MATH 331: Introduction to Partial Differential Equations
Spring 2025 Course Syllabus

NJIT Academic Integrity Code: All Students should be aware that the Department of Mathematical Sciences takes the University Code on Academic Integrity at NJIT very seriously and enforces it strictly. This means that there must not be any forms of plagiarism, i.e., copying of homework, class projects, or lab assignments, or any form of cheating in quizzes and exams. Under the University Code on Academic Integrity, students are obligated to report any such activities to the Instructor.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating or plagiarizing will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu

COURSE INFORMATION

Course Description: Partial differential equations in science and engineering. Topics include initial- and boundary-value problems for parabolic, hyperbolic, and elliptic second-order equations. Emphasis is placed on separation of variables, special functions, transform methods, and numerical techniques.

Number of Credits: 3

Prerequisites: MATH 211 or MATH 213 and MATH 222 all with a grade of C or better.

Course-Section and Instructors:

Course-Section	Instructor
Math 331-004	Professor V. Matveev

Office Hours for All Math Instructors: Spring 2025 Office Hours and Emails

Required Textbook:

Title	*Applied Partial Differential Equations*
Author	Richard Haberman
Edition	5th
Publisher	Pearson Prentice-Hall
ISBN #	978-0321797056

Website	Canvas

University-wide Withdrawal Date: The last day to withdraw with a **W** is Monday, April 7, 2025. It will be strictly enforced.

COURSE GOALS

Course Objectives

- Students will gain a clear intuitive understanding of partial differential equations and their relevance to describing physical phenomena such as diffusion and wave propagation.
- Students will gain a deep understanding of Fourier series by mastering the theory of boundary value problems.
- Students will learn the separation of variables method to solve linear parabolic, elliptic and hyperbolic partial differential equations.
- Students will gain practical knowledge of basic numerical techniques for solving partial differential equations using the finite difference method.
- Students will learn the basics of the Fourier transform method for solving PDEs on an infinite domain.

Course Outcomes

- Students can derive the heat equation from basic principles such as energy conservation and the Fourier law of heat conduction.
- Students can calculate and visualize Fourier cosine or sine series of a function of one variable.
- Students can find equilibrium solutions to heat or wave equations, and explain their physical meaning.
- Students can write down the complete solution of a linear homogeneous wave, heat or Laplace equation on a rectangular or radially-symmetric domain using separation of variables.
- Students can apply the concept of linearity to solve non-homogeneous PDEs by the method of linear superposition.
- Students can solve the heat equation with Dirichlet boundary conditions using the finite difference approach and will develop a basic understanding of computational algorithms that are used to approximate numerically the solutions of mathematical problems.
- Students can use the Fourier transform method to solve the heat equation and the Laplace equation in a semi-infinite plane or strip.
- Students have a grasp of the basic principles of Sturm-Liouville theory of boundary-value problems.
- Students can use the Rayleigh Quotient to gain information about the lowest eigenvalue and the corresponding eigenfunctions for a boundary value problem.

Course Assessment: The assessment of objectives will be achieved through homework assignments and midterm/final examinations testing the specific outcomes listed above.

POLICIES

DMS Course Policies: All DMS students must familiarize themselves with, and adhere to, the Department of Mathematical Sciences Course Policies, in addition to official university-wide policies. DMS takes these policies very seriously and enforces them strictly.

AI Usage Policy: This course expects students to work without artificial intelligence (AI) assistance in order to better develop their skills in this subject area. As such, AI-generated output is not permitted as part of any of the submitted class homework assignments.

Grading Policy: The final grade in this course will be determined as follows:

Homework	18%
Quizzes	18%
Midterm Exam I	30%
Final Exam	34%

Your final letter grade will be based on the following tentative curve.

A	90 - 100	**C**	61 - 67
B+	82 - 89	**D**	53 - 60
B	75 - 81	**F**	0 - 52
C+	68 - 74		

Attendance Policy: Attendance at all classes is **mandatory per DMS policy.** Please make sure you read and fully understand the Math Department's Attendance Policy. This policy will be enforced. A couple missed lectures over the course of the semester will not impact your grade, but try and borrow notes from your classmates if you have to miss a class. See also Makeup Exam Policy below.

Religious Observance: NJIT is committed to supporting students observing religious holidays. Students must notify their instructors in writing of any conflicts between course requirements and religious observances, ideally by the end of the second week of classes and no later than two weeks before the anticipated absence.

Email and Canvas: Important announcements will be sent via email and cross-posted in Canvas. It is important that you regularly check your NJIT email account and Canvas course page for class assignments and announcements from your instructor.

Homework and Quizzes: Homework problem sets will be posted in Canvas by the instructor each week, and may include problems requiring basic coding in MATLAB or Mathematica. All homework should be submitted via Canvas. Short quizzes will be given at the start of the class about every other week.

Exams: There will be one midterm exam and a cumulative final exam during the final exam week:

Midterm Exam	March 13, 2025
Final Exam Period	May 10 - May 16, 2025

The final exam will test your knowledge of all the course material taught in the entire course. Make sure you read and fully understand the Math Department's Examination Policy. This policy will be strictly enforced.

Makeup Exam Policy: There will be **NO MAKE-UP EXAMS** during the semester. In the event an exam is not taken, and under circumstances where the student has a legitimate reason for missing the exam, the student should contact the Dean of Students office and present written verifiable proof of the reason for missing the exam, e.g., a doctor's note, police report, court notice, etc. clearly stating the date AND time of the mitigating problem. The student must also notify the Instructor that the exam will be missed.

Cellular Phones: All cellular phones and other electronic devices must be switched off during all class times.

ADDITIONAL RESOURCES

Math Tutoring Center: Located in the Central King Building, Lower Level, Rm. G11 (See: Spring 2025 Hours)

Further Assistance: For further questions, students should contact their instructor. All instructors have regular office hours during the week. These office hours are listed on the Math Department's webpage for Instructor Office Hours and Emails.

Accommodation of Disabilities: The Office of Accessibility Resources and Services (OARS) offers long term and temporary accommodations for undergraduate, graduate and visiting students at NJIT.

If you are in need of accommodations due to a disability please If you need an accommodation due to a disability please contact the Office of Accessibility Resources and Services at oars@njit.edu. The office is located in Kupfrian Hall, Room 201. A Letter of Accommodation Eligibility from the Office of Accessibility Resources and Services office authorizing your accommodations will be required.

For further information regarding self identification, the submission of medical documentation and additional support services provided please visit the Office of Accessibility Resources and Services (OARS) website at: https://www.njit.edu/accessibility/

Important Dates (See: Spring 2025 Academic Calendar, Registrar)

Date	Day	Event
January 21, 2025	Tuesday	First Day of Classes
January 27, 2025	Monday	Last Day to Add/Drop Classes
March 16, 2025	Sunday	Spring Recess Begins
March 22, 2025	Saturday	Spring Recess Ends
April 3, 2025	Thursday	Wellness day
April 7, 2025	Monday	Last Day to Withdraw
April 18, 2025	Friday	Good Friday - No Classes
April 20, 2025	Sunday	Easter Sunday - No Classes Scheduled
May 6, 2025	Tuesday	Thursday Classes Meet
May 7, 2025	Wednesday	Friday Classes Meet
May 7, 2025	Wednesday	Last Day of Classes
May 8, 2025	Thursday	Reading Day 1

May 9, 2025	Friday	Reading Day 2
May 10 - May 16, 2025	Friday to Thursday	Final Exam Period

Course Outline:

Lecture (date)	Sections	Topic
1 (1-21)	1.1, 3.3	Introduction, review of Calculus III (visualizing scalar fields); Fourier Series
2 (1-23)	3.3	Fourier series continued: Sine and Cosine series
3 (1-28)	3.4-3.5	Fourier series continued: term-by-term operations
4 (1-30)	1.2-1.3	Heat equation: 1D derivation & boundary conditions
5 (2-4)	1.3-1.4	Heat equation: equilibrium temperature distribution
6 (2-6)	1.4-1.5	More equilibrium solutions; heat equation in higher dimensions
7 (2-11)	2.1-2.2	Linearity and Superposition
8 (2-13)	2.3	Method of separation of variables: boundary value problems
9 (2-18)	2.4.1-2.4.2	Solving heat equation in 1D rod: insulated ends
10 (2-20)	2.4.2-2.4.3	Solving heat equation in 1D rod: circular ring
11 (2-25)	8.1, 8.2	Dealing with non-homogeneous problems
12 (2-27)	2.5.1	Laplace's equation inside a rectangle
13 (3-4)	2.5.2, 2.5.4	Laplace's equation inside a disk; qualitative properties
14 (3-6)	4.1-4.2, 4.4	Wave equation: 1D derivation and vibrating string with fixed ends
14 (3-11)		**Exam Review**
15 (3-13)		**Midterm Examination**
Mar 16-22		**Spring Break**
17 (3-25)	4.3	Wave equation: boundary conditions and vibrating string continued

18 (3-27)	5.1-5.4	Sturm-Liouville eigenvalue problems: properties; proof of orthogonality
19 (4-1)	5.5, 5.6	Sturm-Liouville problems: self-adjointness; Rayleigh quotient
April 3	**Wellness Day - No Classes**	
April 7	**Last Day to Withdraw**	
20 (4-8)	5.6	Rayleigh Quotient test function examples
21 (4-10)	5.8	More Rayleigh Quotient examples; Robin boundary conditions
22 (4-15)	6.1-6.2	Finite difference numerical methods
23 (4-17)	6.2-6.3.2	Euler finite difference method for heat equation, continued
24 (4-22)	7.1-7.2	PDE's in 2+1 dimensions: vibration of a rectangular membrane
25 (4-24)	10.1-10.3	Heat equation on an infinite line; Fourier Transform derivation
26 (4-29)	10.4, 10.6	Fourier Transform problems
27 (5-1)	10.4, 10.6	More Fourier Transform applications
28 (5-6)	**Last Class: Final Exam Review**	