NJIT New Jersey's Science & Technology University

THE COLLEGE OF SCIENCE AND LIBERAL ARTS

THE DEPARTMENT OF MATHEMATICAL SCIENCES

MATH 331-003: Introduction to Partial Differential Equations
Fall 2020 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 331-003	Professor L. Cummings

Office Hours for All Math Instructors: Fall 2020 Office Hours and Emails

Required Textbook:

Title	*Applied Partial Differential Equations*
Author	Haberman
Edition	5th
Publisher	Pearson Prentice-Hall
ISBN #	Print ISBN:978-0134995434 eBook ISBN: 978-0321905673
Website	http://web.njit.edu/~matveev/Courses/M331_F20/

University-wide Withdrawal Date: The last day to withdraw with a **W** is **Monday, November 9, 2020**. 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 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	25%
Exam I	20%
Exam II	20%
Final Exam	35%

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

A	90 - 100	**C**	61 - 67
B+	82 - 89	**D**	52 - 60
B	75 - 81	**F**	0 - 51
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.

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 assigned regularly by the instructor via canvas and may include problems requiring basic coding in MATLAB or Mathematica. Due dates as posted on canvas; late work is not accepted (rare exceptions may be made if there is good reason). All HW assignments are to be submitted via the canvas course page (NOT email).

Make-up Policy: No make-ups are allowed for missed quizzes and midterm exam. If your documented absence is cleared with the Dean of Students, the corresponding score will be dropped from the final grade calculation, so there is no penalty in such cases, but there will be no make-up administered.

Attendance: Virtual attendance in WebEx class is mandatory. WebEx polls will be conducted to verify attendance. A couple missed lectures over the course of the semester will not impact your grade, but please don't miss class if you don't have to.

Accommodations: Students requiring special accommodations are referred to the Office of Accessibility Resources & Services (OARS), Tel. 973-596-5417 or email oars@njit.edu. See also the OARS website, https://www.njit.edu/studentsuccess/accessibility/

Exams: All exams will be administered via canvas using lockdown browser with Respondus monitoring. For students who don't have webcams, webex proctoring using smartphone can be arranged with the instructor. Students with technology deficiencies should contact the Dean of Students Office (dos@njit.edu).

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 I	October 7, 2020
Mideterm Exam II	November 4, 2020
Final Exam Period	December 15 - 21, 2020

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.

Policy on Academic Integrity: Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.

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, plagiarizing or using any online software inappropriately 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

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: Fall 2020 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: 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 Chantonette Lyles, Associate Director of Disability Support Services at 973-596-5417 or via email at lyles@njit.edu. The office is located in Kupfrian Hall, Room 201. 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:

- https://www.njit.edu/studentsuccess/accessibility/

Important Dates (See: Fall 2020 Academic Calendar, Registrar)

Date	Day	Event
September 1, 2020	T	First Day of Classes
September 5, 2020	S	Saturday Classes Begin
September 7, 2020	M	Labor Day
September 8, 2020	T	Monday Classes Meet
September 8, 2020	T	Last Day to Add/Drop Classes
November 9, 2020	M	Last Day to Withdraw
November 25, 2020	W	Friday Classes Meet
November 26-29, 2020	R - Su	Thanksgiving Recess - University Closed
December 10, 2020	R	Last Day of Classes
December 11 & 14, 2020	F & M	Reading Days
December 15 - 21, 2020	T - M	Final Exam Period

Course Outline

Lecture (Date)	Sections	Topics
1 (9-3)	1.1-1.3	Introduction: PDEs in physics; derivation of 1D heat equation
2 (9-8) TUES	1.3-1.4	Heat equation: Equilibrium solutions; boundary & initial conditions
3 (9-10)	1.5	Heat equation in higher dimensions

4 (9-14)	2.1-2.2	Linearity & superposition
5 (9-17)	2.3	Method of separation of variables: boundary value problems
6 (9-21)	3.1-3.3	Fourier series review
7 (9-24)	3.4-3.6	Fourier series continued
8 (9-28)	2.4.1-2.4.2	Solving heat equation in 1D rod: insulated ends
9 (10-1)	2.4.2-2.4.3	Solving heat equation in 1D rod: circular ring
10 (10-5)		**REVIEW FOR EXAM I**
OCOBER 7	**EXAM 1**	All material covered to date
11 (10-8)	2.5.1	Laplace's equation inside a rectangle
12 (10-12)	2.5.2, 2.5.4	Laplace's equation inside a disk; qualitative properties
13 (10-15)	4.1-4.3	Wave equation: 1D derivation and vibrating string with fixed ends
14 (10-19)	4.4-4.5	Wave equation: boundary conditions and vibrating string continued
15 (10-22)	5.1-5.4	Sturm-Liouville eigenvalue problems: properties; proof of orthogonality
16 (10-26)	5.5	Sturm-Liouville problems: self-adjointness; Rayleigh quotient
18 (11-2)	5.6-5.7	Rayleigh Quotient test function examples
18 (11-8)		**REVIEW FOR EXAM II**
NOVEMBER 4	**EXAM 2**	All material covered since Exam I
19 (11-5)	5.8	More Rayleigh Quotient examples; Robin boundary conditions
NOVEMBER 9	**LAST DAY TO WITHDRAW**	
20 (11-9)	6.1-6.2	Finite difference numerical methods
21 (11-12)	6.3.1-6.3.4	Euler finite difference method for heat equation; von Neumann stability
22 (11-16)	7.1-7.3	PDE's in 2+1 dimensions: vibration of a rectangular membrane
23 (11-19)	7.7	Bessel equation and Bessel functions
24 (11-23)	7.8	Vibration of a circular membrane
25 (11-30)	10.1-10.3	Heat equation on an infinite line; Fourier Transform derivation
26 (12-3)	10.4, 10.6	Fourier Transform problems
27 (12-7)	10.4, 10.6	More Fourier Transform applications
28 (12-10)	**FINAL EXAM REVIEW**	