MECE-744: Nonlinear Controls **Computer Project #3**
Spring 2015-2016 (Sem: 2155) *Due 04-12-16*

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

1. a project write-up with clearly defined answers and any required hand calculations.
2. a print out of the Matlab command window showing your Matlab solution answers, if applicable. 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/Plots
5. a soft copy of your program required to run all the problem parts (place it in the mycourses dropbox shell)

1) Design an input-state feedback linearization for the nonlinear system shown below so that the first state, x_1 meets the following design criteria:

- x_1 is constrained as follows $-0.2 \le x_1 \le 1.05$
- a peak time of < 1 sec
- a 5% settling time of < 3 sec

$$\boxed{\begin{aligned} \dot{x}_1 &= x_1^2 + x_2 + x_3 \\ \dot{x}_2 &= x_3^2 + x_1 \sin x_2 + u \\ \dot{x}_3 &= x_1 \end{aligned}} \quad \Rightarrow \text{nonlinear system model}$$

with the following initial condition set:

$$x_1(0) = 1$$
$$x_2(0) = x_3(0) = 0$$

-Plot a 6 second time history solution x_1, x_2, and x_3 and controller effort, u on separate figures and verify the design criteria have been met (4 separate figures must be shown).

-Show the hand derivation of your input-state feedback linearization control law.

-Show the values of your feedback controller gains.

-You must choose an "appropriate" delta-t for you Simulink simulation effort!

2) Design an input-output feedback linearization for the nonlinear system shown below so that output tracks a known desired function reasonable well:

$$\boxed{\begin{aligned}\dot{x}_1 &= x_2 \\ \dot{x}_2 &= -x_1 - 2x_1^2 x_2 + (x_2 + 5)u \\ y &= x_1\end{aligned}}$$ => nonlinear system model

with a desired tracking of:

$$y_d = \sin 2t$$

-Plot a 10 second time history with y and y_d overlaid with each other (1 figure).

-Plot a 10 second time history with $\dot{y}$ and $\dot{y}_d$ overlaid with each other(1 figure).

-Plot a 10 second time history of the controller effort, *u* (1 figure).

-What is the relative order, *r* of the system?

-Show the hand derivation of your input-output feedback linearization control law.

-Show the values of your feedback controller gains.

-You must choose an "appropriate" delta-t for you Simulink simulation effort