MATH 489 – Partial Differential Equations

Course Description from Bulletin: First-order equations, characteristics. Classification of second-order equations. Laplace's equation; potential theory. Green's function, maximum principles. The wave equation: characteristics, general solution. The heat equation: use of integral transforms. (3-0-3)

Enrollment: Elective for AM and other majors

Textbook(s): Walter E. Strauss, *Partial Differential Equations: An introduction*, Wiley

Other required material: None

Prerequisites: MATH 461

Objectives:

1. Students will understand basic concepts such as linear operators and linearity, partial differential equation and associated boundary and initial value problems, and well posed problems.
2. Students will be able to decide whether a linear equation is of hyperbolic, parabolic or elliptic type.
3. Students will understand the concept of maximum principle, existence and uniqueness.
4. Students will know the concept of Green's functions and be able to derive them and use them in some simple cases.
5. Students will understand the notions of Poisson's equation and the Poisson integral formula.
6. Students will understand the three-dimensional wave equation and Huygen's principle.
7. Students will be able to handle the notions of orthogonality and eigenfunction expansions and have some acquaintance with Bessel and Legendre functions.
8. Students will be able to apply the notions learned here to some physical problems.

Lecture schedule: 3 50 minutes (or 2 75 minutes) lectures per week

Course Outline:	Hours
1. First order linear partial differential equations	4
a. Linear homogenous equations	
b. Characteristics	
c. Linear non-homogenous equations	
d. Well posed problems – boundary and initial value problems	
2. Second order partial differential equations	4
a. Hyperbolic	
b. Parabolic	
c. Elliptic	
3. The wave equation and the diffusion equation	6
a. Characteristics	
b. Solution of initial value problems	
c. Maximum principles and uniqueness	

4. Harmonic Functions 8
    a. Laplace's equation
    b. Poisson's equation
    c. Maximum principles
    d. Poisson's formula for solutions of boundary value problems in disk
    e. Green's functions
    f. Uniqueness
5. Waves in space 2
    a. Characteristic cone
    b. Hugyen's Principle
6. General Fourier Series 8
    a. Orthogonality
    b. Eigenfunction expansions
    c. Bessel functions and Legendre functions
7. Some non-linear equations 6
8. Some physical examples 4

Assessment:	Homework	10-30%
	Computer Programs/Project	10-20%
	Quizzes/Tests	20-50%
	Final Exam	30-50%

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