Syllabus
Applied Mathematics & Statistics 553.386
Scientific Computing: Differential Equations
Spring, 2020
(4 credits, EQ)

Description
A first course on computational differential equations and applications. Topics include floating-
point arithmetic, algorithms and convergence, root-finding (midpoint, Newton, and secant methods), numerical-
differentiation and integration, and numerical solution of initial value problems (Runge-Kutta, multi-
step, extrapolation methods, stability, implicit methods, and stiffness). Theoretical topics such as existence,
uniqueness, and stability of solutions to initial-value problems, conversion of higher order/ non-autonomous
equations to systems, etc., will be covered as needed. Matlab is used to solve all numerical exercises; no
previous experience with computer programming is required.

Prerequisites
Differential Equations (EN.553.291, AS.110.302, AS.110.306, or equivalent)
Calculus 3 (AS.110.202, AS.110.211, or equivalent)

Instructor
Professor Gregory Eyink, eyink@jhu.edu, url: http://www.ams.jhu.edu/~eyink/
Office: Whitehead 202D, 410-516-7201
Office hours: Mon - Wed 1:00-1:50 pm and by appointment???

Teaching Assistant
Phillip Kerger, pkberger@jhu.edu
Office: Whitehead 211F
Office hours: ???

Meetings
Lectures: Monday, Wednesday, Friday 10 –10:50 am, Whitehead 304
Section: Tuesday 9 – 9:50 am, Wolman MPR

Textbook
Required: R. L. Burden, J. D. Faires, and A. M. Burden Numerical Analysis, 10th Ed., Cengage Learning (2016). See https://sites.google.com/site/numericalanalysis1burden. We will
cover the following chapters in more or less detail, and supplemented with some additional material:

- Chapter 1: Mathematical Preliminaries and Error Analysis
- Chapter 2: Solutions of Equations in One Variable
- Chapter 3: Interpolation and Polynomial Approximation
- Chapter 4: Numerical Differentiation and Integration
- Chapter 5: Initial-Value Problems for Ordinary Differential Equations

Online Resources
Please point your browser to http://www.ams.jhu.edu/~eyink/SciCompODE for all assignments, solutions, and lecture handouts. Occasionally, the website will also be used to provide reminders and additional information. (Typically this info will also be transmitted to the class via email.) Please check the website frequently for updates.

Course Objectives
(1) Learn how computers represent numbers and how to estimate error in numerical computations
(2) Learn the mathematical algorithms underlying numerical software for solving ODE’s, as in Matlab, Octave, Python, etc.
(3) Learn basic Matlab programming skills, particularly for numerical solution of ODE’s
(4) Learn how to solve numerically the practical problems of differential equations arising in mathematics, science and engineering and to assess reliability of the solutions

Course Topics
• floating-point arithmetic
• algorithms and convergence
• root-finding
• interpolation theory
• numerical integration & differentiation
• numerical methods for ODE’s.
• basic MATLAB programming

Course Expectations & Grading
Grading: The student’s final grade will be based upon homework and exams. The breakdown will be:

<table>
<thead>
<tr>
<th>Item</th>
<th>Percent of Grade</th>
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</thead>
<tbody>
<tr>
<td>Homework</td>
<td>50%</td>
</tr>
<tr>
<td>Midterm Exam</td>
<td>25%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>25%</td>
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Throughout the semester the following grading rule will be used:

<table>
<thead>
<tr>
<th>Letter Grade</th>
<th>Percent of Total</th>
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</thead>
<tbody>
<tr>
<td>A-/A/A+</td>
<td>90-100%</td>
</tr>
<tr>
<td>B-/B/B+</td>
<td>80-89%</td>
</tr>
<tr>
<td>C-/C/C+</td>
<td>70-79%</td>
</tr>
<tr>
<td>D-/D/D+</td>
<td>60-69%</td>
</tr>
<tr>
<td>F</td>
<td>0-59%</td>
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</tbody>
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Homework: Homework will consist of problems covering material up to 2 days before the due date. Please review the Homework Submission Guidelines below. Homework cannot be accepted for credit after solutions have been posted on-line. If a homework is missed and there is a valid excuse, then it will be removed from the student’s total grade for the course, and the remainder of the homework assignments re-weighted.

Exams: The Final Exam will be cumulative, but focussed primarily on the material covered since the Midterm. There is no senior option for this course. Make-ups for the Midterm and Final Exams may be available if exams are missed due to illness or family emergency. Make-up exams are only available if discussed with the instructor at least 1 day before the date of the exam. If an emergency arises after that time and there is a valid excuse, then the exam will be removed from the student’s total grade for the course, and the remainder re-weighted accordingly. Proper documentation of the emergency must be presented before either of these options can be offered.
**Attendance:** Students are not formally penalized for missing lectures/sections. However, it is the student’s responsibility to arrange to obtain notes for any missed classes and to turn in any homework due on the date of the missed class.

**Homework Submission Guidelines**
Please make sure your name is on your homework submission. Please make sure to staple the pages of your submission together. Loose pages may be lost. Please write neatly. The unreadable is ungradable. Please submit your problems in the order they appear on the assignment sheet. Please make sure to show all work and document any assumptions you are making. If you use special computer software (e.g., MATLAB, Python, Excel, etc.) to complete your homework/project, please read, and adhere to, the Software Usage Guidelines (see below). Homework is due in class on the posted date unless otherwise instructed. Do not leave your homework in the instructor or TA mailboxes in rooms 212 or in the AMS main office. If you are unable to turn in your homework in class, please slide your assignment under the TA’s office door before the due date or submit the assignment by e-mail, but only if this has been approved in advance by the instructor.

**Software Usage Guidelines**
You may use any applicable software to do homework assignments, e.g. MATLAB, Python, Excel, etc. Please include not only printouts of results but also all relevant codes. The codes should be sent by e-mail to the TA or instructor (e.g. in a zipped directory). If you also print the codes out, then please try to save paper by printing double-sided or half pages (2-to-1, one-sided). The answers from the computer must include the requisite amount of explanation. Unless specifically instructed otherwise, you may use symbolic computation software for theoretical problems, but again you must include printouts of relevant code.

**Key Dates**
Key dates (exams, etc.) are at [http://www.ams.jhu/~eyink/SciCompODE/386schedule.html](http://www.ams.jhu/~eyink/SciCompODE/386schedule.html)

**Assignments & Readings**
Reading assignments are also at [http://www.ams.jhu/~eyink/SciCompLA/386schedule.html](http://www.ams.jhu/~eyink/SciCompLA/386schedule.html)
Dates given there are only approximate, and will vary somewhat from year to year.

**Ethics**
The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition.

In addition, the specific ethics guidelines for this course are:

1. If you work in a group you **must** write up your solutions separately. Anything that looks too much like someone else’s work is likely to be considered cheating. Such assignments will receive a grade of zero and you may be subject to other disciplinary action.

2. If you work in a group on coding for homework, the group cannot create a joint computer printout and copy it for all group members. Even if you work in a group, you must still do the software work yourself and turn in your own output.

3. You are free to use any online material (books, articles, Wikipedia pages, etc.) to assist you in the solutions of homework, but any such material must be cited in your submission with an appropriate reference (e.g. url). If material is taken without credit from an online (or any other) source, it will be considered plagiarism.

4. If the midterm or final exam are given as take-homes (which will be decided by class vote), then you must attest in writing that you have not been assisted by any classmate, friend or family member.

Report any violations you witness to the instructor.
You can find more information about university misconduct policies on the web at these sites:
- Undergraduates: studentaffairs.jhu.edu/student-life/student-conduct/resources-conduct-ethics/
- Graduate students: e-catalog.jhu.edu/grad-students/graduate-specific-policies/
Students with Disabilities
Any student with a disability who may need accommodations in this class must obtain an accommodation letter from Student Disability Services, 385 Garland, (410) 516–4720, studentdisabilityservices@jhu.edu.

ABET Outcomes
- Ability to apply mathematics, science and engineering principles (a).
- Ability to design a system, component, or process to meet desired needs (c).
- Ability to identify, formulate and solve engineering problems (e).
- Ability to use the techniques, skills and modern engineering tools necessary for engineering practice (k).