Practice problems for MATH302: Differential Equations

Lecture 1: Introduction to differential equations

Read Chapter 1. Some of the material will be familiar from today's lecture, while other material will be new to you. Don't worry about making complete sense out of all of it, just try to get accustomed to the important ideas. Pay particular attention to the talk about direction fields and integral curves.

Lecture 2: First-order linear ODEs

Section 2.1: 13, 15, 18, 20, 30, 31, 34. Problems 1–12 are meant to be done using Maple (or a similar software package). If you are already familiar with Maple and want to teach yourself how to solve ODEs and plot direction fields in Maple, feel free to practice with some of these problems. If you would like a Maple tutorial, I would be happy to help during my office hours.

Lecture 3: Separable Equations

Section 2.2: 1–8. Section 2.4: 1–6, 28 (read the description of Bernoulli equations and problem 27 before attempting problem 28)

Lecture 4: Modeling Population Dynamics

Section 2.5: 1–5, 7, 14, 15(a), 25

Lecture 5: Linearizing the nonlinear, separating the inseparable

Section 2.2: 32, 33. The Bernoulli equation example from class had been previously assigned, so just make sure you would be able to solve it (or a similar problem) if asked.

Lecture 6: Second order linear homogeneous ODEs with constant coefficients

Section 3.1: 1–16, 21. Section 3.4: 7–22. Section 3.5: 1–14.

Lecture 7: The theory of second order linear homogeneous equations

Section 3.2: 1–6, 14, 25. Section 3.3: 1–6, 15, 24.

Lecture 8: Solving second order linear nonhomogeneous equations

Section 3.6: 2, 3, 6, 13.

Lecture 10: The general theory of linear equations

Section 4.1: 11, 17 (the motive here is that a set of solutions may appear at first glance to be linearly independent, but it actually turns out to be linearly dependent). Section 4.2: 11, 12. Section 4.3: 9.

Lecture 11: Linear homogeneous equations with nonconstant coefficients

Section 5.2: 1, 2, 5. Section 5.3: 17. Section 5.5: 13, 21.

Lecture 12: Intro to systems of ODEs, review of matrix basics

Section 7.1: 1, 3, 15, 16. Also, if you are not already comfortable with the basics of matrix arithmetic, try some of the following problems from section 7.2: 1, 2, 3, 6, 10–16.

Lecture 13: Eigenvalues and eigenvectors

Section 7.3: 15–19.

Lecture 14: Homogeneous first order linear systems with constant coefficients

Section 7.5: 6, 16. Section 7.6: 2. Section 7.8: 3, 7.

Lecture 15: Systems with equilibrium solutions: stability and phase portraits

Look at problem 24 in Secton 9.2. You won't be asked to solve it, but its message is useful to your overall education in this course: trajectories of 2×2 autonomous systems never cross. Two different trajectories may *converge* at an equilibrium point, but they never cross!

Lecture 16: Almost linear systems

Section 9.3: 1–4, 18.

Lecture 17: Modeling population of competing species

Section 9.4: 2. This problem is very similar to the example used in class. Once again you should find four equilibrium points: one at the origin, one corresponding to each species' carrying capacities, and a fourth one somewhere in the middle. The difference here is that the fourth equilibrium is unstable (so there is no "happy coexistence").