MATH 256-201 2017-2018 W2
Differential Equations

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Description: From UBC Calendar: "Linear ordinary differential equations, Laplace transforms, Fourier series and separation of variables for linear partial differential equations."

Prerequisites: Differential calculus (differentiate polynomials, trigonometric functions, fractions etc., product rule, chain rule) and integral calculus (integrate polynomials, basic trigonometric functions, fractions etc., integration by parts, change of variables). Linear algebra (eigenvalues and eigenvectors of matrices). Partial differentiation (chain rule required for starred sections).

Office hours: Tuesdays and Thursdays 4.30pm - 5.30pm. Both in LSK 303B. Door should be open, please knock if not.

Assessment: The course will be graded as follows: 10% Homework (5 % Asignments and 5 % Webwork), 40% Two mid-term exams (20 % each), 50% Final exam.

Textbook: The course is *loosely* based on the textbook by Boyce and DiPrima "Elementary Differential Equations and Boundary Value Problems" (any edition). However, this textbook does not replace the lectures, and is not necessary for the course. You might find it useful as a good source of extra worked examples and problem sets. The relevant sections are shown in square brackets in the outline below.

Outline: Sections marked with ** will be covered in class if time permits, but will not be examined.

0. Introduction

    0.1. Terminology of differential equations [1.3]

1. Linear, first-order, ordinary differential equations (ODEs)

    1.1. Homogeneous, linear, constant coefficient, first-order ODEs
    1.2. Inhomogeneous, linear, constant coefficient, first-order ODEs

1.3. Integrating factors for non-constant coefficient, linear, first-order ODEs [2.1]

2. Nonlinear, first-order ODEs

   2.1. Separable first-order ODEs [2.2]
   2.2. Autonomous first-order ODEs and stability [2.5]
   2.3. ** Discrete equations (the logistic map) [2.9]
   2.4. ** Existence and uniqueness (linear vs nonlinear ODEs) [2.4]

3. Linear, second-order ODEs

   3.1. Homogeneous, linear, second-order ODEs [3.1, 3.4, 3.5]
   3.2. ** Linear-independence and the Wronskian [3.2, 3.3]
   3.3. Inhomogeneous, linear, second-order ODEs [3.6, 3.7]
   3.4. Beating, resonance, and damping [3.8, 3.9]
   3.5. ** Euler equations [5.5]

4. Systems of first-order ODEs

   4.1. Homogeneous systems of linear, first-order ODEs [7.5, 7.6]
   4.2. Inhomogeneous systems of linear, first-order ODEs [7.9]
   4.3. ** The Lorenz equations, or, the most famous system of ODEs [9.8]

5. Laplace Transforms

   5.1. Properties of the Laplace transform [6.1]
   5.2. Solving linear ODEs with the Laplace transform [6.2]
   5.3. Step functions and discontinuous forcing [6.3, 6.4]
   5.4. Impulses [6.5]
   5.5. Convolutions [6.6]

6. Fourier Series

   6.1. Properties of sine and cosine [10.2]
   6.2. Writing periodic functions as Fourier series [10.2, 10.4]

7. Separation of variables for partial differential equations (PDEs)

   7.1. Heat equation for a conducting rod with homogeneous boundary conditions [10.5]
   7.2. Heat equation for a conducting rod with inhomogeneous boundary conditions [10.6]
   7.3. ** Similarity solutions for the heat equation
   7.4. Wave equation for an elastic string [10.7]
   7.5. ** Propagation of waves on an infinite elastic string
   7.6. Laplace equation [10.8]
   7.7. ** Potential flow around a cylinder