Syllabus For Math 640:463/645:527

Spring 2023
Rutgers University-Camden

COURSE TITLE: Applied Partial Differential Equations/Method of Applied Mathematics

TEXTBOOKS: *Applied Partial Differential Equations* (3^{th} ed), by J. David Logan, Springer, 2015. Available online at: https://link.springer.com/book/10.1007/978-3-319-12493-3.

COURSE DESCRIPTION: This three-credit course is an introduction to theory and applications of partial differential equations (PDEs). Topics include: (1) Conservation laws and mathematical models for diffusion, vibration, and heat conduction. (2) Cauchy problems for heat and wave equations on unbounded domains, Duhamel's principle, Laplace and Fourier transforms. (3) Orthogonal expansions and Fourier series. (4) Separation of variables, Sturm-Liouville problem, Laplace equation. (5) Applications of PDEs in life sciences. (6) Numerical methods. We will cover most materials in the textbook. We will also cover selective topics on spectral theory of partial differential operators if time permitting.

OBJECTIVES: By the end of this course, students will be able to: (1) Understand the classification and physical origins for partial differential equations. (2) Know how to solve basic partial differential equations such as the Laplace, heat, and wave equations via methods of separation of variables, Duhamel's Principle, Laplace transform, Fourier transform, and Fourier series. (3) Know how to use numerical methods to solve partial differential equations. (4) Familiar with applications of the partial differential equations in life and physical sciences.

INSTRUCTION: This is an in-person class. However, Canvas, Zoom, and other digital platforms will be used to aid the instruction and communication. Students are expected to have access to high speed internet, a laptop/desktop computer together with built-in or separate microphone, and a scanner or a phone camera with an app for producing pdf documents.

COURSE INFORMATION:

- Instructor: Siqi Fu
- Office: BSB 426
- Office hours: TTH 3:00 pm–4:00 pm or by appointments
- Phone: 856 225-2349.
- E-mail: sfu@camden.rutgers.edu
- Web page: http://people.camden.rutgers.edu/sfu

- Lectures: TTH 4:20 pm-5:40 pm at BSB 108

ASSESMENT: Homework and projects will be assigned and collected regularly. There will be two midterm tests on Tuesdays, February 28 and April 11 during regular lecture hours. The final will be on Tuesday, May 9, 2:45 pm-5:45 pm as specified by the campus-wide final exam schedule. Grades will be assigned based on students' performance in the homework and project assignments, mid-term tests, and the final exam according to the following weights:

- Homework and Project Assignments: 20%
- Test I (February 28): 25%
- Test II (April 11): 25%
- Final (May 9): 30%

ATTENDANCE POLICY: Attendance will be checked and is expected for every class with exception for illness, court appearance, and other legitimate emergency. See Rutgers University Attendance Policy for detail.

CODE OF CONDUCT AND ACADEMIC INTEGRITY: Rutgers University-Camden seeks a community that is free from violence, threats, and intimidation; is respectful of the rights, opportunities, and welfare of students, faculty, staff, and guests of the University; and does not threaten the physical or mental health or safety of members of the University community, including in classroom space, and a community in which students respect academic integrity and the integrity of your own and others' work.

As a student at the University you are expected adhere to the Student Code of Conduct and Academic Integrity Policy. Please review the Academic Integrity Policy and Code of Conduct.

STUDENTS WITH DISABILITIES: If you are in need of academic support for this course, accommodations can be provided once you share your accommodations indicated in a Letter of Accommodation issued by the Office of Disability Services (ODS). If you have already registered with ODS and have your letter of accommodations, please share the letter with this instructor early in the course. If you have not registered with ODS and you have or think you have a disability (learning, sensory, physical, chronic health, mental health or attentional), please contact ODS by first visiting their website.The website will further direct you who to contact and how to contact them depending on the free, confidential services you are in need of. Please Note: Accommodations will be provided only for students with a Letter of Accommodation from ODS. Accommodation letters only provide information about the accommodation, not about the disability or diagnosis.

HEALTH AND SAFETY PROTOCOLS: You are expected to follow Rutgers University's Health and Safety Protocols. Please refer to the website https://coronavirus.rutgers.edu/spring-2023-health-and-safety-protocols/ for details.

TENTATIVE SCHEDULE: Precise Homework assignments will be posted on the course Canvas site with specified due dates.

Lecture	Sections	Topics	Suggested Homework Problems
1	1.1	PDE models	2, 5*, 6*, 8
2	1.2	Conservative Laws	2, 5*, 7*, 8
3	1.3	Diffusion	2, 3*, 4*, 5
	1.4	Diffusion and Randomness	2, 3*, 9*
4	1.5	Vibration and Acoustics	3, 4*, 5*
5	1.6*	Quantum Mechanics	
	1.7	Heat Conduction in Higher dimensions	3*, 4, 5, 6*
6	1.8	Laplace's Equation	1*, 3, 4*
7	1.9	Classification of PDEs	1*, 2, 3, 5*
8	2.1	Cauchy Problem for the Heat Equation	1*, 2*
9	2.2	Cauchy Problem for Wave Equations	2, 3, 5*, 6*
10	2.3	Well-Posed Problems	1*, 2
11	2.4	Heat and Wave Equations on Semi-Infinite Domains	2*, 3*, 4
12	2.5	Sources and Duhamel's Principle/Review for Test 1	1*, 2*, 3*, 4*
13		Extra topics/Catch-up/Test 1	
14	2.6	Laplace Transform	1, 2*, 3, 6*, 8, 9
15	2.7	Fourier Transform	2*, 10*, 11*
16	3.1	The Fourier Method	1*
17	3.2	Orthogonal Expansions	2*, 4, 13*
18	3.3	Classical Fourier Series	4*, 6*
19	3.3	Classical Fourier Series (Continued)/Catch-up	
20	4.1	Separation of Variables	1*, 3a), 4
21	4.2	Sturm-Liouville Problmes	2*, 3, 7*
22	4.4	Laplace's Equation	1*, 2, 3*
23		Extra topics/Catch-up/Test 2	
24	4.7	Sources on Bounded Domains	1, 4*, 5*, 9
25	4.8	Poisson's Equations	1, 2*, 3*, 7
26	5.3	Applications in Life Sciences	
27	6.1	Introduction to Finite Difference Methods	
28	6.2	Numerical methods for the Heat Equation	