Department of Mathematics
Pomona College

Course Outline for Mathematics 180
Introduction to Partial Differential Equations
Spring 2018

Time	MWF 10:00 AM - 10:50 AM
Place:	Millikan Room 2131
Instructor:	Dr. Adolfo J. Rumbos
Office:	Andrew 2287.
Phone/e-mail:	ext. 18713 / arumbos@pomona.edu
Courses Website:	**http://pages.pomona.edu/~ajr04747/**
Office Hours:	TR 9:00 am - 9:50 am, or by appointment
Text:	*Introduction to Partial Differential Equations and Hilbert Space Methods,* by Karl E. Gustafson. Published by Dover.
Prerequisites:	Ordinary Differential Equations and some Real Analysis course

Course Description. This course is an introduction to the theory and applications of partial differential equations (PDEs). PDEs are expressions involving functions of several variables and its derivatives in which we seek to find one of the functions, or a set of functions, subject to some initial conditions (if time is involved as one of the variables) or boundary conditions. They arise naturally when modeling physical or biological systems in which assumptions of continuity and differentiability are made about the quantities in question. In this course we will discuss several modeling situations that give rise to PDEs.

PDEs are classified in various ways. PDEs range from linear to nonlinear; single equations to systems; and from first degree to higher degree. There is also a further classification determined by the behavior of solutions of certain classes of equations. Over the years, researchers have identified three major classes of PDEs: hyperbolic, elliptic and parabolic. Archetypal instances of these classes of PDEs are the classical equations of mathematical physics: the wave equation, Laplace's or Poisson' equations, and the heat or diffusion equations, respectively. In this course we will provide examples of analysis for each of these types of equations.

In problems involving PDEs we are mainly interested in the question of existence of solutions. In a few cases, answering these questions amounts to coming up with formulas for the solutions. In this course we will discuss a few techniques for constructing solutions: separation of variables, Fourier series expansions, Hilbert space methods (orthogonal functions expansions), Green's function methods, transform methods (e.g., Fourier transform) for the special case of linear equations. In most cases, however, explicit constructions of solutions are not possible. In these cases, the only recourse we have is analytical proofs of existence, or nonexistence, and qualitative analysis to deduce properties of solutions. We will discuss a few general approaches for the analysis of PDE problems, including the method of characteristics for first order PDEs, the maximum principle and energy methods. We will also delve into the theory of Sturm-Liouville boundary value problems and eigenvalue problems.

Course Structure and Expectations

The structured of the coursed is centered on lectures and readings on the topics listed in the attached tentative schedule of lecture and examinations, homework assignments, two examinations and a term project.

Readings and problem sets will be assigned at every lecture and collected on an alternate basis. Students are strongly encouraged to work on every assigned problem. **Late homework assignments will not be graded**.

The term project will consist of a **paper and presentation** on a topic not covered in the lectures. Ideas for topics in the term project may be found in the text for the courses; possible topics may range from applications of the theory and techniques learned in class to problems in various fields in science to advanced analysis techniques that are not covered in the course. Presentations will take place in the last three weeks of the semester

Grading Policy

Grades will be based on the homework, two examinations and a term project involving an advanced topic in the analysis of PDE problems. The overall score will be computed as follows:

homework	20%
Examinations	50%
term project	30%

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Tentative Schedule of Lectures and Examinations

Date			Topic
W	Jan.	17	Introduction to PDEs: The vibrating string equation
F	Jan.	19	Solving the vibrating string equation
M	Jan.	22	Separation of variables
W	Jan.	24	Fourier series expansion
F	Jan.	26	Convergence of Fourier series
M	Jan.	29	Existence and uniqueness for the one-dimensional wave equation
W	Jan.	31	The diffusion equation
F	Feb.	2	Solving the one-dimensional heat equation in a bounded interval
M	Feb.	5	Existence and uniqueness for the heat equation
W	Feb.	7	Laplace's equation and the Dirichlet problem
F	Feb.	9	Solving the Dirichlet problem in a square
M	Feb.	12	The Dirichlet problem in a disc
W	Feb.	14	The Poisson kernel
F	Feb.	16	Fundamental solution of Laplace's equation
M	Feb.	19	Review
W	Feb.	21	**Exam 1**
F	Feb.	23	Green's function
M	Feb.	26	The maximum principle
W	Feb.	28	Existence and uniqueness for the Dirichlet problem
F	Mar.	2	Sturm-Liouville eigenvalue problems
M	Mar.	5	Eigenvalue problems
W	Mar.	7	Eigenvalues of the Laplacian
F	Mar.	9	Eigenvalues of the Laplacian (continued)
M	Mar.	12	*Spring Recess!*
W	Mar.	14	*Spring Recess!*
F	Mar.	16	*Spring Recess!*

Date		**Topic**
M	Mar. 19	Equations in infinite domains
W	Mar. 21	The heat kernel
F	Mar. 23	Transform methods
M	Mar. 26	The Fourier Transform
W	Mar. 28	Problems
F	Mar. 30	*Cesar Chavez Day*
M	Apr. 2	Conservation equations
W	Apr. 4	Method of characteristic curves (continued)
F	Apr. 6	Method of characteristic curves (continued)
M	Apr. 9	Review
W	Apr. 11	**Exam 2**
F	Apr. 13	Special Topic
M	Apr. 16	Special Topic
W	Apr. 18	Special Topic
F	Apr. 20	Special Topic
M	Apr. 23	Special Topic
W	Apr. 25	Special Topic
F	Apr, 27	Special Topic
M	Apr. 30	Special Topic
W	May 2	Special Topic