UNIVERSITY of NICOSIA

Course Syllabus

Course Code	Course Title	ECTS Credits
MATH-342	Numerical Analysis II	8
Prerequisites	**Department**	**Semester**
MATH-341	Computer Science	FALL
Type of Course	**Field**	**Language of Instruction**
Elective	Mathematics	English
Level of Course	**Lecturer(s)**	**Year of Study**
1st Cycle	Nectarios Papanicolaou	3rd
Mode of Delivery	**Work Placement**	**Corequisites**
Face-to-face	N/A	None

Course Objectives:

The main objectives of the course are to:

- Cover matrix norms in detail.
- Discuss iterative methods for linear algebraic systems of equations. Analyze their stability and convergence rate.
- Introduce students to nonlinear systems of algebraic equations.
- Cover in depth the theory and applications of the numerical eigenvalue problem.
- Further develop function approximation by discussing techniques such as Hermite Interpolation, Splines and Least Squares.
- Further develop Numerical Integration. Discuss Gaussian and Romberg Integration in detail. Introduce adaptive Integration.

Learning Outcomes:

After completion of the course students are expected to be able to:

1. Implement iterative methods for linear algebraic systems of equations.
2. Utilize matrix norms to assess the convergence rate and stability of numerical methods for linear systems.
3. Find eigenvalues and eigenvectors of a square matrix numerically.
4. Apply Hermite Interpolation, Splines and Least Squares techniques to fit given data and approximate functions.
5. Implement and analyze advanced numerical integration methods.
6. Design numerical algorithms and implement them using high-level programming languages. Assess the results obtained using the appropriate theory.

Course Contents:

1. Numerical Linear Algebra Part I: Systems of Algebraic Equations
    a. Review of Linear Algebra
    b. Vector and Matrix Norms
    c. Direct Methods
        - Review of Gaussian elimination and LU-decomposition
        - Symmetric Positive Definite matrices and the Cholesky Factorization
        - Operation count
        - The Condition Number and Perturbations
    d. Iterative methods for linear systems
        - Diagonal dominance
        - Gauss-Seidel
        - Jacobi
        - SOR Method
    e. Methods for nonlinear systems of algebraic equations
        - Fixed point method
        - Newton's method

2. Numerical Linear Algebra Part II: The Numerical Eigenvalue Problem
    a. Review of eigenvalues, eigenvectors and orthogonality
    b. Gerschgorin Theorem
    c. Power Methods
    d. Householder's Method
    e. The QR Algorithm

3. Interpolation and Approximation
    a. Hermite Interpolation
    b. Splines
    c. Least squares
        - Data fitting
        - Linear least squares
        - Polynomial least squares approximation
    d. Stability of polynomial interpolation

4. Numerical Integration
    a. Gaussian Quadrature and Orthogonal polynomials
    b. Richardson Extrapolation
    c. Romberg Integration
    d. Adaptive Integration

Learning Activities and Teaching Methods:

Lectures, Homework and Programming Assignments.

Assessment Methods:

Homework, Midterm Exam, Programming Assignments, Final Exam.

Required Textbooks / Readings:

Title	Author	Publisher	Year	ISBN
An Introduction to Numerical Methods and Analysis (2nd Edition, also available as e-textbook)	J. F. Epperson	Wiley	2013	9781118367599

Recommended Textbooks / Readings:

Title	Authors	Publisher	Year	ISBN
Numerical Linear Algebra	L. N. Trefethen and D. Bau III	SIAM	1997	9780898713619
Elementary Numerical Anaysis (3rd edition)	K. Atkinson, W. Han	Wiley	2004	0471433373