Math 405 and Math 607E, Fall 2016

Numerical Methods for Differential Equations

Instructor: Colin Macdonald, LSK 303c, cbm@math.ubc.ca

Web Page: www.math.ubc.ca/~cbm/math405/2016

First Lecture: Thursday, Sept 08, 2016.

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 as part of their undergraduate training 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 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. The basic numerical methods (e.g., interpolation, numerical integration, numerical differentiation, numerical linear algebra and root finding) are introduced and then applied to the solution of ordinary and partial differential equations. This approach helps to contextualize the numerical methods and enables us to focus on applications of the methods to practical problems.

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

equation boundary value problems: finite difference, finite element and spectral methods. Fast solution techniques: direct sparse solvers and iterative methods. Time stepping techniques for initial value problems. Computational 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-Late October in class (to be determined).

Assignments: There will be around five assignments. These are intended to be challenging. Some computation will be required. Octave and MATLAB are two similar high-level mathematical computation package that would be suitable for these computations, but other packages or basic computer languages can be used.

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.