MATHEMATICS 2250-1
Differential Equations and Linear Algebra
SYLLABUS
Fall semester 2012

Lecture 2250-1	MTWF 8:35-9:25 a.m.	WEB L 104
Instructor:	Prof. Nick Korevaar	
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Section 2250-6	Th. 8:35-9:25 a.m.	JFB 103
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Course home page: www.math.utah.edu/ ∼korevaar/2250fall12

Text: *Differential Equations and Linear Algebra*
by C.Henry Edwards and David E. Penney
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Lecture/section Format: MTWF lecture presentations in 2250-1 are complemented by the Thursday section 2250-6. This section will work with concepts related to the weekly homework problems and quizzes. Two of the Thursday section dates are reserved for midterm exams.

Prerequisites: Math 1210-1220 (or 1250-1260 or 1270-1280, i.e. single-variable calculus.) You are also expected to have learned about vectors and parametric curves (Math 2210, 1260, 1280, or Physics 2210 or 3210). Practically speaking, you are better prepared for this course if you've had multivariable calculus (1260, 1280, 2210, or equivalent), and if your grades in the prerequisite courses were above the "C" level.

Grading: Two midterm exams each count for 20% of your course grade. The final exam will count for 30% of your grade. Homework and projects will count for a total of 20% of the final grade. Friday quizzes will count for remaining 10% of your course grade. **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 August 29 is the last day to drop this class, Tuesday September 4 is the last day to add it. Friday October 19 is the last day to withdraw. (All of these dates are easy to find in the University academic calendar.)

Course Learning Objectives:

Be able to model dynamical systems that arise in science and engineering, by using general principles to derive the governing differential equations or systems of differential equations. These principles include linearization, compartmental analysis, Newton's laws, conservation of energy and Kirchoff's law.

Learn solution techniques for first order separable and linear differential equations. Solve initial value problems in these cases, with applications to problems in science and engineering. Understand how to approximate solutions even when exact formulas do not exist. Visualize solution graphs and numerical approximations to initial value problems via slope fields.

Become fluent in matrix algebra techniques, in order to be able to compute the solution space to linear systems and understand its structure; by hand for small problems and with technology for large problems.

Be able to use the basic concepts of linear algebra such as linear combinations, span, independence, basis and dimension, to understand the solution space to linear equations, linear differential equations, and linear systems of differential equations.

Understand the natural initial value problems for first order systems of differential equations, and how they encompass the natural initial value problems for higher order differential equations and general systems of differential equations.

Learn how to solve constant coefficient linear differential equations via superposition, particular solutions, and homogeneous solutions found via characteristic equation analysis. Apply these techniques to understand the solutions to the basic unforced and forced mechanical and electrical oscillation problems.

Learn how to use Laplace transform techniques to solve linear differential equations, with an emphasis on the initial value problems of mechanical systems, electrical circuits, and related problems.

Be able to find eigenvalues and eigenvectors for square matrices. Apply these matrix algebra concepts to find the general solution space to first and second order constant coefficient homogeneous linear systems of differential equations, especially those arising from compartmental analysis and mechanical systems.

Understand and be able to use linearization as a technique to understand the behavior of nonlinear autonomous dynamical systems near equilibrium solutions. Apply these techniques to non-linear mechanical oscillation problems and other systems of two first order differential equations, including interacting populations. Relate the phase portraits of non-linear systems near equilibria to the linearized data, in particular to understand stability.

Develop your ability to communicate modeling and mathematical explanations and solutions, using technology and software such as Maple, Matlab or internet-based tools as appropriate.

Assessment Details:

The midterm exams will be on Thursday September 27 and Thursday November 8, in our 2250-6 section room JFB 103. The final exam will be at the University specified time of Monday December 10, 8:00-10:00 a.m., in our classroom WEB L 104. The final will cover the entire course, although the material after the second midterm (Chapters 6-7,9) can be expected to have extra weight.

No midterm or final exam scores are dropped, and there are no makeup exams except for University sanctioned reasons. Midterm and final exams are closed-book and closed-note. No technology

except for scientific calculators may be used, and most students won't need these. These exams are designed to test you understanding of the course learning objectives.

Homework will be due every Friday at the start of class. Your initial assignment is due on the Friday of the first week. You will expected to submit written solutions for the homework problems that are to be turned in. Homework is partly a chance to drill the basic concepts but is also an important opportunity to explore problems and applications in more depth, more broadly and more realistically than you might expect on exams. It will often be appropriate to use technology to solve homework problems. Beyond their contributions to your course grades, the real value in carefully working the homework problems and projects is that mathematics (like anything) must be practiced and experienced to really be understood.

You are encouraged to make friends and study groups for discussing homework and class concepts, although you will each hand in your own solutions to the specified homework problems. Copying someone elses work is wrong and won't be productive for your own learning process. In particular, copying solutions from written solutions elsewhere is plagiarism.

The weekly quizzes will administered each week (except for those weeks when there is a midterm exam), at the start of class. They will cover some of the key concepts from the homework and lectures. The quiz problems will generally require less originality and be less complicated than the more challenging of the homework problems. Weekly quizzes provide a good diagnostic tool for you and me to gauge your understanding of key concepts, in preparation for the more consequential midterm and final exams. Your lowest three quiz scores will be dropped, and there are no makeup quizzes.

There will be several computer projects assigned during the semester. They will be written using the software package MAPLE, although you may use MATLAB or other software or internet sites for your solutions when appropriate. In addition, you will be asked to use technology to check various homework calculations throughout the course. We do not assume you have previous experience with mathematical software.

Tutoring Center: 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 2250 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.

There is a computer lab in the Rushing Student Center. You all have Math Department computer accounts by virtue of being enrolled in a Math class. There are other labs around campus where MAPLE, MATLAB, and other software is also available, for example at the College of Engineering and Marriott Library.

There will tutoring center support for the MAPLE in these projects (and for your other homework) as well. There will be introductory sessions to the Math lab and to MAPLE. These will be held in LCB 115, and times will be announced during the first week of classes.

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	20 Aug	1.1-1.2	differential equations and mathematical models
T	21 Aug	1.2	integral as general and particular solutions
W	22 Aug	1.3	slope fields and solution curves
F	24 Aug	1.3-1.4	and separable differential equations
M	27 Aug	1.4-1.5	continued
T	28 Aug	1.5	and linear first order differential equations
W	29 Aug	1.5, EP 3.7	and circuits
F	31 Aug	2.1-2.2	population models
M	3 Sept	none	Labor Day
T	4 Sept	2.1-2.2	equilibrium solutions and stability
W	5 Sept	2.2-2.3	and acceleration-velocity models
F	7 Sept	2.3	continued
M	10 Sept	2.4-2.6	numerical solution approximations
T	11 Sept	3.1-3.2	introduction to linear systems
W	12 Sept	3.1-3.2	matrices and gaussian elimination
F	14 Sept	3.3	reduced row echelon form
M	17 Sept	3.3-3.4	and matrix operations
T	18 Sept	3.3-3.4	matrix algebra
W	19 Sept	3.4-3.5	and inverses
F	21 Sept	3.5	continued
M	24 Sept	3.6	determinants
T	25 Sept	3.6	continued
W	26 Sept	1-3	review
Th	27 Sept	1-3.6	EXAM 1
F	28 Sept	4.1-4.3	linear combinations in $\mathbb{R}^n$
M	1 Oct	4.1-4.3	span and independence
T	2 Oct	4.3-4.4	subspaces
W	3 Oct	4.4	bases and dimension
F	5 Oct	5.1-5.2	intro to second order linear differential equations
M	8 Oct	none	Fall break
T	9 Oct	none	Fall break
W	10 Oct	none	Fall break
F	12 Oct	none	Fall break

M	15 Oct	5.1-5.2	general solutions to linear DEs
T	16 Oct	5.2-5.3	superposition; homogeneous DEs with constant coefficients
W	17 Oct	5.3	nth order linear DE's with constant coefficients
F	19 Oct	5.3	Euler's formula and expontial-trig solutions to DE's
M	22 Oct	5.4	unforced mechanical vibrations
T	23 Oct	5.4	and pendulum model
W	24 Oct	5.5	particular solutions to non-homogeneous DE's
F	26 Oct	5.5-5.6	continued; begin forced oscillations
M	29 Oct	5.6 and EP 3.7	continued and RLC circuit analog
T	30 Oct	10.1-10.2	Laplace transforms and initial value problems
W	31 Oct	10.1-10.2	continued
F	2 Nov	10.1-10.3	partial fractions and translations
M	5 Nov	10.2-10.3	continued
T	7 Nov	10.4-10.5	the unit step function; convolution
W	8 Nov	4,5,10,EP	review
Th	8 Nov	4,5,10,EP	EXAM 2
F	9 Nov	10.5, EP 7.6	periodic function and impulse function forcing
M	12 Nov	6.1-6.2	eigenvalues and eigenvectors
T	13 Nov	6.1-6.2	diagonalization
W	14 Nov	7.1	existence and uniqueness for first order systems of DEs
F	16 Nov	7.2-7.3	matrix systems of DE's; connection to eigenanalysis
M	19 Nov	7.3	applications of 1st order ODE systems
T	20 Nov	7.3-7.4	spring systems
W	22 Nov	7.4	forced undamped spring systems - practical resonance
F	23 Nov	none	Thanksgiving
M	26 Nov	7.4	continued
T	27 Nov	9.1	equilibria, stability and portraits for nonlinear systems
W	28 Nov	9.2	linearization near equilibrium solutions
F	30 Nov	9.2-9.3	and ecological models
M	3 Dec	9.3	continued
T	4 Dec	9.4	nonlinear mechanical systems
W	5 Dec	9.4	continued
F	7 Dec	review	review
M	10 Dec	FINAL EXAM	comprehensive; 8:00-10:00 a.m. WEB L 104