EE 475 Fall 2008 Midterm Exam #1

Name____________________

Instructions:

1. This is a closed-book and closed-notes exam for individual work. You may have one sheet of formulae of size no larger than US letter. A scientific calculator is allowed.
2. Time for the exam is 50 minutes. Do as many problems as you can.
3. Each problem, regardless its level of difficulty, is weighted equally.

Problems:

1. An LTI system has input output transfer function $H(s) = (s + s*e^{-s\pi})/(s^2+1)$. Find the (true) poles and zeros of the system.

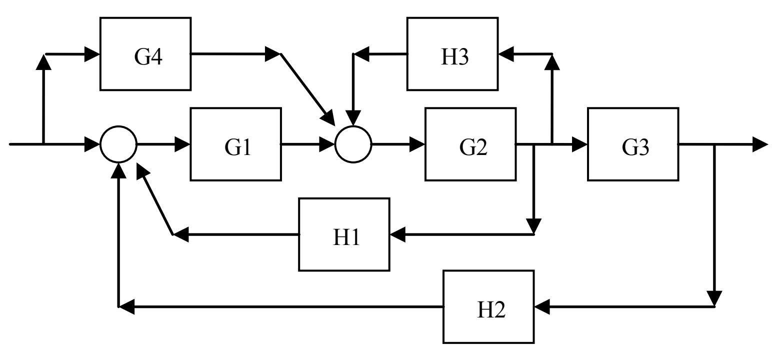
2. For the system given in problem 1, find the unit impulse response of the system.

3. Determine if the system in problem 1 is BIBO stable.

4. A system has TF = $1/(s^2+2s+2)$. Find the final value of the system's unit step response if the final value exists.

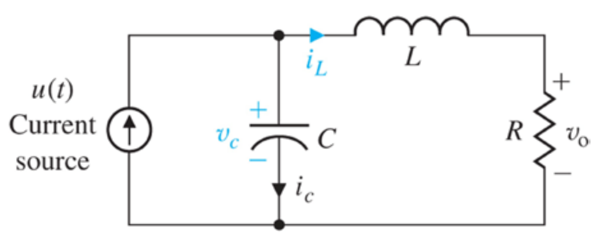
5. For the system in problem 4, find its initial value of its impulse response.

6. For the block diagram below, draw the equivalent signal flow graph using 5 nodes: input, output, and one node for each of the 3 junctions.

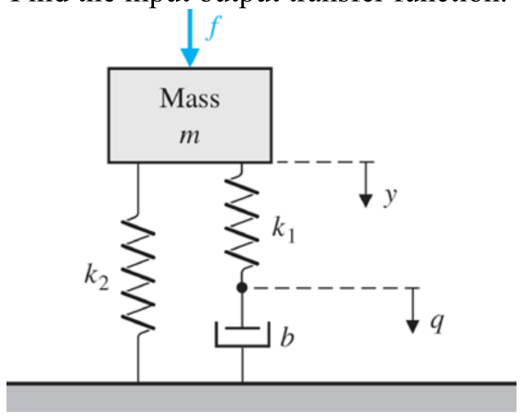


7. Find the input output transfer function for the system in problem 6. Assume all + signs at the summing junctions.

8. Given the circuit below. u(t) is input and the voltage vo(t) is output. Use the capacitor voltages and inductor current as state variables. Derive the state space model for the circuit.



9. For the suspension system below, the applied force is input and the position of the mass is output. Develop the input output model in the form of a single ordinary differential equation. Find the input output transfer function.



10. Given $M(t) = \begin{bmatrix} e^{t} & (e^{t} - e^{-t})/2 \\ 0 & e^{-t} \end{bmatrix}$. Is M(t) a state transition matrix? If it is, find A such that M(t) = exp(At); if not, explain why not.

11. Given A= [0 1; 2 3], B= [0; 1], C= [2 4], D= [0]. Find the Transfer function.

12. For the system in the last problem, determine if the system is completely controllable by computing the controllability matrix.

13. For the system in the last problem, determine if the system is completely observable by computing the observability matrix.

14. An LTI system transfer function $H(s) = 5/(s+5)$. Find the time-domain output response $y(t)$ that is due to the input $x(t)=\sin(t)u(t)$, where $u(t)$ is the unit step function.

15. Determine if the output $y(t)$ in the last problem will settle into a steady state signal. If it does, find the steady state signal.

16. Make a signal flow graph and block diagram from the following equations:

$$dX1/dt = X2 + X3 + u$$
$$dX2/dt = -0.5X2 - X1$$
$$dX3/dt = X1 + X2 - 0.5X3$$
$$Y = X1 + X2 + X3$$

17. Determine if the following system is completely observable and/or completely controllable:

$$A=\begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 3 & 0 & 0 \\ 0 & 0 & -3 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad B=\begin{bmatrix} 1 \\ 2 \\ 5 \\ 3 \end{bmatrix} \quad C=\begin{bmatrix} 1 & 0 & 2 & 4 \end{bmatrix} \quad D=\begin{bmatrix} 0 \end{bmatrix}$$

18. Determine if the following system is completely observable and/or completely controllable:

$$A=\begin{bmatrix} 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 2 & 1 & 0 \\ 0 & 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \quad B=\begin{bmatrix} 0 & 0 \\ 0 & 1 \\ 1 & 1 \\ 1 & 0 \\ 0 & 1 \end{bmatrix} \quad C=\begin{bmatrix} 1 & 2 & 3 & 4 & 5 \\ 0 & 3 & 4 & 2 & 1 \end{bmatrix} \quad D=\begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$