APPM 5470, Methods of Applied Mathematics: Partial Differential Equations and Integral Equations *Fall 2017*

Instructor: Prof. Mark Hoefer, ECOT 325, 303-492-0593, hoefer@colorado.edu

Lecture Time & Location: MWF 12-12:50am, FLMG 103

Office hours: W 1pm-2pm, Th 11:15am-12:45pm, or by appt

Course webpage: https://www.colorado.edu/amath/course-pages/fall-2017/appm5470

Course Overview: Covers properties and solutions of partial differential equations. Topics include the method of characteristics, well-posedness, wave, heat and Laplace equations, Green's functions and fundamental solutions, maximum principles, elliptic equation theory, and conservation laws.

This course is a self-contained introduction to partial differential equations (PDE). Being a mathematics course, both analytical solution methods and their convergence as well as qualitative properties of solutions, e.g., well-posedness and regularity, will be presented. Being an applied mathematics course, emphasis will be placed on obtaining results and their physical implications.

Prerequisites: Partial differential equations (APPM 4350 or MATH 4470), restricted to graduate students only.

Primary Text: *Partial Differential Equations, An Introduction to Theory and Applications* by Michael Shearer and Rachel Levy, Princeton University Press, 2015.

Additional Useful Texts: *Partial Differential Equations* by Walter A. Strauss, 2nd edition, Cambridge University Press, 2008 (introductory); *Partial Differential Equations* by Lawrence C. Evans, American Mathematical Society, 2002 (advanced).

Grading: 50% for seven problem sets, 50% for three in-class exams. The standard grading scale, subject to possible *down*shifting, will be used, e.g. 90-100% A, 80-89% B, etc.

Problem sets: Seven approximately bi-weekly problem sets will be assigned. You are encouraged to discuss problems with other students or with me. You must write up your own work legibly and clearly. It is self evident that you must comprehend the material and be able to solve the problems on your own. Problem sets will be graded on a 0-100 scale based on the amount attempted and detailed grading of selected problems. Your time and my time are valuable. **Therefore, if I cannot understand your results (e.g. incomprehensible proofs, poorly written calculations, etc.), then you will get the problem wrong.** Problem sets are due by 5pm on the due date in my office (ECOT 325); slide your solutions under my door if I am not there. Late homework will not be accepted.

Assignment/Exam Schedule	Date Assigned	Due Date
Problem set 1	Aug 30	Sept 11
Problem set 2	Sept 11	Sept 22
Problem set 3	Sept 22	Oct 6
Problem set 4	Oct 6	Oct 20
Exam 1	Oct 9	Oct 9
Problem set 5	Oct 20	Nov 3
Problem set 6	Nov 3	Nov 17
Exam 2	Nov 6	Nov 6
Problem set 7	Nov 17	Dec 8
Exam 3	Dec 13	Dec 13

Class Policies:

- Classroom discussion and questions are encouraged and supported.
- The instructor will organize for classes missed due to travel or sickness.
- Arrive on time (5 minutes early if possible) as warm-up problems and important announcements are presented at the beginning of class.
- Late homework will not be accepted.
- Written requests issued by the Office of Disability Services will be honored.

Students with disabilities (official CU policy):

If you qualify for accommodations because of a disability, please submit to Professor Hoefer a letter from Disability Services in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities. Contact Disability Services at 303-492-8671 or by e-mail at dsinfo@colorado.edu.

If you have a temporary medical condition or injury, see Temporary Medical Conditions: Injuries, Surgeries, and Illnesses guidelines under Quick Links at Disability Services website and discuss your needs with Professor Hoefer.

Academic Integrity and CU Student Honor Code: You are expected to follow university guidelines (http://www.colorado.edu/policies/academic-integrity-policy).

Planned course schedule:

Week	**Chapter**	**Material Covered**
1	1,2	introduction, well-posedness, classification of 2nd order PDE, Cauchy-Kovalevskaya theorem for initial value problems, balance laws
2	3	method of characteristics, shock waves
3	4	derivation of wave equation, d'Alembert's solution
4	4	energy method, Duhamel's principle, wave equation in $\mathbb{R}^2$ and $\mathbb{R}^3$
5	5	heat equation, fundamental solution, Cauchy problem, energy method
6	5,6	maximum and Duhamel's principles for heat equation; Fourier series, separation of variables for heat equation
7	6,8	separation of variables for heat/wave equations, fundamental solution for Laplace's equation
8	8	solving Poisson's equation in $\mathbb{R}^n$, properties of harmonic functions, Poisson's formula via separation of variables
9	9	boundary value problems, test functions and distributions, Green's functions
10	10,11	method of images; inequalities, basics of Sobolev spaces, elliptic theory for Poisson's equation
11	11	Lax-Milgram and linear second-order elliptic equations
12	11,12	traveling wave solutions for Burgers', KdV, Fisher's, bistable equations
13	12,13	traveling solutions continued; scalar conservation laws, shocks, rarefactions
14	13,14	Lax entropy condition, viscous Burgers' equation, linear systems of first-order PDE
15	14	systems of hyperbolic conservation laws, shallow water equations