NATIONAL UNIVERSITY OF SAN MARCOS

FACULTY OF MATHEMATICAL SCIENCES

SYLLABUS

1. GENERAL INFORMATION

1.1 Course name	:	Calculus IV
1.2 Code	:	MA211
1.3 Academic Program	:	Scientific Computing
1.4 Credits	:	3
1.5 Prerrequisites	:	• MA210. Calculus III. (4^{th} Sem) • MA121. Linear Algebra I. (3^{rd} Sem)
1.6 Type of Course	:	Mandatory
1.7 Area of Studies	:	Estudios Generales
1.8 Number of Weeks	:	16
1.9 Hours per week	:	1 HT; 4 HP;
1.10 Cycle	:	I
1.11 Learning modality	:	Face to face
1.12 Academic Period	:	2026-I
1.13 Semester Start Date	:	
1.14 Semester End Date	:	

2. PROFESSORS

Meetings after coordination with the professor

3. INTRODUCTION TO THE COURSE

The nature of the course is theoretical-practical; its purpose is to develop a conceptual and methodological framework aimed at providing a solid mathematical foundation for understanding all natural phenomena. It includes the following thematic units: Sequences in R^n, C, (R^m, R). Directional derivatives and implicit differentiation. Isometries of R^n, conics, and quadric surfaces. Vector fields.

4. GOALS

- Understand the concepts of vector fields and differential operators
- Apply line and surface integrals to physical problems
- Master the fundamental theorems of vector calculus
- Solve problems of flux, circulation, and vector potentials

5. COMPETENCES

ABET-1) An ability to identify, formulate, and solve broadly defined technical or scientific problems by applying knowledge of mathematics and science and/or technical topics to areas relevant to the discipline. (Usage)

6. TOPICS

Unit 1: Numerical Differentiation and Integration (20 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Finite difference approximations (forward, backward, central) • Richardson extrapolation • Newton-Cotes formulas (Trapezoidal rule, Simpson's rule) • Gaussian quadrature • Error analysis for numerical integration	• Compute derivatives of functions using finite difference schemes [Usage] • Apply Richardson extrapolation to improve the accuracy of numerical approximations [Usage] • Implement numerical integration rules (Trapezoidal, Simpson, Gaussian) [Usage] • Compare the accuracy and efficiency of different numerical integration methods [Assessment] • Analyze the error for numerical differentiation and integration formulas [Assessment]
Readings : [**Marsden2003**], [**Stewart2016**]	

Unit 2: Numerical Methods for Ordinary Differential Equations (ODEs) (20 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Euler's method and its variants (forward, backward) • Runge-Kutta methods • Multistep methods (Adams-Bashforth, Adams-Moulton) • Stability and convergence analysis for ODE solvers • Systems of ODEs and higher-order ODEs	• Implement basic ODE solvers (Euler, Runge-Kutta) [Usage] • Analyze the stability and convergence properties of ODE numerical methods [Assessment] • Select an appropriate numerical method for a given ODE based on stability and accuracy requirements [Assessment] • Solve systems of ODEs and convert higher-order ODEs to first-order systems [Usage]
Readings : [**Marsden2003**], [**Stewart2016**]	

Unit 3: Interpolation and Function Approximation (20 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Polynomial interpolation (Lagrange, Newton forms) • Spline interpolation (cubic splines) • Least squares approximation • Runge's phenomenon and Chebyshev nodes • Error analysis for interpolation	• Construct interpolating polynomials using different methods [Usage] • Implement cubic spline interpolation [Usage] • Apply least squares method for data fitting [Usage] • Explain Runge's phenomenon and strategies to mitigate it [Familiarity] • Analyze the error of an interpolation scheme [Assessment]
Readings : [**Marsden2003**], [**Stewart2016**]	

Unit 4: Roots Finding and Basic Numerical Optimization (20 hours)	
Competences Expected: ABET-1	
Topics	**Learning Outcomes**
• Bisection method and fixed-point iteration • Newton's method and secant method for root finding • Convergence analysis and order of convergence • Gradient descent for univariate optimization • Rate of convergence and stopping criteria	• Implement root-finding algorithms (bisection, Newton, secant) and analyze their convergence [Usage] • Classify the order of convergence of iterative methods [Assessment] • Apply gradient descent to solve simple univariate optimization problems [Usage] • Design appropriate stopping criteria for iterative methods [Usage]
Readings : [**Marsden2003**], [**Stewart2016**]	

7. WORKPLAN

7.1 Methodology

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

7.2 Theory Sessions

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

7.3 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.

8. EVALUATION SYSTEM

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

9. BASIC BIBLIOGRAPHY