The final exam will cover all material in the course. In addition to the material in the previous two study guides, here are some study ideas.

Second Order Linear Equations and Mass-Spring Systems

- Know variation of parameters and reduction of order. I'll give you the variation of parameters formula if you need it. But you need to know what it's good for.
- Know the difference between underdamped, overdamped, and critically damped mass-spring systems.
- What do the graphs of solutions of mass-spring systems look like?
- Give an example of frictionless mass spring system (with forcing term) that experiences resonance.
- Look over Lab 3, and the online solutions. What is the meaning of the curve $R(\beta)$?
- When does practical resonance occur in a mass-spring system with friction?
- What are beats? Give an example of a mass-spring system (with forcing term) that will exhibits solutions with beats.

Systems of Equations

Be able to:

- Convert a 2^{nd} order differential equation into a first order system.
- Convert a first order 2×2 system into a 2^{nd} order differential equation.
- Understand the relationship between a phase portrait and time series of solutions. Given an orbit, know how to plot the corresponding time series.

Linear Systems

You should be able to perform the following tasks concerning the system

$$\mathbf{x}' = A\mathbf{x}$$

where A is a constant 2×2 matrix.

- Find eigenvectors/eigenvalues of A.
- Sketch the system's phase portrait.

- Find the general solution.
- Given an initial condition, find the corresponding solution.
- Given information about the eigenvalues of A, discuss the stability of the origin.

Laplace Transforms

- Know the definition of the Laplace transform, and be able to compute them from scratch in easy cases (e.g. $f(t) = e^{5t}$).
- Know how to solve a linear equation using Laplace transforms.
- Know how to use the shift and switching properties.
- Know how to deal with differential equations with discontinuous forcing terms.
- Be able to take the Laplace transform of a piecewise defined function.
- Be able to solve linear differential equations with a right-hand side involving a Dirac delta function.

I will provide you with a table of transforms.