

Topics for Exam 1**1. Modeling via Differential Equations**

- 1.1 Conservation principles
- 1.2 Compartment models

2. Types of Differential Equations

- 2.1 Order
- 2.2 Linear versus nonlinear
- 2.3 Systems
- 2.4 Autonomous systems

3. Solving Linear Systems of Differential Equations

- 3.1 General solutions
- 3.2 Initial conditions
- 3.3 Solving two-dimensional linear systems with constant coefficients
 - 3.1 Homogeneous and nonhomogeneous systems
 - 3.2 Diagonalizable systems
 - 3.3 Non-diagonalizable systems
- 3.4 One-dimensional Systems
 - 4.1 Separation of variables
 - 4.2 Integrating factors
- 3.5 Second order equations

4. Phase-Plane Analysis of Linear Systems

- 4.1 Solution curves (trajectories, orbits)
- 4.2 Equilibrium points
- 4.3 Phase portrait
- 4.4 Nullclines

Relevant sections in text: 1.1, 1.2, 1.9, 2.1, 2.2, 3.1, 3.2, 3.3, 3.5 and 3.6.

Relevant sections in the online class notes: 2.1, 2.2, 3.1 and 4.1.

Relevant assignments: 1, 2, 3, 4 and 5.

Important concepts: Solution curves (trajectories, orbits), phase portrait, general solutions, diagonalizability, Jordan canonical forms.

Important skills:

- Know how to apply conservation principles to obtain differential equations models;
- know how to solve linear first order equations by separating variables, or using integrating factors;
- know how to turn a second order equation into a two-dimensional system;
- know how to construct solutions of homogeneous, two-dimensional systems with constant coefficients;
- know how to sketch phase portraits;
- know how to apply nullcline analysis.