ECE-205

Exam 3

Fall 2011

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

Problem 1 __________/30

Problem 2 __________/15

Problem 3 __________/20

Problem 4 __________/15

Problems 5 _________/20

Total ________________

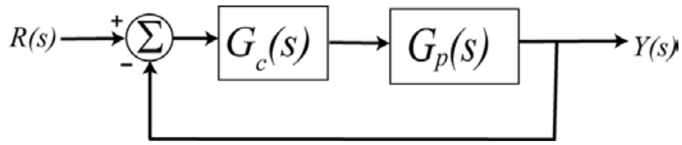
1) (30 points) For the following transfer functions, determine ***both*** the *impulse response* and the *unit step response* of the system. *Do not forget any necessary unit step functions.*

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

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

c) $H(s) = \dfrac{s}{s^2+4s+5}$

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)

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

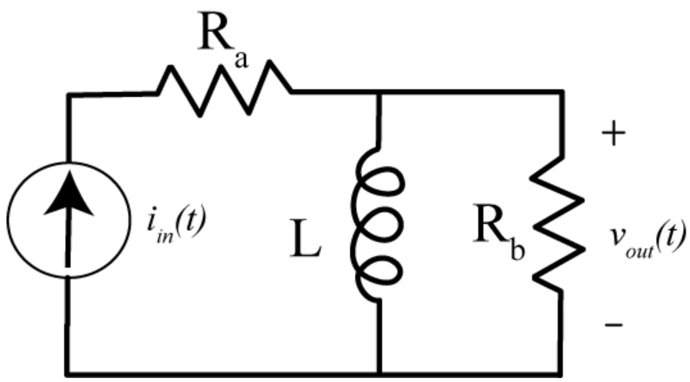
3) (20 points) For the following circuit determine

a) the zero input response (ZIR)

b) the zero state response (ZSR)

c) the <u>*transfer function*</u> $H(s)$

Note; You will need to include initial conditions for some of this problem.



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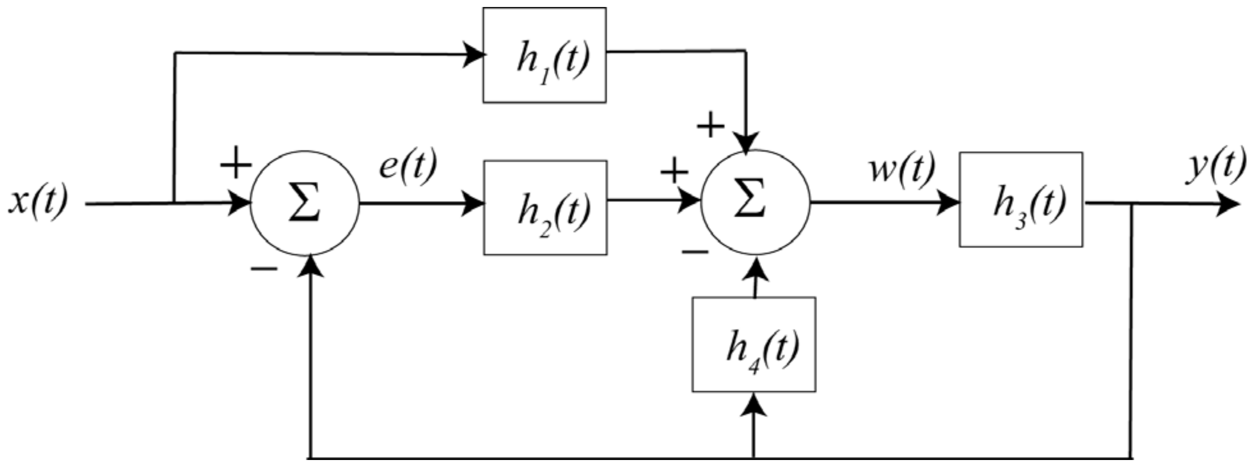
4) (15 points) For the following block diagram



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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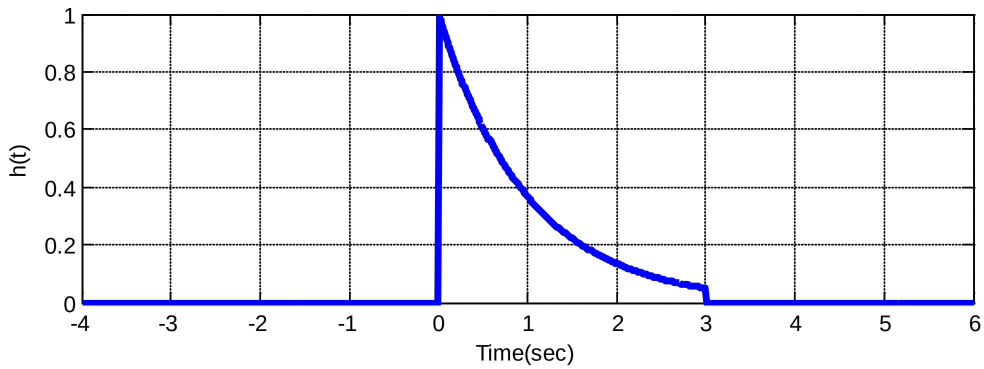
5) (20 points) Consider a linear time invariant system with impulse response given by

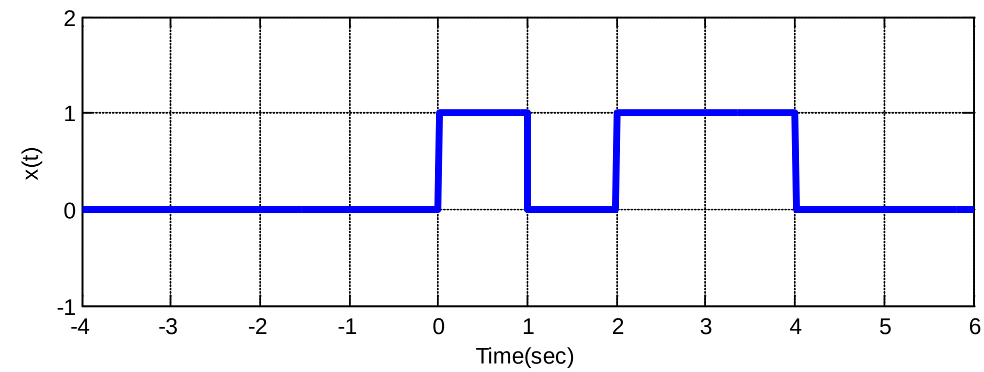
$$h(t) = e^{-t}[u(t) - u(t-3)]$$

The input to the system is given by

$$x(t) = [u(t) - u(t-1)] + [u(t-2) - u(t-4)]$$

The impulse response and input are shown below:





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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