**Math 471: Introduction to Numerical Methods**  
Winter 2019, University of Michigan

**Instructor**  
Deniz Bilman, bilman@umich.edu, http://www-personal.umich.edu/~bilman

**Office Hours**  
M 10–11 AM, W 10–11 AM and 5–6 PM, @ 1830 East Hall

**Course Grader**  
Yuqi Jin, yuqijin@umich.edu

**Course Meeting Times**

Math 471 Section 1 meets MWF 8:00–8:50 AM in 1084 EH  
Math 471 Section 2 meets MWF 9:00–9:50 AM in 1084 EH

You can only attend the section you are enrolled in.

**Textbooks**

**Recommended text:**

**Prerequisites**

Differential equations (e.g. Math 216, 256, 286, or 316)
Linear algebra (e.g. Math 217, 417, or 419)

**Course Description & Goals**

This is a survey of the basic numerical methods which are used to solve scientific problems. A numerical method is an algorithm, or a sequence of steps, for solving a set of equations. These can be linear equations, nonlinear equations, or differential equations. We will study the accuracy, stability, and efficiency of the some of the basic methods. The emphasis is evenly divided between the analysis of the methods and their practical applications. Some convergence theorems and error bounds are proved. Scientific problems were traditionally investigated by theory and experiment, but now computer simulations are also being used in problems such as airplane design, weather prediction, modeling the spread of an epidemic, and improving the efficiency of solar cells, to cite just a few examples. There are software packages that can be used as a black box, but in this course we will look under the hood and see how the methods work.

The course also provides an introduction to MATLAB, an interactive program for numerical linear algebra, as well as practice in computer programming. One goal of the course is to show how calculus and linear algebra are used in numerical analysis.

**Topics**

A tentative list of topics to cover are (the indicated chapters are from the textbook by Bradie):

- Chapter 1: Floating Point Arithmetic and Error Propagation (1.2–1.4)
- Chapter 2: Rootfinding (2.1–2.7)
- Chapter 3: Systems of Equations & Numerical Linear Algebra (3.1–3.10)
- Chapter 5: Interpolation (5.1–5.8)
- Chapter 6: Numerical Integration (6.3–6.7)
- Chapter 7: Numerical Methods for Differential Equations (7.1–7.6)
- Chapter 8: Two-Point Boundary Value Problems (time-permitting)

**Alternative Courses**

Math 371 is a less sophisticated version intended principally for sophomore and junior engineering students.
Math 571 is mainly taken by graduate students, but should be considered by strong undergraduates.

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GRADING
Course work will be weighted according to the following percentages:

| homework assignments: 35% | midterm exam: 25% | final exam: 40% |

HOMEWORK
Homework will be assigned every 1-2 weeks. Some problems will require programming, for which MATLAB is recommended (you may also use Python). You are allowed (and in fact, encouraged) to work together on homework assignments, but you must write up your solutions independently. Your solutions may be typed or written by hand, but they should be clear and legible and show all of your work. The homework will be collected at the beginning of class on the due date. No late homework will be accepted. Late homework includes assignments handed in during or at the end of the class period on the due date. Please staple your homework before turning it in.

EXAMS
There will be one in-class midterm exam and one final exam. The midterm exam will be in class (50 or 55 minutes) and the final exam will last 2 hours. No calculators are allowed on the exams.

Midterm Exam: Monday, February 25, 2019, in class

The exam dates are absolutely firm. Travel plans will not be considered a sufficient excuse to take an examination on a different date.

DISABILITIES AND CONFLICTS
Any student with a documented disability should contact me as soon as possible so that we can discuss arrangements to fit your needs. In particular, a Verified Individualized Services and Accommodations (VISA) form must be provided to me at least two weeks prior to the need for a test accommodation. The Services for Students with Disabilities (SSD) Office (G664 Haven Hall; http://ssd.umich.edu/) issues VISA forms.

Students with conflicts or special exam-taking requirements should contact me via e-mail, with appropriate documentation if applicable, by Friday, January 25.

CANVAS WEBSITE
There is a Canvas site for the course (separate sites for each section):
Section 1: https://umich.instructure.com/courses/276724
Section 2: https://umich.instructure.com/courses/267308

Please verify by Monday, January 14 that you are able to access this site. Assignments and grades for the assignments will be distributed through this site.

ADVICE FOR STUDENTS
1. Questions are encouraged — if something is unclear during class, please ask, ask, ask, ask. Review your the notes after each class and make a list of points that are unclear. Ask me about these points either in class or office hours. Do not postpone understanding something.
3. Try to focus less on your course grade and focus on learning the subject. Ask me anything to help you understand the subject better.
4. Be in full control of your work. When a code you wrote works (i.e. gives you the “desired answer”) for example, make sure you understand completely why it worked instead abandoning it immediately.
5. Make the point above a habit. If you do not understand why a method, an algorithm, a piece of code works, you do not know know when it will fail. The consequences of such failures are known to be catastrophic:
   - Disasters Attributable to Bad Computing, by Doug Arnold: http://www-users.math.umn.edu/~arnold//disasters/disasters.html,
   - Collection of Software Bugs, by Thomas Huckle: https://www5.in.tum.de/~huckle/bugse.html.

Ann Arbor, January 2019