Math 4362, Spring 2024
Partial Differential Equations

Course Information

20463 Math 4362.001 TuTh 10:00-11:15 SCI 3.240

Professor Contact Information

Instructor: John Zweck

Office: FO 3.704J

Email: zweck@utdallas.edu

Webpage: I will maintain a web page for the course linked from the MATH 4362 eLearning course and from http://www.utdallas.edu/~zweck. I will also communicate with you using a class email list.

Phone: (972) 883-6699 (Do not leave a message. Email me instead.)

Office Hours: Th 11:30-12:30 *and by appointment*. If you cannot come to my office hours *please* contact me in class or by email to set up a time to meet. Also, you are encouraged to ask me questions by email.

Course Pre-requisites

MATH 2420 and MATH 2451

Course Description

This course presents a survey of classical and numerical methods for the solution of linear and nonlinear boundary value problems governed by partial differential equations. Modeling and application-related issues are included throughout.

More specifically, topics to be covered in MATH 4362 will include:

1. Linear and Nonlinear Waves
   (a) Transport phenomena and traveling waves
   (b) Initial Value (Cauchy) Problems
   (c) The method of characteristics
   (d) Nonlinear waves, Burger's equation and shock formation
   (e) The wave equation and d'Alembert's formula

(f) Telegrapher's equation

2. Heat equation on the real line
   (a) Fundamental solution
   (b) Heat equation with source terms
   (c) Duhamel's Principle
   (d) Solution via Fourier transforms
3. Heat equation on a bounded interval
   (a) Initial Boundary Value Problems
   (b) Maximum principle
   (c) Well-posedness
4. Fourier Series
5. The method of separation of variables
   (a) Heat equation
   (b) Wave equation
   (c) Laplace and Poisson equations
6. Generalized Functions and Green's Functions
   (a) The Delta function
   (b) Green's functions for one-dimensional boundary value problems
   (c) Green's functions for the planar Poisson equation
7. Euler-Bernoulli Beam Equation

Student Learning Outcomes

This course is focused on the following fundamental partial differential equations: transport and wave equations, diffusion/heat equations, and the Laplace and Poisson equations. The student learning outcomes for the course are as follows.

1. Formulate appropriate initial and boundary value problems for each of these equations.
2. Provide physical interpretations of these partial differential equations.
3. State and apply theorems on the analytical and physical properties of solutions of these partial differential equations.

4. Calculate Fourier series, and state and apply theorems on their convergence.

5. Calculate solutions of initial/boundary-value problems for partial differential equations using the method of characteristics, separation of variables, and Fourier series methods.

6. Define the delta function and related generalized functions, and perform calculations involving derivatives, integrals, and convergence of generalized functions.

7. Apply the method of Green's functions to obtain solutions of inhomogeneous linear boundary value problems.

Textbooks

[PO] *Introduction to Partial Differential Equations*, by Peter J. Olver, Springer Undergraduate Texts in Mathematics, 2014

[JB] PDE Lecture Notes by Jon Bell.

Academic Calendar and Assignments

The Lecture Notes and Homework Assignments will be posted on the course web page. Most of the problems will be graded.

Grading Policy

Grades: Homework 25%, Essay 15%, Midterm Exam I 15%, Midterm Exam II 15% Final Exam 30%

Homework: Assigned weekly. Submit to eLearning by midnight each Thursday.

Essay: Topic approval due by Thursday February 15th. Essay due by Thursday April 18th.

Midterm Exam I: Tuesday Feb 27th in class [75 minutes]

Midterm Exam II: Tuesday April 9th in class [75 minutes]

Final Exam: TBA. The final exam will be based on the whole course.

Essay

You will write a 3-5 page essay on a PDE that is not covered in the lecture material for the course. The essay must be based on material in at least one textbook and at least two research papers. Your essay should include

1. Name and brief history of the PDE

2. Description of an application modeled by the PDE

3. Detailed description of the PDE, including physical meaning of each term
4. Discussion of appropriate initial and/or boundary values
5. Formula for an analytical solution in a special case
6. Discussion of qualitative properties of solutions
7. Brief summary of numerical solution methods
8. Numerical solutions and their physical interpretation (figures may be extracted from research papers with attribution)
9. Open problems

Essay Rules:

- By February 15th, you must send me an email explaining what PDE you will write about together with one textbook and two research paper references and an outline with roughly one sentence on each of the 9 items listed above.
- Your essay must be written in LaTeX. I recommend using the platform Overleaf for typsetting in LaTeX.
- You need to include a bibliography that refers to the books and journal articles used.
- Students are *not* permitted to use AI software (eg., large language models).
- **Grading rubric:** For each of the 9 items listed above: 10 points; Bibliography: 10 points. Total Points: 100. Students who do not submit pre-approval email by the deadline will be penalized 20 points.

Instructor Policies

Homework

You may ask me questions about the homework and you may discuss a first draft of your solutions with another student in the class. However the final version must be your own.

Making up an exam you missed

If you miss one of the exams you *may* be given the chance to take a make up exam. To request a make up you should contact me **no later than 48 hours after** the exam time. Generally speaking, you will be offered a make up if you are sick or if a close relative or friend is gravely injured/sick or dies. However I will listen to all reasonable requests. Be prepared to bring appropriate evidence in support of your request.

Academic Integrity

I will be vigorous in reporting all instances of cheating to the University administration. See http://www.utdallas.edu/deanofstudents/dishonesty/

UT Dallas Syllabus Policies and Procedures

The information at http://go.utdallas.edu/syllabus-policies constitutes the University's policy abd procedures segement of the course syllabus.

The descriptions and timelines contained in this syllabus are subject to change at the discretion of the Professor.