

# MATH 2250-001, Differential Equations and Linear Algebra, Spring 2020

**Instructor:** Nathan Willis

**Class Meetings:** Monday, Tuesday, Wednesday, and Friday at 7:30-8:20 in CSC 208

**Nathan's Email:** willis@math.utah.edu

**Nathan's Office:** JWB 118

**Nathan's Office Hours:** TBD

**Lab Instructor:** Lingyao Xie

**Lab Meetings:** Thursday in JTB 140 from 7:30-8:20 AM (Section 002) or 8:35-9:25 AM (Section 003)

**Lingyao's Email:** lingyao@math.utah.edu

**Lingyao's Office:** LCB Loft

**Lingyao's Office Hours:** TBD

**Text:** *Differential Equations and Linear Algebra*, 4th Edition, by C. Henry Edwards, David E. Penney, and David Calvis. ISBN-13: 978-0134497181. More information can be found at the link below:

<http://www.math.utah.edu/schedule/bookInfo/M2250TextInclusiveAccess-1.pdf>

**Midterm 1:** Friday, February 14 during the regular scheduled class in CSC 208

**Midterm 2:** Friday, March 27 during the regular scheduled class in CSC 208

**Final Exam:** Wednesday, April 29 from 8:00-10:00 AM in CSC 208

**Canvas:** Canvas will be used for posting course announcements, homework assignments, grades, files and any relevant supplementary material. You are also welcome and encouraged to make use of the Canvas discussion board to discuss course problems or topics. You can access the Canvas page through CIS or by logging in at [utah.instructure.com](http://utah.instructure.com). Students should check the Canvas page regularly for course information and resources. Email notifications and correspondence will be sent to the student's UMail address ([u-number]@utah.edu); this email account must be checked regularly.

**Grading:** Following are the grade components and the percentage each contributes to a student's final grade:

- **Homework Assignments (20%) -**

- Roughly three to four textbook sections are due every Wednesday at the end of class. The homework will typically cover lectures through to the preceding Wednesday. If you click on a homework assignment, you will see listings of problems.
- After the homework assignments are turned in three problems will be chosen to be graded, each out of 5 points. There will also be 5 points given for completing all problems. Making each homework out of 20 points.
- Two 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. Late is considered anytime after I leave the classroom on the day the assignment is due.
- Homework must be stapled (NOT paper clipped, folded in some witty way, etc...) or it will not be accepted.

- **Quizzes (5%) -**

- At the end of every Friday class, a short 1-2 problem quiz will be given, taking roughly 10-15 minutes to complete. The quiz will cover relevant topics covered since the previous Friday.
- Note that the quiz is on the material from that week, and thus you will not have completed the homework assignment on said material yet. Therefore, you are expected to come to class and review your notes to prepare for the weekly quiz.

- Two of a student's lowest quiz scores will be dropped.
- **Lab (20%)** -
  - 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 worksheets.
  - The lab worksheets 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 worksheets 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 consequently 20% of your total grade. Attendance to the lab and participation in the lab is mandatory and **attendance/participation will be taken each week by the TA**. Credit will be broken out into 5% lab attendance and 15% for well-written lab worksheet-reports.
  - The lowest lab score will be dropped.
- **Midterm Exams (30%, 15% each)** -
  - Two 50-minute midterm exams will be given in class on select Fridays (**February 14th** and **March 27th**).
  - A review sheet will be posted a week prior to the midterm that will cover the same material. Review of the practice problems will occur in the lab before the exam.

**There will be no retakes of midterm exams for any reason.**

- **Final Exam (25%)** -
  - A two-hour comprehensive exam will be given **Wednesday, April 29 from 8:00-10:00 AM in CSC 208**.
  - As with the midterms, a final exam review sheet will be posted a week prior.

**There will be no retakes of the final exam for any reason.**

Final course letter grades will be determined as follows: If  $X$  is your course percentage weighted according to the above, then  $\{X \geq 93\% \Rightarrow A, X \geq 90\% \Rightarrow A-, X \geq 87\% \Rightarrow B+, X \geq 83\% \Rightarrow B, X \geq 80\% \Rightarrow B-, X \geq 77\% \Rightarrow C+, X \geq 73\% \Rightarrow C, X \geq 70\% \Rightarrow C-, X \geq 67\% \Rightarrow D+, X \geq 63\% \Rightarrow D, X \geq 60\% \Rightarrow D-, X < 60\% \Rightarrow E\}$ . The instructor retains the right to modify this grading scheme during the course of the semester; students will, of course, be well notified of any adjustments.

Any grading questions, disputes, or concerns either with the instructor or the TA need to be addressed within a week of the graded work being returned to the student.

### Additional Resources

- **Tutoring Center & Computer Lab**- There is free tutoring in the T. Benny Rushing Mathematics Student Center (room 155, the lower level between JWB and LCB), as well as a computer lab. For more information see <http://www.math.utah.edu/ugrad/tutoring.html>

- **Private Tutoring-** University Tutoring Services, 330 SSB. There is also a list of tutors at the math department office JWB 233.

**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.

### **Expected Learning Outcomes:**

- **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 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.

**Important Dates:**

Classes begin	Monday, January 6
Last day to add without a permission code	Friday, January 10
Last day to drop (delete) classes	Friday, January 17
Last day to add, elect CR/NC, or audit classes	Friday, January 17
Midterm 1	Friday, February 14
Last day to withdraw from classes	Friday, March 6
Midterm 2	Friday, March 27
Last day to reverse CR/NC option	Friday, April 17
Classes end	Tuesday, April 21
Final Exam	Wednesday, April 29

**Student Responsibilities:** All students are expected to maintain professional behavior in the classroom setting, according to the Student Code, spelled out in the Student Handbook. You have specific rights in the classroom as detailed in Article III of the Code. The Code also specifies proscribed conduct (Article XI) that involves cheating on tests, collusion, fraud, theft, etc. Students should read the Code carefully and know you are responsible for the content. According to Faculty Rules and Regulations, it is the faculty responsibility to enforce responsible classroom behaviors, beginning with verbal warnings and progressing to dismissal from class and a failing grade. Students have the right to appeal such action to the Student Behavior Committee. <http://regulations.utah.edu/academics/6-400.php>

**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 (CDA), 162 Olpin Union Building, 581-5020 (V/TDD). CDA will work with you and me to make arrangements for accommodations. All information in this course can be made available in alternative format with prior notification to CDA

**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 8-5pm. Please visit their website for more information about what support they offer, a list of ongoing events and links to outside resources: <http://veteranscenter.utah.edu/>. Please also let me know if you need any additional support in this class for any reason.

**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).

**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 <https://wellness.utah.edu/> or 801-581-7776.

**Dean of Students Office:** The Dean of Students Office is dedicated to being a resource for students through support, advocacy, involvement, and accountability. It serves as a support for students facing challenges to their success as students, and assist with the interpretation of university policy and regulations. Please consider reaching out to the Office of the Dean of Students for any questions, issues and concerns. <https://deanofstudents.utah.edu/> or 801-581-7066.

**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](https://safeu.utah.edu).

**Student Names and Personal Pronouns:** Class rosters are provided to the instructor with the students 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 pronoun 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 pronoun will be respected. If you need assistance getting your preferred name on your U-ID card, please visit the LGBT Resource Center Room 409 in the Olpin Union Building, or email [bpeacock@sa.utah.edu](mailto:bpeacock@sa.utah.edu) to schedule a time to drop by. The LGBT Resource Center hours are M-F 8am-5pm, and 8am-6pm on Tuesdays.

**Extenuating Circumstances:** If you have crisis-level extenuating circumstances which require flexibility, it is completely your responsibility to communicate with me as soon as possible so I can help you in some manner. The longer you wait to communicate with me, the less I can and am willing to do to help.

**Academic Misconduct:** If you cheat on any homework, project, quiz, or exam, you will automatically get a zero for that grade. Depending on the severity of the cheating, I may decide to fail you from the class. Please note that the use (or even just pulling it out of your pocket) of a cell phone or any other electronic internet device is considered cheating and cause for receiving an automatic zero on an exam. Also, if you exhibit any other behaviors that are unethical, like offering me a bribe to give you a better grade (even if you later claim you were joking), I will report your behavior to the Dean of Students.

**Classroom Social Equity:** I strive to be ethical, kind, fair, inclusive, and respectful in my classroom and expect students to behave likewise. In this regard, I have these requests of you, my student:

1. Please do tell me, discreetly, if you have any sort of anxiety disorder, TBI, PTSD, C-PTSD, or any other challenge that would cause psychological harm to you by me calling on you in class. I want students to feel a little uncomfortable and stretched during class, while working on problems as a large group, but I definitely don't want to cause anyone harm. So, please discreetly tell me if that is the case for you and I will confidentially accommodate your request. Updated December 3, 2018
2. If your preferred name is different than your legal first/last name (the preferred name you chose does indeed show up in CIS on my roll sheet, but not yet in Canvas), please let me know. It also helps if you log into Canvas and go to Account (on far left) →Settings and change your Display Name to be the name you prefer to be addressed by.

3. If there is ever a time that you feel this course or the curriculum is not equitable, please email me or meet with me to discuss your concerns so I have a chance to address that.

### **Additional Policies:**

- All correspondence for this class will be done through UMail or Canvas. You need to be checking your UMail daily during the week, and also checking for Canvas updates and announcements. If you do not check your UMail or Canvas regularly, you should have your messages forwarded to an email address that you do check. It is your responsibility to stay caught up on announcements, schedule changes, etc., and not seeing an email with the information is not an excuse.
- You should always feel free to email me at willis@math.utah.edu with questions about course material, your grade, course policies, other concerns, or to set up a meeting outside of office hours. I will respond to all student emails in a timely fashion (within 24 hours, but more quickly if it is a time sensitive situation) between 8am and 5pm on weekdays. If you email me after 5pm I may not get back to you until the next day. If you email me over a weekend, I may not get back to you until the following Monday. (But I will do my best to respond to time-sensitive emails as soon as possible). Also, if you are emailing with a question regarding a math problem: It helps me immensely if you include the problem statement (either typed out or attached as a photo or scanned image) and also a brief summary of steps you have taken so far (again, either typed out or attached in an image). This will allow me to give you the best feedback possible.
- If you have concerns of your success in this class it is your responsibility to raise these issues with me and it is prudent to do so early in the semester.
- Under no circumstances will I make individual adjustments to student's final grades. Any adjustments to final grades will be consistent throughout the entire class, but you should not expect or rely on such adjustments to get the grade you desire. The only changes to your final grade can come from retrieving your final exam and checking for any grading errors, again these will be handled to be consistent with the entire class.
- Cell phones should be put away during class. If there is an emergency situation, let me know. If you need to use your phone during class, please leave the classroom.
- There will be no cursing or negative ranting (for example, "math sucks") either verbally or on any written work turned in. The penalty for such things on written work will be a zero on that assignment or test.
- If you miss a day of class, it is your responsibility to get caught up with the material.
- I will post my lecture notes to Canvas after each class. However, students are still expected to take notes and participate during lecture. If I notice that students quit actively taking notes during class I will stop posting the lecture notes.
- I reserve the right to change my policies stated in this syllabus at any point in the semester. If I do make a change to a policy, I will announce it in class, by email, and on Canvas.

**Course Roadmap Week-by-Week (Subject to Change):**

Week	Dates	Sections	Material
1	1/6-1/10	1.1, 1.2, 1.3, 1.4	Differential equations Mathematical models Integral as general and particular solutions Slope fields Seperable differential equations
2	1/13-1/17	1.4, 1.5, 2.1, 2.2	Seperable equations continued Linear differentail equations Circuits, mixture models, and population models Equilibrium solutions and stability
3	1/21-1/24	2.2, 2.3, 2.4	Equilibrium solutions and stability continued Acceleration-velocity models Numerical solutions
4	1/27-1/31	2.5, 2.6, 3.1	Numerical solutions continued Linear systems
5	2/3-2/7	3.1, 3.2, 3.3, 3.4	Matrices and matrix operations Gaussian Elimination Reduced Row Echelon Form
6	2/10-2/14	3.5, 3.6	Matrtix inverses Determinants <b>Midterm 1 on Friday</b>
7	2/18-2/21	4.1, 4.2, 4.3, 4.4	Vector spaces Linear combinations in $\mathbb{R}^n$ Span and linear independence Subspaces, bases, and dimension
8	2/24-2/28	5.1, 5.2, 5.3	2nd-order linear differential equations General solutions Superposition, homogeneity, and constant coeeficients
9	3/2-3/6	5.4, 5.5, 5.6	Mechanical vibrations and pendulum model Particular solutions to non-homogeneous problems Forcing and resonance
10	3/9-3/13	<b>SPRING BREAK</b>	
11	3/16-3/20	10.1, 10.2, 10.3	Laplace transforms Solving IVPs with transforms Partial fractions and translations
12	3/23-3/27	10.4, 10.5	Unit step functions Convolutions <b>Midterm 2 on Friday</b>
13	3/30-4/3	6.1, 6.2, 7.1	Eigenvalues and eigenvectors Diagonalization 1st-order systems of ODE
14	4/6-4/10	7.2, 7.3, 7.4	Matrix systems Eigenanalysis Spring systems and forced undamped systems Practical Resonance
15	4/13-4/17	9.1, 9.2, 9.3	Equilibria and stability Phase portraits for non-linear systems Ecological models
16	4/20-4/21	9.4	Nonlinear mechanical systems