Math 2250-001 (Fall 2017)

Differential Equations and Linear Algebra

Lectures: MTWF 7:30-8:20 am, JWB 335

Section 002 Lab: H 07:30-8:20 am JTB 320
Section 003 Lab: H 08:35-9:25 am JTB 110

Course Information

- Instructor: Gregory Handy
- Office: LCB (LeRoy Cowles building) 326
- Email Address: handy@math.utah.edu
- Office Hours: TBD and by appointment
- Prerequisites: C or better in (MATH 2210 OR MATH 1260 OR MATH 1280 OR MATH 1321 OR MATH 1320 OR ((MATH 1220 OR MATH 1250 OR MATH 1270 OR MATH 1311 OR AP Calculus BC score of 5) AND PHYS 2210 OR PHYS 3210)).
- Textbook: The textbook is a custom edition designed for the University of Utah. This book will also be used for the Partial Differential Equations course, MATH 3140/50. If you plan on taking that course, then you should buy the new custom edition (available at the bookstore).

Title :	Linear Algebra & Differential Equations Custom Edition
Authors :	C. Henry Edwards & David E. Penney
ISBN :	9781269425575

  If you do not plan on taking MATH 3140/50, then the 3rd edition, *may* suffice. I don't know if there are any changes in the numbering of exercises. You will need to check with a fellow student who has the custom edition.

- Class website: **Canvas** will be used regularly (posting homework, grades, etc.)

Technology: Calculators will not be allowed on quizzes or exams. Students are not expected to have prior programming experience, but will be required to run portions of code that will be provided in lecture and lab. The code will use the following programs: MATLAB, Maple, and Mathematica. These programs are great resources to check homework assignments prior to submitting them for evaluation. I encourage you to review your work before instructor evaluation.

Grading Policy:

- Homework (10%), and Quizzes (15%):
  - There will be weekly homework assignments. The assignments will be posted on **Canvas** and will be **due on Wednesdays at the beginning of class**. Be sure to show all work. Optional problems will also be posted, and while they will not be graded, they are fair game for exams and quizzes.
  - Solutions to the homework will be posted online the day they are due, and therefore, late homeworks will not be accepted.
  - Each Friday there will be a ~15-20 minute quiz on that week's homework.
  - The two lowest quiz grades will be dropped. Due to this policy, there will be no make-up quizzes.

- Weekly Lab (5+15 = 20%):
  - Attendance to the lab section is required, and will count for 5% of a students total grade.
  - The remaining 15% of the lab grade will be determined by the lab submissions that will be graded.
  - The policies, grading criteria, and expectations of the lab will be communicated by the lab instructor during the first week. Questions about the content or grading of the lab should be directed toward the lab instructor.
- Two In-class Exams (2×15 = 30% total):
  - Students will have two in-class exams, fifty minutes in length, which will make up a total of 30% of your course grade.
  - The dates of the exams are **September 29 and November 10**.
  - Make-up midterms will not be offered unless the student notifies me before the day of the exam that he/she will be unable to attend and provides documented proof of significant illness, etc.
- Final Exam (25%)
  - The final exam will be given on **Friday, December 15, 08:00 a.m.-10:00 a.m.** in JWB 335.
  - You will not be allowed to make-up the final exam with the exception of truly extreme circumstances.
- Grading Scale

A	A-	B+	B	B-	C+	C	C-
$> 93\%$	(93-90]%	(90-87]%	(87-83]%	(83-80]%	(80-77]%	(77-73]%	(73-70]%

D+	D	D-	E
(70-67]%	(67-63]%	(63-60]%	$< 60\%$

  - This scale may be adjusted to benefit all students of the class.

Responsibilities: All students are expected to maintain adult and professional behavior in the classroom. Please respect your classmates by not engaging in idle chatter, using your cell phone, or otherwise creating distractions. More importantly, students are prohibited by the **Student Code** from cheating, as well as committing acts of fraud, vandalism, or theft.
Part of my responsibilities is maintaining a classroom conductive to learning and enforcing responsible classroom behavior. This instructor will take disciplinary actions, beginning with verbal warnings and ultimately progressing to dismissal from this class and a failing grade. Students have the right to appeal such action to the Student Behavior Committee.

Extra Help: You may find that you need some extra help beyond what the class can provide. There are several tutoring services available. The Math Department has a free drop-in tutoring center located in the T. Benny Rushing Mathematics Center. Information about the center can be found at http://www.math.utah.edu/ugrad/tutoring.html. For more personalized attention, the ASUU Tutoring Center (www.sa.utah.edu/tutoring) provides both individual and group tutoring at reasonable rates.

ADA Statement: 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 & Access, 162 Olpin Union Building, 801-581-5020. CDA will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in alternative format with prior notification to the Center for Disability & Access.

Important Dates:

Classes begin	Monday, August 21
Last day to add without a permission code	Friday, August 25
Last day to drop (delete) classes	Friday, September 1
Last day to add, elect CR/NC, or audit classes	Friday, September 1
Last day to withdraw from classes	Friday, October 20
Last day to reverse CR/NC option	Friday, December 1
Classes end	Thursday, December 7
Final Exam	Friday, December 15

Course Goals and Description:
A major goal of Math 2250 is to master the basic tools and problem solving techniques important in differential equations and linear algebra. These basic tools and problem solving skills are described below.

Tools and skills:

- 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.
- Manage to utilize 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, 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 utilize 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.

Problem solving fluency

- 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. Solving a problem often requires a series of transformations that include utilizing the methods of calculus. Students will be able to select the appropriate calculus operations to apply to a given problem, execute them accurately, and interpret the results using numerical and graphical computational aids.
- Students will gain experience with problem solving in groups. Students should be able to effectively transform problem objectives into appropriate problem solving methods through collaborative discussion. Students will also learn how to articulate questions effectively with both the instructor and TA, and be able to effectively articulate how problem solutions meet the problem objectives.

Tentative Lecture Schedule

Week 1: §1.1-1.4 — math models, general/particular solutions, slope fields, separable equations.
Week 2: §1.4-1.5, §2.1-2.2 — linear equations, circuits, mixture models, population models.
Week 3: §2.2-2.4 — equilibria, stability, acceleration-velocity models, numerical solutions.
Week 4: §2.5-2.6, §3.1 — numerical schemes, linear systems;
Week 5: §3.1-3.4 — linear systems, matrices, Gaussian elimination, reduced row echelon form
Week 6: §3.5-3.6 — matrix inverses, determinants. **midterm exam 1 on material from weeks 1-5**
Week 7: §4.1-4.4 — vector spaces, linear dependence, span, subspaces, bases and dimension.
Week 8: §5.1-5.3 — 2nd order DEs, general solutions, superposition, homogeneity, constant coefficients.
Week 9: §5.4-5.6 — mechanical vibrations, pendulums, solutions to non-homogeneous problems.
Week 10: §5.6, §10.1-10.3 — forced oscillations, resonance, Laplace transforms.
Week 11: §10.4-5 — unit steps, convolutions. **midterm exam 2 on material from weeks 6-10**
Week 12: §6.1-6.2, §7.1 — impulse functions, eigenvectors/values, 1st order systems.
Week 13: §7.2-7.4 — matrix systems, eigen-analysis, spring systems, forced undamped systems.
Week 14: §7.4, §9.1-9.3 — equilibria, stability, phase portraits, ecological models.
Week 15: §9.3-9.4 — population models, nonlinear mechanical systems.
Week 16: finals week

Disclaimer: This syllabus has been created as a preview to the course and I have tried to make it as accurate as possible. However, I reserve the right to make reasonable changes to the above policies.