MTH 452/552. Numerical Solution of ODEs
Winter 2017

Professor. Adel Faridani, Kidder 294A, 541-737-5182.
E-mail: faridani@math.oregonstate.edu

Office hours. Will be determined on the first day of classes.

About the course. This course is an introduction to the numerical solution of systems of Ordinary Differential Equations (ODEs). Some of the most common numerical methods will be introduced and analyzed, and fundamental concepts such as finite difference approximations, consistency, zero-stability, convergence, stiffness, and absolute stability will be discussed. Most of the course will be concerned with initial value problems. Two–point boundary value problems will be discussed as time permits.

Prerequisites. The course can be used as an entry point into the MTH 451/551 - MTH 453/553 sequence, and therefore no background in numerical analysis will be assumed. Some familiarity with ODEs (MTH 256) and Linear Algebra (as covered in MTH 306 or MTH 341) is required. Practical work on the computer using the MATLAB problem-solving environment will be an integral part of the course, and therefore some programming experience is also required. However, with some extra effort the required level of MATLAB programming skills can be acquired with self-study of tutorials before classes begin or during the first week of classes (see also below). Students who are not sure about prerequisites are encouraged to contact me.

Textbook. *Finite Difference Methods for Ordinary and Partial Differential Equations* by R. L. LeVeque. The core of the course will be material corresponding to chapters 1, 5, 6, 7, and 8.

The material that students are expected to master will be covered in the lectures, and the function of the textbook is mainly to assist with understanding this material. The lectures will not necessarily always follow the text, so attendance at all lectures is very important. While I may often post my notes after a lecture, good note taking is nevertheless strongly recommended.

Objectives of the course and learning outcomes. The main objectives and learning outcomes are as follows. A successful student will ...

- Obtain both an intuitive and a working understanding of the numerical methods introduced during the course. This includes being able to choose a suitable method, assess its reliability and speed, and to implement it on a computer as well as using it in a 'hand' calculation for simple cases.

- Be familiar with a number of examples where ODEs are applied in science and engineering.

- Understand and be able to explain the meaning and significance of fundamental concepts such as finite difference approximations, truncation error, consistency, zero-stability, convergence, stiffness, and absolute stability.

- Be able to use the above concepts to identify numerical methods that are suitable for a given problem.

- Understand, and be able to apply, the mathematical techniques and theorems which are needed for analyzing the numerical methods. For example the basic existence and uniqueness theorems, Taylor's Theorem in several variables, and rewriting a given system of ODEs as a first order system of ODEs.

- Improve his/her programming skills and achieve a solid proficiency in using MATLAB, a modern interactive programming environment.

- Become an increasingly educated and thoughtful user of numerical software.

MATLAB. MATLAB is available for download on student's personal computers via a campus-wide license. For more information please see

http://is.oregonstate.edu/accounts-support/software/software-list/matlab

Furthermore, MATLAB is also available online for use with a web browser at matlab.mathworks.com, once you have created your free personal Matlab account as described in the link above.

Introductory tutorials on MATLAB are available online. See for example the 'Matlab Onramp' course at

`https://matlabacademy.mathworks.com/`

You will need to log in with your Matlab account to access this course.

Students unfamiliar with MATLAB are encouraged to work through this material before the term starts or during the first week of classes.

Exams. There will be one midterm (Wednesday, Feb. 8, in class) and a final exam (Wednesday, March 22, 9:30AM). A calculator is required for both exams.

Grading policy. There will be regular homework assignments. The homework will count 40 percent, the midterm 25 percent, and the final will count 35 percent towards your grade. If your midterm does not go well, you may make up for it in the final: If your final is *better* than your midterm, the midterm will be discarded and the final score will count 60 percent. If the final is not better than the midterm, it will count 35 percent and the midterm 25 percent.

In case you miss the midterm, the final exam will count in its place. Please contact me well in advance if you have a valid reason for requesting an exception from this policy.

The homework grades for MTH 552 will be obtained according to the following scheme.

Let s be $100\times$(points scored)/(total points).

A $75 \leq s$

B $60 \leq s < 75$

C $45 \leq s < 60$

D $30 \leq s < 45$.

Midterm and final exam will be designed such that grading can follow a similar scale. The exact grading scale for each exam will be announced in class.

University regulations require different expectations for MTH 452. MTH 452 students will do the same work but will be graded one grade higher than than the scheme above.

In order to complete the course at least one of the programming homework problems must be solved.