UNIVERSITY of NICOSIA

Course Syllabus

Course Code	Course Title	ECTS Credits
MATH-343	Numerical Methods for Data Science	6
Prerequisites	**Department**	**Semester**
MATH-195, MATH-280 and COMP-240	Computer Science	Spring
Type of Course	**Field**	**Language of Instruction**
Elective	Mathematics	English
Level of Course	**Lecturer(s)**	**Year of Study**
1st Cycle	Nectarios Papanicolaou	2nd, 3rd
Mode of Delivery	**Work Placement**	**Corequisites**
Face-to-face	N/A	None

Course Objectives:

The main objectives of the course are to:

- Introduce students to the concepts of computational error, floating point arithmetic and asymptotic order.
- Cover in depth the theory and applications of numerical methods for solving nonlinear algebraic equations.
- Discuss direct methods for the solution of systems of linear equations in detail.
- Develop polynomial interpolation and cover data fitting via the least squares method.
- Introduce fundamental numerical differentiation techniques.
- Introduce students to Numerical Quadrature.
- Discuss the practical implementation of numerical algorithms using the Python programming language.

Learning Outcomes:

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

1. Use error and asymptotic order of convergence to assess numerical methods.
2. Implement approximate methods for finding the solution of nonlinear algebraic equations.
3. Apply direct methods to solve linear systems of algebraic equations.
4. Use polynomial interpolation and least squares to approximate functions and fit data.
5. Utilize finite differences to approximate derivatives of functions.

6. Apply fundamental numerical integration methods.
7. Design numerical algorithms and implement them using the Python programming language.

Course Contents:

1. Review of Calculus and Introductory Concepts
    a. Taylor's Theorem, the Mean Value and Extreme Value Theorems
    b. Error and Asymptotic Order
    c. Elementary Computer Arithmetic
2. Root Finding
    a. The Bisection Method
    b. Newton's Method
    c. The Secant Method
    d. Fixed Point Iterations
3. Numerical Solution of Linear Systems
    a. Review of Linear Algebra
    b. Gaussian Elimination and Pivoting
    c. Operation Counts
    d. LU Decomposition.
4. Approximation and Interpolation
    a. Lagrange Interpolation
    b. Least Squares Approximation
5. Numerical Differentiation
    a. Finite Difference Approximations to Derivatives
    b. Truncation Error
6. Numerical Integration
    a. Review of the Riemann Integral
    b. The Trapezoidal Rule
    c. Simpson's Rule
    d. The Midpoint Rule

Learning Activities and Teaching Methods:

Lectures, Assignments, Online Material.

Assessment Methods:

Theoretical and Programming Assignments, Midterm Exam, Final Exam.

Required Textbooks / Readings:

Title	Author(s)	Publisher	Year	ISBN
An Introduction to Numerical Methods and Analysis (2nd Edition, also available as e-textbook)	J. F. Epperson	Wiley	2013	9781118367599
Numerical Python (E-book available via UNic library)	R. Johansson	Apress Berkeley	2015	9781484205532

Recommended Textbooks / Readings:

Title	Author(s)	Publisher	Year	ISBN
Applied Numerical Methods with Python for Engineers and Scientists	S. Chapra and D. Clough	McGraw-Hill	2022	9781266651496
Numerical Mathematics and Computing (7th Edition)	W. Cheney and D. Kincaid	Cengage Learning	2012	9781133103714