



**NATIONAL UNIVERSITY OF ENGINEERING**  
**COLLEGE OF ENVIRONMENTAL ENGINEERING**  
**ENVIRONMENTAL ENGINEERING PROGRAM**

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**MA141– NUMERICAL METHODS**

**I. GENERAL INFORMATION**

<b>CODE</b>	: MA141 Numerical Methods
<b>SEMESTER</b>	: 5
<b>CREDITS</b>	: 3
<b>HOURS PER WEEK</b>	: 4 (Theory – Practice)
<b>PREREQUISITES</b>	: AA231 – AA222
<b>CONDITION</b>	: Compulsory

**II. COURSE DESCRIPTION**

This course prepares students in the application of numerical calculus methods for solving mathematical problems arising in engineering applications. Students analyze the concept of computing errors and discrete data, iterations processes and numeric stability and their application for solving linear and nonlinear equations, definite multiple integrals and ordinary differential equations. Students develop computer codes implementing the numerical methods and analyze obtained results.

**III. COURSE COMPETENCIES**

1. Have full consciousness of the presence of errors when taking measurements and making calculations. It classifies and interprets them.
2. Identify appropriate strategies for numerical solutions of problems related to engineering calculations solves them whit a computer.
3. Calculate numerical processes errors and give the appropriate interpretation of results.
4. Develop computer programs for implementing numeric algorithms.

**IV. COURSE CONTENTS**

**1. BASIC KNOWLEDGE OF ERRORS**

Error and its classification / Absolute and relative errors / Propagation of error / Stable and unstable processes / Calculation of a series, estimation of error / Criterion to finish an infinite process.

**2. NON-LINEAR EQUATIONS**

Models that drive us to solve a nonlinear equations / Closed methods (bisection) / Open methods (Secant, Newton) / Contracted functions / Consecutive approximation method / Computer codification.

**3. LINEAR SYSTEMS OF EQUATIONS AND THE PROBLEM OF EIGENVALUES**

Matrix norms and Conditioning / Eigenvalues and Eigenvectors / power iteration for the calculation of the largest eigenvalue in the module / Simple Gaussian elimination / Iterative methods: Jacobi, Gauss-Seidel / Computer codification.

**4. FUNCTION APROXIMATION**

Divided differences / Polynomial and trigonometric interpolation / Polynomial and trigonometric adjustment (discrete Fourier transform) / Non-linear adjustment / Computer codification.

## 5. QUADRATURE

Gauss quadrature / Trapeze method, open and closed cases / Romberg's method / Simpson's rule, open and closed cases / Computer codification.

## 6. NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS / 6 HOURS

One-step methods: Euler, Runge-Kutta of order 4 / Finite difference and frontier differential equations / Computer codification.

## V. LABORATORY AND PRACTICE

Laboratory 1: Errors, / Stable and unstable processes, series calculus

Laboratory 2: Non-linear equations

Laboratory 3: Linear systems and eigenvalues

Laboratory 4: Approximation

Laboratory 5: Approximation of a definite integral

Laboratory 6: Numerical solution of ordinary differential equations

## VI. METHODOLOGY

The course takes place in sessions of theory and computer laboratory. In theory sessions, faculty presents the concepts, theorems, and applications. In laboratory sessions Mathcad software is used to implement numerical methods for solving problems and analyze their solutions. In every single session the active participation of the students is encouraged.

## VII. GRADING SYSTEM

The Final Grade (PF) is calculated with the following formula:

$$PF = (EP + EF + PL) / 3$$

EP: Mid-term exam    EF: Final Exam

PL: Average of computer laboratory experiences

## VIII. BIBLIOGRAPHY

### 1. Chapra S. & Canales R.

Numerical Methods for Engineers

Edit. Mc Graw Hill . N.Y. 2010.

### 2. Aljama C. Tomás , Cadena M. Miguel , Charleston V. , Miguel , Yañez S. Oscar

Digital Signal Processing

Metropolitan Autonomous University, Mexico, 2008.