18.330: Introduction to Numerical Analysis
Fall 2023

Course Information

Time & Location: TR 9:30-11 in 2-135
Instructor: John Urschel
Email: urschel@mit.edu
Office Hours: M 8:30-9:30, W 1-2 in 2-279
Teaching Assistant: Tino Guillaume Damiani (office hours T 4-5 in 2-333B)

Course Description

This course analyzes the basic techniques for the efficient numerical solution of problems in science and engineering. Topics include root finding, interpolation, approximation of functions, integration, differential equations, and direct and iterative methods in linear algebra.

Prerequisites: Calculus II & 18.03. 18.06 is useful, but not necessary.

There is no official textbook. Here are four books (all available online) you may find useful:
Numerical Analysis by Burden and Faires (more accessible)
Numerical Analysis: A Graduate Course by Stewart (more computational)
Introduction to Numerical Analysis by Stoer and Bulirsch (a classic)
Numerical Analysis by Kress (more advanced)

Assignments & Grading

There will be seven problem sets and a final project. Each problem set will treat one of the seven major topics of the course (see schedule below) and contain six problems, two of which will require coding. Submit any four problems you want. You may collaborate with classmates and reference outside material, but you must write your own solutions and note your collaborators and sources for each problem set. **Late assignments will not be accepted** – to be granted an exception (due to illness or extenuating circumstance) please contact Student Support Services and have them contact me before the assignment deadline.

The final project will consist of a technical report on a numerical subject of your choosing that relates to the course material but has not been covered in depth in class or on a problem set. Further details will be provided as the semester progresses.

The course grade is determined by the following components:

Problem Sets	70% (10% each)
Final Project	30% (5% for an on-time proposal)

and assigned according to the scale: $90-100$ A, $80-89.9$ B, $70-79.9$ C, $60-69.9$ D, $0-59.9$ F. These cutoffs may be lowered at the discretion of the instructor. If you believe a problem set was graded incorrectly, let me know as soon as possible.

Tentative Schedule

The following is a *tentative* schedule for the course.

Topic	Dates	Brief Description
Fundamentals of Numerical Analysis	$9/7 - 9/14$	floating point arithmetic, normed spaces, error analysis, algorithm design
Direct & Iterative Methods for Solving Linear Systems	$9/19 - 9/28$	Gaussian elimination, pivoting strategies, Jacobi iteration, Gauss-Seidel method
Solving Non-Linear Equations	$9/28 - 10/12$	fixed point theorem, bisection method, Newton's method, secant method, Aitkin's Δ^2 method, polynomial root-finding
Eigenvalue Problems	$10/17 - 10/24$	power method, Householder reflections, QR algorithm
Function Approximation	$10/26 - 11/2$	polynomial interpolation, cubic splines, orthogonal polynomials
Numerical Differentiation & Integration	$11/7 - 11/14$	finite differences, Newton-Cotes formulae, Gaussian quadrature
Numerical Solution to Differential Equations	$11/16 - 11/28$	initial value problems, boundary value problems, introduction to partial differential equations
Additional Topics (time permitting)	$11/30 - 12/12$	depends on the interests of the class, may include: Krylov subspace methods, integral equations, finite element method, numerical optimization, least squares problems, Monte Carlo methods, automatic differentiation, interval arithmetic

Student Support Services

If a personal or medical issue is interfering with your studies, please contact your medical provider if you need medical attention, and do not hesitate to email me. If an illness or serious personal problem will cause you to miss a problem set or project, please discuss this with Student Support Services (phone 617-253-4861).

Student Disability Services

MIT is committed to the principle of equal access. Students who need disability accommodations are encouraged to speak with Kathleen Monagle, Associate Dean, early in the semester so that accommodation requests can be addressed in a timely fashion. You may also consult with Student Disability Services in 5-104, or at 617-253-1674. If you have already been approved for accommodations, please contact me as soon as possible so that we can work together to get your accommodation logistics in place.