MAT 256 Differential Equations and Linear Algebra

Summer 2024

Course Credits: 4
Contact Hours: 56 hours
Instructor: TBA
Email:TBA

COURSE OBJECTIVES

This is a comprehensive course that delves into the fundamental principles of linear algebra, while integrating the concepts and methodologies of solving differential equations. The class will provide students with a strong foundation in vector spaces, matrices, and linear transformations, complemented by an in-depth exploration of first-order and second-order differential equations. This synergy between linear algebra and differential equations not only enhances problem-solving skills but also offers a unique perspective on applied mathematics, essential for engineering, physics, and various quantitative disciplines.

Upon Completion of this Course, students will be able to:

1. Understand fundamental concepts of differential equations and their applications in modeling real-world phenomena;
2. Demonstrate proficiency in solving various types of differential equations using analytical and computational techniques;
3. Apply linear algebra principles to analyze systems of linear equations and their geometric interpretations;
4. Interpret eigenvalues and eigenvectors in the context of linear transformations and their significance in solving differential equations;
5. Synthesize knowledge of differential equations and linear algebra to tackle advanced problems in physics, engineering, and other scientific disciplines.

PREREQUISITES

MAT 110 Calculus I; MAT 120 Calculus II

GRADING

Grades will be determined by accumulating points, with 100 points being the maximum, as follows:

ITEM	POINTS
4 Assignments	20 Points
2 Quizzes	20 Points
Midterm Exam	25 Points
Final Exam	35 Points
Total	100 Points

Late submissions will be graded at the end of the course. Grades will be assigned according to the following rule:

$A \geq 90 > B \geq 80 > C \geq 70 > D \geq 60 > F$.

We reserve the right to make adjustments to the overall grading policy.

COURSE MATERIALS

Required Texts:

Robert McOwen, ***Worldwide Differential Equations with Linear Algebra***, 2012, Worldwide Center of Mathematics, LLC.

Recommended (Optional) Texts or Other Materials:

None

COURSE TOPICS

MODULE	TASKS
Module 1	**Topics:** Topic 1: Introduction to Differential Equations Topic 2: First-Order Differential Equations: Separable Equations, Exact Equations Topic 3: Linear Differential Equations: Homogeneous and Non-Homogeneous Equations Topic 4: Second-Order Differential Equations: Constant Coefficients, Undetermined Coefficients, Variation of Parameters

	Assessments: Assignment #1
Module 2	**Topics:** Topic 5: Systems of Linear Equations: Matrix Representation, Gaussian Elimination Topic 6: Eigenvalues and Eigenvectors: Characteristic Equation, Diagonalization Topic 7: Matrix Operations: Addition, Multiplication, Inverse Topic 8: Vector Spaces: Subspaces, Basis, Dimension **Assessments:** Quiz #1
Module 3	**Topics:** Topic 9: Linear Transformations: Matrix Representation, Kernel, Image Topic 10: Inner Product Spaces: Orthogonality, Orthonormal Basis Topic 11: Introduction to Laplace Transform: Definition, Properties Topic 12: Inverse Laplace Transform: Partial Fractions, Convolution **Assessments:** Assignment #2 Midterm Exam
Module 4	**Topics:** Topic 13: Applications of Laplace Transform: Circuit Analysis, Control Systems Topic 14: Numerical Methods for Differential Equations: Euler's Method, Runge-Kutta Methods Topic 15: Existence and Uniqueness of Solutions: Picard's Theorem, Existence Theorem for Linear Systems Topic 16: Stability Analysis: Phase Plane Analysis, Eigenvalue Stability **Assessments:** Assignment 3 Quiz #2
Module 5	**Topics:** Topic 17: Higher-Order Differential Equations: Reduction of Order, Method of Undetermined Coefficients Topic 18: Partial Differential Equations: Classification, Separation of Variables Topic 19: Boundary Value Problems: Sturm-Liouville Theory, Green's Functions Topic 20: Introduction to Nonlinear Differential Equations: Phase Portraits, Bifurcations **Assessments:** Assignment 4

Module 6	Topic 21: Introduction to Eigenvalue Problems: Singular Value Decomposition, Principal Component Analysis Topic 22: Applications in Engineering: Vibrations, Heat Conduction Topic 23: Applications in Physics: Wave Equation, Schrödinger Equation Topic 24: Applications in Biology: Population Dynamics, Epidemic Modeling **Assessments:** Final Exam

ATTENDANCE

1) Class attendance is required. Missing classes without permission will lead to decrease in overall grade.

Missing less than two classes: no penalty.

Missing more than two classes: 7% will be taken off from the overall grade.

If the instructor reports a student's frequent missing of class to the Soochow University Academic Administration Office, the student might get a written warning and might be prohibited from attending final exam.

2) Participants in this course are expected to arrive in class promptly and adequately prepared. The primary objective of this course is to critically engage with the readings and the subject matter. Therefore, course participants are expected to have completed the reading prior to class and prepare thoughtful reflections/commentaries to share with fellow colleagues.

LEARNING REQUIREMENTS

1) Late assignments are not acceptable and are subjected to grade deductions.

2) Assignments submitted in the wrong format will be counted as not submitted.

3) Failure to submit or fulfill any required course component results in failure of the class.

4) Make-up for midterm and final exams only with valid excuses, as defined by the University.

5) In order to earn a Certificate of Completion, participants must thoughtfully complete all assignments by stated deadlines and earn an average quiz score of 50% or greater.

TECHNOLOGY POLICY

The use of electronic devices in class is distracting, both for the user and for the rest of the class. Only non-programmable calculators can be used in the tests and exam. Any attempts to use cell phones and other electronic communication devices will be seemed as cheating. Laptops are discouraged, unless you use them for activities DIRECTLY related to the course (eg., note taking, reading course documents).

ACEDEMIC INTEGRITY POLICY

Soochow University highly values the academic integrity and aims to promote the academic fairness, honesty and responsibility. Any academic dishonesty behaviors and any attempts to cheats and plagiarism will be reported to the university administration office. A written warning and the relevant penalties will be imposed. The record might be shown on the official university transcript.

DISABILITY ACCOMMODATION

Soochow University is committed to maintaining a barrier-free environment so that students with disabilities can fully access programs, courses, services, and activities at Soochow University. Students with disabilities who require accommodations for access to and/or participation in this course are welcome.

Note:

Please contact the University Administrative Office immediately if you have a learning disability, a medical issue, or any other type of problem that prevents professors from seeing you have learned the course material.