MATH 2280-1, Fall 2012
Introduction to Differential Equations

Instructor: Jingyi Zhu, 581-3236, zhu@math.utah.edu, LCB 335

Time and Place: MTWF 7:30 - 8:20 am, WEB 1230

Office Hours: MWF 1:30 - 2:30 pm, or by appointment.

Course Homepage: `www.math.utah.edu/~zhu/2280_12f.html`

Text: *Differential Equations and Boundary Value Problems, Computing and Modeling* by C. Henry Edwards and David E. Penney, 4th edition. ISBN: 9780131561076

Prerequisites: A grade of at least "C" in Math 2270 (linear algebra), and any of 1260, 1280, or 2210 (calculus through multivariable calculus).

Course Objectives: Math 2280 is an introduction to ordinary and partial differential equations, and how they are used to model problems arising in engineering and science. We will have an opportunity to participate in presenting, modeling, and solving many classical and more recent problems through differential equations, often with a time factor. The main goal is to relate a natural phenomenon to a mathematical framework involving derivatives, and eventually interpret the solutions so that we gain more understanding of the phenomenon in question.

Course Outline: 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, and it is therefore essential to have that knowledge handy so we are comfortable with that tool. The semester begins with first-order differential equations: their origins, geometric meaning (slope fields), analytic and numerical solutions, in Chapters 1-2. To provide a perspective that highlights the relevance, 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 (particularly the concept of eigenvalues) 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 to help understand existence and uniqueness of solutions, and provide the main idea in numerical 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 the classical partial differential equations: the heat, wave and Laplace equations, and to the use of Fourier series and separation of variable ideas to solve these equations in special cases. This material is covered in Chapter 9 of the text.

Coursework: The course consists of the following four components:

- Homework: Weekly homework will be assigned each Monday and collected on the following Monday afternoon, and a large proportion of the problems will be graded by a grader. It is encouraged for you to form study groups for discussing and working on homework, although you will each hand in your own papers. The Math tutoring center is in the Rushing Student Center, in the basement between LCB and JWB on Presidents Circle. You will be able to find tutors there who can help with Math 2280 homework (8 am - 8 pm Monday-Thursday and 8 am - 4 pm on Fridays). The page `www.math.utah.edu/ugrad/mathcenter.html` has more information.

- Projects: The subject of differential equations is driven by its applications, and the computer allows you to study interesting problems which are conceptually clear but computationally difficult. An important component of the course is to develop quantitative feelings for the solutions, and experimenting computer generated solutions is an effective way to achieve this. You will be encouraged (but not required) to do the computer projects in groups of 2-3 people, and each group may hand in a single solution.

- Midterm exams: Friday September 28 and Friday, Nov 9.

- Final exam: Friday, December 14, 2012, 8:00 - 10:00 am, in our regular class room. The final is comprehensive and it will cover all the materials in the course. The scheduled time is set by the University.

Problem Sessions: There will be some sessions led by the instructor to discuss exercise problems. The dates and time will be announced as we move along.

Grading: Homework assignments will count for 30% and projects will count for 10%, each midterm exam will count for 15%, and the final exam will count for 30%. You must take the final exam in order to receive a grade of "C" or better.

ADA Statement: The American with Disabilities Act requires that reasonable accommodations be provided for students with physical, sensory, cognitive, systemic, learning, and psychiatric disabilities. Please contact the instructor at the beginning of the semester to discuss any such accommodations you may require for this course.

Tentative Schedule

exam dates scheduled, daily topics subject to change

day	date	section	topics
M	Aug 20	1.1	introduction to differential equations
T	Aug 21	1.2	integrals as general and particular solutions
W	Aug 22	1.3	slope fields and solution curves
F	Aug 24	1.4	separable differential equations
M	Aug 27	1.4-1.5	separable differential equations and linear first order equations
T	Aug 28	1.5	linear first order equations
W	Aug 29	2.1	population models
F	Aug 31	2.2	equilibrium solutions and stability
M	Sept 3	none	Labor Day Holiday
T	Sept 4	2.3	acceleration-velocity models
W	Sept 5	2.4	Euler's method
F	Sept 7	2.5	analysis of Euler's method
M	Sept 10	2.6	Runge-Kutta method
T	Sept 11	3.1-3.2	introduction to linear differential equations
W	Sept 12	3.2-3.3	general solutions of linear equations
F	Sept 14	3.3	homogeneous equations with constant coefficients
M	Sept 17	3.3-3.4	mechanical vibrations
T	Sept 18	3.4	mechanical vibrations
W	Sept 19	3.5	particular solutions to nonhomogeneous equations
F	Sept 21	3.5	continued
M	Sept 24	3.6	forced oscillations and resonance
T	Sept 25	3.7	electrical circuits
W	Sept 26	chapters 1-3	review
F	Sept 28	chapters 1-3	first exam
M	Oct 1	4.1	first-order systems of differential equations
T	Oct 2	4.2	method of elimination
W	Oct 3	4.3, 5.1	numerical methods for systems, matrices and systems
F	Oct 5	5.2	eigenvalue/vector method for homogeneous systems
M-F	Oct 8-12	none	Fall Break

M	Oct 15	5.2	eigenvalue/vector method for homogeneous systems
T	Oct 16	5.3	second-order systems and coupled springs
W	Oct 17	5.3	continued
F	Oct 19	5.4	multiple eigenvalue solutions
M	Oct 22	5.4	continued
T	Oct 23	5.5	matrix exponentials and linear systems
W	Oct 24	5.5-5.6	nonhomogeneous linear systems
F	Oct 26	5.6	continued
M	Oct 29	6.1	non-linear systems and phase plane analysis
T	Oct 30	6.1	continued
W	Oct 31	6.2	almost linear systems
F	Nov 2	6.3	predator-prey systems
M	Nov 5	6.4	nonlinear mechanical systems
T	Nov 6	6.5	chaos in dynamical systems
W	Nov 7	chapters 4-6	review
F	Nov 9	chapters 4-6	second exam
M	Nov 12	7.1	Laplace transform
T	Nov 13	7.2	transforming initial value problems
W	Nov 14	7.3	translations and partial fractions
F	Nov 16	7.4	derivatives, integrals, and products
M	Nov 19	7.5-7.6	periodic functions and impulses
T	Nov 20	9.1	trigonometric series
W	Nov 21	9.2	Fourier series and convergence
F	Nov 23	none	Thanksgiving Holiday
M	Nov 26	9.3	sine and cosine series
T	Nov 27	9.4	applications of Fourier series
W	Nov 28	9.4	continued
F	Nov 30	9.5	heat equation
M	Dec 3	9.5	separation of variables
T	Dec 4	9.6	vibrating strings and one-dimensional wave equation
W	Dec 5	9.7	steady-state temperature and Laplace's equation
F	Dec 7	chapters 1-7, 9	review