

Study guide for exam 1, math 286, Spring 2009

Note that you will be asked questions relating to the IODE projects!

Hint: Best way to study is to go over as many problems as you can in the book.

Section 3.2: Higher order linear equations. See the summary handout. Note the similarity to 3.1. Main new idea from here is *linear independence*.

Section 3.3: Higher order linear homogeneous ODEs with constant coefficients. Note the similarity with second order.

Section 3.4: Know how to solve and interpret equations relating to mechanical vibrations. Keywords to know: *underdamped*, *overdamped*, *critically damped*, *amplitude*, *frequency* (know difference between angular or circular frequency vs. frequency), *phase shift*.

Section 3.5: Be able to solve nonhomogeneous equations with constant coefficients using both undetermined coefficients and variation of parameters.

Section 3.6: Forced oscillations. Key words to know: *natural frequency*, *resonance*, *practical resonance*, *transient solution*.

Section 4.1: Know how to set up systems. Know how to take a higher order equation (or system of equations) and turn it into a first order system.

Know how to sketch a *direction field* and *phase portrait* of solutions for autonomous systems (systems where the equations do not depend on time t).

Section 5.1: Know how to do basic algebra with matrices, how to add, multiply them, how to compute the derivative, and how to compute the inverse of at least 2x2 and diagonal matrices. Be able to solve for constants in a general solution of a system given the initial values. Know how a first order linear system of ODEs looks in matrix notation. Know *superposition*, *linear independence*, and *existence and uniqueness* for first order linear systems.

Section 5.2: Be able to find eigenvalues of a matrix. Know how to solve homogeneous first order systems with constant coefficients using the eigenvalue method. Be able to sketch phase diagrams/portraits of the solutions and classify the portraits according to behaviour (sink, source, saddle point, spiral sink, spiral source, ellipses).

Section 5.3: Coupled undamped oscillatory systems. Be able to set up the equations, know how to solve the system, and how to interpret the result. Key words: *natural (or normal) modes*, *natural frequencies*.

Section 5.4: Handle repeated eigenvalues in solving systems using the eigenvalue method. Key words: *complete eigenvalue*, *defect*, *generalized eigenvector*. Be able to do multiplicity 2 eigenvalues with defect 1.

Section 5.5: Know definition of matrix exponential, know how to compute it. Know how to use it to solve linear homogeneous equations.