Due W 09/24

1. Build yourself a control system simulatator based upon a numerical ordinary differential equation solver (e.g., *ode23()* in Matlab) following the approach discussed in class. You'll want the option of performing dynamic control in continuous-time with the controller added to the system's differential equations or as a discrete-time controller that updates at specified intervals of time while the system continuously evolves.

   (a) Build a simulation for the pendulum using the nonlinear model and test that it behaves as expected for a constant control input (zero and less than gravitational torque) and variety of initial conditions. Plot the angular position and velocity versus time.

   (b) Build a simulation for the magnetic-ball system using the nonlinear model and confirm it will levitate at 0.5m by starting it there with exactly the right (constant) input, and that it will fall if the input is less than that necessary for levitation. Plot the position, velocity and current versus time.

   (c) Download the simple visualization/animation m-files *drawpendulum()* and *draw-magneticball()* from the course web page and use them to view the systems' responses.

   (d) Implement the realistic PID controllers (both continuous- and discrete-time versions) presented on pages 36-38 for both systems and tune based upon the procedures also presented on pages 36-38. Try a variety of initial conditions and setpoints. Plot the states and view the systems' responses with the animations.

   (e) Investigate the effect of the sampling time on the performance of the discrete-time controller by varying it from small (say 1ms) to large (say 1s). How do the responses of the continuous-time and discrete-time controllers compare?