MATH 2250-001
Differential Equations & Linear Algebra
Syllabus

General Information

Instructor: Samantha Linn
Email: linn@math.utah.edu
MATH 2250-001 lecture: 7:30-8:20am MTWF, AEB 350
Samantha's office hours: TBD

Lab TA: Kees McGahan
Email: mcgahan@math.utah.edu
MATH 2250-002 lab: 7:30-8:20am Th, JWB 333
MATH 2250-003 lab: 8:35-9:25am Th, LCB 215
Kees' office hours: TBD

Textbook: Differential Equations and Linear Algebra (ISBN-13: 978-0134497181). You should have received an email from the Inclusive Access program that gives you the option to OPT OUT if you do not wish to buy the textbook through this program and be charged their textbook fee. If you do nothing then you will be automatically OPTED IN and charged the fee. You are welcome to acquire the textbook however you'd like (including sharing among your peers), but be cognizant of the fact that your weekly homework problems will come from the book.

JupyterHub: https://tljh.math.utah.edu

Important Dates

- First class: Monday Jan 10
- Holiday (no class): Monday Jan 17
- Drop deadline: Friday Jan 21
- Midterm 1: Friday Feb 18 (week 6)
- Holiday (no class): Monday Feb 21
- Withdrawal deadline: Friday Mar 4
- Spring break (no class): Mar 7-11
- Midterm 2: Friday Apr 8 (week 12)
- Last class: Tuesday Apr 26
- Final exam: Thursday Apr 28, 10:30am-12:30pm in AEB 350

Evaluating your work

Homework (20% of grade): Homework is due on Tuesdays at 11:00pm and roughly three problems per homework will be randomly selected for grading by the grader. Your lowest two homework scores will be dropped.

Lab (17% worksheets, 3% attendance): Lab worksheets are due on Wednesdays at 11:00pm. The lab is 20% of the designated class time and thus 20% of your grade. The specifics of lab worksheet and attendance grading is determined by the TA, Kees.

Quizzes (10%): Quizzes covering relevant topics in the week's lectures and lab will be given the first 5-10 minutes of each Friday's lecture, not including exam days. They will consist of one or two questions each and full credit will be given based on effort (not correctness). Your lowest two quiz scores will be dropped.

Exams (15% midterm 1, 15% midterm 2, 20% final): Midterm and final exam dates are specified above. Two 50-minute midterms will be given. A practice exam will be posted about a week prior to the midterm that will cover the same material. Review of the practice exam will occur both in lecture and lab. A two-hour comprehensive final exam will be given at the end of the semester. As with the midterms, a practice final will be posted about a week prior. It is your responsibility to be at the final exam at the University-designated time.

Extra credit (1%): There will be an extra credit opportunity involving your homework which will be further discussed in the first week of class. Completion of this work will result in a 1% increase in your total grade.

Letter grades: If X is your percentage grade, then $X \geq 93\% \implies$ A, $X \geq 90\% \implies$ A-, $X \geq 87\% \implies$ B+, $X \geq 83\% \implies$ B, $X \geq 80\% \implies$ B-, $X \geq 77\% \implies$ C+, $X \geq 73\% \implies$ C, $X \geq 70\% \implies$ C-, $X \geq 67\% \implies$ D+, $X \geq 63\% \implies$ D, $X \geq 60\% \implies$ D-, $X < 60\% \implies$ E. Letter grade assignments can be changed uniformly for all students, at the discretion of the instructor.

Grade adjustment: The final exam is comprehensive. Moreover, the last 4 weeks of material in the course will be over-represented on the final because it merges all prior topics into a coherent whole. If your performance on the final exam exceeds prior performance, the course grade may be adjusted upward to reflect your improvement. The specific rules for this grade adjustment will be devised by the instructor after the final exam is completed, and will be applied evenly to all students.

Course Considerations

- You must abide by the Student Honor Code. During exams and quizzes, you are not permitted to collaborate with each other, or communicate or seek help from third parties in-person or on the web. All work must be original, solely performed by you.
- You are highly encouraged to collaborate on homework or lab assignments to enhance your knowledge. However, the work you submit must reflect your own knowledge (i.e., no copying others' work or letting others copy you). Instances of academic dishonesty will result in a zero on that homework, lab, quiz, or exam. Depending on the severity, it may be reported to the department.
- Exams, homework, and labs will be scored on gradescope.com. Regrade requests (in Gradescope, not email) must be lodged in a timely fashion within a week of grade posting. Final exams will be posted and three days will be allotted to lodge regrade requests before final scores are posted. Regrade requests may involve crafting an argument for why you deserve more points. All regrade requests will be considered but should be based on the facts of the problem, the rubric employed, and the work given on the page of the exam, but not what you intended to write, or thought, or any other rationales. The goal of grading is to fairly apply a grading procedure to every student, so, a regrade request may result in an increase, decrease, or no change in score.

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.
- Use the basic concepts of linear algebra (linear combinations, span, independence, basis, dimension) to understand the solution space to linear equations, linear DEs, and linear systems of DEs.
- Understand the natural initial value problems for first order systems of DEs, and how they encompass the natural initial value problems for higher order and general systems of DEs.
- 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 Python or MATLAB.
- Read and understand problem descriptions, then formulate equations modeling the problem usually by applying geometric or physical principles. Solving a problem often requires specific solution methods listed above. You will be able to select the appropriate operations, execute them accurately, and interpret the results using numerical and graphical computational aids.
- Gain experience with problem solving in groups. You should be able to effectively transform problem objectives into appropriate problem solving methods through collaborative discussion. You will also learn how to articulate questions effectively with both the instructor and TA, and be able to effectively convey how problem solutions meet the problem objectives.

Other Important Things

Student Names and Personal Pronouns: Class rosters are provided to the instructor with the student's legal name as well as preferred first name (if previously entered by you in the Student Profile section of your CIS account). While CIS refers to this as merely a preference, I will honor you by referring to you with the name and pronouns that feels best for you in class, on papers, exams, group projects, etc. Please advise me of any name or pronoun changes (and update CIS) so I can help create a learning environment in which you, your name, and your pronouns will be respected. If you need assistance getting your preferred name on your UIDcard, please visit the LGBT Resource Center Room 409 in the Olpin Union Building.

Undocumented Student Support: Immigration is a complex phenomenon with broad impact—those who are directly affected by it, as well as those who are indirectly affected by their relationships with family members, friends, and loved ones. If your immigration status presents obstacles to engaging in specific activities or fulfilling specific course criteria, confidential arrangements may be requested from the Dream Center. Arrangements with the Dream Center will not jeopardize your student status, your financial aid, or any other part of your residence. The Dream Center offers a wide range of resources to support undocumented students (with and without DACA) as well as students from mixed-status families. To learn more, please contact the Dream Center at 801.213.3697 or visit dream.utah.edu.

Students With Disabilities: 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 Services, 162 Olpin Union Building, 581-5020 (V/TDD). CDS will work with you and the instructor to make arrangements for accommodations. All information in this course can be made available in alternative format with prior notification to the Center for Disability Services.

Wellness Statement: Personal concerns such as stress, anxiety, relationship difficulties, depression, cross-cultural differences, etc., can interfere with a student's ability to succeed and thrive at the University of Utah. For helpful resources contact the Center for Student Wellness at www.wellness.utah.edu or 801-581-7776.

Addressing Sexual Misconduct: Title IX makes it clear that violence and harassment based on sex and gender (which includes sexual orientation and gender identity/expression) is a Civil Rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran[1]s status or genetic information. If you or someone you know has been harassed or assaulted on the basis of your sex, including sexual orientation or gender identity/expression, you are encouraged to report it to the University's Title IX Coordinator; Director, Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or to the Office of the Dean of Students, 270 Union Building, 801-581-7066. For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to police, contact the Department of Public Safety, 801-585-2677(COPS).

Campus Safety: The University of Utah values the safety of all campus community members. To report suspicious activity or to request a courtesy escort, call campus police at 801-585-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit safeu.utah.edu.

Tentative Class Schedule

- Week 1: (1.1-4) Introduction to DEs, integral as general and particular solutions, separable equations, and linear first order equations, slope fields
- Week 2: (1.4-5, 2.1-2) Circuits, mixture models, population models, acceleration-velocity models.
- Week 3: (2.2-4) DE analysis: Existence and uniqueness, equilibrium solutions and stability, bifurcations.
- Week 4: (2.5-6, 3.1) Numerical solutions: Euler, Heun's, linear systems
- Week 5: (3.1-4) Linear systems, Gaussian elimination, reduced row echelon form, matrix operations.
- Week 6: (3.5-6) Matrix inverses, determinants, review; Midterm 1 covering weeks 1-5.
- Week 7: (4.1-4) Vector spaces, linear combinations, span, independence, subspaces, bases and dimension.
- Week 8: (5.1-3) Second-order linear DEs, general solutions, superposition, homogeneity.
- Week 9: (5.4-6) Mechanical vibrations, mass-spring-damper models, particular solutions to non-homogeneous problems, forcing and resonance.
- Week 10: (10.1-4) Laplace transforms, solving IVPs with transforms, partial fractions and translations.
- Week 11: (10.4-5) Discontinuous forcing, step functions, pulse functions, convolutions.
- Week 12: (6.1-2, 7.1) Eigenvalues and eigenvectors, diagonalization; Midterm 2 covering weeks 6-11.
- Week 13: (7.2-5) Matrix diagonalization, matrix ODE systems, non-homogeneous systems.
- Week 14: Mass-spring systems, forced undamped systems.
- Week 15: Review.