Partial Differential Equations Syllabus (Math 5339 A/G)

Instructor: Dr. Shijun Zheng
Lecture Hours & Location: MWF 12:20-1:10, MP 2044
Office: MP 3306
Office Hours: TR 2:00-3:30 PM or by appointment.
Phone: 478-1338
E-Mail: szheng@GeorgiaSouthern.edu
Course Web: http://cosm.georgiasouthern.edu/˜szheng

Text: *Partial Differential Equations, An Introduction*, by Walter Strauss, 2nd Ed.

References: *Introduction to Fourier Analysis and Differential Equatoins*, Lecture Notes by the Instructor
Partial Differential Equations, by Lawrence C. Evans
Introduction to Partial Differential Equations, second Edition, Gerald Folland

Course Description: The course will study differential equations of several variables like Laplace, heat and wave equations, which arise in physics, engineering, biology, chemistry and social science. Topics include initial and boundary value problems, methods of separation of variables and eigenfunction expansions, Fourier transforms, method of characteristics for first-order partial differential equations. Time permitting I will give introductory examples of nonlinear partial differential equations, as well as Green's functions, maximum principle and numerical methods. Graduate students may be given some extra assignment not required of undergraduate students.

Prerequisites: Grade of C or better in M2243 (Calculus III) and M3230 (ODE).

Grading: Your course grade will be based on the percentage of total points you have earned divided by the number of total points available. An approximation of the number of points available is: 60 points for homework/projects and class participation, two tests worth 80 points each, and a final exam worth 100 points.

The grading scale is: A 85% or above; B 75–84 %; C 65-74%; D 55-64%; and F 54% or below.

Homework: *Working on homework problems or projects is strongly recommended.*
The written work you submit for grading should be neat so that it is easy-to-read by anyone. We will discuss the tentative course structure during the course.

Group Discussions and Term Project. During the course of the semester, several sets of problems will be given, either in-class or take-home. Students will form several groups to discuss and work on the assigned problems for better understanding the materials.

TABLE 1. **Course Materials from The Text**

	$au_{xx} + bu_{xy} + cu_{yy} + du_x + eu_y + fu = 0$	Second-order PDE
	$u_{xx} = 0$ $\quad u_t = \kappa u_{xx}$ $\quad u_{tt} = c^2 u_{xx}$	elliptic-parabolic-hyperbolic
Chapter 1		
	PDEs from physics	$F(x, u, Du, \ldots, D^m u) = 0$
Chapter 2		
	Wave and diffusion equations	$u_t = \kappa \Delta u \quad u_{tt} = c^2 \Delta u$
Chapter 4		
	Separation of variables	$u = f(x)g(y)$
Chapter 5		
	Fourier series	$f = \sum_k c_k e^{ikx}$
Chapter 6		
	**Laplace equation	$\Delta u = 0$
Chapter 7		
	**Green's functions	$u(x) = \int G(x, y) f(y) dy$
**Chapters 8, 13, 14		
	Selected toptics in numerical methods and applications	$u_{xx} \approx \frac{u(x+h,y)-2u(x,y)+u(x-h,y)}{h^2}$

OpenCourse source: MIT open course with Strauss
http://dspace.mit.edu/bitstream/handle/1721.1/75812

Study Philosophy: In addition to solving problems and reviewing class notes, you should also carefully lean and relearn, read (and reread) and study (and restudy) the text on a regular basis as it is especially well-written for a class like this.

Attendance Policy: Students are expected to attend each class meeting and pay attention. A student who misses class is responsible to find out what was discussed and learn the material that was covered on the missed day.

Make-up Policy: Late homework or project will not be accepted unless a reasonable excuse is given. No make-up exams will be given. When a student misses an exam the score from the final exam will be substituted for the missing exam score.

Table 2. **Topics in more detail (tentative)**

Introduction, classification of PDEs	(Strauss 1.1)
First order PDEs: characteristics	(Strauss 1.2; Lecture notes)
Second order equations, wave equation on $\mathbf{R}$	(Lecture notes; Strauss 1.5, 2.1)
domain of dependence, propagation of singularities	(Lecture notes; Strauss 2.1-2.2)
Energy method (wave), maximum principle (Laplace)	(Strauss 2.2-2.3)
Heat and wave equations in half space and on intervals	(Lecture notes; Strauss 3.1-3.2)
Inhomogeneous PDE: Duhamels principle	(Lecture notes; Strauss 3.3-3.4)
Separation of variables, eigenvalue problems	(Lecture notes; Strauss 4.1-4.3)
Inner product space, symmetric boundary condition	(Lecture notes; Strauss 5.1-5.3)
Fourier series	(Strauss 5.1-5.5)
Convergence of Fourier series	(Strauss 5.4-5.5)
Laplaces equation on the disk	(Strauss 6.3)
Solvability of PDE by duality	(Lecture notes)
**Waves in Two and Three Dimensions	(Lecture notes; 9.1, 9.2, 9.3)
**General Fourier Series	(10.1, 10.2, 10.5; Lecture notes)
The Fourier transform and solutions of PDEs	(Lecture notes; Strauss 12.3-12.4)
**Convolutions, solutions of PDEs by Fourier transform	(Lecture notes; Strauss 12.3-12.4)
**Maximum principle, energy decay (heat equation)	(Strauss 2.3, 12.3; Lecture notes)
**Numerical Methods	(Strauss 8.1, 8.2, 8.3)
**Calculus of Variations	(Strauss 14.3)
**Green's Functions	(Strauss 7.1-7.4)

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Civility Statement: See the Student Conduct Code at
http://students.georgiasouthern.edu/judicial/

Final Exam: Monday December 8, 12:30-2:30 pm.
http://em.georgiasouthern.edu/registrar/students/classinformation/