NJIT New Jersey's Science & Technology University

THE COLLEGE OF SCIENCE AND LIBERAL ARTS

THE DEPARTMENT OF MATHEMATICAL SCIENCES

MATH 331-004: Introduction to Partial Differential Equations
Spring 2019 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.

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 P. Petropoulos

Office Hours for All Math Instructors: Spring 2019 Office Hours and Emails

Required Textbook:

Title	*Applied Partial Differential Equations*
Author	Haberman
Edition	5th
Publisher	Pearson
ISBN #	978-0321797056
Website	http://web.njit.edu/~matveev/Courses/M331_S19/

University-wide Withdrawal Date: The last day to withdraw with a **W** is **Monday, April 8, 2019**. It will be strictly enforced.

COURSE OBJECTIVES

Course Learning Goals

- 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	15%
Quiz	15%
Midterm Exam I	30%
Final Exam	40%

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

A	89 - 100	**C**	61 - 67
B+	82 - 88	**D**	53 - 60
B	75 - 81	**F**	0 - 52
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.

Homework and Quiz Policy: Homework problem sets will be emailed by the instructor each week, and may include problems requiring basic MATLAB coding. Homework is in general due each Wednesday; late work is not accepted. Short quizzes will also be given about once per week, on a pre-announced topic.

Email Policy: It is important that you regularly check your NJIT email account for class assignments and announcements from your instructor. Rutgers students should email the instructor their preferred email address at the start of the semester.

Exams: There will be one midterm exam held in class during the semester and one comprehensive final exam. Exams are held on the following days:

Midterm Exam	March 14, 2019
Final Exam Period	May 10 - 16, 2019

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 2019 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.

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

Accommodation of Disabilities: Disability Support Services (DSS) 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 Chantonette Lyles, Associate Director of Disability Support Services at 973-596-5417 or via email at lyles@njit.edu. The office is located in Fenster Hall Room 260. A Letter of Accommodation Eligibility from the Disability Support 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 Disability Support Services (DSS) website at:

- http://www5.njit.edu/studentsuccess/disability-support-services/

Important Dates (See: Spring 2019 Academic Calendar, Registrar)

Date	Day	Event
January 22, 2019	T	First Day of Classes
February 1, 2019	F	Last Day to Add/Drop Classes

March 17 - 24, 2019	Su - Su	Spring Recess - No Classes, NJIT Open
April 8, 2019	M	Last Day to Withdraw
April 19, 2019	F	Good Friday - No Classes, NJIT Closed
May 7, 2019	T	Friday Classes Meet/ Last Day of Classes
May 8 & 9, 2019	W & R	Reading Days
May 10 - 16, 2019	F - R	Final Exam Period

Course Outline

Lecture (Date)	Sections	Topics
1 (1-22)	3.1-3.3	Introduction: visualizing scalar fields, linearity, Fourier series
2 (1-24)	3.4-3.6	Fourier series continued
3 (1-28)	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 (2-5)	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 (2-12)	2.3	Method of separation of variables: boundary value problems
8 (2-14)	2.4.1-2.4.2	Solving heat equation in 1D rod: insulated ends
9 (2-19)	2.4.2-2.4.3	Solving heat equation in 1D rod: circular ring
10 (2-21)	2.5.1	Laplace's equation inside a rectangle
11 (2-26)	2.5.2, 2.5.4	Laplace's equation inside a disk; qualitative properties
12 (2-28)	4.1-4.2, 4.4	Wave equation: 1D derivation and vibrating string with fixed ends
13 (3-5)	4.3	Wave equation: boundary conditions and vibrating string continued
14 (3-7)	4.5	Wave equation: vibrating membrane; dissipation
15 (3-12)	**EXAM REVIEW**	
15 (3-14)	**MIDTERM EXAMINATION**	
3-18 – 3-23	**SPRING BREAK**	
16 (3-26)	5.1-5.4	Sturm-Liouville eigenvalue problems: properties; proof of orthogonality
17 (3-28)	5.5, 5.6	Sturm-Liouville problems: self-adjointness; Rayleigh quotient
18 (4-2)	5.6	Rayleigh Quotient test function examples
19 (4-4)	5.8	More Rayleigh Quotient examples; Robin boundary conditions
April 8, 2019	**LAST DAY TO WITHDRAW**	
20 (4-9)	6.1-6.2	Finite difference numerical methods
21 (4-11)	6.2-6.3.2	Euler finite difference method for heat equation; von Neumann stability
22 (4-16)	7.1-7.2	PDE's in 2+1 dimensions: vibration of a rectangular membrane
23 (4-18)	7.7, 7.8	Bessel equation and Bessel functions
24 (4-23)	7.7	Vibration of a circular membrane

25 (4-25)	10.1-10.3	Heat equation on an infinite line; Fourier Transform derivation
26 (4-30)	10.4, 10.6	Fourier Transform problems
27 (5-2)	10.4, 10.6	More Fourier Transform applications
28	**FINAL EXAM REVIEW**	