MATH 331: Introduction to Partial Differential Equations
Fall 2024 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. Violations of the code (e.g. 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 331-001	Professor V. Matveev

Office Hours for All Math Instructors: Fall 2024 Office Hours and Emails

Required Textbook:

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

University-wide Withdrawal Date: The last day to withdraw with a **W** is **Monday, November 11, 2024**. It will be strictly enforced.

COURSE GOALS

Course Objectives

- Students will gain a clear intuitive understanding of the concept of a partial differential equation and its relevance to describing physical phenomena such as diffusion and wave propagation.
- Students will gain a deeper 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 spectral Fourier transform method for solving PDEs on an infinite or semi-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 the heat or wave equation 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-homogenous PDEs by the method of linear superposition.
- Students can solve the heat equation with Dirichlet boundary conditions using the finite difference approach and have a basic understanding of computational algorithms that are used to approximate solutions of mathematical problems.
- Students can use the Fourier transform method to solve the heat equation and Laplace's equation in a semi-infinite plane or strip.
- Students understand the basic principles of Sturm-Liouville theory as it relates to 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, quizzes and 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.

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

Homework	18%
Quizzes	18%
Midterm Exam	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**	54 - 60
B	75 - 81	**F**	0 - 53
C+	68 - 74		

Attendance Policy: Attendance at all classes will be recorded and is **mandatory**. Please make sure you read and fully understand the Math Department's Attendance Policy. This policy will be strictly enforced. Attendance will be taken each lecture and regular attendance is encouraged. 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. Missed quizzes will result in a zero score for the corresponding quiz (See Makeup Exam Policy below)

Email and Canvas: Regularly check your NJIT email account and the course information posted on Canvas for class assignments and announcements from your instructor.

Homework: 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 about once per week, on a pre-announced topic, and will be given in-person.

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

Midterm Exam	October 30, 2024
Final Exam Period	December 15 - December 21, 2024

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 QUIZZES OR EXAMS** during the semester. In the event an exam is not taken under rare 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 Math Department Office/Instructor that the exam will be missed.

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

Use of Generative AI: not permitted for completion of assignments, unless explicitly requested by the professor.

ADDITIONAL RESOURCES

Math Tutoring Center: Located in the Central King Building, Lower Level, Rm. G11 (See: Fall 2024 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 need an accommodation due to a disability, please contact the Office of Accessibility Resources and Services at oars@njit.edu, or visit Kupfrian Hall 201 to discuss your specific needs. A Letter of Accommodation Eligibility from the office authorizing student accommodations is 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: Fall 2024 Academic Calendar, Registrar)

Date	Day	Event
September 2, 2024	Monday	Labor Day
September 3, 2024	Tuesday	First Day of Classes
September 9, 2024	Monday	Last Day to Add/Drop Classes
November 11, 2024	Monday	Last Day to Withdraw
November 26, 2024	Tuesday	Thursday Classes Meet
November 27, 2024	Wednesday	Friday Classes Meet
November 28 to December 1, 2024	Thursday and Sunday	Thanksgiving Recess - Closed
December 11, 2024	Wednesday	Last Day of Classes
December 12, 2024	Thursday	Reading Day 1
December 13, 2024	Friday	Reading Day 2
December 15 to December 21, 2024	Sunday to Saturday	Final Exam Period

Course Outline

Lecture / Date	Sections	Topic
1 (09/05)	3.1-3.3	Introduction: visualizing scalar fields, linearity, Fourier series
2 (09/09)	3.4-3.6	Fourier series continued
3 (09/11)	3.4-3.6	Fourier series continued: term-by-term operations
4 (09/16)	1.2-1.3	Heat equation: 1D derivation & boundary conditions
5 (09/18)	1.3-1.4	Heat equation: equilibrium temperature distribution
6 (09/23)	1.4-1.5	More equilibrium solutions; heat equation in higher dimensions
7 (09/25)	2.1-2.2	Linearity and Superposition
8 (09/30)	2.3	Method of separation of variables: boundary value problems
9 (10/02)	2.4.1-2.4.2	Solving heat equation in 1D rod: insulated ends
10 (10/07)	2.4.2-2.4.3	Solving heat equation in 1D rod: circular ring
11 (10/09)	8.1-8.2	Dealing with non-homogeneous problems
12 (10/14)	2.5.1	Laplace's equation inside a rectangle
13 (10/16)	2.5.2, 2.5.4	Laplace's equation inside a disk; qualitative properties
14 (10/21)	4.1-4.2, 4.4	Wave equation: 1D derivation and vibrating string with fixed ends
15 (10/23)	4.3	Wave equation: boundary conditions and vibrating string continued
16 (10/28)	**Exam Review**	
17 (10/30)	**Midterm Examination**	
18 (11/04)	5.1-5.4	Sturm-Liouville eigenvalue problems: properties; proof of orthogonality
19 (11/06)	5.5-5.6	Sturm-Liouville problems: self-adjointness; Rayleigh quotient
20 (11/11)	5.6	Rayleigh Quotient test function examples
Nov 11	**Last Day to Withdraw**	
21 (11/13)	5.8	More Rayleigh Quotient examples; Robin boundary conditions
22 (11/18)	6.1-6.2	Finite difference numerical methods
23 (11/20)	6.2-6.3.2	Euler finite difference method for heat equation, continued
24 (11/25)	7.1-7.2	PDE's in 2+1 dimensions: vibration of a rectangular membrane
25 (12/02)	10.1-10.3	Heat equation on an infinite line; Fourier Transform derivation
26 (12/04)	10.4, 10.6	Fourier Transform problems
27 (12/09)	10.4, 10.6	More Fourier Transform applications
28 (12/11)	**Final Exam Review**	

Updated by Professor V. Matveev - 8/2024
Department of Mathematical Sciences Course Syllabus, Fall 2024