**Final Exam**

**Due:** Thursday, December 8, 2022, 3:30 PM

**Abilities to be Tested**

1. Create and critique differential equation models of a variety of natural phenomena including the population of a single species, spring-mass-damper systems, a pendulum, predator and prey interactions, competitive species interactions, and chemical reactions. Interpret solutions of such equations back in the real-world context.

2. Solve first-order differential equations using integrating factors, separation of variables, guess and check, linearity, slope field sketches, phase line sketches, Euler’s numerical approximation, Laplace transforms, and computer software. Identify equilibria and their stability properties. Apply the Existence and Uniqueness Theorem properly. Identify and describe bifurcations using words and diagrams.

3. Solve constant coefficient linear second-order differential equations analytically using guess and check, undetermined coefficients, Laplace transforms, and computer software.  Identify natural and resonant frequencies.  Describe the importance of resonance.

4. Solve first-order systems of differential equations using guess and check, phase plane sketches, dependent vs. independent variable graphs, linear analysis of equilibria, Hamiltonian analysis, Lyapunov function analysis, and computer software. Apply the Existence and Uniqueness Theorem properly.

**Study Suggestions**

1. Ask yourself which of the above abilities you already have. For the ones that are weak, reread the text and/or lecture notes.

2. Rework a selection of homework, assignment, and midterm exam problems.

3. Prepare a review sheet. Although the final exam is closed book, the act of preparing a reference sheet often helps with synthesis.

4. Try some of the practice final exams obtained from Robert Devaney and Paul Blanchard.

**Mechanics**

Paper, writing instruments, and a basic scientific calculator are the only resources you may use while working on the exam.