NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF SCIENCES

ENGINEERING PHYSICS PROGRAM

IF392 – NUMERIC CALCULUS II

I. GENERAL INFORMATION

CODE	:	IF392 Numeric Calculus II
SEMESTER	:	6
CREDITS	:	4
HOURS PER WEEK	:	6 (Theory – Practice)
PREREQUISITES	:	IF321 Numeric Calculus I, CF391 Mathematical Methods for
CONDITION	:	Compulsory

II. COURSE DESCRIPTION

This course prepares students in the application of numerical calculus methods for solving mathematical problems arising in engineering applications. Numerical methods for solving ordinary differential equations, initial value problems and partial-derivatives equations are analyzed and applied for solving physics-related engineering problems. Students develop computer codes implementing the numerical methods and analyze obtained results.

III. COURSE COMPETENCIES

1. Know and apply different methods for solving differential equations.
2. Know and apply the finite-difference method for solving mathematical problems.
3. Understand partial derivatives and apply methods for solving them in engineering problems.

IV. COURSE CONTENTS

1. INTRODUCTION
Ordinary differential equations / Properties / Numerical methods / Numerical solution of ordinary differential equations / Errors: local and global error / Errors estimates / Richardson formula.

2. INITIAL VALUE PROBLEMS
First-order initial value problems / Existence and uniqueness theorem / Order-n initial value problems / Order reduction / Numerical methods for first-order initial value problems / Fixed step-size methods / Euler method, Taylor method, Runge-Kutta method / Butcher table for Runge-Kutta method / Extrapolation method. Gragg-Bulirsch-Stoer / Variable step size methods / Euler-Heun method / Bogacki-Shampine method / Runge-Kuuta-Fehlberg method.

3. STABILITY AND RIGIDITY IN INITIAL VALUE PROBLEMS
Stability / Dahlquist test equation / Amplification factor / Stability region / Implicit methods with fixed step size / Euler implicit method / Trapeze implicit method / Rigidity / Implicit methods with variable step size / Rosenbrock modified implicit method.

4. FINITE DIFFERENCE METHOD
Derivatives numeric approximation: forward, backward, central / Solution of two-point boundary value problems / Dirichlet, Neumann and Robin boundary conditions / Solutions of Sturm-Liouville problems / Time-independent Schrodinger equation (one dimensional) / Eigenvalues and eigenstates in finite potential wells.

5. PARTIAL DERIVATIVE EQUATIONS

Lineal partial derivatives equations / Second order partial derivatives equations / Classification / Elliptic equations. Poisson equation / Gauss elimination method / Parabolic equation. One-dimensional heat diffusion equation / Explicit method / Implicit method / Hyperbolic equation. One-dimensional wave equation / Stability of time-dependent partial differential equations / Von Neumann criteria.

V. COMPUTER LABORATORY

Computer programs implementing algorithms and numerical methods.

VI. METHODOLOGY

The course takes place in sessions of theory and computer laboratory. In theory sessions, faculty presents the concepts, theorems, and applications. In practice sessions specialized 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 practice and computer laboratory experiences

VIII. BIBLIOGRAPHY

1. **Jaan Kiusalaas**
   Numerical Methods in Engineering
   Cambridge University Press, 2010.
2. **Joe Hoffman**
   Numerical Methods for Engineers and Scientists
   McGraw Hill Editorial, 2012.
3. **Richard Burden**
   Numerical Analysis
   International Thompson Editorial, 2002.