Partial Differential Equations

Applied and Comp Math 901

Section: G100

Term: 2012 Fall

Instructor: Instructor: N. Nigam
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Office Hours: Wednesdays, Thursdays.

Discussion Topics: In this course, we will study partial differential equations which arise in a large variety of applications. We will investigate nonlinear first-order pde, including the method of characteristics, conservation laws, and Hamilton-Jacobi equations. After briefly discussing the classification of second order linear pde, we will study in depth Laplaces equation, the heat equation and the wave equation. We will look at fundamental solutions, mean-value theorems and maximum principles, and energy methods for these problems. In general it is hard to find explicit solutions of pde, but we learn techniques like separation of variables, similarity solutions, and some transform methods. This provides us with tools to try while solving new PDE. We also quickly survey important concepts from functional analysis and Sobolev spaces, to aid in establishing well-posedness for some classes of linear PDE. This provides us with analytical tools to study PDE qualitatively. A more detailed outline of the course is given in table 1.

Learning Outcomes: There are two broad classes of desired learning outcomes for this course. First, you will gain familiarity with some standard mathematical techniques and tools for studying the properties of PDE. Some of these will be constructive, in the sense of helping you derive analytical solutions; other tools are more generally applicable (and therefore more powerful) tools to gain qualitative insight for PDE without closed-form solutions. Second, youll learn to recognize and use these tools yourselves. This second learning outcome is as important as the first.

Standards for written work: Any work you hand in must represent your own work and your own understanding. Late work will not be accepted, in fairness to other students. The use of LaTeX is strongly recommended; it is tedious at first, but will prove rather useful through your graduate career.

Academic honesty: All work you hand in must be your own. You may (and should) work with each other while learning, but when you hand in any material, it must be your effort. Using online help for assignments also constitutes plagiarism. You should cite everyone you work with, and any materials you referred to. If you are using phrases or sentences from books or papers, you MUST put quotes around this material, and provide a reference.There are NO exceptional circumstances in this regard. It is better not to hand in an assignment, than to cheat. If you are unsure about how to cite material, please ask. I have a zero-tolerance policy for academic dishonesty. I may, at my discretion, perform MOSS tests on work you hand in. You should familiarize yourself with SFUs academic dishonesty policies.

Table 1: TENTATIVE TOPIC SCHEDULE

§No.	Topics
§1	Introduction and overview
§2	LP2: Laplaces equation, fundamental solution
§3	LP2: mean-value theorem, strong maximum principle
§4	LP2: uniqueness, regularity, energy methods
§5	LP2: Greens functions
§6	LP2: Heat equation, fundamental sol., Cauchy problem
§7	LP2: Duhamels princ., mean-value thm., max. princ.
§8	LP2: Uniqueness, regularity, energy method
§9	Weak solutions and first look at Sobolev spaces
§10	LP2: Wave equation, dAlembert soln.
§11	LP2: spherical means
§12	LP2: Duhamels principle, energy methods
§13	Distributions and fundamental solutions
§14	Weak solutions, review

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§15 Non-linear 1st order PDE, Transport equation
§16 NL1: complete integrals
§17 NL1: method of characteristics
§18 NL1: characteristics, boundary conditions
§19 NL1: characteristics: applications
§20 NL1: shocks, entropy conditions
§21 NL1: entropy solutions
§22 NL1: Riemanns problem
§23 NL1: Hamilton-Jacobi equation, Legendre tranform
§24 NL1: Hopf-Lax formula
§25 Applications and systems of conservation laws
§26 Riemann invariants
§27 Explicit methods: separation of variables
§28 EM3: seperation of variables, similarity solutions
§29 EM3: similarity solutions, Barenblatts solution
§30 EM3: Fourier transform
§31 EM3: Laplace transform
§32 EM3: Hopf-Cole transform
§33 EM3: Hodograph and Legendre transforms
§34 EM3: Power series solutions
§35 EM3: Power series, Cauchy-Kovalevskaya thm.
§36 FA4: Quick introduction to Sobolev spaces
§37 FA4: Riesz Representation, Lax-Milgram, Well-posedness
§38 FA4: Compact operators, Fredholm Alternative,
§39 FA4: Well-posedness

Grading: Homework: 60%
Cumulative in-class final, Dec. 3: 40%

Required Texts: The textbook will be Partial Differential Equations by L.C. Evans; supplementary suggested
readings include the PDE books An introduction to PDE by Renardy and Rogers, and Partial Differential Equations by Fritz John.

Recommended Texts:

Materials/Supplies:

Prerequisite/Corequisite: A solid undergraduate course in PDE(equivalent to SFUs Math 418), and at least
a first course in real analysis (equivalent to SFUs Math 320). Contact me if you have not had these
prerequisites.

Notes: THE INSTRUCTOR RESERVES
THE RIGHT TO CHANGE ANY OF THE ABOVE INFORMATION.

Students should be aware that they have certain rights to confidentiality concerning the return of course papers and the posting of marks. Please pay careful attention to the options discussed in class at the beginning of the semester.