Faculty of Eng. & Natural Sci.

ENS409-202302

Numerical Analysis

Instructor

Name	Email	Office	Phone	Office Hours
Mustafa Ünel	munel@sabanciuniv.edu	FENS-1066	9549	Before and after classes, or by appointment.

Course Content

This course covers the use of numerical computing techniques for mathematical and scientific problems. Topics include floating-point representation, approximations and computer arithmetic, error analysis, conditioning and stability, Taylor series, roots of nonlinear equations, Newton's method, curve fitting and interpolation, solutions to systems of linear equations using techniques such as LU decomposition, Gaussian elimination, Jacobi, Gauss-Seidel Iteration, eigenvalue problems, numerical integration and solutions to differential equations.

Objectives

To provide a solid background for understanding and implementing numerical analysis and related algorithms.

Recommend or Required Reading

Textbook

- Numerical Analysis, J. Douglas Faires and Richard L. Burden, Thomson Press, 2004 (9th edition is available as pdf)

Optional Readings

- Applied Numerical Methods with MATLAB for Engineers and Scientists, S. C. Chapra, 3rd Edt., Tufts University, McGraw-Hill, 2012.
- Numerical Methods for Engineers, S. C. Chapra and R. P. Canale, 6th Edition, McGraw-Hill, 2010
- Numerical Methods using MATLAB, J.H. Mathews & K.D. Fink, 4th Edt., Pearson, 2004.

Assessment Methods and Criteria

	Percentage (%)	Number of assessment methods
Homework	10	5
Individual Project	25	5
Midterm	30	1
Final	30	
Participation	5	

Course Outline

Analytical and exact methods can provide solutions for a limited class of problems. Practical real-life problems often require computational solutions of complicated mathematical problems for arbitrarily shaped geometries and complicated material properties. Computers and numerical methods provide an alternative for such complicated problems. This course will introduce numerical analysis for modeling various scientific problems. The advantages and drawbacks of various computational techniques will be provided. Students will gain hands-on experience for numerical solutions by developing simple computer codes.

Topics:

- Introduction to Numerical Methods
- Mathematical Preliminaries and Error Analysis
- Solution of Nonlinear Equations
- Interpolation
- Least Squares Regression
- Matrices and Systems of Linear Equations
- Numerical Differentiation and Integration
- Ordinary and Partial Differential Equations

Learning Outcomes

- Perform error analysis; compute absolute and relative errors, round-off and truncation errors; identify subtractive cancellation and error magnification in numerical computations

- Implement various root-finding algorithms for the solution of nonlinear equations

- Interpolate data using Lagrange and Newton polynomials

- Approximate noisy data using least squares regression techniques

- Develop computational algorithms for direct and iterative solutions of the system of linear equations

- Compute numerical derivatives and integrals using various approximations and improve the estimates using Richardson extrapolation

- Solve ordinary differential equations numerically using Euler, second and fourth-order Runge-Kutta methods

- Gain hands-on experience by developing Matlab programs for numerical problems.

Course Policies

- This is a physical-only course.
- More than 70% attendance earns participation points.
- Make-up will be given only for official excuses.