Math 405/607E, Section 101, Fall 2026

Numerical Methods for Differential Equations

Instructor: Brian Wetton, MATX 1107, wetton@math.ubc.ca

Audience: The course is intended for 3rd and 4th year students in Science, Engineering, Commerce, or a quantitive Arts programme who wish to learn the basic numerical techniques they will require in business, industry, or graduate school. The course will also be useful to graduate students who have not taken basic numerical methods courses as part of their undergraduate training and who need these skills to do their research.

Undergraduate Prerequisites: Math 405 has a prerequisite of one of Math 256, Math 257, Math 316, Math/Mech 358, or Phys 312.

Graduate Credit: The graduate version (Math 607E) of this course has a prerequisite of some knowledge of differential equations (ordinary and partial). A project involving some more detailed numerical analysis or computation is required in addition to the undergraduate material.

Course Objectives: The primary objective of the course is to introduce the basic numerical techniques for solving ordinary and partial differential equations in a single course, which does not require any previous numerical courses as a prerequisite.

Marks (Math 405): 50% final, 30% midterm and 20% assignments

Marks (Math 607E): 40% final, 20% midterm, 20% assignments and 20% final project

Midterm Date: Wednesday, October 28 in class.

Assignments: There will be five challenging assignments. Some computation will be required. MATLAB is a high level mathematical computation package that is suitable for these computations, but other packages (Jupyter notebooks with Python) or basic computer languages can be used. Note that at least half of the questions on the midterm and final exam will be assignment questions with slight modifications.

Collaboration: Students can collaborate freely on assignments with each other and AI tools. All such collaboration must be acknowledged in the assignment submission.

Project: Required for the graduate version (Math 607E) of the course. Topics will be finalized the week after the midterm in consultation with the instructor. The project could be a computation related to the student's thesis work.

Text: No text. Written notes will be provided.

Material: Floating point approximation and condition number. Newton's method for nonlinear vector problems. Numerical optimization (Newton's method and steepest descent). Functional approximation by power series, piecewise polynomial and spectral techniques. Numerical integration (quadrature) and differentiation. Discretization techniques for differential equation boundary value problems: finite difference and spectral methods. Fast solution techniques: direct sparse solvers and iterative methods. Time stepping techniques for initial value problems. Finite difference approximation of heat, wave, and Poisson equations. Computational implementation is an important aspect of the course.