# EE5321, Spring 2018
# Homework 1: MATLAB and Simulink Warm-Up

**Problem 1)** Simulink modeling of ODEs - 30 points
In Simulink, given the below second order ordinary differential equation

$$1.5\ddot{x} + 2\dot{x} + 3.25x = 2.2u$$

and taking the control input to be a unit step function occurring at one second.

a) Use the Laplace transform to convert the ODE into a transfer function form and plot the simulation time history for a 10 second simulation.
b) Convert the second order ODE into two first order ODEs and implement those, using a simple integrator for the time derivative integration, as was demonstrated in class. Generate and plot the simulation time histories.
c) Convert the two first order ODEs into a state-space form and use the state space block with the unit step input to generate and plot the simulation time history.

**Problem 2)** Communication between MATLAB and Simulink - 30 points
a) Create a new Simulink model running with a fixed-step integrator with a step size of 0.1 seconds and a stop time of 10 seconds. Use a sine wave source to create data that is sent back to MATLAB. Create a script in MATLAB to call the Simulink simulation and bring the data back to MATLAB, plotting the time history.
b) Using the time vector from part a), create data for a cosine wave and send the data into the simulation. In Simulink, subtract the data created in MATLAB from a cosine source in Simulink and plot the difference.

**Problem 3)** 40 points
Implement the following ODE in Simulink using a fixed step integration with a time step of 0.1 seconds and use a unit step occurring at one second as the input.

$$\ddot{x} + \zeta\dot{x} + x = u$$

a) Create a MATLAB script to vary the value of zeta from 0.1 to 1.2 in increments of 0.1, capture the data in MATLAB, and plot the outputs on one graph for a 10 second simulation.
b) Remove the unit step input and create an input back at MATLAB for the Simulink model where the control is 1 for the first 10 seconds and is -1 for the second 10 seconds (total sim time of 20 seconds). Set zeta to 0.7, use MATLAB to call the Simulink simulation, feeding the new control input to the simulation, and plot the results back at MATLAB.

<u>MATLAB calling Simulink hints:</u>

```
t=[0:0.1:10]';
u=sin(t);
[t,y]=sim('test1',10,[],[t u]);
plot(t,y)
```