UM53A: Differential Equations

Course Description
UM53A is a one-semester course that covers the fundamental concepts of an introductory undergraduate-level course on elementary differential equations and boundary-value problems. Particular emphasis is placed on advanced logical reasoning, integrated problem-solving and proof-writing.

Required Textbook
Elementary Differential Equations and Boundary Value Problems,
William E. Boyce and Richard C. DiPrima

Course Topics

- **Introduction to Differential Equations**
  Mathematical models; Direction fields; Classification of differential equations

- **First Order Differential Equations**
  Linear equations; Integrating factors; Separable equations; Modeling with first order equations; Difference between linear and nonlinear equations; Autonomous equations; Population dynamics; Exact equations; Numerical approximations (Euler’s method); Existence and Uniqueness Theorem; First order difference equations

- **Second Order Linear Equations**
  Homogeneous equations with constant coefficients; Solutions of linear homogeneous equations; Complex roots of the characteristic equation; Wronskian; Repeated roots; Reduction of order; Nonhomogeneous equations and the method of undetermined coefficients; Variation of parameters

- **Higher Order Linear Equations**
  General theory of nth order linear equations; Homogeneous equations with constant coefficients; Undetermined coefficients; Variation of parameters Series Solutions of Second Order Linear Equations Power series; Series solutions near an ordinary point

- **The Laplace Transform**
  Definition of the Laplace transform; Solution to initial-value problems; Step functions; Differential equations with discontinuous forcing functions; The convolution integral

- **Systems of First Order Linear Equations**
  Review of matrices; Linear algebra; Linear independence; Eigenvectors and eigenvalues; Systems of first order linear equations; Homogeneous linear systems with constant coefficients; Complex eigenvalues; Fundamental matrices; Repeated eigenvalues; Nonhomogeneous linear systems
Overview of Assignments

Each semester, the letter grade in the course will be determined based on performance on the following types of assignments.

- **In class participation:** Students are expected to participate in in-class discussion sections, and are expected to have a functioning graphics tablet for presenting problems and asking questions during discussion sections. Students will contribute to and be part of an active learning environment.

- **Homework assignments:** Students will complete regular homework assignments (written and/or electronic) to demonstrate their mastery and knowledge of the material covered in each week’s lectures and discussion sections.

- **Unit exams:** Students will complete written exams designed to test depth of understanding of multivariable calculus concepts and the ability to integrate knowledge of course concepts to solve problems and write proofs. There will be approximately 2-3 such exams per semester.

- **Final exam:** There will be a comprehensive, proctored final exam each semester. The final exam will include material covered in lecture, discussion, homework assignments, and exams.