Due Monday, September 19 EE571 Easy 1 Problem Assignment!! HW#7

0. Lab 1 (the in lab portion) is due Monday. Each person should e-mail his/her own lab.

1. Given the following state variable model (see HW#4):

$$\dot{x} = \begin{bmatrix} -4 & 2 \\ 2 & -4 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} w, \quad x(-3) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} x + [2] w$$

a) Use the solution, $x(t) = e^{A(t-t_0)}x(t_0) + \int_{t_0}^{t} e^{A(t-\tau)}Bw(\tau)d\tau$ derived last time to find x(t) if the input to our system is $w(t)=e^{-t}u(t)$.

b) Use your solution to find y(t)

c) Assume that the initial condition is zero then find the transfer function H(s)=Y(s)/W(s).

d) Determine the stability of $\dot{x} = Ax + Bw(t), \; x(t_0)$ 1 if A =

$$i)\begin{bmatrix} 0 & 1 \\ 0 & -2 \end{bmatrix} \quad ii)\begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix} \quad iii)\begin{bmatrix} -1 & 1 \\ 0 & -1 \end{bmatrix} \quad iv)\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$$

e) Determine the stability of the systems modelled by the following transfer functions

$$i)\ H(s) = \frac{10(s-1)}{(s+1)(s+2)} \quad ii)\ H(s) = \frac{10(s-1)}{(s+1)(s-2)} \quad iii)\ H(s) = \frac{10(s-1)}{s(s+1)} \quad iv)\ H(s) = \frac{10(s-1)}{s^2(s+1)}$$

f) Draw the overall block diagram for the following automatic shutter system. The system works by using a servomotor (similar to our Motomatic) and a worm gear to open a 2 meter by 2 meter square aperture. The worm gear converts angular displacement to linear displacement with a ratio of 100 radians = 1 meter. A photo cell is located on the exposed plate and converts light into a voltage. The amount or illumination the photocell is exposed to is 1 candela (cd) for every square meter of aperature opening. The photocell outputs a voltage of 1 volt per candela. This voltage is subtracted from a reference voltage by means of a differential amplifier. The motor torque constant is 0.1 Nm/A (i.e., $T_m = 0.1\ I_a$) and the motor inerita is $J_a = 1$ kgm^2. The viscous friction constant is F=0.2Nms, the winding resistance is R_a=1 ohm and the amplifier gain is K_a=50. The back emf constant is K_b = .2 Vs/rad and the armature inductance is L_a = 100 mH.