



National University of Engineering (UNI)
School of Civil Engineering
Syllabus 2027-I

1. COURSE

MA112. Calculus II (Mandatory)

2. GENERAL INFORMATION

2.1 Course	: MA112. Calculus II
2.2 Semester	: 2 nd 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	: MA111. Calculus I. (1 st Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

This course covers integral calculus for functions of a single variable and the geometric foundations needed for multivariable calculus. It emphasizes the accumulation of quantities and the inverse relationship between differentiation and integration, provides tools for calculating areas, volumes, arc length, and work, and introduces vectors and the geometry of three-dimensional space, quadric surfaces, parametric equations, polar coordinates, and vector-valued functions of a real variable.

5. GOALS

- Understand the definite integral as a limit of Riemann sums and master techniques of integration, improper integrals, and infinite series.
- Apply the definite integral to calculate areas, volumes of revolution, arc length, surface area, work, and centroids.
- Operate with vectors in three-dimensional space and use them to determine lines and planes.
- Classify quadric surfaces from their general equation.
- Analyze curves described parametrically and in polar coordinates, including their calculus and area.
- Describe space curves as vector-valued functions and compute their arc length, curvature, and torsion.

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: Integral Calculus (14 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• The Fundamental Theorem of Calculus • Integration techniques including substitution and parts • Engineering applications of integration: areas, volumes, centroids, and moments of inertia	• State and explain the Fundamental Theorem of Calculus [Familiarity] • Calculate definite integrals arising from engineering problems such as work, fluid pressure, and heat transfer [Usage]
Readings : [Stewart2016], [Larson2018], [Thomas2014]	

Unit 2: Improper Integrals (6 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Improper integrals over unbounded intervals • Improper integrals of unbounded (discontinuous) integrands • Convergence criteria and comparison tests for improper integrals	• Determine whether an improper integral arising from an engineering model converges, using comparison and other convergence tests [Assessment] • Evaluate an improper integral by taking the appropriate limit, when it converges [Usage]
Readings : [Stewart2016], [Larson2018], [Thomas2014]	

Unit 3: Sequences, Series, and Power Series (14 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Sequences and series: convergence tests (ratio, root, comparison, integral) • Power series, radius of convergence, and Taylor/Maclaurin series • Engineering use of Taylor polynomials for linearization and numerical approximation	• Determine convergence of a power series and construct a Taylor series for a standard engineering function [Assessment] • Apply a Taylor polynomial to approximate or linearize an engineering function [Usage]
Readings : [Stewart2016], [Larson2018], [Thomas2014]	

Unit 4: Applications of the Definite Integral (16 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Area between curves by integrating with respect to x or y • Volume of solids of revolution by the disk and washer method • Volume of solids of revolution by the cylindrical shell method • Work via integration (springs, pumping fluids, cables) • Moments and centroid of a plane region or solid	• Calculate the volume of a solid of revolution using the disk, washer, or cylindrical shell method [Usage] • Calculate the work done by a variable force using integration [Usage]
Readings : [Stewart2016], [Thomas2014]	

Unit 5: Vectors and the Geometry of Space (6 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Dot and cross products: definition, properties, and geometric interpretation • Equations of lines and planes in space	• Compute the dot and cross products of vectors to solve engineering force and moment problems [Usage] • Determine equations of lines and planes in space from the geometric data of an engineering problem [Usage]
Readings : [Stewart2016], [Larson2018]	

Unit 6: Quadric Surfaces (6 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Classification of quadrics (ellipsoids, paraboloids, hyperboloids) from their general equation	• Classify a quadric surface and identify its geometry for engineering component modeling [Usage]
Readings : [Stewart2016], [Larson2018]	

Unit 7: Parametric Equations and Polar Coordinates (12 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Parametric curves and their calculus, applied to trajectories in kinematics • Polar coordinates and their conversion to Cartesian coordinates	• Calculate the velocity and acceleration of a trajectory described parametrically [Usage] • Convert between polar and Cartesian coordinates when modeling engineering geometries [Usage]
Readings : [Stewart2016], [Thomas2014]	

Unit 8: Vector Functions of a Real Variable (10 hours)	
Competences Expected: ABET-1	
Topics	Learning Outcomes
• Definition, domain, and range of vector functions of a real variable • Limits, continuity, and derivatives of vector functions • Arc length and natural parametrization of a curve • Tangent, normal, and binormal vectors; moving Frenet frame • Curvature, torsion, and Frenet-Serret formulas	• Identify limits, continuity, and derivatives of vector functions of a real variable [Familiarity] • Compute tangent, normal, and binormal vectors and reparametrize a curve by arc length [Usage] • Calculate curvature and torsion using the Frenet-Serret formulas [Assessment]
Readings : [Stewart2016], [Thomas2014]	

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