Syllabus for Math 2280-001 Differential Equations

Spring 2017

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office hours: (subject to change) M,W 2:00-3:00 p.m. in LCB 204.
Lecture: MWF 8:05-9:25 a.m. in LCB 215
Lab: T 8:35-9:25 a.m. in JTB 120

Course websites

Daily lecture notes and weekly homework assignments will be posted on our public home page.

http://www.math.utah.edu/∼korevaar/2280spring17

Most students find that using and annotating the notes is helpful in understanding the class material. Some lecture material is included in the notes and there are also large open spaces in which we will work out examples together. My goal is to have weekly class notes posted on or by the preceding Friday. This should give ample time for you to print them out or to download electronic versions that you can annotate. Printing for math classes is free in the Math Department Rushing Student Center, in the basement of LCB. After class I will post filled-in versions of the notes but it will still be to your benefit to have attended and actively participated in the discussion and work leading to the filled-in versions. Class discussion will often be related to homework and lab problems.

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

Textbook: *Differential Equations and Boundary Value Problems, Computing and Modeling, 5th edition*, by Edwards and Penney. ISBN=978-0-321-79698-1.

Final Exam logistics: Friday April 28, 8:00 -10:00 a.m., in our MWF classroom LCB 215. This is the University scheduled time and location.

Catalog description for Math 2280: Linear and nonlinear differential equations and systems of equations, with applications. Matrix exponential, fundamental solution matrix, phase-space and portraits, stability, initial- and boundary-value problems, introduction to partial differential equations. Requires familiarity with linear algebra. Includes theoretical and computer lab components.

Prerequisites: Linear Algebra, Math 2270. Although not a prerequisite, 2280 students would benefit from having taken multivariable calculus, 2210. They need an understanding of curves and tangent vectors to understand the geometric meaning of solutions of a system of differential equations. It is also important for them to have an understanding of partial derivatives.

Grading

Math 2280-001 is graded on a curve. **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. To see historical distributions of grades in my Math 2280 classes you can look at my old course home pages, on the exam pages.

Details about the content of each assignment type, and how much they count towards your final grade are as follows:

- Homework (25%): Homework from roughly three textbook sections is due every Friday at the beginning of class, based on lecture sections covered through the preceding Wednesday. All assignments will be posted on our public page, the Friday before they are due. Several problems per section will be randomly selected for grading. Two of a student's lowest homework scores will be dropped. Only hard-copy assignments will be accepted—no digital copies—and no late homework will be accepted.

- Lab attendance (5%): In the Tuesday labs you will work in groups, on selected problems from the homework. Generally the homework will be divided into two parts: drill-type problems and multi-step, often applied problems, that integrate several ideas at once. In addition to letting you check your basic skills, the lab will be a chance to get started on these latter problems in a group setting, where you can also develop your math-explaining and collaboration skills with potential study group partners. You may miss up to two labs with no penalty.

- Quizzes (10%): At the end of most Friday classes, a short 1-2 problem quiz will be given, taking roughly 10 minutes to do. The quiz will cover relevant topics from the week's lectures, homework, and lab section work. Two of a student's lowest quiz scores will be dropped. There are no makeup quizzes. You will be allowed and encouraged to work together on these quizzes.

- Midterm exams (30%): Two class-length midterm exams will be given, On Friday February 17 and Friday March 31. Review for the exams will occur either in lecture or in the lab sections, in the days before the exams. No midterm scores are dropped.

- Final exam (30%): A two-hour comprehensive exam will be given at the end of the semester. As with the midterms, a practice final will be posted. Please check the final exam time, which is the official University scheduled time. It is your responsibility to make yourself available for that time, so make any arrangements (e.g., with your employer) as early as possible.

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 shedule 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 17** 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 March 31**, 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: continued, and review day. Final exam Friday April 28, 8:00-10:00 a.m. in our MWF classroom LCB 215. This is the University scheduled time and location.