ROWAN UNIVERSITY
Department of Mathematics

Syllabus
Math 01.515 - Engineering Applications of Analysis

COURSE DESCRIPTION:

Math 01. 515 Engineering Applications of Analysis, 3 s.h.

This course will cover various techniques for solving linear and nonlinear partial differential equations (PDEs) arising from physical and engineering applications; this includes both analytical and numerical methods. More specifically, students will learn the method of separation of variables for solving multi-dimensional problems, Fourier/Laplace transforms for solving infinite-domain problems, numerical methods (finite-difference, finite- element, Monte-Carlo), Green's functions, method of characteristics, and inverse scattering. Basic applications include a vibrating membrane (wave equation), heat flow along a metal plate (heat equation), steady-state fluid flow (Laplace's equation), traffic flow (shock waves), and solitary waves (solitons). Students will be required to use a computer algebra system, e.g. Mathematica, to solve problems.

OBJECTIVES:

Students in this course will become familiar with various analytical and numerical techniques for solving partial differential equations (PDEs). At the end of this course, students will be able to:

1. Use analytical techniques such as separation of variables, Fourier series, Green's functions for solving linear multi-dimensional PDEs.
2. Use numerical methods such as finite-difference, finite-element, and Monte-Carlo to solve PDEs.
3. Use method of characteristics and method of inverse scattering to solve nonlinear PDEs.
4. Identify mathematical models for describing various physical and engineering applications.
5. Use a computer algebra system, e.g. Mathematica, to solve problems.

TOPICAL OUTLINE:

Topics that may be covered include:

1. Separation of variables, superposition principle, Fourier series.
2. Heat equation, Laplace's equation, wave equation.
3. Green's functions, nonhomogeneous problems.
4. Finite-difference methods, finite-element method, Monte-Carlo.
5. Fourier transforms, Laplace transforms, infinite-domain problems.
6. Method of characteristics, shock waves.
7. Solitons, inverse scattering.

TEXTS:

The following books may be used as texts for the course.

- Richard Haberman, Elementary Applied Partial Differential Equations,5th edition, Prentice-Hall, 2013.
- W. A. Strauss, Partial Differential Equations: An Introduction, 2nd edition, Wiley, 2008.
- Erwin Kreyszig, Advanced Engineering Mathematics, 10th edition, Wiley, 2011.

Reviewed: 04/2021