INSTRUCTOR: Andrew Watson
Preferred name and pronouns: Andrew; he/him/his
Office: LCB 315 (just down the hall from our classroom, by the common area with the whiteboard)
Email: awatson@math.utah.edu
Web Page: Canvas [utah.instructure.com/courses/602965]
Office Hours: (subject to change) MW 9:30–10:30, or by appointment


COURSE WEBPAGE: All course information and announcements will be posted on the course page in Canvas. It also contains material that may help you succeed in this course. I shall assume that you are keeping up to date with its contents.


PREREQUISITES: Linear Algebra, Math 2270, and its prerequisite courses of single and multi-variable calculus.

COURSE OVERVIEW: Math 2280 is an introduction to ordinary differential equations, and how they are used to model problems arising in engineering and science. It is the second semester of the year long sequence 2270–2280, which is an in-depth introduction to linear mathematics. Along with Calculus, the linear algebra that you learned in Math 2270 will provide a surprising amount of the conceptual and computational framework for our discussions in Math 2280. This will become more apparent as the course progresses.

STRATEGIES FOR SUCCESS:

- Attend and participate in class regularly.
- Read or at least scan the relevant textbook sections and lecture note outlines before you attend class.
- Ask questions and be involved.
- Plan to do homework daily; try homework on the same day that the material is covered in lecture; do not wait until just before homework is due to begin serious work.
- Form study groups with other students.

Important Dates:

- Drop Deadline: Friday, January 17th
- First Test: Friday, February 14th
- Withdraw Deadline: Friday, March 6th
- Second Test: Friday, March 27th
- Course Final: Wednesday, April 29th, 8am–10am
EXTRA HELP: Do not hesitate to come to my office during office hours or by appointment to discuss a homework problem or any aspect of the course. The T. Benny Rushing Mathematics Tutoring Center offers free tutoring. Beginning the second week of classes, tutoring will be available from 8am to 8pm Monday through Thursday and 8am to 6pm on Friday. If you want to hire an outsider tutor (for a fee), you can find a list of such people through the math department.

LEARNING OBJECTIVES: The goal of Math 2280 is to master the basic tools and problem solving techniques important in differential equations, as well as to understand the larger conceptual framework that ties these ideas together. Specific goals include:

- Be able to model dynamical systems that arise in math, 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 and conservation of energy.
- 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. Understand phase diagram analysis for autonomous first order differential equations.
- Apply vector space concepts from linear algebra such as linear combinations, span, independence, basis and dimension, to understand the solution space to linear differential equations and linear 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 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.
- 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.
- Be able to apply matrix algebra concepts related to eigenvalues, eigenvectors and matrix diagonalization, in order 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.
- Learn how to work with matrix exponentials and other fundamental matrix solutions, as tools for understanding linear systems of differential equations with constant coefficients.
- Understand and be able to use linearization as a technique to understand the behavior of nonlinear dynamical systems near equilibrium solutions. Apply these techniques to autonomous systems of two first order differential equations, including interacting populations and systems arising from non-linear forced oscillation problems.
- Learn about Fourier series, and use them as an “infinite superposition” tool to study forced oscillation problems.
- Learn how to find solutions to Laplace’s equation, the heat equation and the wave equation using separation of variables, together with Fourier series and superposition.
- Develop your abilities to model dynamical systems with differential equations, and to understand solutions analytically and with technology and software such as Matlab and internet-based tools as appropriate.
GRADING: Math 2280-001 is graded on a curve. By this I mean that the final grading scale may end up lower than the usual 90/80/70% cut-offs (the grading scale will never end up higher than these cut-offs). Typical final grade distributions in Math 2280 are roughly 40% each for As and Bs, and 20% with lower grades. Individual classes may vary. Details about the content of each assignment type, and how much they count towards your final grade are as follows:

<table>
<thead>
<tr>
<th>Category</th>
<th>% of grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>20%</td>
</tr>
<tr>
<td>Quizzes</td>
<td>10%</td>
</tr>
<tr>
<td>Exam 1</td>
<td>20%</td>
</tr>
<tr>
<td>Exam 2</td>
<td>20%</td>
</tr>
<tr>
<td>Final</td>
<td>30%</td>
</tr>
</tbody>
</table>

- **Homework:** There will be one homework assignment each week. Homework problems will be posted on our public page, and homework assignments will be due at the beginning of class on Wednesdays. Homework assignments must be stapled. Unstapled assignments will not receive credit. I understand that sometimes homework cannot be completed on time due to circumstances beyond your control. To account for this, each student will be allowed to turn in two late homework assignments throughout the course of the semester. These assignments cannot be turned in more than one week late, and must be turned in on a Wednesday with the next homework assignment. You do not need to tell me the reason why your homework assignment is late. Homework will be a mixture of problems from the text and custom problems, and will vary from computational practice to modeling and more conceptual questions. There will be applications that require technology to complete. We will make use of Matlab for some of these applications.

- **Quizzes:** At the end of most Wednesday classes, a short 1-2 problem quiz will be given, taking roughly 10 minutes to do. The quiz will cover relevant topics from the weeks lectures and homework. Your lowest two quiz scores will be dropped. There are no makeup quizzes. You are allowed and encouraged to work together on these quizzes.

- **Midterm Exams:** Two class-length midterm exams will be given, on Friday February 15 and Friday March 29. No midterm scores are dropped.

- **Final Exam:** A two-hour comprehensive exam will be given at the end of the semester. As with the midterms, a practice final will be posted. Please check the final exam time, which is the official University scheduled time. It is your responsibility to make yourself available for that time, so make any arrangements (e.g., with your employer) as early as possible.

This syllabus can change: Depending on many factors during the semester, I reserve the right to change the class structure and this syllabus. If they occur, you will be notified by these changes.

UNIVERSITY POLICIES:

1. **The Americans with Disabilities Act.** 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 this class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building, (801) 581-5020. CDS will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in an alternative format with prior notification to the Center for Disability Services.

2. **University Safety Statement.** 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

3. **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, veterans status or genetic information. If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or 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 the police, contact the Department of Public Safety, 801-585-2677 (COPS).

4. **Student Names & 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, which managed can be managed at any time). While CIS refers to this as merely a preference, I will honor you by referring to you with the name and pronoun that feels best for you in class or on assignments. Please advise me of any name or pronoun changes so I can help create a learning environment in which you, your name, and your pronoun are respected. If you need any assistance or support, please reach out to the LGBT Resource Center.

5. **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 wellness.utah.edu or 801-581-7776.

6. **Diversity/Inclusivity Statement.** It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students’ learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of diversity: gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements for you. (Source: University of Iowa College of Education)

7. **Undocumented Student Support Statement.** 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.

8. **Veterans Center.** If you are a student veteran, the U of Utah has a Veterans Support Center located in Room 161 in the Olpin Union Building. Hours: M–F 8am–5pm. Please visit their website for more information about what support they offer, a list of ongoing events and links to outside resources: veteranscenter.utah.edu. Please also let me know if you need any additional support in this class for any reason.
Week-by-Week Topics Plan

Topic schedule is subject to slight modifications as the course progresses, but exam dates are fixed.

**Week 1:** 1.1–1.4; differential equations and mathematical models; slope fields and initial value problems; separable differential equations.

**Week 2:** 1.5, 2.1–2.2; linear differential equations; applications of separable equations to population models; phase diagram analysis.

**Week 3:** 2.3–2.6; improved acceleration-velocity models; numerical solutions to DEs.

**Week 4:** 3.1–3.3; higher order linear differential equations; homogeneous and non-homogeneous problems.

**Week 5:** 3.4–3.6; applications to unforced mechanical vibrations; non-homogeneous linear differential equations and applications to forced mechanical vibrations.

**Week 6:** 3.6–3.7; applications and review. Midterm exam 1 on Friday February 14 covering material from weeks 1–6.

**Week 7:** 7.1–7.4; Laplace transform approach to linear differential equations.

**Week 8:** 4.1, 4.3, 5.1–5.2; first order systems of differential equations, numerical methods, analytic solution of homogeneous first order systems with eigenvalue and eigenvector computations, input-output models.

**Week 9:** 5.2–5.4; mechanical vibrations and second order systems.

**Week 10:** Spring break!

**Week 11:** 5.4–5.7; multiple eigenvalue solutions, matrix exponentials, and applications.

**Week 12:** Continued and review Midterm exam 2 on Friday March 27, covering material from weeks 7–12.

**Week 13:** 6.1–6.4; non-linear systems of first order differential equations with applications to ecological models and nonlinear mechanical systems.

**Week 14:** 9.1–9.4; Fourier series, with application to forced oscillations.

**Week 15:** 9.5–9.7; introduction to partial differential equations and course review

**Week 16:** Review, and Final exam Wednesday, April 29, 8:00-10:00 am in our classroom LCB 323. This is the University scheduled time and location.