ESE 406 - SPRING 2012
HOMEWORK #3
DUE 1-Feb-2011 (with Late Pass 6-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 3.2(a). Answer: $\frac{s+2}{s^2}$.

We can verify the answer using MATLAB:

```
>> laplace(1+2*t)
ans =
(2+s)/s^2
```

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

c. Problem 3.7(c). Answer: $(3e^{-2t}\cos 4t - e^{-2t}\sin 4t)$

We can verify the answer using MATLAB:

```
>> ilaplace((3*s+2)/(s^2+4*s+20))
ans =
exp(-2*t)*(3*cos(4*t)-sin(4*t))
```

d. 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 You should be able to solve all parts of problems 3.19 through 3.22 in the textbook. Submit solutions to the following problems from the textbook:

OOPS!

PLEASE DISREGARD PROBLEM #2

ESE 406 - Problem 3.20(a). Answer: $\frac{Y}{R} = \frac{G_1}{1+G_1} + G_2.$

ESE 505 & MEAM 513 - Problem 3.20(b). Answer: $\frac{Y}{R} = G_7 + \frac{G_1G_3G_4G_6}{(1+G_1G_2)(1+G_4G_5)}$

Problem 3.21(b). Answer: $\frac{Y}{R} = \frac{b_1s^2 + b_2s + b_3}{s^3 + a_1s^2 + a_2s + a_3}$

Note that there are infinitely many possible block diagrams that correspond to a given transfer function. This particular form of block diagram is called the "observer canonical form". The coefficients of the numerator and denominator polynomials appear as gains. This form is discussed in Chapter 7.

Problem 3 The equations that govern a non-linear circuit are given to you in Problem 9.2.

ESE 406 -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 ($\Delta U(s)=0.1/s$), with an initial state perturbation of zero.

ESE 505 & MEAM 513 Students - Work all parts. Also, find the response of v(t) to a control perturbation that is a step of magnitude 0.1 ($\Delta U(s)=0.1/s$), with an initial state perturbation of zero, for all 3 equilibria.

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.