Math 224 (1366): Elementary Differential Equations
Spring 2017 Syllabus

Instructor: Peter Thomas, Yost 212 / pjthomas@case.edu

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Class meetings MWF 9:30-10:20 a.m., Bingham 304.

Office hours MWF 8:30-9:20 a.m., and by appointment (pjthomas@case.edu) Office: Yost 212.

Required text *Differential Equations* (fourth edition) by Blanchard, Devaney and Hall should be available from the University Bookstore. Please alert the instructor if the books run out. The textbook includes information for accessing DETools, a differential equations solver and demo suite created by the authors. See below under "Software".

Course Prerequisite Math 223, Calculus for Science and Engineering III.

Website Reading assignments and exercises will be available at through a google drive folder at

`https://drive.google.com/open?id=0B-JMPWjMi0mscDM2SzNSN1JLb3M`

A schedule of readings is on this spreadsheet

`https://docs.google.com/a/case.edu/spreadsheets/d/15_IexQpSkzF2fYQVK2BEonTLrRY__0fC1pa5fuGFlrY/edit?usp=sharing`

Some course materials may also be distributed using `canvas.case.edu`.

Communications Due to the large volume of e-mail directed to the instructor's CWRU e-mail account, please include "MATH 224" in the subject line of course-related e-mails.

Course Description & Goals The following description is given in the general bulletin:

> A first course in ordinary differential equations. First order equations and applications, linear equations with constant coefficients, linear systems, Laplace transforms, numerical methods of solution.

Since Newton, quantitative understanding of natural laws has often been expressed as relationships between rates of change of different variables, such as position and time, chemical concentration and time, population levels and time, amplitude and space, energy and temperature, and so on. Such laws are expressed in the language of differential equations, *e.g.*

$$du/dt = f(u,t), \tag{1}$$

and systems of such equations. Students in the course will explore classical, qualitative, and numerical approaches to finding exact and approximate solutions of differential equations such as (1). For most functions f arising in practice, there is no closed-form analytic solution. Digital computing has greatly expanded our ability to study the properties of numerical solutions closely approximating the exact solutions of differential equations. In addition, computers have increased our ability to visualize the solutions of equations and infer qualitative information about their behavior.

Differential equations is a core discipline for much of applied mathematics, and provides a bridge between the more abstract branches of mathematics and the real world of applications in the sciences. Differential equations is the culmination of the calculus sequence: it is the point where all the tools of the calculus can be brought to bear on significant physical, chemical and biological problems. A goal of the course will therefore be for students to practice applying mathematics to both abstract and concrete problems.

Another goal of the course is for students to develop familiarity with numerical methods for solving differential equations. Students will also gain experience with graphic representation of direction fields, trajectories and phase space representation of solutions.

A third goal for the course is for students to gain experience with the qualitative analysis of solutions of differential equations.

Finally, through written homeworks and exams students will have the opportunity to practice clear, concise communication of mathematical ideas.

Course Requirements The instructor will usually assign reading in Blanchard, Devaney and Hall to be done before coming to class. If a student must miss a class meeting due to religious observance, sporting event, illness or other, he or she is nevertheless responsible for material covered. I recommend making arrangements in advance with another student to get a copy of the day's notes in case of a missed class. Please inform the instructor of dates you must miss class well in advance so as to avoid quizzes or exams falling on those days.

Like mastering a sport, a language or a musical instrument, the only sure way to learn mathematics is by regular practice. The purpose of the reading assignments, in-class exercises, and homework assignments is to guide your weekly practice in differential equations. Daily homework assignments will be worth 10 points each, and are due at the beginning of class two class meetings after they are assigned. (Homework assigned on a Monday is due the following Friday, *et cetera*.) **Late homeworks will generally not be graded.**

There will be two fifty minute long midterm examinations, each worth 100 points. These exams are to be completed by the student alone without help from any source, animate or inanimate (this includes books, calculators, computers, notes, cellphones or other communications device, and of course other students.) The first midterm exam will be given in class on **Monday, February 27**, and will cover material in chapters one and two. The second midterm exam will be given in class on **Friday, April 7**, and will cover material in chapter three.

The final examination will be given on **Friday, May 1, from 4:00 p.m. - 7:00 p.m.**. This will be a cumulative exam, and will be worth 300 points. Makeup exams and rescheduled exams *will not be permitted* except in the case of documented medical or other emergency.

Time and effort: If you find that your work in this course occupies significantly more than nine or significantly less than six hours per week, you are welcome to discuss the situation with the instructor. If you find the course is not sufficiently fast paced for you, the instructor would be happy to suggest reading materials or research projects that go deeper into differential equations and dynamical systems theory than a typical 200-level course can.

Active Learning A growing body of research suggests that active involvement of students during class can be at least as effective a teaching method as traditional (teacher active, student passive) lecture. This is not a new idea (*cf.* John Dewey's philosophy of *learning by doing*). In this class we will often work in groups of up to five students to solve problems at the chalk board, with the instructor providing advice; on some occasions we will have use simulation technology (ODE tools or XPP); on some occasions there will be lectures as well.

Grading Scale Standards for grading are as described in the official faculty guide (see https://case.edu/ugstudies/documents/undergraduate-instructor's-manual.pdf).

Letter Grade	Meaning
A	Excellent
B	Good
C	Fair
D	Passing
F	Failing
I	Incomplete
AD	Successful audit
NG	Unsuccessful audit

Grades will be determined by the total number of points obtained on the final (300 points), the midterm exams (100 points each), and homeworks (normalized to 100 points total) during the semester.[1] The standards distinguishing "excellent" from "good", "fair" from "passing" and so on necessarily involve judgement on the part of the instructor. Hence I do not use predefined percentages as boundaries between different letter grades. But I will try my best to be reasonable and fair while upholding the high standards employers and graduate schools expect from this university.

Provisional grades based on homeworks and first exam will be provided in time for the midterm progress report.

Accessability During the semester I am prepared to meet individually with any and all students enrolled in this course. I would like especially to meet with students with disabilities who are registered with the Coordinator of Disability Services (368-5230) and who may need individual arrangements.

Supplemental texts Many textbooks have been written on differential equations. The following texts are a few of the instructor's favorites:

1. *Elementary Differential Equations and Boundary Value Problems*, Boyce and Di Prima. Another standard text on differential equations, Boyce and Di Prima gives a slightly more in depth treatment of the same topics we will cover.
2. *Nonlinear Dynamics and Chaos*, Strogatz. A very readable treatment of many of the same topics we will cover. Available in paper back and well worth it.

[1] Contingent on adequate grading support; this section has not yet been assigned a grader but should be soon.

3. *Differential Equations, Dynamical Systems, and an Introduction to Chaos*, Hirsch, Smale and Devaney. An advanced undergraduate / beginning graduate textbook going significantly deeper into topics related to those in this course.
4. *Linear Algebra and Its Applications*, Strang. A standard text in the theory of matrices and systems of linear algebraic equations, and a useful reference for when we work with systems of linear differential equations.

Software Although no particular software package is required for the course, some assignments will require finding numerical solutions of differential equations. Any of the following packages should prove useful in the course, so use whichever you are most comfortable with:

- *Matlab* is a general purpose numerical software package, also capable of doing symbolic computations. It is available through http://software.case.edu; it is also available in Nord Hall's public Engineering Lab.
- *Mathematica* is a general purpose symbolic software package, also capable of doing numerical computations. It is available through http://software.case.edu; it is also available in Nord Hall's public Engineering Lab.
- *XPP* is a numerical solver and visualization tool for ODEs in two dimensions. It is available as a free download from

  `http://www.math.pitt.edu/~bard/xpp/xpp.html`
- *dfield* and *pplane* are useful visualization tools for ODEs in one and two dimensions that were originally written as additions to *Matlab*. They are available as free downloads from

  `http://math.rice.edu/~dfield/`

  Platform independent java versions are now available from

  `http://math.rice.edu/~dfield/dfpp.html`

Please note: XPP, dfield and pplane are available for free for educational use only. Commercial users must contact the authors to discuss terms of use.

The DE Tools program provided with the textbook has many illustrative examples as well, and may be used for homework assignments. Please inform the instructor if you are unable to download it (for instructions, please see the preface to your textbook.)

Academic Integrity Contrary to common stereotypes, mathematics is an inherently social, cooperative activity. Many students learn best by discussing concepts, problems and techniques with their peers. I encourage you to work with one or two other students in the course outside of class to understand the course material, discuss ways of solving problems, and strategies for computer implementations. The main purpose of the homework exercises is for you to practice and become comfortable with the course material.

Your collaborations should stop at the point where you begin the final writeup of an assignment. If an assignment involves writing computer code or working through a computer exercise, you should do so on your own. As in any scholarly work, when you do obtain outside help you must acknowledge it. (*E.g.* "by using the orthogonality of the eigenvectors (suggested by Jane Student), we can establish that ..."; if writing computer code you can use comments to indicate *e.g.* "this algorithm occurred to me while discussing the problem with

Joe Student" where appropriate.) Such an acknowledgment will never lower your grade; it is required as a simple matter of intellectual fairness. (I adapted this paragraph from a similar one in the Fall 2004 syllabus of Physics 110 by Professor D. Styer, of Oberlin College, whom I hereby acknowledge.)

For more information on the University's ethics policy, please consult `http://studentaffairs.case.edu/handbook/policy/ethics.html`.