Math 7313, Fall 2016
Partial Differential Equations I

Course Information

86603 Math 7313.001 TuTh 4:00pm-5:15pm GR 4.204

Professor Contact Information

Instructor: John Zweck

Office: FO 3.704J

Email: zweck@utdallas.edu

Webpage: I will maintain a web page for the course, linked from my web page http://www.utdallas.edu/~zweck. *Bookmark it!* I will also communicate with you using a class email list. (I do *not* use eLearning.)

Phone: (972) 883-6699 (Do not leave a message. Email me instead.)

Office Hours: Th 10:15-11:15, *and by appointment*. If you cannot come to my office hours *please* contact me in class or by email to set up a time to meet. Also, you are encouraged to ask me questions by email.

Course Pre-requisites

MATH 6301 (Real Analysis) and MATH 6315 (Ordinary Differential Equations), or equivalent.

Course Description

Catalogue Entry: *Classical and modern solution techniques for initial and boundary value problems for parabolic, elliptic, and hyperbolic linear partial differential equations. Existence, uniqueness, well-posedness, fundamental solutions, and Green's functions. First-order nonlinear equations, scalar conservation laws, and the method of characteristics. An introduction to weak solutions and the theory of Sobolev spaces.*

More specifically, topics to be covered will include:

- **General concepts**: Linearity, well-posedness, initial and boundary value problems.
- **Diffusion**: The heat equation; classical solutions via Fourier series and separation of variables; existence and uniqueness of solutions; fundamental solutions; solution of non-homogeneous diffusion equation via Duhamel's method.

- **Introduction to the Theory of Distributions:** Test functions, distributions, examples; applications to PDE's.
- **The Laplace/Poisson Equation**: Uniqueness of solutions, Properties of harmonic functions (mean value theorem, maximum principle, smoothness of solutions, Liouville's theorem); Fundamental solutions; Green's functions and representation formulae for solutions of Dirichlet and Neumann problems.
- **First order equations and scalar conservation laws:** Linear transport equation; Semi-linear and quasi-linear equations and the method of characteristics; Burger's equation, shocks, and traffic dynamics.
- **Waves and Vibrations:** Type of waves; derivation of the wave equation; uniqueness of solutions; d'Alembert's formula; solution of non homogeneous equation via Duhamel's method, Kirchoff's formula.
- **Regularity theory:** An introduction Sobolev spaces and regularity theory for elliptic equations [*if time permits*].

Student Learning Outcomes

This course introduces students to three of the major families of partial differential equations (PDEs): parabolic, elliptic, and hyperbolic equations. For each family, we have the following learning goals.

1. Derive PDEs from physical principles
2. Formulate appropriate initial and boundary conditions for PDEs
3. Prove and apply to the study of PDEs results from other fields of mathematics including multivariable calculus, Fourier analysis, real analysis and the theory of distributions
4. Calculate explicit solutions to PDEs
5. Prove and apply properties of solutions of PDEs

Required Textbooks and Materials

The required text for the course is the one by Salsa, referenced below. The following texts on Partial Differential Equations are all recommended and represent a range of perspectives and levels of sophistication.

[SS] "Partial Differential Equations in Action: From Modeling to Theory", by Sandro Salsa, Springer, 2008.[1]

[1] The text is available on-line through the UTD Library

[**LE**] "Partial Differential Equations", by Lawrence Evans, American Mathematical Society, 2010

[**WS**] "Partial Differential Equations, An Introduction", by Walter Strauss, Wiley, 1992

[**MG**] "Partial Differential Equations", Analytical and Numerical Methods", by Mark Gockenbach, (2nd Edition), SIAM, 2011.

[**OHLM**] "Applied Partial Differential Equations", by Ockendon, Howison, Lacey, and Movchan, Oxford University Press, 1999.

[**RH**] "Applied Partial Differential Equations with Fourier Series and Boundary Value Problems", by Richard Haberman, Pearson, 2012.

[**DK**] "Distributions: Theory and Applications", by J. Duistermaat and J. Kolk, Birkhuser, 2010.

Academic Calendar and Assignments

The Lecture Notes and Homework Assignments are available on my web page. Homework problems for material covered on **Tu, Th** will be due at the *start* of class the following **Thursday**. Most of the problems will be graded. Make sure your homework paper is *stapled*.

Grading Policy

Grades: Homework 40%, Midterm 30%, Final 30%

Midterm Exam: There will be one two hour closed-book midterm exam held in the Testing Center during the time window Thursday Oct 13th to Saturday Oct 15th.

Final Exam: There will be one three hour closed-book final exam held in the Testing Center during the time window Thursday Oct 13th to Saturday Oct 15th.

The final will be based on the whole course.

Instructor Policies

Homework

No late homework will be accepted! **Your lowest two homework grades will be dropped.** You may ask me questions about the homework and you may collaborate with another student in the class. In fact you are encouraged to do so! However the final write up is your own – *two identical homework papers will both be given zero.*

Making up an exam you missed

If you miss one of the exams you *may* be given the chance to take a make up exam. To request a make up you should contact me **no later than 48 hours after** the exam time. Generally speaking, you will be offered a make up if you are sick or if a close relative or friend is gravely injured/sick or dies. However I will listen to all reasonable requests. Be prepared to bring appropriate evidence in support of your request.

Academic Integrity

I will be vigorous in reporting all instances of cheating to the University administration. See http://www.utdallas.edu/deanofstudents/dishonesty/

UT Dallas Syllabus Policies and Procedures

The information at http://go.utdallas.edu/syllabus-policies constitutes the University's policy abd procedures segement of the course syllabus.

The descriptions and timelines contained in this syllabus are subject to change at the discretion of the Professor.