

## **MATH 331: Introduction to Partial Differential Equations** *Spring 2022 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](mailto:dos@njit.edu)

Please be sure you read and fully understand our [DMS Online Exam Policy](#).

### **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:**

<b>Course-Section</b>	<b>Instructor</b>
Math 331-002	Professor V. Matveev

**Office Hours for All Math Instructors:** [Spring 2022 Office Hours and Emails](#)

**Required Textbook:**

<b>Title</b>	<i>Applied Partial Differential Equations</i>
<b>Author</b>	Richard Haberman
<b>Edition</b>	5th

<b>Publisher</b>	Pearson Prentice-Hall
<b>ISBN #</b>	978-0321797056
<b>Website</b>	Canvas

**University-wide Withdrawal Date:** The last day to withdraw with a W is **Monday, April 4, 2022**. It will be strictly enforced.

## **COURSE GOALS**

### **Course Objectives**

- Student will gain a clear intuitive understanding of the concept of partial differential equation and its relevance to describing physical phenomena such as diffusion and wave propagation.
- Students will gain deeper understanding of the 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 the 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 prove orthogonality and uniqueness of solutions to a boundary value problem.
- Students can use the Rayleigh Quotient to gain information about the lowest eigenvalue and the corresponding eigenfunctions for a boundary value problem
- Students can find equilibrium solutions to heat or wave equation, and be able to explain their physical meaning
- Students can write down the complete solution of a linear homogeneous wave, heat or Laplace's equation on a rectangular or rotationally-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 finite difference approach will develop an understanding of computational algorithms that are used to approximate numerical solutions of mathematical problems.
- Students can use the Fourier transform method to solve the heat equation and the Laplace's equation in a semi-infinite plane or strip.

**Course Assessment:** The assessment of objectives will be achieved through homework assignments, quizzes, and common examinations testing each of 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	17%
Quizzes	17%
Midterm Exam	30%
Final Exam	36%

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. 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:** 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 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	March 10, 2022
Final Exam Period	May 6 - May 12, 2022

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.

## ADDITIONAL RESOURCES

**Math Tutoring Center:** Located in the Central King Building, Lower Level, Rm. G11 (See: [Spring 2022 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 contact Scott Janz, Associate Director of Disability Support Services at [973-596-5417](tel:973-596-5417) or via email at [scott.p.janz@njit.edu](mailto:scott.p.janz@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/studentsuccess/accessibility/>

**Important Dates** (See: [Spring 2022 Academic Calendar, Registrar](#))

Date	Day	Event
January 18, 2022	Tuesday	First Day of Classes
January 22, 2022	Saturday	Saturday Classes Begin
January 24, 2022	Monday	Last Day to Add/Drop Classes
March 14, 2022	Monday	Spring Recess Begins
March 19, 2022	Saturday	Spring Recess Ends
April 4, 2022	Monday	Last Day to Withdraw
April 15, 2022	Friday	Good Friday - No Classes
April 17, 2022	Sunday	Easter Sunday - No Classes
May 3, 2022	Tuesday	Friday Classes Meet
May 3, 2022	Tuesday	Last Day of Classes
May 4 - May 5, 2022	Wednesday and Thursday	Reading Days
May 6 - May 12, 2022	Friday to Thursday	Final Exam Period

## Course Outline

Lecture / Date	Sections	Topic
1 (1-20)	3.1-3.3	Introduction: visualizing scalar fields, linearity, Fourier series
2 (1-24)	3.4-3.6	Fourier series continued
3 (1-27)	3.4-3.6	Fourier series continued: term-by-term operations
4 (1-31)	1.2-1.3	Heat equation: 1D derivation & boundary conditions
5 (2-3)	1.3-1.4	Heat equation: equilibrium temperature distribution
6 (2-7)	1.4-1.5	More equilibrium solutions; heat equation in higher dimensions
7 (2-10)	2.1-2.2	Linearity and Superposition
8 (2-14)	2.3	Method of separation of variables: boundary value problems
9 (2-17)	2.4.1-2.4.2	Solving heat equation in 1D rod: insulated ends
10 (2-21)	2.4.2-2.4.3	Solving heat equation in 1D rod: circular ring
11 (2-24)	8.1, 8.2	Dealing with non-homogeneous problems
12 (2-28)	2.5.1	Laplace's equation inside a rectangle
13 (3-3)	2.5.2, 2.5.4	Laplace's equation inside a disk; qualitative properties
<b>14 (3-7)</b>	<b>Exam Review</b>	
<b>15 (3-10)</b>	<b>Midterm Examination</b>	
<b>Mar 14-19</b>	<b>Spring Break</b>	
16 (3-21)	4.1-4.2, 4.4	Wave equation: 1D derivation and vibrating string with fixed ends
17 (3-24)	4.3	Wave equation: boundary conditions and vibrating string continued
18 (3-28)	5.1-5.4	Sturm-Liouville eigenvalue problems: properties; proof of orthogonality
19 (3-31)	5.5, 5.6	Sturm-Liouville problems: self-adjointness; Rayleigh quotient
<b>April 4</b>	<b>Last Day to Withdraw</b>	
20 (4-4)	5.6	Rayleigh Quotient test function examples
21 (4-7)	5.8	More Rayleigh Quotient examples; Robin boundary conditions
22 (4-11)	6.1-6.2	Finite difference numerical methods
23 (4-14)	6.2-6.3.2	Euler finite difference method for heat equation, continued
24 (4-18)	7.1-7.2	PDE's in 2+1 dimensions: vibration of a rectangular membrane
25 (4-21)	10.1-10.3	Heat equation on an infinite line; Fourier Transform derivation
26 (4-25)	10.4, 10.6	Fourier Transform problems
27 (4-28)	10.4, 10.6	More Fourier Transform applications
<b>28 (5-2)</b>	<b>Final Exam Review</b>	

*Updated by Professor V. Matveev - 1/7/2022  
Department of Mathematical Sciences Course Syllabus, Spring 2022*