FACULTY OF **ENGINEERING**

DEGREE COURSE: **COMPUTER AND CONTROL ENGINEERING BS**

SUBJECT: NUMERICAL ANALYSIS

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OBJECTIVES

This course is aimed at learning numerical algorithms for solving linear equation systems, nonlinear equations and ordinary differential equations. Furthermore, the computer platform Matlab is presented as a software tool to implement numerical methods.

CONTENTS

a. Introduction
    1. Presentation of course
    2. Introductory notions
    3. Numbering systems
    4. Errors and their sources
    5. Error propagation
b. Overview of matrices and vector spaces
    1. Matrices: Definitions and properties
    2. Determinant and inverse of a matrix
    3. Matrix operations
    4. Special matrices and vector spaces
c. Solution of linear equation systems
    1. Generalities on linear equation systems
    2. Definitions and fundamental theorems
    3. Direct methods: basic concepts
    4. Gauss elimination algorithm
    5. Pivoting strategy
    6. Solution of linear systems by matrix operation
    7. Gauss-Jordan algorithm
    8. LU factorization
    9. Cholesky algorithm
    10. Iterative methods : basic concepts
    11. Gauss-Seidel algorithm
    12. Jacobi algorithm
    13. Relaxation SOR and gradient algorithms
d. Solution of non-linear equations
    1. Generalities on non linear equations
    2. Bisection method

3. False position method
4. Newton-Raphson method
5. Newton-Raphson method: weak points

e. Eigenvalues and eigenvectors
   1. Overview on eigenvalues and eigenvectors
   2. Eigenvalue localization
   3. Power method
   4. Inverse power method
   5. Inverse power method with shifting
   6. Jacobi method

f. Numerical solution of ordinary differential equations
   1. Generalities on differential equations
   2. One step method
   3. Euler method
   4. Multistep methods
   5. Numerical methods for solving differential equations governing forced vibrations of a single-degreee-of-freedom system

g. Matlab
   1. Introduction to Matlab
   2. Scalar operations
   3. Arrays and matrices
   4. Matrix operations
   5. Polynomials
   6. Functions
   7. Diagrams
   8. Algebric equations and linear systems
   9. Non linear equations
   10. Introductions to Matlab coding

LEARNING OUTCOMES

Ability to deal with basic problems of computer engineering and automation by means of numerical methods, namely those related to system analysis and automatic control.

ASSESSMENT

Written exam: multiple choice and open questions

RECOMMENDED TEXTBOOKS

Lecture notes are sufficient to pass the examination with top grades.
Suggested additional reading:

- K. J. Bathe and E. L. Wilson, Numerical Methods in Finite Element Analysis, Prentice-Hall, 1976
- Klaus-Jürgen Bathe. Finite Element Procedures in Engeneering Analysis. Prentice-Hall 1982
- Walter Gautschi. Numerical Analysis. Springer, 2012