University of Nicosia, Cyprus

Course Code	**Course Title**	**ECTS Credits**
MATH-342	Numerical Analysis II	8
Department	**Semester**	**Prerequisites**
Mathematics	Fall or Spring	MATH-341
Type of Course	**Field**	**Language of Instruction**
Elective	Mathematics	English
Level of Course	**Year of Study**	**Lecturer(s)**
1st Cycle	3rd	Dr Nectarios Papanicolaou Dr. Marios Christou
Mode of Delivery	**Work Placement**	**Co-requisites**
Face-to-face	N/A	None

Objectives of the Course:

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 non-linear systems of algebraic equations.
- Further develop function approximation by discussing techniques such as Splines and Least Squares.
- Cover in depth the theory and applications of the numerical eigenvalue problem.
- 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:

- Implement iterative methods for linear algebraic systems of equations.
- Utilize matrix norms to assess the convergence rate and stability of numerical methods for linear systems.
- Apply Splines and Least Squares techniques to fit given data and approximate functions.
- Find eigenvalues and eigenvectors of a square matrix numerically.
- Implement and analyze advanced numerical integration methods.
- 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
    - Review of Direct Methods
    - Matrix Norms
    - Diagonal dominance
    - The Cholesky decomposition
    - Iterative methods for linear systems
        - Gauss-Seidel
        - Jacobi
        - SOR Method
    - Operation count and rate of convergence
    - Methods for non-linear systems of algebraic equations
        - Fixed point method
        - Newton's method
2. Interpolation and Approximation
    - Splines
    - Least squares
        - Data fitting
        - Linear least squares
        - Polynomial least squares approximation
    - Stability of polynomial interpolation
3. The Numerical Eigenvalue Problem
    - Brief review of eigenvalues and eigenvectors
    - Gerschgorin Theorem
    - Power Methods
    - Householder's Method
    - The QR Algorithm
4. Numerical Integration
    - Gaussian Quadrature and orthogonal polynomials
    - Richardson Extrapolation
    - Romberg Integration
    - Quadrature with non-smooth Integrals
    - Adaptive Integration

Learning Activities and Teaching Methods:

Lectures, Homework and Programming Assignments

Assessment Methods:

Homework, Mid-Term Exam, Programming Assignments, Final Exam

Required Textbooks/Reading:

Authors	Title	Publisher	Year	ISBN
J. F. Epperson	An Introduction to Numerical Methods and Analysis (Revised Edition)	Wiley	2007	0470922486

Recommended Textbooks/Reading:

Authors	Title	Publisher	Year	ISBN
R. L. Burden, J. D. Faires	Numerical Analysis (9^{th} edition)	Brooks-Cole	2010	0538733519
K.Atkinson, W. Han	Elementary Numerical Anaysis (3^{rd} edition)	Wiley	2004	0471433373