18.303: Linear Partial Differential Equations 2-143 T-Th 11-12:30

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The main purpose of this course is to introduce the basic linear PDE's, the heat equation, the wave equation, Laplace's equation and some generalizations which describe a broad range of scientific phenomenon. We will study the basic techniques for finding exact and approximate solutions. These techniques include separation of variables, eigenfunction expansions, and Green's functions.

A basic pedagogical issue which arises is the balance between scientific motivation and derivation of the basic equations and the study of techniques for solutions and what those solutions teach us about the science. Since this is a one-term math course, it is necessary to deemphasize motivation. I therefore must assume that students have already encountered one or more of the basic PDE's in science courses and find them useful and interesting enough to study the underlying mathematics more carefully. This course should work well for such students. It may not work so well for students who have never seen a PDE and thus have only a vague idea of what they are used for in the scientific world.

There is a traditional PDE text which students in the past have liked, namely Elementary Applied Partial Differential Equations, by Haberman. The 4th edition was ordered at the MIT Coop as a required text. A used copy of the 3rd edition would be almost equally useful to students.

If you glance at the text you will see that Haberman jumps right in to PDE's. Our course will start off somewhat differently. For the first 5-6 lectures we will review 2nd order linear ORDINARY differential equations from an advanced 18.03 viewpoint. We will emphasize boundary value problems (also called Sturm-Liouville problems) and the infinite sets of eigenfunctions and eigenfunction expansion theorems to which they lead. This material will be the basis for much of our work on PDE's, so it is good to discuss it first in a reasonably systematic way. After that we will launch into PDE's, and I certainly hope to cover much of the interesting mathematics (and some of the natural science!) associated with the heat equation, the Laplace/Poisson equation, and the wave equation. Most of this material is discussed in Haberman, but probably not in the same order as in class. Some topics will be treated at a more advanced level than in Haberman.

I plan to assign problem sets due (approximately) every two weeks. These problems are designed to stimulate you to think about the lecture material, and I view them as very important. You will probably find it useful to practice on some of the simpler problems in Haberman, although some problems from the text will be assigned. There will be a mid-term exam and a final exam. Both of them will probably be open book (Haberman only) open notes exams. The weight of the assigned work in determining the final grade will be (approximately) 30 % problem sets, 30 % mid-term, and 40 % final. It is also my intention to make xerox copies of my own (handwritten!) lecture notes available to students. This should free you to think during lecture rather than write. I view this as a privilege for students and not a reason to skip class. The privilege may well be suspended if I perceive that students are skipping class because notes are available.