Instructor: Prof. Aaron Fogelson  
Email: fogelson@math.utah.edu

Lectures meet Monday, Wednesday, Friday 1:25 PM – 2:45 PM in BEH S 116. Laboratory meets on Thursdays with TA Trung Chau Email: chau@math.utah.edu

Section 17: 12:55PM-1:45 PM, ST 214
Section 18: 2:00 PM -2:50 PM, ST 214

Course website: check the Canvas course page in your CIS (you're in it now!)
Office phone: 801 581 8150
Fogelson's Office hours: Mondays and Tuesdays 3-4 PM in LCB 312 or by appointment

First Midterm: Friday, September 27
Second Midterm: Friday, November 8
Course Final: Thursday, December 12 1:00-3:00 PM in BEH S 116.

Drop Deadline: Friday, August 30
Labor Day (NO CLASS): Monday, September 2
Fall Break (NO CLASS) Saturday-Sunday, October 5-13
Withdraw Deadline: Friday, October 18
Thanksgiving Break (NO CLASS): Thursday-Sunday, November 28 – December 1
Reading Day: Friday, December 6


The work you will complete in Math 2250 comprises weekly homework and quizzes, two midterm exams, and a comprehensive final exam. Homework will be turned in and quizzes will be given every Friday except during exam days and holidays. The three lowest homework scores will be dropped and the two lowest quiz scores will be dropped. Midterm exams will be given on scheduled Fridays.

Details about the content of each assignment type are as follows:

1. Homework: Roughly three textbook sections are due every Friday in class. The homework will typically cover lectures from the preceding week or two. If you click on a homework assignment, you will see listings of problems, about three of which will be randomly selected for grading by the grader. Three of a student's lowest homework scores will be dropped. Homework will only be accepted in class, no electronic copies. No late homework will be accepted.

2. Quizzes: At the end of every Friday class, a short 1-2 problem quiz will be given, taking roughly 10-15 minutes to complete. Alternatively, quizzes may be given online in the Canvas system which can be taken at a self-selected time on Friday during the day. The quiz will cover relevant topics covered in the week's lectures and in the lab section group work. Two of a student's lowest quiz scores will be dropped.
3. **Midterm exams**: Two 55-minute midterm exams will be given on select Fridays. 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 in the lab section.

4. **Final exam**: A two-hour comprehensive exam will be given. As with the midterms, a practice final will be posted about a week prior.

5. **Lab**: Every Thursday a Teaching Assistant- (TA) directed lab section will be held. These lab sections will have smaller class sizes, consisting of working on lab worksheet-reports. The lab worksheet-reports will tend to cover longer, more in-depth problems than that found in homeworks and exams, and will sometimes require use of instructor-supplied Maple or Matlab software to complete. The TA will be there to help guide students through the problems. Completion of worksheet-reports will require work outside of the lab hour. The lab work serves the the goal of learning complete problem-solving fluency (see below), where students will develop skills to solve problems involving multiple coordinated skills, including interpretation and identification of relevant variables and unknowns, operationalization of the question into a series of executable methods, and interpretation and communication of results. The lab represents 20% of the class time every week, and is worth 15% of your total grade.

6. **Extra help**: The TA will hold office hours in the Warnock Engineering Tutoring Lab (WEB 1705) and will be available for any questions, especially for helping complete lab assignments. TAs from other Math 2250 sections will also hold their office hours in the tutoring lab. These TAs will be familiar with your lab assignments and homework and should offer a broad time availability for any help you may need.

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

**Course Learning Objectives:**

**The Basic Topics**

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.

**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 specific solution methods listed above. Students will be able to select the appropriate operations, execute them accurately, and interpret the results using numerical and graphical computational aids.

Students will also 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 convey how problem solutions meet the problem objectives.
**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.

**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 [safe.utah.edu](http://safe.utah.edu).

**Week by week guide (subject to change)**

Week 1: 1.1-4—Differential equations, mathematical models, integral as general and particular solutions, slope fields, separable differential equations

Week 2: 1.4-5, 2.1-2—Separable equations cont., linear differential equations, circuits, mixture models, population models, equilibrium solutions and stability

Week 3: 2.2-4—Equilibrium solutions and stability cont., acceleration-velocity models, numerical solutions

Week 4: 2.5-6, 3.1—Numerical solutions cont., linear systems

Week 5: 3.1-4—Linear systems, matrices, Gaussian elimination, reduced row echelon form, matrix operations Rules

Week 6: 3.5-3.6—Matrix inverses, determinants, review; Midterm exam 1 covering material from weeks 1-5

Week 7: 4.1-4—Vector spaces, linear combinations in Rn, span and independence, subspaces, bases and dimension

Week 8: 5.1-3—Second-order linear DEs, general solutions, superposition, homogeneity and constant coefficients

Week 9: 5.4-6—Mechanical vibrations, pendulum model, particular solutions to non-homogeneous problems, forcing and resonance; Super quiz
Week 10: 10.1-4—Laplace transforms, solving IVPs with transforms, partial fractions and translations

Week 11: 10.4-5—Unit steps, convolutions; **Midterm exam 2** covering weeks 6-10 material

Week 12: 6.1-2, 7.1—Eigenvalues and eigenvectors, diagonalization, first-order systems of ODE Parts.

Week 13: 7.2-5—Matrix systems, eigenanalysis, spring systems, forced undamped systems, practical resonance


Week 15: Review