

Math 405/607E

2018W Term 1

Sept–Dec 2018

## Numerical Methods for Differential Equations

**Instructor:** Colin Macdonald, LSK 303c, [cbm@math.ubc.ca](mailto:cbm@math.ubc.ca)

**Web Page:** [www.math.ubc.ca/~cbm/math405/2018](http://www.math.ubc.ca/~cbm/math405/2018)

**First Lecture:** Thursday, Sept 6, 2018.

**Audience:** The course is intended for 3rd and 4th year students in Science or Engineering 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 and who need to learn these skills in order to do their research.

**Undergraduate Prerequisites:** Math 405 has a prerequisite of one of Math 256, 257, or 316.

**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 undergrad material.

**Course Objectives:** The primary objective is to introduce the basic numerical techniques for solving ordinary and partial differential equations. The course covers some theory but it is largely practical; a secondary goal is to become comfortable with software for numerical computing (such as Octave, MATLAB and Python) even if you have no previous experience with computing. Many illustrative software demos will be provided and we will use Git for collaborative software development.

**Text:** No official text. Written notes will be provided. Some suggestions of optional texts will be provided in lectures and on the web page.

**Material:** Newton's method for nonlinear problems. Approximation of functions (e.g., polynomial and piecewise polynomial). Numerical integration and differentiation. Discretization techniques for differential equations: finite difference, finite element, finite volume, and spectral methods. Stability, consistency and convergence. Time stepping techniques for initial value problems. Numerical linear algebra including direct and iterative methods. Software and implementation is an important aspect of the course.

**Marks (Math 405):** 40% final, 10% midterm and 50% assignments.

**Marks (Math 607E):** 30% final, 10% midterm, 40% assignments and 20% final project.

**Midterm Date:** Mid-to-late October in class (to be determined).

**Assignments:** There will be around five assignments. These are intended to be challenging. Computation will be required. Octave and MATLAB are two high-level mathematical computation packages that would be suitable for these computations. Some homework may involve Python programming on [ubc.syzygy.ca](http://ubc.syzygy.ca).

**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.

Updated: August 20, 2018.