Math 2250-010
Superquiz 1 Review Questions
January 30, 2014

The superquiz is the first 25 minutes of class on Friday January 31. I will hand out the quizzes before 8:05 to people who are there, and we will start right at 8:05. The quiz will be about 2-3 times longer than our regular quizzes and touch on some of the main topics from Chapters 1-2. (Clearly, it can't cover all topics!) Last fall 2013 is the first time we gave superquizzes, and I recommend you look at the first superquiz from then to get an idea about topics, length, and difficulty.

I recommend trying to study by organizing the main conceptual and computational framework of the course so far. Then test yourself by making sure you can explain these concepts and do typical problems which illustrate them, from our notes, homework, quizzes, labs and from the text 1.1-1.5, 2.1-2.6. As with all quizzes and exams in our class, you may use a scientific (not graphing) calculator. Since symbolic answers (e.g. $\frac{\ln(2)}{5}$) are accepted for all problems on exams, no calculator is really needed, unless you worry about arithmetic errors that a scientific calculator could catch, or if you want to check the decimal value to see if your answer is reasonable. I try to design quiz, superquiz, and exam questions so that they are testing concepts without the challenging computations that you might expect to find in lab, or in harder homework problems.

Here is my own outline of key topics from Chapters 1-2. Can you find example problems from quizzes, lecture notes, and/or homework that test the concepts?

1) What is a differential equation? What is its order? What is an initial value problem, for a first or second order DE?
How do you check whether a function solves a differential equation? An initial value problem?

2) Can you convert a description of a dynamical system in terms of rates of change, or a geometric configuration in terms of slopes, into a differential equation?

3) Can you recognize and solve separable differential equations and linear differential equations, and corresponding initial value problems?

4) Can you model and solve differential equations related to the following important applications: acceleration depending only on time (1.2); exponential growth/decay and Newton's law of cooling (1.4); <u>input-output modeling</u> (1.5); <u>improved population models</u> (2.1-2.2); <u>improved velocity models that account for drag</u> (2.3)? (Toricelli's Law (1.4), electrical circuits (EP 3.7), escape velocity (2.3) will not be on the super quiz.)

5) What is the connection between a first order differential equation and a slope field for that differential equation? The connection between an IVP and the slope field? How do slope fields explain why you expect solutions to IVP's to exist, at least for values of the input variable close to its initial value? Do you expect uniqueness? (Do you remember the condition on the slope field function $f(x, y)$ in some rectangle containing the initial point, that guarantees existence? The additional condition that guarantees uniqueness as well?) What does the slope field have to do with geometrically interpreting Euler's method for numerical approximation to solutions of differential equations? (You are expected to remember the steps for Euler, but any improved Euler or Runge-Kutta problem would include the pseudo-code for one step.)

6) What's an autonomous differential equation? What's an equilibrium solution to an autonomous differential equation? What is a phase diagram for an autonomous first order DE, and how do you construct one? How does a phase diagram help you understand stability questions for equilibria?