Math 146 A. Ordinary and Partial Differential Equations

Text: *Elementary Differential Equations and Boundary Value Problems,* by Boyce and DiPrima. 10th Edition

Week 1 – Section 1.1, 7.1, 8.1 (optional)

- Review of direction field
- Introduction to systems of ODEs and how a system of two ODEs relates to a second-order ODEs
- Basic existence and uniqueness theorem, optionally including some description of its proof

Week 2 – Section 7.3, 7.4, 7.5

- Homogeneous, nonhomogeneous equations and the principle of superposition
- Linear independence of functions; fundamental sets of solutions
- Wronskian
- Solving homogeneous linear systems with constant coefficients
- Distinct real roots for an n-dimensional system; introduce the ideas of stability and long-term behavior of the system.

Week 3 – Section 7.6, 7.7

- Complex roots, focusing on 2-dimensional systems
- Fundamental matrix, exponential matrix/map
- Diagonalizing systems

Week 4 – Section 7.8, 7.9

- Root space decomposition (generalized eigenvectors), repeated roots
- Nonhomogeneous linear systems

Week 5 – Midterm, 9.1, 9.2

- Begin nonlinear systems and stability by reviewing the types of solutions obtained so far based upon characterizations of the roots
- Relate these to types of orbits that occur and their stability
- Make more formal the ideas of phase portraits already introduced

Week 6 – Section 9.2, 9.3

- Do several examples of autonomous nonlinear systems, drawing their phase portraits

- Discuss critical points
- Almost linear systems: linearizing nonlinear ODEs near a critical (stationary, equilibrium) point Discuss 2D case in detail
- Discuss which types of equilibrium points are stable or unstable under perturbation

Week 7 – 9.2, 9.4

- Discuss damped and/or undamped pendulum in detail
- Finding exact solutions
- Competing species

Week 8 – 9.5, 9.6

- Predator/prey
- Begin Liapunov's second method

Week 9 – 9.6, 9.7

- Finish Liapunov's second method
- Limit cycles

Week 10 – 9.8 and Review

- The Lorenz equations; strange attractors

Math 146 B. Ordinary and Partial Differential Equations

Text: *Elementary Differential Equations and Boundary Value Problems,* by Boyce and DiPrima. 10th Edition

Week 1 – 4.1 to 4.4

Higher Order Linear Equations

Week 2 – 5.1 to 5.3

Series Solutions Near an Ordinary Point

Week 3 – 5.4 to 5.6

Series Solutions Near a Regular Singular Points

Week 4 – 5.7, Catch-up, and Test

Bessel's Equation

Week 5 – 10.1 to 10.2

Two-Point Boundary Value Problems and introduction of Fourier Series

Week 6 – 10.3 and 10.4

The Fourier Convergence Theorem; Even and odd functions;

Week 7 -- 10.5 to 10.7

Heat Conduction; Wave Equation

Week 8 – 10.8, Catch-up, and Test

Laplace's Equation

Week 9 – 11.1 to 11.3

Boundary Value Problems

Week 10 – 11.4 and Review

Sturm-Liouville Problems

Math 146 C. Ordinary and Partial Differential Equations

Text: *An introduction to Partial Differential Equations*, by Y. Pinchover and J. Rubinstein, Cambridge University Press, 2006.

Reference: Partial Differential Equations, by W. Strauss.

Week 1-2

Selection sections of Chapter 1 and 2: Introduction and first order equations; classification of PDEs, PDEs as mathematical models natural processes, characteristic method.

Week3-4

Chapter 5: separation of variables

Week 5-6

Chapter 7: elliptic equations

Week 7

Parts of Chapter 8, Green's functions

Week 8-10

Parts of Chapter 9, equations in high dimensions, including Laplace equation, heat equation, wave equation, eigenvalue problems