Department of Mathematics
Pomona College

Math 182. Partial Differential Equations Spring 2014

Course Outline

Time and Place:	MWF 10:00 am – 10:50 am Mudd Science Library 125
Instructor:	Dr. Adolfo J. Rumbos
Office:	Mudd Science Library 106
Phone/e-mail:	ext. 18713 / arumbos@pomona.edu
Office Hours:	MWF 11:05 am-11:55 am, TR 9:00 am – 10:00am, or by appointment
Text:	*Introduction to Partial Differential Equations and Hilbert Space Methods,* by Karl E. Gustafson, Dover.
Course Website:	**http://pages.pomona.edu/~ajr04747/**
Prerequisites:	Ordinary Differential Equations and some 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 (e.g., separation of variables, series expansions and Green's function methods) 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 and variational methods for a large class boundary value problems for second order PDEs..

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 al 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. The term paper will be **due on Wednesday, May 7, 2014**. 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 22	Introduction: Where do PDEs arise?
F	Jan 24	Conservation principles
M	Jan 27	The equations of fluid mechanics
W	Jan 29	Euler's equations
F	Jan 31	Diffusion equation
M	Feb 3	An application to traffic flow modeling
W	Feb 5	Method of characteristics
F	Feb 7	Method of characteristics (continued)
M	Feb 10	Types of PDEs
W	Feb 12	Classification of second order PDEs
F	Feb 14	Problems
M	Feb 17	Solving the diffusion equation
W	Feb 19	Existence
F	Feb 21	The heat kernel
M	Feb 24	The principle of superposition
W	Feb 26	Solutions via Fourier series
F	Feb 28	Solutions via Fourier series (continued)
M	Mar 3	Solutions via Fourier transform
W	Mar 5	The eigenvalue problem for the Laplacian
F	Mar 7	Solutions via eigenfunction expansion
M	Mar 10	Probelms
W	Mar 12	Review
F	Mar 14	**Exam 1**
M	Mar 17	*Spring Recess*
W	Mar 19	*Spring Recess*
F	Mar 21	*Spring Recess*
M	Mar 24	Application: vibrations of a strings and membranes
W	Mar 26	vibrations membranes (continued)
F	Mar 28	*César Chávez Day*

Date		Topic
M	Mar 31	Elliptic boundary value problems
W	Apr 2	The Green's function
F	Apr 4	Existence and properties of solutions
M	Apr 7	Variational problems
W	Apr 9	Variational problems (continued)
F	Apr 11	Hilbert space methods
M	Apr 14	Hilbert space methods (continued)
W	Apr 16	Review
F	Apr 18	**Exam 2**
M	Apr 21	Presentations
W	Apr 23	Presentations
F	Apr 25	Presentations
M	Apr 28	Presentations
W	Apr 30	Presentations
F	May 2	Presentations
M	May 5	Presentations
W	May 7	Presentations and term paper due