MATH 2250-7/8-9, Spring 2017
Differential Equations and Linear Algebra

Instructor: Jingyi Zhu, 581-3236, zhu@math.utah.edu, LCB 335
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Time and Place: MWF 1:25-2:45 pm, JWB 335 (lecture); and H 12:55-1:45 or 2:00-2:50 pm, WBB 207 (lab)

Office Hours: MTF 3:00 -4:00 pm, or by appointment.

Course Homepage: `www.math.utah.edu/~zhu/2250_17s.html`

Text: *Differential Equations and Linear Algebra: with Introductory Partial Differential Equations* by Edwards, Penney, and Haberman. ISBN-13: 9781269425579 (custom edition), ISBN: 9780136054252 (non-custom edition)

Lecture/Section Format: lecture presentations in 2250-7 are complemented by the Thursday sections 2250-8 or 2250-9. This section will work with concepts related to the weekly homework problems and quizzes.

Prerequisites: Math 1210-1220 or 1310-1320 (or 1250-1260 or 1311-1321, i.e. single-variable calculus). You are also expected to have learned about vectors and parametric curves (Math 2210, or Physics 2210 or 3210). Practically speaking, you are better prepared for this course if you have had multivariable calculus (1320, 1321, 2210, or equivalent), and if your grades in the prerequisite courses were above the C level.

Course Objectives: Math 2250 is an introduction to differential equations and linear algebra, two important mathematical subjects that are particularly essential in engineering problem solving, and how they are used to model problems arising in engineering and science. The specific objectives are summarized as follows.

- Use general principles to model a phenomenon and derive the relevant governing differential equations;
- Learn solution techniques and visualization tools for first order separable and linear differential equations;
- Learn matrix algebra techniques, in order to be able to compute the solution space to linear systems and understand its structure;
- 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;

- Learn how to use Laplace transform techniques to solve linear differential equations;

- Understand the concepts of eigenvalues and eigenvectors and be able to compute them. Apply them to find the general solution space for first and second order constant coefficient homogeneous linear systems of differential equations;

- Understand and be able to use linearization as a technique to study the behavior of nonlinear autonomous dynamical systems near equilibrium solutions;

- 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.

Coursework: The course consists of the following four components:

- Homework: Weekly homework will be assigned each Friday and collected on the following Friday 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 2250 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.

- Lab work and projects: The subject of differential equations is driven by its applications, and computers allow 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 goal. In the lab sessions, students will be able to read and understand problem descriptions, then be able to formulate equations modeling the problem usually by applying geometric or physical principles. Students will be able to select the appropriate operations, execute them accurately, and interpret the results using numerical and graphical computational aids.

- Two midterm exams: **Friday, February 17 and Friday, March 31**.

- Biweekly quizzes: a 10-minute quiz will be given every other Friday unless there is a midterm exam scheduled. They serve as quick reviews of the basic concepts learned over this period.

- Final exam: **Friday, April 28, 1:00 - 3:00 pm, in JWB 335**. The final is comprehensive and it will cover all the materials in the course. The scheduled time is set by the University.

- Exam/Quiz policies: all exams and quizzes are closed book and closed note, but long formulas will be provided during the exams. A scientific calculator will be allowed during the exam/quiz, but you can expect the required work of numerical calculation to be kept at minimum. Laptops, cell/smart phones and any other wireless devices are not permitted during the exams.

Grading: Homework assignments will count for 15%, lab sessions will count for 15%, each midterm exam will count for 15%, Friday quizzes totaled will count for 10%, and the final exam will count for 30%. You must take the final exam in order to receive a grade of "C" or better. Grading scores will be based on the following chart:

Table 1: Grading Scales

%-age	90-100	85-89	80-84	75-79	70-74	65-69	60-64	55-59	45-54	0-44
Grade	A	A-	B+	B	B-	C+	C	C-	D	E

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, **quiz dates denoted with (*)**

day	date	section	topics
M	Jan 9	1.1-2	Differential equations, Mathematical models
W	Jan 11	1.2-3	Integral as solutions, Slope fields
F	Jan 13	1.4	Separable differential equations
M	Jan 16		Martin Luther King holiday
W	Jan 18	1.5	Linear first-order equations
F	Jan 20 (*)	2.1	Population models
M	Jan 23	2.2	Equilibrium solutions and stability
W	Jan 25	2.3	Acceleration-velocity models
F	Jan 27	2.4	Numerical solution approximations
M	Jan 30	2.5-2.6	Numerical solution approximations continued
W	Feb 1	3.1	Introduction to linear systems
F	Feb 3 (*)	3.2	Matrices and Gaussian elimination
M	Feb 6	3.3	Reduced row echelon form
W	Feb 8	3.4	Matrix operations
F	Feb 10	3.5	Inverse matrices
M	Feb 13	3.6	Determinants
W	Feb 15		Review of Chapters 1-3
H	Feb 17		**Midterm exam 1**
M	Feb 20		Presidents' Day holiday
W	Feb 22	4.1-2	Vector space and subspaces
F	Feb 24	4.3	Linear combinations and independence
M	Feb 27	4.4	Bases and dimension
W	Mar 1	5.1	2nd-order linear differential equations
F	Mar 3 (*)	5.2	General solutions

Tentative Schedule
(continued)

day	date	section	topics
M	Mar 6	5.3	Homogeneous equations with constant coefficients
W	Mar 8	5.4	Mechanical vibration
F	Mar 10	5.5	Pendulum model
	Mar 12-18		Spring Break
M	Mar 20	5.6	Particular solutions to nonhomogeneous equations
W	Mar 22	10.1-2	Laplace transforms to solve initial value problems
F	Mar 24(*)	10.3	Partial fractions and translation
M	Mar 27	10.4-5	Derivatives/integrals, Convolutions
W	Mar 29		Review of Chapters 4, 5 and 10
F	Mar 31		**Midterm exam 2**
M	Apr 3	6.1	Eigenvalues and eigenvectors continued
W	Apr 5	6.2	Diagonalization
F	Apr 7 (*)	7.1	First-order systems
M	Apr 10	7.2	Matrix systems of DE's
W	Apr 12	7.3	Eigenanalysis
F	Apr 14	7.4	Mechanical vibration
M	Apr 17	9.1-2	Stability and phase plane, Almost linear systems
W	Apr 19	9.3	Linearization near equilibrium solutions
F	Apr 21(*)	9.4	Nonlinear mechanical systems
M	Apr 24		Course review
F	Apr 28		**Final exam**