

Syllabus – Math 319

Techniques in Ordinary Differential Equations

Prerequisite: Math 222

Outline of Subject Matter:

1. Introduction: definition of an ODE, basic problems (IVP and BVP), examples
2. First order equations (1-2 weeks)
 - (a) linear: homogeneous and inhomogeneous
 - (b) nonlinear: separable
 - (c) application: logistics equation
3. General approaches to first order equations (1-2 weeks)
 - (a) direction fields
 - (b) the basic existence and uniqueness theorem
 - (c) the Euler scheme
4. Second order linear equations with constant coefficients (2-3 weeks)
 - (a) homogeneous case
 - (b) remarks on higher order equations, linear independence, and the Wronskian
 - (c) inhomogeneous equations via methods of annihilators and variation of parameters
 - (d) applications to forced oscillation problems, effect of resonances
5. Laplace transform (2 weeks)
 - (a) definition and elementary properties
 - (b) application to constant coefficient linear equations
 - (c) discontinuous and impulsive forcing terms
6. First order systems (2 weeks)
 - (a) conversion of 2nd and higher order equations to systems (focusing on systems in the plane and simple cases in 3 dimensions)
 - (b) discussion of algebraic properties of vectors in and matrices on the plane and 3 dimensional space. Also differentiation of vector and matrix functions
 - (c) solution of linear constant coefficient systems

7. Two dimensional systems and the phase plane (2-3 weeks)
 - (a) classification of (equilibria for) linear systems
 - (b) qualitative behavior of nonlinear systems: classification of equilibria;
 - (c) stability
 - (d) applications, e.g. to the pendulum, population models

8. Boundary value problems (as time permits)
 - (a) physical origins via separation of variables from PDE
 - (b) Fourier expansions
 - (c) eigenvalue problems
 - (d) more general expansion methods

9. More on systems (time permitting)
 - (a) qualitative behavior in the phase plane: limit cycles, heteroclinics, homoclinics, etc.; the Poincaré-Bendixson Theorem
 - (b) the dependence of equations on parameters; bifurcation
 - (c) chaotic solutions

Topics 8 and 9 can be interchanged if desired.

Text: Boyce and DiPrima – Elementary Differential Equations and Boundary Value Problems – Wiley – 7th edition

Instructor: Paul Rabinowitz

Office Hours: (Room 625 Van Vleck Hall) MWF 9:50 – 10:50 or by appointment

Homework: Assigned each lecture and due following lecture. There will also be computer assignments designed to learn about MATLAB and its applications to the material in this course. These exercises will be due one week after being assigned.

Exams: 6 weeks, 12 weeks, final exam

Revised by P. Rabinowitz, Sept. 2003