MAE 105

Introduction to Mathematical Physics (4 units)

Class/Laboratory Schedule: 4 lecture hours per week

Course Coordinator(s): Janet Becker, David Saintillan

Textbooks/Materials:

1. R, Haberman, Elementary Applied Partial Differential Equations

Catalog Description: Fourier series, Sturm Liouville theory, elementary partial differential equations, integral transforms with applications to problems in vibration, wave motion, and heat conduction.

Prerequisites: Phys. 2A-2B, Math 20D or 21D. Restricted to Engineering Majors

Course Type: Required

Performance Criteria:

Objective 1

1.1 To be able to set up appropriate initial and boundary conditions for simple heat conduction problems.

1.2 To separate the time and spatial variation for heat conduction problems with differing boundary conditions and identify the eigenvalue problem to solve to obtain the eigenfunctions and to complete the solution of the original problem.

1.3 To be able to solve Laplace's equation using separation of variables and the necessary eigenvalue problems.

To use Matlab or another programming language to code and plot the solution to the Laplace’s equation.

1.4 To understand the concept of reflection across boundaries and the periodic extension.

1.5 To be able to solve inhomogeneous PDEs subject to homogeneous and inhomogeneous boundary conditions.

Objective 2

2.1 To be able to use separation of variables to set up necessary eigenvalue problems for a given PDE.

2.2 To be able to obtain Fourier series representation of a given function, and the solution of boundary value problems. To plot Fourier series using Matlab or another programming language.

2.3 To understand the concept of orthogonality of the eigenfunctions and its mathematical and physical importance.
2.4 To be able to find Fourier transform of given functions using tables and also the inverse Fourier transform.
2.5 To be able to reduce given partial differential equation into an associated ordinary differential equation using the Fourier and Laplace transform methods.
2.6 To be able to use convolution theorem to solve simple problems in infinite space.

Course Objectives:
(Numbers in parenthesis refer to MAE Program Outcomes)

1. To teach students the relation between three fundamental physical phenomena (time-dependent and steady state heat conduction, and wave motion) and the corresponding mathematical formulation in terms of partial differential equations and the associated initial-boundary data. (1, ME10)

2. To teach students elementary techniques of solving simple linear partial differential equations to obtain complete solutions in terms of given data. (1, ME10)

Course Topics:
1. Classification of Partial Differential Equations (PDE) in Terms of their Physical Applications
2. Parabolic PDE: Diffusion Phenomena
3. Elliptic PDE: Potential Fields and FLow, Steady State Heat equation
4. Hyperbolic: Vibrations, Wave Motion
5. Initial-Boundary Value Problems: Heat Conduction
6. Method of Separation of Variables
7. Diffusion PDE
8. Laplace’s Equation
9. Wave Equation
10. Fourier Series
11. Vibrating Strings and Membranes
12. Sturm-Liouville Eigenvalue Problem
13. PDE with Three Independent Variables
14. Non-Homogeneous Problems
15. Infinite and Semi-Infinite Domains: Fourier and LaPlace Transform Solutions of PDE’s

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