

Course Outline for MATH 4352, Partial Differential Equations

MATH 4352 Partial Differential Equations (3 units)

Prerequisite: Graduate standing in Mathematics or [MATH 3351](#).

Introduction to partial differential equations. Transport equations, wave equation, heat equation, and Laplace's equation. The D'Alembert solution to the wave equation, method of characteristics, Green's functions, the maximum principle, separation of variables, Fourier series/transforms, and operator eigenvalue problems. 3 lectures. Formerly MATH 418.

Course Learning Objectives	
1	Construct linear partial differential equation (PDE) models for real world phenomena such as diffusion and wave propagation.
2	Identify linear parabolic, hyperbolic, and elliptic PDEs and describe the key characteristics of well-posed problems for each case.
3	Use free-space Green's functions and the method of images to solve linear PDEs on unbounded or highly symmetric domains.
4	Apply Sturm-Liouville theory and the method separation-of-variables to solve linear parabolic, hyperbolic, and elliptic PDEs for various boundary conditions.
5	Solve the linear wave equation using characteristics and D'Alembert's solution.
6	Use the spectral Fourier transform to solve linear PDEs on infinite and semi-infinite domains.
7	Develop and apply techniques for additional instructor-selected problems in PDEs such as the method of characteristics for quasilinear PDEs, construction of soliton solutions in nonlinear PDEs, and/or an introduction to constructing numerical solutions for PDEs.

Expanded Course Content

Textbooks, materials, and/or other resources

Instructors can choose from a variety of textbooks and/or additional readings; possible textbooks include:

- Walter A. Strauss, Partial Differential Equations: An Introduction (2nd edition), Wiley, 2007.
- Peter J. Olver, Introduction to Partial Differential Equations, Springer, 2016.

Textbooks, materials, and/or other resources

- Sandro Salsa, Partial Differential Equations in Action: From Modelling to Theory, Springer, 2016.
- David J. Logan, Applied Partial Differential Equations, Springer, 2015.
- Richard Haberman, Applied Partial Differential Equations with Fourier Series and Boundary Value Problems, Pearson, 2018.
- Athanassios S. Fokas, A Unified Approach to Boundary Value Problems, Society of Industrial and Applied Mathematics, 2008.

This sample course outline is based primarily upon the Strauss (2007) text with supplemental readings from Fokas (2008).

Week	Readings	Topics of Discussion
1	Chapter 1 (Strauss)	Where PDEs Come From
2	Chapter 2 (Strauss)	Waves and Diffusions
3	Chapter 3 (Strauss)	Reflections and Sources
4	Chapter 4 (Strauss)	Boundary Problems
5	Chapter 6 (Strauss)	Harmonic Functions
6	Chapter 7 (Strauss)	Green's Identities and Green's Functions
7	Chapter 8 (Strauss)	Computation of Solutions
8	Chapter 9 (Strauss)	Waves in Space
9	Chapter 10 (Strauss)	Boundaries in the Plane and in Space
10	Chapter 11 (Strauss)	General Eigenvalue Problems
11	Chapter 12 (Strauss)	Distributions and Transforms
12	Chapter 13 (Strauss)	PDE Problems from Physics
13	Chapter 14 (Strauss)	Nonlinear PDEs
14	Part 1, Chapter 1 (Fokas)	A New Transform Method for Linear Evolution Equations (Evolution Equations on the Half-Line)
15	Chapter 2 (Fokas)	Evolution Equations on the Finite Interval

Method of Assessment

The possible methods of assessment are written individual examinations, quizzes, in-class worksheets and presentations, projects, and homework. One or more midterms and a cumulative final exam are required.

Instructional Mode

The instructional mode for this class is face-to-face. This designation means that the essential academic standards of the course require in-class student engagement, and thus remote instruction is not appropriate.