MAT 463/563 Exam II Review

1. Nonlinear Systems of Differential Equations
    a. Autonomous Equations $\dfrac{dy}{dt} = f(y)$
        i. Equilibrium solutions $f(y_0) = 0$.
        ii. Classification (stable, unstable)
        iii. Phase Lines, Bifurcation Diagrams
        iv. Types of bifurcation – saddle node, transcritical, pitchfork, Hopf
    b. Nonlinear Systems
        i. Linearization About Equilibrium (Fixed) Points
        ii. Stability of Fixed Points – classify.
        iii. Identifying Interesting Features of Nonlinear Systems
        iv. Limit Cycles
    c. Phase space plots – Given a direction field, identify equilibria, limits cycles, etc.
    d. Polar coordinate forms of systems
    e. Flows, orbits, trajectories, semiorbits, asymptotics, ω-limits
    f. Poincaré-Bendixon Theorem
    g. Nonautonomous systems, Surface of Section
2. Application Problems
    a. Mixing Problems, Compartmental Problems
    b. Population Dynamics (Logistic, Lotka-Volterra, etc)
    c. Masses plus springs
    d. Nonlinear pendulum
    e. Duffing Equation, Lorenz model, and other models
3. Simulink
    a. Given a diagram, what is being solved, or
    b. Given a simple ODE or system, sketch how one might set up a model.