University of Arkansas – Fort Smith
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General Syllabus

MATH 44203 Partial Differential Equations

Credit Hours: 3 Lecture Hours: 3 Laboratory Hours: 0

Prerequisite: MATH 29174 Differential

Equations Effective Catalog: 2020~2021

I. Course Information

A. Catalog Description

Topics include first- and second-order equations, the method of characteristics, separation of variables, D'Alembert's solution, the heat, wave, and Laplace equations, Fourier series and Sturm-Liouville problems.

II. Student Learning Outcomes

A. Subject Matter:

Upon completion of this course, the student will be able to:

1. Recognize the differences between ODEs and PDEs and know which one is appropriate for various modeling applications.
2. Derive the heat and wave equations with various boundary conditions.
3. Classify partial differential equations given in any of the standard coordinate systems.
4. Determine the existence of a solution and, if an analytic solution can be obtained, select the appropriate technique for constructing the solution.
5. Apply the method of separation of variables.
6. Construct a Green's function.
7. Use technology for finding solutions; know how to use the method of characteristics to solve first order PDEs and understand the geometric underpinnings of the method.
8. Derive and apply D'Alembert's solution to the wave equation.
9. Solve Sturm-Liouville problems.
10. Analyze partial differential equations qualitatively including the concepts of conservation laws, long term behavior, equilibrium solutions, and energy considerations.
11. Apply Fourier series to approximate functions and be able to plot and animate Fourier series approximations on a computer algebra system.

12. Apply partial differential equations to model real-world processes, especially those involving the propagation of waves, diffusion and heat transfer.
13. Use technology appropriately to solve partial differential equations analytically or numerically and obtain qualitative information such as parameter analysis.

B. University Learning Outcomes

Partial Differential Equations enhances student ability in the following areas:

Analytical Skills

Critical Thinking Skills: Students will analyze various mathematical concepts that arise in the study of partial differential equations such as the qualitative behavior of solutions to equations and to draw conclusions and make generalizations based on these concepts.

Quantitative Skills: The students will solve partial differential equations numerically and work with mathematical formulas to arrive at the solution of partial differential equations.

Communication Skills (written and oral)

Students will compose coherent explanations that effectively communicate applications of partial differential equations to solve problems.

III. Major Course Topics

A. Introduction to differential equations with modeling applications
   1. Partial differential equations
   2. Strategies for studying PDE
B. First-order equations: constant coefficient, variable coefficient, quasi-linear and nonlinear
   1. Linear equation
   2. Semilinear equation
   3. Quasilnear equation
   4. Nonlinear equation
C. Second-order equations: linear equations, canonical form and the method of Characteristics
   1. Linear equation
   2. Semilinear equation
   3. Hyperbolic equation
   4. Parabolic equation
   5. Elliptic equation
D. Wave equation, D'Alembert solution

1. Solution by spherical means
2. Nonhomogeneous method problem
3. Energy methods
4. D’Alembert soluntion

E. Green's functions
1. The Heat equation
2. The Laplace equation
3. The Wave equation

F. Separation of variables: heat equation, superposition principle
1. The Heat equation
2. The Laplace equation
3. The Wave equation
4. Equations with more than two variables

G. Fourier Series
1. Properties of Sine and Cosine
2. The Fourier series
3. Fourier Sine and Cosine series
4. Completeness

H. Laplace equation
1. The Two-dimensional problem
2. Conformal mapping
3. Fundamental solution
4. Solutions in terms of integral equation