Principles and Techniques of Applied Mathematics

MATH 373, MWF 12:00 - 12:50, Swords 328, Spring 2007

Professor Gareth Roberts

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Office hours: Mon. 11:00 - 11:50, Tues. 1:30 - 3:30, Wed. 11:00 - 11:50, Fri. 9:00 - 9:50 or by appointment.

Required Text: *Fourier Series and Boundary Value Problems*, Seventh Edition, James Ward Brown and Ruel V. Churchill

Course Prerequisites: MATH 304 (Ordinary Differential Equations)

Web page: `http://mathcs.holycross.edu/~groberts/Courses/MA373/homepage.html` Homework assignments, exam materials, schedule changes, useful links and other important information will be posted at this site. Please bookmark it!

Syllabus: This is an applied mathematics course focusing on partial differential equations (PDE's), that is, equations relating the partial derivatives of unknown functions to themselves. Any physical process which involves both a spatial variable and a time variable can often be represented using a PDE. We will study equations modeling physical phenomenon such as heat flow, diffusion and vibrations. In addition to developing the mathematical techniques for solving these equations, we will also be concerned with the physics behind their derivation and solution.

One famous example is the one-dimensional wave equation $u_{tt} = c^2 u_{xx}$ where $u(x,t)$ is the displacement from equilibrium at position x and time t, and c is a constant representing the speed of the wave. Among other things, this equation describes the vibration of a plucked guitar string, the sound waves in a pipe, vibrations of an elastic bar and the long water waves in a straight canal. As with ordinary differential equations, the goal is to find the unknown function $u(x,t)$ which satisfies the given PDE as well as some prescribed initial conditions and boundary conditions.

We will learn the Fourier method for solving boundary value problems. This method involves expressing an arbitrary function as an infinite series of trigonometric functions. Thus, a significant amount of time will be spent at the start of the course calculating coefficients and studying convergence properties of these special series, known as Fourier series. Although this material may seem dry at times and more suited to an analysis course, it will lay the foundations for our main tool of solving PDE's.

We will cover material from Chapters 1 through 5 of the text. Time permitting, we will consider orthonormal sets of functions and more complicated boundary value problems in Chapters 7 and 8. A rough outline of the semester is as follows:

- Introduction: the heat and wave equations, review of infinite series (2 classes)
- Fourier Series: piecewise continuous functions, computing coefficients for cosine, sine and full Fourier series (5 classes)

- Convergence of Fourier Series: piecewise smooth functions, a Fourier theorem, absolute and uniform convergence, differentiation and integration of Fourier series (9 classes)
- Exam 1 (Chapters 1 and 2)
- Physical Examples: linear PDE's, the heat equation, Laplaces's equation, the wave equation (d'Alembert's solution), second-order linear PDE's, boundary conditions (5 classes)
- The Fourier Method : linear operators, the superposition principle, separation of variables (4 classes)
- Solving Boundary Value Problems: heat and wave equations with Dirichlet, Neumann, periodic or mixed boundary conditions, temperature in a slab, a plucked string, an elastic bar, a vibrating drum (7 classes)
- Exam 2 (Chapters 3, 4 and 5)
- Orthonormal sets and inner products of functions, regular Sturm-Liouville problems, solving Robin boundary conditions (4 classes)
- Final Exam

Homework: Homework will be assigned on a regular basis (approximately 8 assignments for the semester). Assignments will be posted on the course web page. There will be a list of problems for you to hand in, a nonempty subset of which will be graded. Although there are no formal computer projects for this course, certain homework problems will involve the use of Maple (for example, plotting more and more terms of a Fourier series to see convergence). The goal is to use the computer as a visual and computational aid to further your understanding of the underlying mathematical process.

While you are allowed and encouraged to work on homework problems with your classmates, the solutions you turn in to be graded should be your own. Take care to write up solutions **in your own words**. Plagiarism will not be tolerated and will be treated as a violation of both the departmental policy on academic integrity and the college's policy on academic honesty.

NOTE: LATE homework will NOT be accepted. The only excused homework which is late will be accompanied by a letter from your Class Dean. However, you will be allowed ONE "mulligan" over the course of the semester where you can turn in the assignment up to one week after the original due date.

Exams: There will be two evening midterm exams and a comprehensive final at the end of the semester. Please make a note of these dates and plan accordingly. Any conflicts must be legitimate and brought to my attention well before the scheduled exam date. If you have any specific learning disabilities or special needs and require accommodations, please let me know early in the semester so that your learning needs may be appropriately met. You will need to contact the director of Disability Services in Hogan 209 (x 3693) to obtain documentation of your disability. We will review for the midterms during the Wednesday class on the week of the exam.

	Exam 1	**Thurs., March 1**	**6:00 - 7:30 pm**
Exam Schedule:	**Exam 2**	**Thurs., April 19**	**6:00 - 7:30 pm**
	Final	**Sat., May 5**	**2:30 - 5:30 pm**

Academic Integrity: The Department of Mathematics and Computer Science has drafted a policy on academic integrity to precisely state our expectations of both students and faculty with regards to cheating, plagiarism, academic honesty, etc. You are required to read this policy and sign a pledge agreeing to uphold it. Anyone who violates the Departmental Policy on Academic Integrity will receive a 0 for that assignment as well as possible further disciplinary action involving your Class Dean.

Grade: Your course grade will be based on the following breakdown:

- homework assignments 30%
- classroom participation/interest 5%
- midterm exams 35% (best exam 20%, second best 15%)
- final exam 30%

How to do well in this course:

- Attend class, participate and ask questions.
- Work with your classmates. Organize study groups.
- Be an active, aggressive learner.
- Do your homework regularly.
- Read the text.

Some quotes:

> *Never regard study as a duty, but as the enviable opportunity to learn.*

Albert Einstein

> *You must learn by doing the thing – for though you think you know it, you have no certainty until you try.*

Sophocles