99]	

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

- [BO99] Carl M. Bender and Steven A. Orszag. *Advanced Mathematical Methods for Scientists and Engineers I: Asymptotic Methods and Perturbation Theory*. Springer, 1999.
- [Str08] Walter A. Strauss. *Partial Differential Equations: An Introduction*. 2nd. Wiley, 2008.
- [Ste16] James Stewart. *Cálculo de varias variables: Trascendentes tempranas*. 8th. Cengage Learning, 2016.
- [BDM17] William E. Boyce, Richard C. DiPrima, and Douglas B. Meade. *Ecuaciones Diferenciales y Problemas con Valores en la Frontera*. 11th. Limusa Wiley, 2017.