Syllabus for Math 2250-001
Differential Equations and Linear Algebra
Summer 2017

General Course Information:

Course: Differential Equations and Linear Algebra (Math 2250-001).
Instructor: Keyvan Yaghmayi.
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Phone: 801-581-8345.
Email: yaghmayi@math.utah.edu.
Class Location: LCB 219.
Class Time: Monday-Friday 7:30am - 8:30am.
Office Hours: Monday-Friday after the class 8:40am - 9:30am or by appointment.
Course Website: I will use the Canvas: `https://gate.acs.utah.edu/`. You can get there easily from the main University of Utah website `www.utah.edu`. To log in, you use the same student ID and password that you use for Campus Information System.
Textbook: Linear Algebra and Differential Equations: with Introductory Partial Differential Equations and Fourier Series, by Edwards, Penney and Haberman. ISBN-13: 9781269425579 (Custom Edition for the University of Utah).
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)).
Important Dates: The last day to add, drop (delete), elect CR/NC, or audit the class is Wednesday May 24. The last day to withdraw is Friday June 23.
Final Exam: Thursday August 3, 7:30am - 9:30am, in our classroom LCB 219.

Catalog Description:

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, Newtons laws, conservation of energy and Kirchoffs 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.

Here is the week-by-week outline that we will follow (subject to circumstances there might be little changes):

Week 1 (Mon 5/15 - Fri 5/19): 1.1 - 1.4 Differential Equations; Mathematical Models; Integral as General and Particular Solutions; Slope Fields; Separable Differential Equations.

Week 2 (Mon 5/22 - Fri 5/26): 1.5 Linear Differential Equations; 2.1 - 2.3 Mixture Models; Population Models; Equilibrium Solutions and Stability; Acceleration-Velocity Models.

Week 3 (Tue 5/30 - Fri 6/2): 2.4 - 2.6 Numerical Approximation; Euler's Method; Runge-Kutta Method. 3.1 - 3.2 Linear Systems; Matrices and Gaussian Elimination. Monday 5/29 is Memorial Day Holiday.

Week 4 (Mon 6/5 - Fri 6/9): 3.3 - 3.6 Reduced Row-Echelon Matrices; Matrix Operations; Inverses of Matrices; Determinants; 4.1 Vector Spaces.

Week 5 (Mon 6/12 - Fri 6/16): 4.2 - 4.4 Linear Combinations in $\mathbb{R}^n$; Span and Independence; Bases and Dimension. There Will be Quick Review for Exam on Wednesday. Midterm 1 on Thursday 6/15 from Chapter 1, 2, and 3.

Week 6 (Mon 6/19 - Fri 6/23): 5.1 - 5.4 Second-order linear Equations; Superposition; Wronskian; General Solutions; Homogeneous Equations with Constant Coefficients; Mechanical Vibrations; Pendulum Model.

Week 7 (Mon 6/26 - Fri 6/30): Continue 5.4 Mechanical Vibrations; Pendulum Model; 5.5 - 5.6 Non-homogeneous Equations; Undetermined Coefficients; Forced Oscillations and Resonance.

Week 8 (Mon 7/3 - Fri 7/7): 10.1 - 10.4 Laplace Transforms and their Inverse; Transformation of Initial Valued Problems; Translation and Partial Fractions; Derivatives, Integrals, and Products of Laplace Transforms. Tuesday is Independence Day Holiday.

Week 9 (Mon 7/10 - Fri 7/14): 6.1 - 6.2 Eigenvalues and Eigenvectors; Diagonalization; 7.1 First-Order Systems and Applications. There Will be a Quick Review for Exam on Wednesday. Midterm 2 on Thursday 7/13 from Chapter 4, 5, and 10.

Week 10 (Mon 7/17 - Fri 7/21): 7.2 - 7.4 Matrices and Linear Systems; Eigenanalysis; Spring Systems; Forced Undamped Systems, Practical Resonance.

Week 11 (Mon 7/24 - Fri 7/28): 9.1 - 9.4 Equilibria; Stability; Phase Portraits for Non-Linear Systems; Ecological Models. Monday is Pioneer Day Holiday.

Week 12 (Mon 7/31 - Wed 8/2): Review for the Final Exam. Final Exam is on Thursday 8/3 (Comprehensive).

Homework:

You will be weekly homework assignments from the textbook. Homework problems and due dates will be posted on Canvas regularly. I encourage you to discuss your homework problems with one another, ask help from instructors in the tutoring center, or stop by at office hours. Be sure that the final copy you hand in is written entirely with your words as you understand the solution. If you spend enough time on the homework to gain understanding, then the exams would be easy for you! Late assignments will not be accepted and if you will be absent the day that an assignment is due you must turn it in to me before the class in which it is due. Homework problems will be graded and returned to you.

Lab Session:

The lab session is one day per week where I give you 2-3 challenging and more involved "story" problems usually over material you've recently turned in homework on. In fact, these problems often revolve around engineering and physics applications and are a little harder but as a bonus you get to do it in class with my help. You should move your chairs into small groups and start working on the problems in groups. I will circulate in class and have conversations with your group, answer to your questions, and give hints.

Lab day will be on Wednesday and lab session problems will be posted on Canvas under the name of "Lab Session Problems". In class you should at least get a conceptual feel for all the problems on the sheet. You will have the rest of the week to finish them off. Please turn in your neat and clear work the following lab day. We do this every week except on exam weeks, when we will use that day for review.

Quizzes:

There will be short "group quizzes" in almost every week. The dates and the sections that they cover will be posted on Canvas. It should take approximately 10-15 minutes to complete the quiz. I will upload the solutions and grades on canvas. Quizzes will not be excused due to absences or lateness so please be prompt and present. At the end of the semester, your lowest quiz score will be dropped and will not count toward your overall grade.

You are encouraged to work together on quizzes by making groups of 2, 3 or 4 with friends/neighbors in class and discussing problems and your possible solutions within the group. You should write your answer based on your own understanding and in your own words. It is totally fine if someone likes to work individually.

Tests:

There will be two midterms along with a comprehensive final exam. All of them are in the scheduled classroom (LCB 219) and at the class time.

Midterm One: Thursday June 15, from chapter 1, 2, and 3 (sections that we cover).
Midterm Two: Thursday July 13, from chapter 4, 5, 10 (sections that we cover).
Final Exam: Thursday August 3, 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!

Grading:

The grades will be calculated as follows:

Homework 10%
Lab Session 10%
Quizzes 10%
Midterm One 20%
Midterm Two 20%
Final Exam 30%

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).

Some Policies/Comments:

- Unless specifically noted, no calculators will be allowed during tests or quizzes. It is recommended that you complete your homework without calculators and then check your answers by calculators (or any other preferred technology).
- Cheating will not be tolerated at any time during this course. Any student found cheating will receive a zero for the assignment or test on which the cheating occurred.
- Please staple your homework! Otherwise, I am not responsible for lost papers.
- If you have any questions, ideas, or suggestion, please feel free to contact me. I promise to do everything in my power to help.
- If there is something that I want to inform you, I will reach you by your email. 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.

Tutoring and Extra Help:

- **Tutoring Lab:** The math tutoring center is available free of charge to all university students. It is located in room 155 of the T. Benny Rushing Mathematics Center (adjacent to the LCB and JWB). The tutoring center is open Monday-Thursday 8:00am-8:00pm, and Friday 8:00am-4:00pm. Please take advantage of the tutoring center as needed throughout the semester. They are also offering group tutoring sessions. If you're interested, inquire at `http://www.math.utah.edu/ugrad/tutoring.html`
- **ASUU Tutoring Center:** University Tutoring Services, 330 SSB. They offer inexpensive tutoring, please see their website: `http://tutoringcenter.utah.edu`
- **Khan Academy:** It is a non-profit, free, educational organization for anyone, anywhere. They have some amazing videos in the Youtube. Check them out: `https://www.khanacademy.org/`

Summer Warning: This class is pretty intense, meaning over a shortened schedule of 11-12 weeks, rather than 15 (and we will miss three classes due to Holidays). We still have to cover all the same material. That being said, we have to perform accordingly. I recommend you to spend 2-3 hours per day (or 5-6 hours every other day) outside of class time to succeed in the class.

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`

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 pro-

grams, 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.

Center for Student Wellness: The Center for Student Wellness is your portal for information, resources and solutions for wellness-related issues. Some of their services include: the provision of health information relevant to students most often this includes information on stress, sleep, nutrition and tobacco use; HIV and STD testing; alcohol education and prevention; and making policy recommendations to maintain a healthy learning environment. If they don't have what you are looking for, they will connect you with someone that does. Check out their website for more detailed information: `http://wellness.utah.edu/`

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 `http://veteranscenter.utah.edu/`

LGBT Resource Center: The LGBT Resource Center provides a comprehensive range of education, information and advocacy services, and works to create and maintain an open, safe, and supportive environment for LGBT students, staff, faculty, alumni, and the entire campus community. Here is their website: `http://lgbt.utah.edu/`

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

Disclaimer: 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 send the change in email.

Good Luck!