ESE 406 - SPRING 2011
HOMEWORK #2
DUE 2-Feb-2011 (with Late Pass 7-Feb-2011)

Problem 1 You should be able to solve all parts of problems 3.2 through 3.9 in the textbook. Submit solutions to the following problems from the textbook:

a. Problem 3.3(c). Answer: $\frac{2}{s^3} + \frac{3}{(s+2)^2+9}$.

b. Problem 3.5(e). Answer: $\frac{s}{s^4+2s^2+1}$.

c. Problem 3.7(d). Also make a pretty graph of f(t).

Answer: $\left(\frac{6}{5}e^{-2t} + \frac{9}{5}e^{-\frac{5}{2}t}\cos\frac{\sqrt{19}}{2}t - \frac{153\sqrt{19}}{285}e^{-\frac{5}{2}t}\sin\frac{\sqrt{19}}{2}t\right)$

d. Problem 3.7(f). Answer: $\frac{2}{5}e^{-t} - \frac{2}{5}\cos 2t + \frac{6}{5}\sin 2t$

e. Problem 3.9(c). Answer: $y(t) = 4 - \frac{5}{2}e^{-t} - \frac{1}{2}\cos t - \frac{1}{2}\sin t.$

Problem 2 We haven't covered electrical circuit analysis yet, but the equations that govern one non-linear circuit are given to you in Problem 9.2. Work part(b) of that problem. Also, find the response of v(t) to a control perturbation that is a step of magnitude 0.1 (ΔU(s)=0.1/s), with an initial state perturbation of zero.

Answer (part b): (Note that the textbook use "δ" for a perturbation, where we used "Δ".)

$$\frac{d}{dt}\begin{bmatrix}\delta i\\ \delta v\end{bmatrix} = \begin{bmatrix}-1 & 1\\ -1 & \frac{\partial g}{\partial v}\end{bmatrix}\begin{bmatrix}\delta i\\ \delta v\end{bmatrix} + \begin{bmatrix}0\\ \frac{\partial g}{\partial u}\end{bmatrix}\delta u \rightarrow \frac{d}{dt}\begin{bmatrix}\delta i\\ \delta v\end{bmatrix} = \begin{bmatrix}-1 & 1\\ -1 & 3\end{bmatrix}\begin{bmatrix}\delta i\\ \delta v\end{bmatrix} + \begin{bmatrix}0\\ -3\end{bmatrix}\delta u.$$

It would be good practice for you to build a simulink model that compares the linear and non-linear responses of the system. The model could also provide you with a check of your solution for the step response. You may use the "polynomial" simulink element, found in the "math" library to represent the function "g" in the problem.