Outline for Exam 1

**Ground Rules:** I’ve listed just about everything we’ve covered. I know it’s quite a bit, but you will have a choice of problems, so *you don’t have to know everything.* You might, for example, want to avoid mathematical modeling. You could still choose a problem with an equation based on a model, but you wouldn’t have to explain or derive the model. You can use a calculator of any type, but you have to show your work. A solution that appears out of nowhere will receive no credit.

**First-Order Equations**
1. First-order, separable, equations.
2. First-order, linear equations.
3. Homogeneous equations, i.e. equations of the form $u' = f\left(\frac{u}{t}\right)$.
4. Exact equations.
5. Bernoulli equations.
6. The initial value problem for equations of the foregoing types.
7. Direction fields.
8. Phase line analysis of autonomous equations.
9. The existence-uniqueness theorem for the initial value problem.
10. The method of Picard iteration.

**Second-Order Equations**
1. The statements, meanings and proofs of the theorems (propositions 13, 15 and 16 from the second set of webnotes on linear equations) about Wronskians, fundamental sets and general solutions to second-order, linear, homogeneous equations.
2. Finding a fundamental set for a homogeneous equation with constant coefficients.
4. Finding a fundamental set for a Cauchy-Euler equation.
5. Derivation and use of the reduction of order formula.
6. Derivation and use of the variation of parameters formula to solve the inhomogeneous equation.

**Mathematical Modeling**
1. Newton’s law of cooling.
2. Derivation and use of the mass balance law for the chemostat.
3. Use and derivation, from Newton’s law and conservation of energy, of equations of motion (e.g. the pendulum equation, body falling through a viscous fluid).
4. The logistic model of population growth.