Math 2250 - 001, Differential Equations and Linear Algebra
SPRING 2019

Instructor: Ornella Mattei
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Office location: JWB 125
Office hours: Tuesdays & Wednesdays 11.30am – 12.30pm, or by appointment
Class schedule: Mondays, Tuesdays, Wednesdays & Fridays 7.30–8.20am, CSC 208
Lab schedule: Thursdays either 7.30–8.20am or 8.35–9.25am, JTB 140 with Junpeng Jiao

Expected Learning Outcomes

The Basic Topics

1. 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.

2. 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.

3. 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.

4. 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.

5. 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.

6. 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.

7. 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.
8. 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.

9. 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.

10. 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**

1. 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.

2. 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.

**Textbook:** Edwards, Penney, Calvis, *Differential Equations and Linear Algebra* (ISBN-13: 978-0134497181). I will also provide notes for the course: after each class I will upload the notes on Canvas.

**Important dates:**
First class: Monday, January 7
Last class: Tuesday, April 23
Spring break: Sunday–Sunday, March 10–17
Martin Luther King Jr. Day: Monday, January 21
Presidents Day holiday: Monday, February 18
**Midterm 1:** Friday, February 15
**Midterm 2:** Friday, March 22
**Final Exam:** Tuesday, April 30, 8.00 – 10.00am (see: https://registrar.utah.edu/academic-calendars/final-exams-spring.php). The location will be announced in class.

**Homework:** Weekly assignments will be posted on Canvas each Friday, and collected in class on the following Friday. *No late homework is accepted*, unless it has been requested and approved
in advance for extreme circumstances.

**Quizzes:** There will be a quiz every Friday except the first Friday of the semester and on midterm days, for a total of 10 quizzes. *There will not be any "make up" quiz.* If you miss a quiz you will receive a "0" on that quiz. However, the three lowest quiz scores will be dropped. Quizzes are open book and open notes.

**Exams:** There will be two midterm exams and a final exam. *There will not be any "make up" exam:* if you miss an exam you will receive a "0" on that exam. No exam scores will be dropped. Calculators, cell phones, books and notes will not be allowed. Cheating will not be tolerated.

**Grades:** The break-up for the grades is the following:

15% homework
10% quizzes
15% labs
15% Midterm 1
15% Midterm 2
30% Final exam

The conversion from numerical scores (N) to letter scores is the following:

\[
\begin{array}{cccc}
100 \geq N \geq 93 : A & 93 > N \geq 90 : A- & 90 > N \geq 87 : B+ \\
87 > N \geq 83 : B & 83 > N \geq 80 : B- & 80 > N \geq 77 : C+ \\
77 > N \geq 73 : C & 73 > N \geq 70 : C- & 70 > N \geq 67 : D+ \\
67 > N \geq 63 : D & 63 > N \geq 60 : D- & N \leq 60 : E \\
\end{array}
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**Tutoring:** I encourage you to come to office hours every time you need it. I am also available to meet students by appointment. You can also seek help at the tutoring center located in room 155 of the T. Benny Rushing Mathematics Center. It is open from Monday to Friday, from 8am to 8pm, except on Fridays when it closes at 6pm. Their website is http://www.math.utah.edu/ugrad/tutoring.html.

**ADA Statement:** The Americans with Disabilities Act requires that reasonable accommodations be provided for students with physical, cognitive, systemic learning, and psychiatric disabilities. The student needs to have such a disability approved by the Disability Service Office (162 Olpin Union Building, (801) 581-5020) in order to have the accommodations provided. The instructor needs to be informed about such a disability and approved accommodations at the beginning of the semester.

**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. Any such changes will be announced in class.