Chapter Review Sheets for
Elementary Differential Equations and Boundary Value Problems, 9e

Chapter 2: First Order Differential Equations

Definitions:

• First Order Ordinary Differential Equation
• Integrating Factor, Integral Curves
• Variation of parameters
• Separable
• Homogeneous differential equations
• Implicit solutions
• Bernoulli Equations
• Logistic equations, intrinsic growth rate
• Existence and Uniqueness of Solutions General Solutions,
• Autonomous, Logistic Growth, Equilibrium Solutions,
• Stable solutions, asymptotically stable solutions, unstable equilibrium solution
• Threshold
• Integrating factors, Exact equations
• Critical Points Exact ODE
• Tangent Line Method (Euler's Method)
• First Order Difference Equation
• Method of successive approximations

Theorems:

• Theorem 2.4.1: Existence and uniqueness of solutions to linear first order ODE's. (p. 68)
• Theorem 2.4.2: Existence and uniqueness of solutions to first order IVP's. (p. 70)
• Theorem 2.6.1: Existence and uniqueness of solutions to exact first order ODE's. (p. 95)
• Theorem 2.8.1: Restatement and elaboration of Theorem 2.4.2. (p. 112)

Important Skills:

• Be able to determine if a first order differential equation is linear or nonlinear. Equation (3) on page 32 gives the form for a linear ODE.
• If the differential equation is linear, compute the integrating factor, and then the general solution. (Ex. 4, p. 38)
• Be able to graph integral curves for an ODE. (Ex. 4, p. 38)
• If it's nonlinear, is it separable? If it's separable, you will need to compute two different integrals.
• It is crucial to know integration of basic functions and integral methods from your calculus course. For Example, various substitutions, integration by parts, and partial fractions will all be utilized. (Ex. 2 & 3, p. 45 & 46)
• If the differential equation is not separable, is it exact? If so, solve it using the method in section 2.6. (Ex. 2, p. 97)
• If it isn't separable or exact, check for substitutions that would convert it into a linear equation, nonlinear equation that is then separable. For example, exercises 27 - 31 (Sec. 2.4, p. 77) show how.
• Bernoulli equations can be transformed into linear equations.
• What happens to solutions as time tends to infinity? Understand stability, asymptotic stability and instability.

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• These important qualitative classifications are at the heart of dynamical systems. Important with this is the concept of a threshold value. (Sec. 2.5, p. 84 - 88)
• Know how to obtain approximate solutions using Euler's method if an analytical solution cannot be found. (Ex. 2, p. 106)
• Understand the three steps in the process of mathematical modeling: construction of the model, analysis of the model, and comparison with experiment or observation. (Ex. 3, p. 54)
• Determine the existence and uniqueness of solutions to differential equations. (Ex. 2, p. 71)
• Know how to recognize autonomous equations, and utilize the direction field to represent solution to them. Be able to determine asymptotically stable, semi-stable, and unstable equilibrium solutions. (Ex. 1, p. 83)

**Relevant Applications:**
• Mixing Problems, Compound Interest, Motion in a Gravitational Field, Radioactive Carbon Do