WUSTL FA2020.L24.Math.4150.01 - Partial Differential Equations

Fall Term 2020

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I am a professor in the Mathematics department since 2019. I was a professor at University of Virginia and a postdoc at Brown before coming to WUSTL. I got my PhD in 2012 from Indiana University. My fields of expertise are Real, Fourier and Harmonic Analysis, and Partial Differential Equations, especially those related to fluids.

Class time/place TR 11:30A-12:50P STL TIME

The course will be fully online with links from the Canvas webpage. Lectures organized as follows

- Tue 11:30A-12:50P - Online synchronous lecture on ZOOM, recorded and made available to course participants on Youtube portal after the class. During the Tuesday lecture I will introduce the main topic of the week and cover most of the theoretical aspects of that topic.
- Thu 11:30A-12:50P - Online synchronous lecture and discussion on ZOOM, recorded and made available to course participants on Youtube portal after the class. During the Thursday lecture, I will answer questions on course material and previously assigned problems. Then we will discuss examples and applications of the theory. On occasion, a problem related to current topics will be presented/assigned and the students will be encouraged to work in groups and present their solution strategies to the other groups.
- lecture notes and slides will be provided beforehand so that you can follow along the presentation.
- a course diary is mantained on the Canvas webpage, with topics and examples covered each day.

Office and Office Hours STL TIME - On ZOOM portal

- Monday and Wednesday: 4-5pm (open hours).
- Tuesday: 10:00-11:00am (open hours)
- Thursday: 10:00-11:00am (open hours), 5-6pm (help session - I discuss homework problems upon request)
- otherwise by appointment (email 15 minutes in advance)

Prerequisites Single variable and multi-variable Calculus (limits and continuity, differentiation and integration, series, uniform convergence, etc.), Linear Algebra (vector spaces, linear mappings, matrices, determinants, etc.), Ordinary Differential Equations. Undergraduate Real Analysis 4120 is helpful but not required. The first week of class is designed for the student to self-verify the extent of his prerequisite knowledge

Course textbook and topics covered The textbook for this class is

Partial Differential Equations in Action: From Modelling to Theory by Sandro Salsa, Springer 2016

WUSTL students may freely and legally download an electronic copy from SpringerOnline at the link **here** and order a paper copy at reduced cost from the same webpage. This textbook has a very useful companion exercise book which is

PDEs in Action: complements and exercises by Sandro Salsa and Gianmaria Verzini, Springer 2016

and available **here**. We will cover most of the first five chapters of the textbook. Other textbooks of interest for the course are

- Walter Strauss, *Partial differential equations: an introduction*, linked here**here**; an introductory textbook with a more theoretical and classical presentation
- L. Craig Evans, *Partial differential equations*; an introductory graduate level textbook

Here follows a high-level overview of topics covered.

- An overview of PDEs: transport, elliptic, parabolic, diffusive, dispersive, reaction... Well-posed problems.

- the Heat equation. Relationship with random walks, Brownian motions. Application to porous media. Backward heat and Black-Scholes
- the Laplace and Poisson equation. Harmonic functions. Single and double layer potentials
- first order equations; conservation laws, the method of characteristics. Traffic dynamics: rarefaction and shock waves
- the Wave equation, representation formulas. Shallow water waves
- additional topics upon request if time permits. Example: dispersion, Schrödinger and KdV equations. Active scalar transport equations. The Euler, Navier-Stokes and SQG equations

Course web page https://wustl.instructure.com/courses/49217 on Canvas. Used to gain access to syllabus, detailed course outline, assignments, homework and exam grades, lecture notes, and course announcements.

Homework There will be weekly homework assignments, collected weekly (usually on Thursdays) for grading purposes. The homework is designed to complement and enrich the theory presented in class. A large part of the homework problems will be discussed during the Thursday interactive. You will also be able to see a summary of your homework grades on the course page. Since solutions will be provided shortly afterwards the deadline, no extensions will be granted as a general policy. **Homework is submitted online through Canvas**.

Note taking/solution writing One of the learning objectives of the class will be improving the students' mathematical presentation and writing skills. Therefore, each week, one or more of the students will be assigned the task of preparing a summary of the class presentation and/or writing down detailed solutions to that week's problem set. The students'contributions will be evaluated and will constitute a small percentage of the final grade.

Exams There will be two midterm exams and a final exam. All exams are off-line. All three exams will be composed of two portions, roughly of equal weight. The first part will consist of questions related to the theory we have seen in class, usually with short answers. The second component will consist of 2-3 problems of length comparable to the homework assignments. The midterm exams will be posted on the tentative dates below and students will have a week of time to complete the assignment. Submission will be through Canvas. The final exam will be posted at the end of the course, with due date that of the final exam, Jan 6, 2021.

Grading

NOTES/SOLUTIONS/ATTENDANCE	5%	
MIDTERMS	35%	dates **Thu Oct 15, Thu Nov 19**
HOMEWORK	25%	(lowest hw score dropped)
FINAL	35%	TAKEHOME

Other factors such as in-class participation and improvement over time may impact positively your final grade.

Grading table

A+	A	A-	B+	B	B-	C+	C	C-	D	F
>100	[90,100]	[85,90)	[80,85)	[75,80)	[70,75)	[65,70)	[60,65)	[55,60)	[50,55)	[0,50)

Submission guidelines Homework submission is electronic on Canvas portal or email to the instructor.

(1) Write your name clearly at the top of every page. Put the problems in order, indicating clearly what you have skipped.
(2) Turn in assignments in time **ON OR BEFORE DUE DATE**. Write neatly. If your homework is too messy, the grader might decide, with the instructor's consent, not to grade it.
(3) **Sourcing solution material from the Internet without mentioning the sources or collaborating without specifying the names of the collaborators is considered blatant academic plagiarism**. Any

instance of academic plagiarism will result in a 0% in the corresponding assignment/exam and discussed with the appropriate University Academic Officers. You can talk to each other about any of homework problems, but when you write up the problems to be handed in, you must work alone.

Questions and office hours Mathematical questions are appreciated and encouraged any time during the class. Please use the office hours as much as possible for additional clarifications, occasional homework help. I will also be answering email questions. Expect a 1 hour reply time on weekdays-work hours and a 12 hour reply time on nights/weekends.