

Syllabus for Math 2280-001 Differential Equations

Spring 2015

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office hours: T 2:00-3:00 p.m, W 10:00-11:00 a.m. in LCB 204. We will have problem sessions on Thursdays, 8:35-9:25 a.m., location TBA. These are optional but encouraged. I am available by appointment as well.

Lecture: MWF 8:05-9:25 a.m. in LCB 215

Course website:

Daily lecture notes, assignments, quizzes, and exams will be posted on our public home page.

<http://www.math.utah.edu/~korevaar/2280spring15>

After the first week I will expect you to bring copies of the lecture notes to class if you plan to use them. They are an outline for the topics we will cover and the problems we will work out in class. Most students find the notes helpful; also that not having them is a hinderance to understanding the class material. My goal is to have notes posted at least 24 hours before class, so that you have ample time to print them out. Printing for math classes is free in the Math Department Rushing Student Center, in the basement of LCB.

Grades will be posted on your CANVAS course page; access via Campus Information Systems.

Textbook: *Differential Equations and Boundary Value Problems, Computing and Modeling*, by Edwards and Penney. You may use either the 4th or 5th editions, ISBN: 978-0-13-156107-6 or 978-0-321-79698-1. I will assign homework problems using the 5th edition, and will try to keep track of any HW changes between the two versions.

Final Exam logistics: Wednesday May 6, 8:00-10:00 a.m., in our classroom LCB 225. This is the official time on the University Final Exam Schedule.

Prerequisite: A grade of at least "C" in Math 2270, Linear Algebra.

Grading: There will be two midterm exams, Friday February 20 and Friday April 3, and each of these will count for 20% of your grade. Weekly homework and/or projects will count for a total of 20%, weekly quizzes given at the start of class on Fridays will count 10%, and the final exam will make up the remaining 30% of your grade. The value of carefully working the homework problems and projects is that mathematics (like anything) must be practiced and experienced to really be learned. Homework/projects also allow for more in-depth exploration, beyond exam preparation. The quizzes should help keep you caught up and highlight key exam topics. **Note:** In order to receive a grade of at least "C" in the course you must earn a grade of at least "C" on the final exam.

University dates to keep in mind: Wednesday January 21 is the last day to drop this class, Friday March 6 is the last day to withdraw. (These dates are easy to find on the University academic calendar.)

Course outline: Math 2280 is an introduction to ordinary differential equations, and how they are used to model problems arising in engineering and science. It is the second semester of the year long sequence 2270-2280, which is an in-depth introduction to linear mathematics. The linear algebra which you learned in Math 2270 will provide a surprising amount of the framework for our discussions in Math 2280, although this will not be apparent at first.

The semester begins with first order differential equations: their origins, geometric meaning (slope fields), analytic and numerical solutions, in Chapters 1-2. The logistic equation and various velocity and acceleration models are studied closely. The next topic area, in Chapter 3, is linear differential equations of higher order, with the principal application being mechanical vibrations (friction, forced oscillations, resonance). This is about the time your linear algebra knowledge will start being helpful.

Next we show how models of more complicated dynamical systems lead to first and second order *systems* of differential equations (Chapter 4), and study Euler's method for numerical solutions to help understand existence and uniqueness of solutions. We use eigenvalues and eigenvectors, matrix exponentials and general vector space theory, to explicitly solve these problems in Chapter 5. The concepts of phase plane, stability, periodic orbits and dynamical-system chaos are introduced with various ecological and mechanical models,

in Chapter 6. The study of ordinary differential equations concludes with an introduction to the Laplace transform, in Chapter 7.

The final portion of Math 2280 is an introduction to Fourier series. We will use them to re-study general forced oscillation problems, and may have time to survey some applications to the classical partial differential equations: the heat, wave and Laplace equations. This material is covered in Chapter 9 of the text.

Strategies for success:

- Attend class regularly.
- Read or at least scan the relevant text book sections and lecture note outlines *before* you attend class.
- Ask questions and become involved.
- Plan to do homework daily; try homework on the same day that the material is covered in lecture; do not wait until just before homework and lab reports are due to begin serious work.
- Form study groups with other students.

Students with disabilities:

The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building, 581-5020 (V/TDD). CDS will work with you and the instructor to make arrangements for accommodations. All information in this course can be made available in alternative format with prior notification to the Center for Disability Services.

Week-by-Week Topics Plan

Topic schedule is subject to slight modifications as the course progresses, but exam dates are fixed.

- Week 1:** 1.1-1.4; differential equations, mathematical models, integral as general and particular solutions, slope fields, separable differential equations.
- Week 2:** 1.4-1.5, 2.1; separable equations cont., linear differential equations, mixture models, population models.
- Week 3:** 2.2-2.6; equilibrium solutions and stability, acceleration-velocity models, numerical solutions.
- Week 4:** 2.5-2.6, 3.1-3.2; numerical solutions cont., introduction to higher order linear differential equations.
- Week 5:** 3.3-3.5; homogeneous linear differential equations and applications to unforced mechanical vibrations; nonhomogeneous differential equations
- Week 6:** 3.5; nonhomogeneous differential equations and review. **Midterm exam 1 on Friday February 20** covering material from weeks 1-6.
- Week 7:** 3.6-3.7, 4.1; forced oscillations, electrical circuits, introduction to systems of differential equations
- Week 8:** 4.1, 4.3, 5.1-5.2; first order systems of differential equations, numerical methods, analytic solution of homogeneous first order systems with eigenvalue and eigenvector computations, input-output models.
- Week 9:** 5.2-5.4; mechanical vibrations and second order systems.
- Week 10:** 5.5-5.6; multiple eigenvalue solutions, matrix exponentials.
- Week 11:** 5.7; nonhomogeneous linear systems and review **Midterm exam 2 on Friday April 3**, covering weeks 7-11 material.
- Week 12:** 6.1-6.4; non-linear systems of first order differential equations with applications to ecological models and nonlinear mechanical systems.
- Week 13:** 7.1-7.4; Laplace transform for linear differential equations and systems.
- Week 14:** 9.1-9.4; introduction to Fourier series, and a return to forced oscillations.
- Week 15:** review day.
- Week 16:** Finals week: comprehensive **final exam Wednesday May 6, 8:00-10:00 a.m. in regular classroom LCB 225. This is the University scheduled time.**