MATHEMATICS 2280-1
Introduction to Differential Equations
SYLLABUS
Spring semester 2011

when: MTWF 8:35-9:25
where: LCB 215

instructor: Prof. Nick Korevaar
office: LCB 204
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office hours: MWF 2:30-3:20, and by appointment, LCB 204
problem session: Th 8:35-9:35 problem session, LCB 215.

course home page: www.math.utah.edu/ ~korevaar/2280spring11

text: *Differential Equations and Boundary Value Problems, Computing and Modeling*
by C.Henry Edwards and David E. Penney
ISBN = 9780131561076 (4^{th} edition)

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

course outline: Math 2280 is an introduction to ordinary and partial 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 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.

homework: when assigned from the text, homework will be collected each week on Fridays, and a large proportion of the problems will be graded. You will know the assignment due on Friday by Monday of the same week, at the latest. You are encouraged to make friends and study groups for discussing and working homework, although you will each hand in your own papers (and copying someone elses work won't be productive for actually learning the mathematics).

A portion of your homework will be in the form of computer projects, usually using the software package MAPLE. 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. 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.

The Math tutoring center is in the Rushing Student Center, in the basement between LCB and JWB on President's Circle. You will be able to find tutors there who can help with Math 2280 homework (8 a.m.- 8 p.m. Monday-Thursday and 8 a.m.- 4 p.m. on Fridays). The page *www.math.utah.edu/ugrad/mathcenter.html* has more information.

problem sessions: I will lead (optional) problem sessions each Thursday from 8:35-9:35, in LCB 215.

exams: There will be two in-class midterms (closed book, scientific calculator only), as well as a final exam. The dates are as follows:

exam 1: Friday February 18. Possible course material is chapters 1-3
exam 2: Friday April 1. Possible course material is chapters 4-6.
Final Exam: Friday April 29, 8-10 a.m. in our classroom LCB 215. The exam will cover the entire course. This is the University-scheduled time.

grading: Each midterm will count for 20% of your grade, the book homework and the projects will count for a total of 30%, 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. **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: Monday January 24 is the last day to add this class, Wednesday January 19 is the last day to drop it. Friday March 5 is the last day to withdraw. (All of these dates are easy to find from the University home page.)

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

Tentative Daily Schedule

exam dates fixed,
daily subject matter approximated

M	10 Jan	1.1	introduction to differential equations
T	11 Jan	1.2	integral and general and particular solutions
W	12 Jan	1.3	slope fields and solution curves
F	14 Jan	1.4	separable differential equations
M	17 Jan	none	Martin Luther King Day
T	18 Jan	1.4-1.5	and linear first order equations
W	19 Jan	1.5	linear DEs
F	21 Jan	2.1	population models
M	24 Jan	2.2	equilibrium solutions and stability
T	25 Jan	2.3	acceleration-velocity models
W	26 Jan	2.3	continued
F	28 Jan	2.4-2.6	numerical solution approximations
M	31 Jan	2.4-2.6	continued
T	1 Feb	3.1-3.2	introduction to linear differential equations
W	2 Feb	3.2-3.3	homogeneous equations with constant coefficients
F	4 Feb	3.3	continued
M	7 Feb	3.3-3.4	and mechanical vibrations
T	8 Feb	3.4	continued
W	9 Feb	3.5	particular solutions to nonhomogeneous equations
F	11 Feb	3.5	continued
M	14 Feb	3.6	forced oscillations
T	15 Feb	3.6	and resonance
W	16 Feb	3.7	electrical circuits
F	18 Feb	1.1-3.7	exam 1
M	21 Feb	none	President's Day
T	22 Feb	4.1	first order systems of differential equations
W	23 Feb	4.3, 5.1	numerical methods for systems and existence uniqueness theory
F	25 Feb	5.1-5.2	eigenvalue/vector method for solving first order DE systems
M	28 Feb	5.1-5.2	continued
T	1 Mar	5.3	second order systems and coupled springs
W	2 Mar	5.3-5.4	and multiple eigenvalue solutions
F	4 Mar	5.4	continued
M	7 Mar	5.4-5.5	matrix exponentials and linear DE systems
T	8 Mar	5.5	continued
W	9 Mar	5.5-5.6	nonhomogeneous linear systems
F	11 Mar	5.6	continued

M	14 Mar	6.1	non-linear systems and phase plane analysis
T	15 Mar	6.1-6.2	continued
W	16 Mar	6.2	predator-prey systems
F	18 Mar	6.3	continued
M	21 Mar	none	spring break!
T	22 Mar	none	spring break!
W	23 Mar	none	spring break!
F	25 Mar	none	spring break!
M	28 Mar	6.3-6.4	and nonlinear mechanical systems
T	29 Mar	6.5	chaos in dynamical systems
W	30 Mar	Review	chapters 4-6
F	1 Apr	Exam 2	chapters 4-6
M	4 Apr	7.1-7.2	Laplace transform
T	5 Apr	7.1-7.3	and transforming initial value problems
W	6 Apr	7.3-7.4	translations and partial fractions
F	8 Apr	7.4-7.5	derivatives, integrals, products, and periodic functions
M	11 Apr	7.5-7.6	impulses and delta functions
T	12 Apr	9.1-9.2	Fourier transform of periodic functions
W	13 Apr	9.1-9.2	continued
F	15 Apr	9.3	sine and cosine series
M	18 Apr	9.3-9.4	and applications
T	19 Apr	9.4	cont'd
W	20 Apr	9.5	heat equation and separation of variables
F	22 Apr	9.5	continued
M	25 Apr	9.6	vibrating strings and the wave equation
T	26 Apr	9.6-9.7	continued
W	27 Apr	9.7	steady state temperature and Laplace equation
F	29 Apr	FINAL EXAM	entire course, 8-10 a.m., in our classroom