Syllabus for Math 2250-001
Differential Equations and Linear Algebra
Summer 2021

General Course Information:

Course: Math 2250 - Differential Equations and Linear Algebra.
Instructor: Keyvan Yaghmayi.
Email: yaghmayi@math.utah.edu.
Office: JWB 104.
Course Website: We use Canvas: `https://gate.acs.utah.edu/`. To log in, use the same student ID and password that you use for Campus Information System.

Class Time: Monday - Friday, 7:30am - 8:30am.
Class Location: Online lectures in Canvas via Zoom. Links are available in Canvas.
Course Type: The class type is listed as an "IVC" in the university catalog, which stands for "Interactive Video Conferencing". This means that the class will be delivered synchronously, i.e. live and at the time listed but entirely online.

Office Hours: I will hold online office hours via Zoom in Canvas. Every Monday 11:20am - 12:20pm and every Thursday 8:45am - 9:45am, or by appointment. The Zoom link is available in Canvas.

Textbook: Differential Equations and Linear Algebra, 4th Edition, by C. Henry Edwards, David E. Penney, and David Calvis. ISBN-13: 978-0134497181. E-textbook is available in Canvas (click on Bookshelf tab). Please read "Textbook Information" file on Canvas or visit

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`http://www.math.utah.edu/schedule/bookInfo/`

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for further information, in particular, if you want to buy hard copy of the text or if you want to opt out of electronic access.

Important Dates: Classes begin Monday, May 17. The last day to add, drop, or audit classes is Wednesday, May 26. The last day to withdraw is Friday, June 25. Last day to reverse CR/NC option is Friday, July 30. *Final Exam* is on Thursday, August 5, 7:30am - 9:30am, in Canvas.

Technical requirements: For both quality learning and proctored testing, students are required to have access to the following equipment:

- A strong internet connection with sufficient bandwidth (in order to participate in online classes, access course materials, and take exams)

- A webcam on your computer or camera on your phone (this is required for taking exams in Zoom; it is recommended for IVC lecture classes)

- A scanning device (smartphones can be used as scanning devices)

- a microphone (used for online meetings)

Note: The Marriott library is loaning laptops to students. They are also offering off-campus internet access. Please visit `https://lib.utah.edu/coronavirus/checkout-equipment.php`

Essential Course Information:

Prerequisites: "C" or better in (MATH 2210 OR MATH 1260 OR MATH 1280 OR MATH 1321 OR MATH 1320 OR ((MATH 1220 OR MATH 1250 OR MATH 1270 OR MATH 1311 OR AP Calculus BC score of 5) AND PHYS 2210 OR PHYS 3210)).

Course Description: This is a hybrid course which teaches the allied subjects of linear algebra and differential equations. These topics underpin the mathematics required for most students in the Colleges of Science, Engineering, Mines & Earth Science.

Expected Learning Outcomes: The goal of Math 2250 is to master the basic tools and problem solving techniques important in differential equations and linear algebra. These basic tools and problem solving skills are:

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. Understand phase diagram analysis for autonomous first order differential equations.

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 dynamical systems near equilibrium solutions. Apply these techniques to non-linear mechanical oscillation problems. (Additional material, subject to time availability: Apply linearization to autonomous 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.

11. 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.

12. 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.

13. 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.

Week-by-Week Course Roadmap: Below is an outline and rough schedule of the sections and topics that we will cover in this course:

Week 1: 1.1 Differential Equations and Mathematical Models, 1.2 Integrals as General and Particular Solutions, 1.3 Slope Fields and Solution Curves, 1.4 Separable Equations and Applications.

Week 2: 1.5 Linear First-Order Equations, 2.1 Population Models, 2.2 Equilibrium Solutions and Stability. **Note: Wednesday, May 26 is the last day to drop**.

Week 3: 2.3 Acceleration-Velocity Models, 2.4 Numerical Approximation: Euler's Method. 2.5 Improved Euler's Method; 2.6 The Runge-Kutta Method. Monday, May 31 is Memorial Day Holiday.

Week 4: 3.1 Introduction to Linear Systems, 3.2 Matrices and Gaussian Elimination, 3.3 Reduced Row-Echelon Matrices, 3.4 Matrix Operations.

Week 5: 3.5 Inverses of Matrices, 3.6 Determinants, Review for Midterm 1. **Note: Midterm 1 is on Friday, June 18, on Materials Covered in Weeks 1-4**.

Week 6: 4.1 The Vector Space $\mathbb{R}^3$, 4.2 The Vector Space $\mathbb{R}^n$ and Subspaces, 4.3 Linear Combinations and Independence. **Note: Friday, June 25 is the Last Day to Withdraw**.

Week 7: 4.4 Bases and Dimension for Vector Spaces, 5.1 Second-Order Linear Equations, 5.2 General Solutions of Linear Equations.

Week 8: 5.3 Homogeneous Equations with Constant Coefficients, 5.4 Mechanical Vibrations, 5.5 Non-homogeneous Equations and Undetermined Coefficients. Monday, July 5 is Independence Day Holiday (observed)

Week 9: 5.6 Forced Oscillations and Resonance, 10.1 Laplace Transforms and Inverse Laplace Transforms; 10.2 Transformation of Initial Valued Problems, Review for Midterm 2. **Note: Midterm 2 is on Friday, July 16, on Materials Covered in Weeks 5-8**.

Week 10: 10.3 Translation and Partial Fractions; 10.4 Derivatives, Integrals, and Products of Laplace Transforms, 10.5 Periodic and Piecewise Continuous Input Functions.

Week 11: 6.1 Introduction to Eigenvalues and Eigenvectors, 6.2 Diagonalization of Matices, 7.1 First-Order Systems and Applications, 7.2 Matrices and Linear Systems.

Week 12: 7.3 The Eigenvalue Method for Linear Systems, 7.4 Second-Order Systems and Mechanical Applications, on Wednesday we Review for the Final Exam. **Note: Final Exam is on Thursday, August 5, 7:30am - 9:30am, Comprehensive**.

Homework:

Homework problems and due dates will be posted on Canvas regularly. The problems will be taken from the book. You should write them on paper, scan and create a single PDF file of your work, then upload it into the Canvas. Please scan and don't take photo. You don't need a scanner; there are directions in Canvas for using your smart phone as scanner. Scanning is easier and faster than taking pictures. The quality is higher than pictures too.

I encourage you to discuss your homework problems with one another, ask help from tutors in the *online math center* (see below), or talk to me during online office hours. The other way that you can get help with homework assignments (and quizzes) is posting discussions in Canvas. In homework assignments please show work. I will drop your lowest homework score at the end of the semester. Your homework assignments will be graded in Canvas.

Lab Session:

The lab session is Thursday where I give you 2-3 challenging and more involved "story" problems. In fact, these problems often revolve around engineering and physics applications and are a little harder but as a bonus you work on them in class with my help. First, I explain the question and probably give you some hint, then we make small groups in the Zoom and start working on the problems in groups. I will join your group and answer to your questions too.

Lab problems will be posted on Canvas under the name of "Lab Session". In class (Zoom meetings) you should get a conceptual feel for all the problems on the sheet. You will have the rest of the week to finish them. Please turn in your <u>neat and clear</u> work in Canvas. We do this every week except on exam weeks that we will use that day for review. At the end of the semester, I will drop your lowest lab score.

Quizzes:

We will have take-home (group) quizzes on the material that already has been taught and covered by homework assignments. I will make quizzes available by Wednesdays 11:59pm and they are due Fridays at 11:59pm. You print, answer questions, scan and upload the PDF file into Canvas (there are directions on Canvas for those who don't have access to printer and/or scanner). There will be 2-3 questions in every quiz. Your quizzes will be graded in Gradescope.

You are encouraged to work on quizzes within small groups of 3 or 4. You would discuss your possible solutions within the group and then write your answer based on your own understanding. Working in groups is encouraged, but it is "individual responsibility" to

complete and submit quizzes. Everyone writes only his/her name on the quiz paper. At the end of the semester, I will drop your lowest quiz score.

Tests:

There will be two midterms along with a "comprehensive" final exam. All exams are during class time. I will provide you exam file in Canvas and proctor you through the Zoom.

Exam One: Friday, June 18$^{\text{th}}$, 7:30am - 8:30am, on Materials covered in Weeks 1-4
Exam Two: Friday, July 16$^{\text{th}}$, 7:30am - 8:30am, on Materials covered in Weeks 5-8
Final Exam: Thursday, August 5$^{\text{th}}$, 7:30am - 9:30am, comprehensive

It is essential that you show all your work. Credit will not be given without the proper work and partial credit will be awarded if you show correct steps even if you do not obtain the final correct number.

Modules: To be organized, I will create "Modules" in Canvas for every week. Weekly Module is going to have five parts: (1) Class Notes (2) Lecture Videos (3) Announcements and Discussions (4) Lab Sessions (5) Homework Assignments and Quizzes (and Exams).

Grading:

The grades will be calculated as follows:

Homework 15%	Lab Session 15%
Quizzes 15%	Midterm 15%
Midterm 15%	Final Exam 25%

The grade scale will be the usual: A (93-100), A- (90-92), B+ (87-89), B (83-86), B- (80-82), C+ (77-79), C (73-76), C- (70-72), D+ (67-69), D (63-66), D- (60-62), E (0-59). If I do need to curve the grades, I will simply shift your overall percentage up by a few points (whatever is necessary).

Tutoring and Extra Help:

- **Math Student Center:** The online math tutoring center is available free of charge to all university students. The tutoring center is open Monday-Thursday 8:00am-8:00pm, and Friday 8:00am-6:00pm. Please take advantage of the tutoring center as needed throughout the semester. Their website is: `http://www.math.utah.edu/undergraduate/mathcenter.php`

- **ASUU Learning Center:** Home of tutoring services here at the University of Utah. If you need help understanding course content or want to develop better strategies for academic success, then check out their website: `http://tutoringcenter.utah.edu`. They offer inexpensive (online) tutoring.

- **Khan Academy:** It is a non-profit, free, educational organization for anyone, anywhere. They have some amazing videos in the Youtube. If you're interested, check out: `https://www.khanacademy.org/`

Some Policies and Comments:

- Please check Canvas regularly (every day or every other day). I will use the following features of Canvas frequently: Pages, Assignments, Zoom, Announcements, Modules, Discussions, Gradescope, Files, and Grades.

- Online attendance to live lectures is strongly encouraged but not required. **Class lectures will be recorded and posted in Canvas**.

- All materials for this course are copyrighted. Do not distribute or share course resources without instructor permission.

- **Late and Missing Assignments Policy:** The course is designed to provide flexibility in the case of a few times. But in general, you are expected to turn things in on time and take quizzes and exams at the times givens. If there are extenuating circumstances, please contact me in a timely way to discuss alternatives. If the situation is one that can be documented, you may be asked to provide documentation. The University of Utah student code allows for making up quizzes or exams in advance for "officially sanctioned University activities, or government obligations, or religious obligations". Please contact me at least one week in advance of any such obligations to arrange accommodation.

- For quizzes and exams, you are allowed to use a "scientific calculator". You can use either a regular physical Texas Instruments scientific calculator or an online scientific calculator. If you search 2+3 in Google a scientific calculator pops up. Other types of calculators like programmable calculators or graphing calculators are not allowed. I will make tests and quizzes to evaluate your mathematical skills and not your calculator skills. For homework assignments, it is okay that you check your answer by advanced calculators or other preferred technology.

- Past semesters, with take-home quizzes and online exams, there was an increase in instances of cheating and other types of academic misconduct. Many online tutoring and video hosting sites, as part of their terms of service, are authorized to fully cooperate with investigations involving academic integrity. All cases involving cheating will be handled according to standard protocols in the Code of Student Rights and Responsibilities. See Policy 6-400 `http://regulations.utah.edu/academics/6-400.php`.

- If there is something that I want to inform you, I will reach out to you by emailing you through Canvas. That is usually your default UMail address (uNID@utah.edu) that you have in the CIS. If you are using other emails more frequently than your UMail, then you can set your UMail to forward to your preferred email address. Also the fastest way to reach me is my email: yaghmayi@math.utah.edu.

- If your preferred name is different than your legal first name (the preferred name you chose does indeed show up in CIS on my roll sheet, but not yet in Canvas), please log into Canvas and go to "Account" (on far left) then "Settings" and change your "Display Name" to be the name you prefer to be addressed by. This will help me greatly to know students' names, and to address you correctly when responding to Canvas comments.

- If you have any thoughts, ideas, or suggestion, please feel free to contact me. I promise to do everything in my power to help.

COVID-19 Considerations:

- Generally, on-campus, all of us should wear a face covering mask and we should also maintain a 6 ft. distance between ourselves while using community rooms and common areas in buildings.

- We must self-report if we test positive for COVID-19 via `https://coronavirus.utah.edu/`.

University of Utah Resources and Policies:

- **Center for Disability & Access:** is dedicated to students with disabilities by providing the opportunity for success and equal access at the University of Utah. They are committed to providing reasonable accommodations as outlined by Federal and State law. The Center for Disability & Access (CDA) also strive to create an inclusive, safe and respectful environment. By promoting awareness, knowledge and equity, they aspire to impact positive change within individuals and the campus community. Please visit `http://disability.utah.edu/` for the latest information.

- **A.D.A. 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, 162 Olpin Union Building, 801-581-5020. CDA will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in alternative format with prior notification to the Center for Disability & Access.

- **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 `https://safeu.utah.edu/`.

- **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`

- **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).

- **Veterans Support Center:** The Center is staffed by student Veterans who are committed to providing their fellow Veterans with the most useful and current information available. The Mission of the Veteran Support Center is to improve and enhance the success of student Veterans; to help them receive the benefits they deserve; to serve as a liaison between the Veteran student community and the University; and to increase their academic success. Additionally to provide an opportunity to continue the relationships built through the service in civilian life. Please see `https://veteranscenter.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 to schedule a time to drop by. The LGBT Resource Center hours are M-F 8am-5pm, and 8am-6pm on Tuesdays.

- **Women's Resource Center:** The Women's Resource Center (WRC) at the University of Utah serves as the central resource for educational and support services for women. Honoring the complexities of women's identities, the WRC facilitates choices and changes through programs, counseling, and training grounded in a commitment to advance social justice and equality. `https://womenscenter.utah.edu/`

- **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.

Disclaimer: This syllabus is meant to serve as an outline and guide for our course. All information on this syllabus is subject to change. If any changes on this syllabus, course policies or course outline arise throughout the semester, then I will announce it in class and post it on Canvas.