MAP 4341/5345 Introduction to Partial Differential Equations

Class 2024 (Spring)

Reading Material

Course Textbook: R. Haberman, Applied Partial Differential Equations, 4th edition (optional)
Recommended Textbook: P.J. Oliver, Introduction to Partial Differential Equations, Springer, 2014 (optional)
S.V. Shabanov, Lecture Notes on Partial Differential Equations (PDEs)

The lecture notes will be posted in the course page. They are close to the classroom lectures and contain practice (homework) problems. Haberman's textbook is an official textbook for this course, but Oliver's textbook is a better reading, in my view. My lecture notes are self-sufficient.

Prerequisites

Students are expected to be familiar with ordinary differential equations and methods to solve them. Basic knowledge of differentiation and integration of functions of several variables is necessary (Calculus 3). The knowledge of basic ideas of linear algebra is not mandatory but will be helpful to comprehend the content of the course.

Course Content

Part 1: Partial differential Equations (PDEs). A solution to a PDE. Examples: 2D Wave equation. 2D Heat equation. 2D Laplace equation. 2D Helmhotz equation. Separation of variables in a PDE. Principle of superposition for a linear PDE. Boundary conditions.

Part 2: First-order PDEs. Basic methods of solving. The method of characteristics for first-order PDEs. The Cauchy problem for first-order PDEs.

Part 3: Classification of second-order PDEs. Hyperbolic, elliptic, and parabolic equations. Initial and boundary value problems for basic second-order PDEs. The existence and uniqueness of the solution. Differential operators in the space of square integrable functions on a bounded region. The eigen-value problem for a differential operator. The Sturm-Liouville problem. Complete sets of functions. The Fourier method for hyperbolic, parabolic, and elliptic problems in two variables for rectangular regions. Separation of variables in polar and spherical coordinates. Harmonic functions and harmonic polynomials in two and three variables. Spherical harmonics. The Fourier method for hyperbolic, parabolic, and elliptic problems in circular, cylindrical, and spherical regions.

Goals: Learning basics techniques to solve first and second-order PDEs with emphasis on the Fourier method for solving initial and boundary value problems for hyperbolic, parabolic, and elliptic second-order linear PDEs.

Class meetings and attendance

The class meets on MWF in-person. The class attendance is not mandatory. But participation in the class and taking notes are essential to avoid any backlog of material to study because the course is developing fast and contains plenty of difficult concepts needed for solving homework and test problems. These concepts might be hard to study on your own. Questions during the lectures are encouraged. If you get any flu-like symptoms, please stay home and, if necessary, get tested for COVID. A make-up for any missed graded assignment (in-class or online) is only with an official (e.g. medical) excuse.

Office hours

There will be in-person office hours. The schedule will be posted after the first week of classes in the course page and Canvas.

Exams

There will be 5-8 graded assignments and the final exam. The midterm and final exams are cumulative and in-person, other assignments are online via canvas. Each online assignment covers the material given in 3-6 lectures prior the assignment (excluding the lecture on the day of the exam for the online tests). The schedule of assignments will be posted in the course page and in Canvas. One formula sheet written by yourself is permitted on the in-class tests. The online assignments will be conducted via Canvas on Mondays evening hours (after 7 pm). You can use any material to prepare your submission but you are not allowed to get help from any person or discuss the problems with any person during the online test (see the "student honor code" below). Each online assignment is open for a specified period of time (1-3 hours) during which it must be completed and submitted via Canvas. The submission is free-response. Indicate the problem number, write your solution (do not omit technical details), box the answer, do the same for all problems, enumerate all pages as 1/n, 2/n, …, n/n, where n is the total number of pages, write and sign the academic honesty pledge at the bottom of the last page, write your name and your UFID number, scan all the pages in the above order into a single PDF file, and submit the file via Canvas. Make sure that you have a software or app to make such a PDF file. Other formats are not acceptable. Late submissions will not be accepted.

Special accommodation: Students requesting special accommodation for exams must first register with the Dean of Student Office. The Dean of Student Office will provide documentation to the student who must then provide this documentation to me when requesting accommodation.

Student honor code: Each online submitted assignment must contain the signed academic honesty pledge: “Herewith I acknowledge that I did all of the above problems myself and did not receive any help from any person”. Submissions without the signed honesty pledge will not be accepted. You are NOT allowed to discuss any assignment during the time period the assignment is open on Canvas. A breach of this policy is considered as cheating. If caught cheating, the course grade is an F, no exception.

Homework

Homework assignments will be posted in the course webpage. Homework is not turned in. Some of the homework problems will be discussed in class or during the office hours (if asked). Solving these problems is essential for understanding the course and attaining a good grade. In this regard, see the “extra credit” section below. Test problems in this course are technically involved. So, practicing the use of the concepts and developing required algebraic skills to realize the concepts are a must-do for any successful student.

Grading

Each assignment contains some number of problems. Each problem is worth one point if solved correctly. If M is the total number of earned points and N is the total number of regular problems given, then your current grade is determined by the average:

G = (M/N) 100%

The grade thresholds are:

A: G>90; A-: G>85; B+: G>80; B: G>75; B-: G>70; C+: G>65; C: G>60; C-: G>55; D+: G>50; D: G>45; D-: G>40; F: G<40

Extra credit

There will be extra credit problems given in some of the assignments. They are not counted in the number N, but can increase your number M if solved correctly. The perfect score can therefore exceed 100% when the extra credit questions are correctly answered. However, these problems require more creativity than the regular ones. In addition, there will be marked homework problems prior each graded assignment. For example, a coming test covers Topics A and B, and some of the homework problems in Topics A and B are marked. Students can submit solutions to these marked problems by email to get an extra credit (if the solution was not discussed in class or office hours). All solutions must be submitted before the coming test and will be posted in the course page in the order they were received. Other students can challenge the posted solutions. The extra credit is granted only to the first correct solution to a marked problem. So, make sure that the submitted solutions are clearly written and checked (at least for basic algebraic errors). The maximal number of extra credit points that can be earned this way is equal to N/10 (rounded to the nearest integer).