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ECE-205

Exam 3

Fall 2013

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

Problem 1 __________/20

Problem 2 __________/15

Problem 3 __________/15

Problem 4 __________/15

Problems 5 _________/14

Problems 6-12 __________/21

Total ________________

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1) (20 points) For the following transfer functions, determine **both**

- the *impulse response*
- the *unit step response*

Do not forget any necessary unit step functions.

a) $H(s) = \dfrac{4}{s^2 + 4s + 8}$

b) $H(s) = \dfrac{se^{-s}}{(s+1)^2}$

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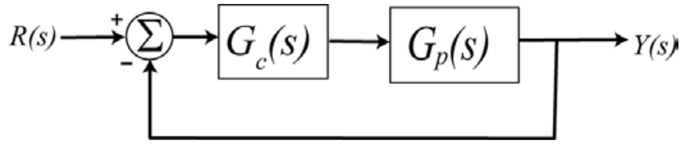
2) (15 points) Consider the following simple feedback control block diagram. The plant, the thing we want to control, has the transfer function $G_p(s) = \dfrac{3}{s+5}$



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 as much as possible)

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 as much as possible)

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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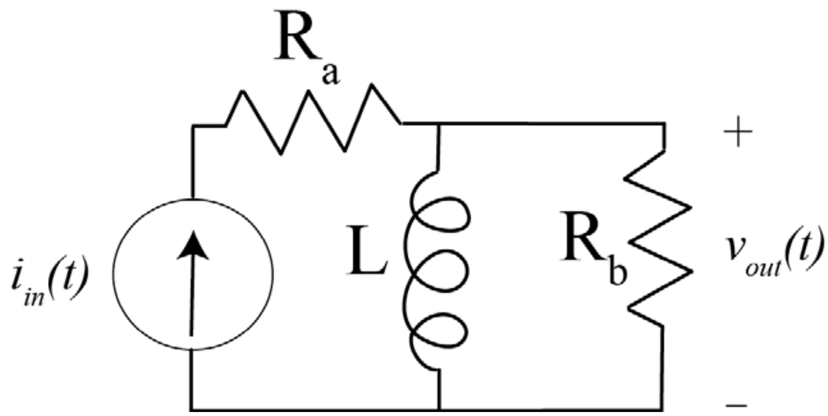
3) (15 points) For the following circuit



- Determine the ZIR
- Determine the ZSR
- Determine the transfer function

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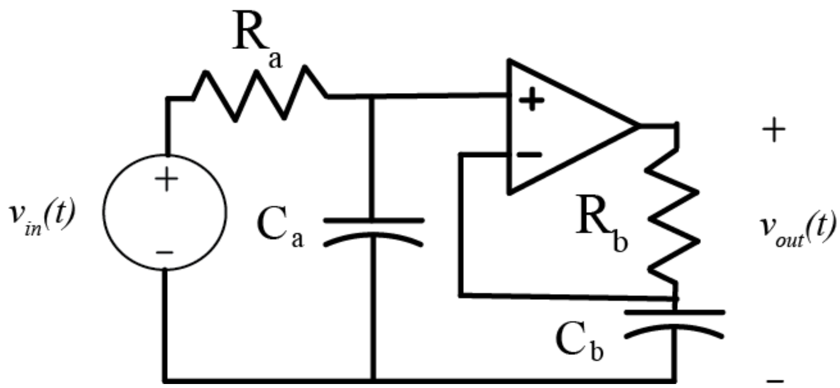
4) (15 Points) Determine the transfer function for the following circuit.



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5) (15 points) Consider a linear time invariant system with impulse response given by

$$h(t) = e^{-(t+1)}u(t+1)$$

The input to the system is given by

$$x(t) = e^{-t}[u(t) - u(t-1)] + 2u(t-2)$$

Using ***graphical evaluation***, determine the output $y(t)$ Specifically, you must

- Flip and slide $h(t)$, ***NOT*** $x(t)$
- Show graphs displaying both $h(t-\lambda)$ and $x(\lambda)$ for each region of interest
- Determine the range of t for which each part of your solution is valid
- Set up any necessary integrals to compute $y(t)$. Your integrals must be complete, in that they cannot contain the symbols $x(\lambda)$ or $h(t-\lambda)$ but must contain the actual functions.
- Your integrals cannot contain any unit step functions
- ***DO NOT EVALUATE THE INTEGRALS!!***

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

$$h_1(t) = [1 + e^{-t}]u(t)$$
$$h_2(t) = e^{-2t}u(t)$$
$$h_3(t) = [2 + \sin(t)]u(t)$$
$$h_4(t) = [1 - t^3 e^{-0.1t}]u(t)$$
$$h_5(t) = [t\sin(t) + e^{-t}]u(t)$$
$$h_6(t) = [te^{-t}\cos(5t) + e^{-2t}\sin(3t)]u(t)$$

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?

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

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

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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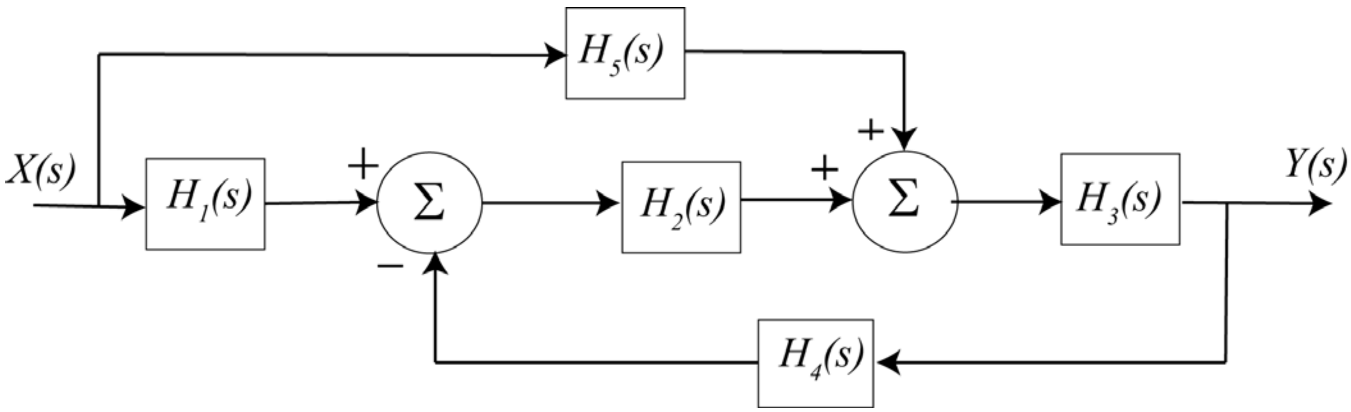
For problems 9-12, consider the signal flow graph representation of the following block diagram.



9) How many **paths** are there? a) 0 b) 1 c) 2 d) 3 e) 4

10) How many **loops** are there? a) 0 b) 1 c) 2 d) 3 e) 4

11) The **determinant** (Δ) is a) 1 b) $1-H_2H_3H_4$ c) $1+H_2H_3H_4$ d) none of these

12) The **transfer function** is a) 1 b) $\frac{H_3H_5+H_1H_2H_3}{1+H_2H_3H_4}$ c) $\frac{H_3H_5+H_1H_2H_3}{1-H_2H_3H_4}$