Fall 2019 Course Syllabus: Math 331-001

Course Title:	**Introduction to Partial Differential Equations**
Textbook:	Applied Partial Differential Equations by Richard Haberman (5th Ed) *Pearson Prentice-Hall*, ISBN: **978-0321797056**
Prerequisites:	(Math 211 or Math 213) and Math 222, with a grade of C or higher
Website:	http://web.njit.edu/~matveev/Courses/M331_F19/

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Course Outline

Lecture / date	**Sections**	**Topic**
1 (9-4)	3.1-3.3	Introduction: visualizing scalar fields, linearity, Fourier series
2 (9-9)	3.4-3.6	Fourier series continued
3 (9-11)	3.4-3.6	Fourier series continued: term-by-term operations
4 (9-16)	1.2-1.3	Heat equation: 1D derivation & boundary conditions
5 (9-18)	1.3-1.4	Heat equation: equilibrium temperature distribution
6 (9-23)	1.4-1.5	More equilibrium solutions; heat equation in higher dimensions
7 (9-25)	2.3	Method of separation of variables: boundary value problems
8 (9-30)	2.4.1-2.4.2	Solving heat equation in 1D rod: insulated ends
9 (10-2)	2.4.2-2.4.3	Solving heat equation in 1D rod: circular ring
10 (10-7)	2.5.1	Laplace's equation inside a rectangle
11 (10-9)	2.5.2, 2.5.4	Laplace's equation inside a disk; qualitative properties
12 (10-14)	4.1-4.2, 4.4	Wave equation: 1D derivation and vibrating string with fixed ends
13 (10-16)	4.3	Wave equation: boundary conditions and vibrating string continued
14 (10-21)	**Exam Review**	
15 (10-23)	**Midterm Examination**	
16 (10-28)	5.1-5.4	Sturm-Liouville eigenvalue problems: properties; proof of orthogonality
17 (10-30)	5.5, 5.6	Sturm-Liouville problems: self-adjointness; Rayleigh quotient
18 (11-4)	5.6	Rayleigh Quotient test function examples
19 (11-6)	5.8	More Rayleigh Quotient examples; Robin boundary conditions
November 11	**Last Day to Withdraw**	
20 (11-11)	6.1-6.2	Finite difference numerical methods
21 (11-13)	6.2-6.3.2	Euler finite difference method for heat equation; von Neumann stability
22 (11-18)	7.1-7.2	PDE's in 2+1 dimensions: vibration of a rectangular membrane
23 (11-20)	7.7, 7.8	Bessel equation and Bessel functions
24 (11-25)	7.7	Vibration of a circular membrane
25 (12-2)	10.1-10.3	Heat equation on an infinite line; Fourier Transform derivation
26 (12-4)	10.4, 10.6	Fourier Transform problems
27 (12-9)	10.4, 10.6	More Fourier Transform applications
28 (12-11)	**Final Exam Review**	

Grading Policy

Assignment Weighting	
Homework	12 %
Quiz	18 %
Midterm Exam	30 %
Final Exam	40 %

Tentative Grading Scale	
A	90 – 100
B+	82 – 89
B	75 – 81
C+	68 – 74
C	61 – 67
D	52 – 60
F	0 – 51

Course Policies

Email: 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.

Homework and Quizzes: Homework problem sets will be emailed by the instructor each week, and may include problems requiring basic coding in MATLAB or Mathematica. Homework is in general due each Wednesday; late work is not accepted; rare exceptions may be given if the work is submitted the same day. In case of absence, homework may be sent to the instructor via email. Short quizzes will be given about once per week, on a pre-announced topic.

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: attendance in this class is mandatory. 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 make-up policy above).

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.