The following list of topics is considered the core content for the course 110.302 Differential Equations. The current text for the course is:


Course Topics

- **Introduction (1- weeks)**
  - 1.1 Mathematical Models and Slope Fields
  - 1.2 Solutions to Some Differential Equations
  - 1.3 Classification of Differential Equations

- **First Order Differential Equations (3- weeks)**
  - 2.1 Linear Equations and Integrating Factors
  - 2.2 Separable Equations
  - 2.3 Modeling with First Order Equations
  - 2.4 Linear vs. Nonlinear Equations
  - 2.5 Autonomous Equations and Population Dynamics
  - 2.5 Exercises: Bifurcation Theory and Diagrams
  - 2.6 Exact Equations and Integrating Factors
  - 2.8 The Existence and Uniqueness Theorem (with proof)

- **Second Order Linear Equations (2 weeks)**
  - 3.1 Homogeneous equations with Constant Coefficients
  - 3.2 Solutions of Linear Homogeneous Equations: The Wronskian
  - 3.3 Complex Roots of Characteristic Equation
  - 3.4 Repeated Roots: Reduction of Order
  - 3.5 Nonhomogeneous Equations: Method of Undetermined Coefficients
  - 3.6 Variation of Parameters
  - 3.7 mechanical and Electrical Vibrations

- **Higher Order Linear Equations (1- weeks)**
  - 4.1 General Theory
  - 4.2 Homogeneous Equations with Constant Coefficients
  - 4.3 The Method of Undetermined Coefficients

- **Systems of First Order Linear Equations (2+ weeks)**
  - 7.1 Introduction
  - 7.2 Review of Matrices
  - 7.3 Linear Algebraic Equations: Independence, Eigensystems
  - 7.4 Basic Theory of First order Linear Systems
  - 7.5 Homogeneous Linear Systems with Constant Coefficients
  - 7.6 Complex Eigenvalues
  - 7.7 Fundamental Matrices
  - 7.8 Repeated Eigenvalues
• **Nonlinear Differential Equations And Stability (2 weeks)**
  - 9.1 The Phase Plane: Linear Systems
  - 9.2 Autonomous Systems and Stability
  - 9.3 Locally Linear Systems
  - 9.4 Competing Species
  - 9.5 Predator-Prey Equations
  - 9.7 Periodic Solutions and Limit Cycles

• **Numerical methods (1- weeks)**
  - 8.1 The Euler or Tangent Line Method
  - 8.2 Improvements to the Euler Method
  - (Optional) 8.3 The Runga-Kutta Method

Optional Topics (One of these will be covered at the Instructor’s discretion.)

• **The Laplace Transform (1 week)**
  - 6.1 Definition of the Laplace Transform
  - 6.2 Solution of Initial value Problems
  - 6.3 Step Functions
  - 6.4 Discontinuous Forcing Functions

• **Series Solutions of Second Order Linear Equations (1 week)**
  - 5.1 Review of Power Series
  - 5.2 Series Solution near an Ordinary Point Part I
  - 5.3 Series Solution near an Ordinary Point Part II
  - 5.4 Euler Equations: Regular Singular Points
  - 5.5 Series Solution near a Singular Point Part I