MECE-744: Nonlinear Controls **Computer Project #1**
Spring 2015-2016 (Spr: 2155) *Due 02-18-16*

Instructions: Use Matlab/Simulink to solve all problems unless otherwise indicated. Save your work in an m-file and a slx-file. Project write-up should include the following:

1. a project write-up with clearly defined answers to each problem.
2. a print out of the Matlab command window showing your Matlab solution answers. Clearly define each solution and the part to which it pertains.
3. a print out copy of your m-file program and any Simulink diagrams.
4. a print out copy of clearly labeled Figures and Plots
5. a soft copy of your program required to run all the problem parts (place it in the mycourses dropbox shell)

1. For the following nonlinear system:

$$\ddot{\theta} + \sin\theta = 0$$

   a. determine the system's equilibrium point by hand calculations (show your work)
   b. determine the Phase Plane Portrait plot including enclosing at least **7** equilibrium points and indicate the directions of each trajectory on the Phase Plane Portrait plot.

2. For the system shown below:

$$\ddot{x} + \dot{x} - 2x = 0$$

   a. determine the Phase Plane Portrait plot and indicate the directions of each trajectory on the Phase Plane plot.
   b. using the Laplace transform method, find the closed-form exact solution to the system with $x(0) = 1$ and $\dot{x}(0) = -2$ (show your hand calculations)
   c. overlay the numerical solution for the initial condition set of part b) with your closed-form exact solution solved in part b). Use Simulink to find the numerical solution using the "ode5" fixed-step solver with a final time of 5 seconds and an integration step-size of 0.01 sec. How does the exact closed-form solution compare to the numerical solution? Does the system appear to be stable for the initial condition set?
   d. Find the system poles. Is the system stable? Does this result agree with the time history plots shown in part c)?

Answer to Part 2)