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ECE-205

Exam 3

Fall 2015

Calculators and computers are not allowed. You must show your work to receive credit.

Problem 1 __________/24

Problem 2 __________/17

Problem 3 __________/16

Problem 4 __________/19

Problems 5 _________/15

Problems 6-8 _________/9

Total ________________

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1) (24 points) For the following transfer functions, determine the *unit step response* of the system. *Do not forget any necessary unit step functions.*

a) $H(s) = \frac{e^{-2s}}{(s+1)^2}$

b) $H(s) = \frac{1}{(s+1)(s+2)}$

c) $H(s) = \frac{1}{s^2 + 2s + 5}$

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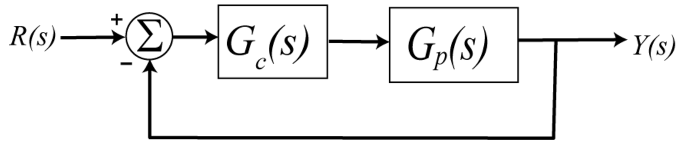
2) (17 points) Consider the following simple feedback control block diagram. The plant, the thing we want to control, has the transfer function $G_p(s) = \dfrac{3}{s+8}$



a) Determine the settling time of the plant alone (assuming there is no feedback)

b) Determine the steady state error for plant alone assuming the input is a unit step (simplify your answer)

c) For a proportional controller, $G_c(s) = k_p$, determine the closed loop transfer function $G_0(s)$

d) Determine the settling time of the closed loop system , in terms of k_p

e) Determine the steady state error of the closed loop system for a unit step, in terms of k_p (simplify your answer)

f) For and integral controller, $G_c(s) = \dfrac{k_i}{s}$, determine the closed loop transfer function $G_0(s)$ and the steady state error for a unit step in terms of k_i

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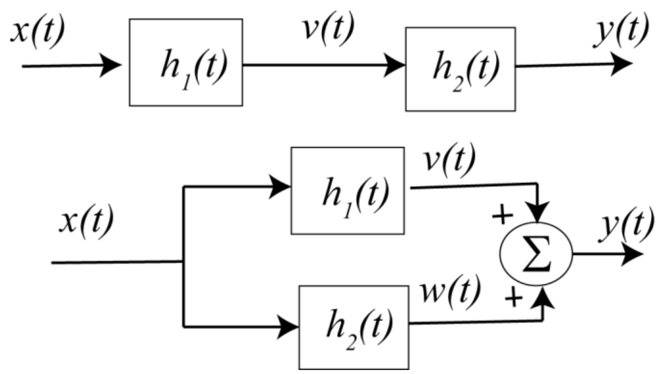
3) (16 points) For the following block diagram

For the following interconnected systems,

i) determine the overall impulse response (the impulse response between input *x(t)* and output *y(t)*) and

ii) determine if the system is causal.



a) $h_1(t) = \delta(t+1),\ h_2(t) = \delta(t+1)$

b) $h_1(t) = u(t+1),\ h_2(t) = u(t-2) + \delta(t-2)$

Series (top) Connections:

Parallel (bottom) Connections:

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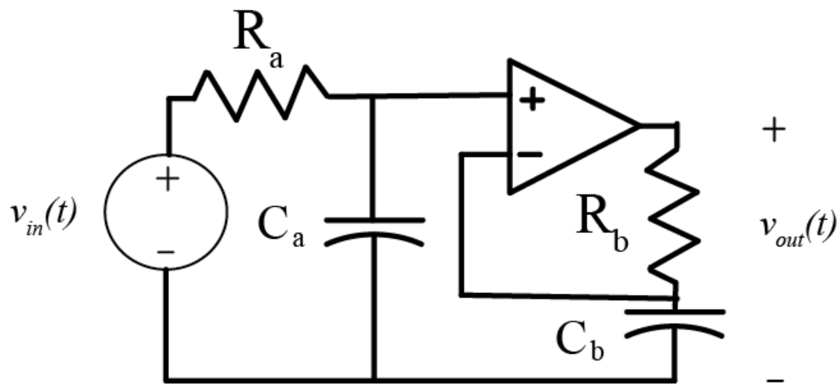
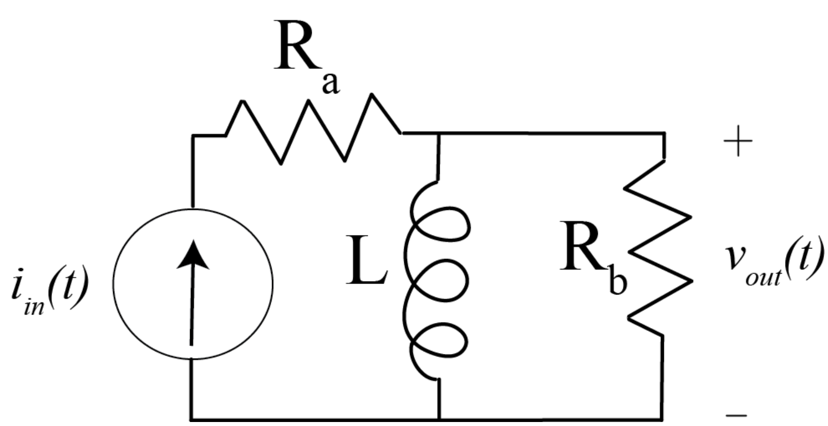
4) (19 points) Determine the transfer function for the following circuits:





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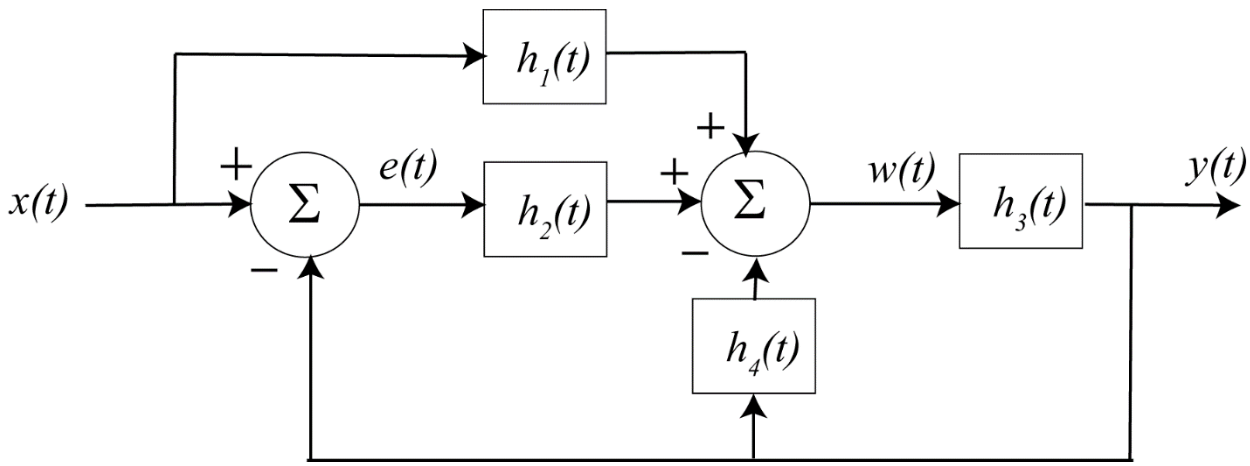
5) (15 points) For the following block diagram



Draw the corresponding signal flow graph, labeling each branch and direction. *Feel free to insert as many branches with a gain of 1 as you think you may need.*

Determine the system transfer function using Mason's gain rule. *You must clearly indicate all of the paths, the loops, the determinant and the cofactors.* ***<u>You need to simplify your final answer!</u>***

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Problems 6 and 7 refer to the impulse responses of six different systems given below:

$$h_1(t) = [\sin(\mathrm{t}) + e^{-t}]u(t)$$
$$h_2(t) = e^{-2t}u(t)$$
$$h_3(t) = \mathrm{t}^2\, u(t)$$
$$h_4(t) = \delta(t-1)$$
$$h_5(t) = [t\sin(t) + e^{-t}]u(t)$$
$$h_6(t) = [te^{-t}\cos(5t) + e^{-2t}\sin(3t)]u(t)$$

6) The number of (asymptotically) **maginally stable systems** is a) 0 b) 1 c) 2 d) 3

7) The number of (asymptotically) **unstable systems** is a) 0 b) 1 c) 2 d) 3

8) Which of the following transfer functions represents a (asymptotically) **stable** system?

$$G_a(s) = \frac{s-1}{s+1} \qquad G_b(s) = \frac{1}{(\mathrm{s}+2)(s+1)} \qquad G_c(s) = \frac{s}{s^2-1}$$

$$G_d(s) = \frac{s+1}{(s+1+j)(s+1-j)} \qquad G_e(s) = \frac{(s-1-j)(s-1+j)}{s+1} \qquad G_f(s) = \frac{(s-1-j)(s-1+j)}{(s+1-j)(s+1+j)}$$

a) all but G_c b) only G_a, G_b, and G_d c) only G_a, G_d, and G_f

d) only G_d and G_f e) only G_a and G_d

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