Math 0290: Differential Equations, Fall 2024
Departmental Syllabus

Overview: Differential equations (DE) represent an important branch of mathematics. Many of their properties have been understood mathematically and they have a history of being successfully applied to important problems in all areas of science and engineering. This course will introduce primarily linear, first-order, and second-order differential equations. Solution techniques for separable equations and homogeneous and inhomogeneous equations as well as a range of modeling-based applications arising in the context of engineering, physics and chemistry will be presented. The application of Laplace transforms to differential equations, systems of linear differential equations, linearization of nonlinear systems, and phase plane methods will be covered. Fourier series, a useful tool in signal processing, will also be introduced, and we will discuss how the Fourier series arises in solving the famous heat equation by separation of variables. The idea of approximating and visualizing solutions using a computer, such as with Matlab, will be introduced early in the term and students are expected to use Matlab as a resource in their work for this course.

Textbooks: Polking, Boggess and Arnold, *Differential Equations with Boundary Value Problems*, second edition, Pearson Prentice-Hall.
There is a link in Canvas which includes the purchase of the electronic version of the textbook onto your tuition statement if you do not 'opt out'. This purchase offers more than what is necessary. The only requirement to this course is the textbook. Students may choose to use the first edition of the text or a used second edition, which may be available at a lower cost. If you wish to do that, you should choose the 'opt out' option prior to the add/drop deadline and visit http://calculus.math.pitt.edu and click the Textbook information link.

Instructor information:
Office Hours:
web:
The Canvas page for this course will contain assignments, handouts, due dates, and announcements.
Tutoring: The Mathematics Department offers a free tutoring service. The Math Assistance Center (MAC) is located on the second floor of the O'Hara Student Center. Tutoring services and tutoring hours will be posted outside the MAC as well as on the web at MAC.

Grades: Homework 20%, Two midterm exams 40% (20% each), Final exam 40%.

Assessments: (1) Weekly homework assignments will be collect at the beginning of the lecture every Monday. (2) There will be two in-class Midterm Exams. The second midterm will not be cumulative to the first. (3) **The cumulative Final Exam will take place** *at a time to be determined by the University***.**
Your course grade will not exceed your Final Exam grade by more than one letter grade.

Grading scale: A/A±:90-100%, B/B±: 80-89%, C/C±: 70-79%, D/D±: 60−69%, F:<60%.

Matlab: Computers are often used to study solutions to differential equations in physics, biology, chemistry, and engineering. Right from the outset, we will discuss how Matlab can help us to visualize the behavior of solutions of differential equations and to approximate these solutions and we will give an introduction to numerical solution techniques. Matlab will not be available on quizzes/exams, however, and will not factor heavily into statements of homework problems; mostly, it is a tool that can help you understand the material better and check your solutions.

Homework policies: Students are required to complete the homework problems; very few students can learn this material without constant practice. Students are welcome to work together on homework. However, each student must turn in his or her own assignments, and no copying from another student's work is permitted. Deadline extensions for homework will not be given. Please feel free to come ask me questions about homework and other course material during office hours or to contact me to schedule alternative appointments. **Your questions are always welcome**.

Midterm exams: These assessments are to be completed in class at the assigned times. The only exception to this policy is as follows: if you have a legitimate medical or academic conflict that will prevent you from being in class for a midterm, then contact me well ahead of time to discuss alternative arrangements.

Final Exam policy: All students must take the departmental Final Exam at the time and place scheduled by the registrar.

Final Grade policy: Your final grade will not exceed your Final Exam grade by more than one letter grade.

Disability Resource Services: If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and Disability Resources and Services (DRS), 140 William Pitt Union, 412-648-7890, drsrecep@pitt.edu, (412) 228-5347 for P3 ASL users, as early as possible in the term. DRS will verify your disability and determine reasonable accommodations for this course.

Academic Integrity: The University of Pittsburgh Academic Integrity Code is available at "Academic Integrity: Avoiding Plagiarism and Understanding Research Ethics: Avoiding Plagiarism". The code states that "A student has an obligation to exhibit honesty and to respect the ethical standards of the academy in carrying out his or her academic assignments." The website lists examples of actions that violate this code. Students are expected to adhere to the Academic Integrity Code, and violations of the code will be dealt with seriously.

Diversity and Inclusion: The University of Pittsburgh does not tolerate any form of discrimination, harassment, or retaliation based on disability, race, color, religion, national origin, ancestry, genetic information, marital status, familial status, sex, age, sexual orientation, veteran status or gender identity or other factors as stated in the University's Title IX policy. The University is committed to taking prompt action to end a hostile environment that interferes with the University's mission. For more information about policies, procedures, and practices, see: https://www.diversity.pitt.edu/civil-rights-title-ix-compliance/policies-procedures-and-practices.

Classroom Recording: To ensure the free and open discussion of ideas, students may not record classroom lectures, discussion and/or activities not already recorded by the instructor, without the advance written permission of the instructor, and any such recording properly approved in advance can be used solely for the student's own private use.

Copyright: Some of the materials in this course may be protected by copyright. United States copyright law, 17 USC section 101, et seq., in addition to University policy and procedures, prohibit unauthorized duplication or retransmission of course materials. See the Library of Congress Copyright Office and the University Copyright Policy.

Math 0290: Differential Equations, Fall 2024
Schedule and practice problems

The following is an approximate schedule for lectures and a full list of practice problems from the course textbook.

Week 1:

August 26
Introduction to differential equations
1.1 Number 1-11.

August 28
First Order Initial Value Problems
2.1 Number 3-6, 10-15, 21-28.

August 30
Numerical Methods. Euler's Method
6.1 Number 1-9, 11.

Week 2:

September 2
Labor Day (University closed)

September 4
Numerical Methods. Runge-Kutta Methods
6.2 Number 1-9.

September 6
Numerical Methods. Numerical Error
6.3 Number 1-6, 11-13.

Week 3:

September 9
Separable Equations.
2.2 Number 1-22, 23-29, 33-35.

September 11
Models of Motion
2.3 Number 1-10.

September 13
First Order Linear Equations
2.4 Number 1-21, 29.

Week 4:

September 16
Mixing Problems.
2.5 Number 1-7, 9-10.

September 18
Electrical Circuits
3.4 Number 1-19.

September 20
Second Order Equations
4.1 Number 1-20, 26-30.

Week 5:

September 23
Linear Homogeneous Equations with Constant Coefficients.
4.3 Number 1-36.

September 25
Harmonic Motion
4.4 Number 1-12, 14-16, 18.

September 27
Inhomogeneous second order equations. Undetermined Coefficients.
4.5 Number 1-29.

Week 6:

September 30
Undetermined Coefficients (continued). 4.5 (cont.) Number 1-29.

October 2
Inhomogeneous Equations. Variation of Parameters
4.6 Number 1-10.

October 4
Forced harmonic motion
4.7 Number 3-11.

Week 7:

October 7
Review

October 9
Midterm 1

October 11
Laplace Transform
5.1 Number 1-29.

Week 8:

`October 14`
Fall Break for students (No classes)

`October 16`
Laplace Transform. Basic Properties.
5.2 Number 1-41.

`October 18`
The Inverse Laplace Transform
5.3 Number 1-36.

Week 9:

`October 21`
Using the Laplace Transform to solve DEs
5.4 Number 1-26.

`October 23`
Discontinuous Forcing Term
5.5 Number 1-25.

`October 25`
The Dirac Delta Function
5.6 Number 1-9.

Week 10:

`October 28` *Convolutions*
5.7 Number 4-24.

`October 30`
Introduction to Systems
8.1 Number 1-16.

`November 1`
Systems (continued)
8.2 Number 1-6, 13-16.

Week 11:

`November 4`
Systems of differential equations, Constant coefficient homogeneous 2×2 systems
8.3 Number 1-6.

`November 6`
Linear Systems with Constant Coefficients
9.1 Number 1-8, 16-23.

`November 8`
Planar Systems
9.2 Number 1-27, 58-61.

Week 12:

`November 11`
Phase Plane Portraits
9.3 Number 20-23.

`November 13`
Nonlinear Systems: Equilibria, Linearization
10.1 Number 1-16.

`November 15`
Review

Week 13:

`November 18`
MIDTERM 2

`November 20`
Fourier series
12.1 Number 1-22.

`November 22`
Fourier Cosine and Sine Series
12.3 Number 1-32.

Week 14:

`December 2`
Heat Equation
13.1 Number 1-9

`December 4`
Separation of variables for the heat equation.
13.2 Number 1-18.

`December 6`
Separation of variables for the heat equation (continued).
13.2 Number 1-18.

`December 9`
Review