Name ____ CM ____________

ECE-205

Exam 3

Winter 2011

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

Problem 1 __________/25

Problem 2 __________/25

Problem 3 __________/25

Problem 4 __________/25

Total ________________

Name ____ CM ____________

1) (25 points) For the following impulse responses and inputs, compute the system output using Laplace transforms. Specifically, compute $H(s)$, $X(s)$, $Y(s)$, and then $y(t)$.

a) $h(t) = e^{-t}u(t)$, $x(t) = u(t)$

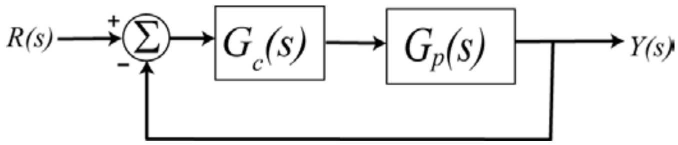
b) $h(t) = e^{-t}u(t)$, $x(t) = 2\delta(t-1)$

c) $h(t) = e^{-t}u(t)$, $x(t) = u(t-2)$

d) $h(t) = e^{-t}u(t)$, $x(t) = e^{-(t-2)}u(t-2)$

Name ____ CM ____________

2) (25 points) Consider the following simple feedback control block diagram. The plant, the thing we want to control, has the transfer function $G_p(s) = \frac{4}{s+2}$



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 as much as possible)

f) For and integral controller, $G_c(s) = \frac{k_i}{s}$, determine the maximum positive value of k_i that produces purely real poles.

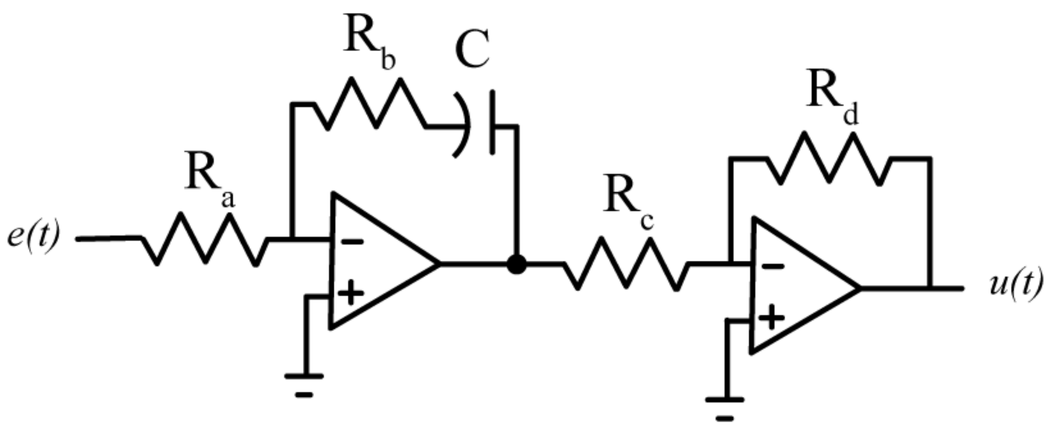
Name ____ CM ____________

3) (25 points)

a) The following circuit can be used to implement the PI controller

$$G_c(s) = \frac{U(s)}{E(s)} = k_p + \frac{k_i}{s}$$

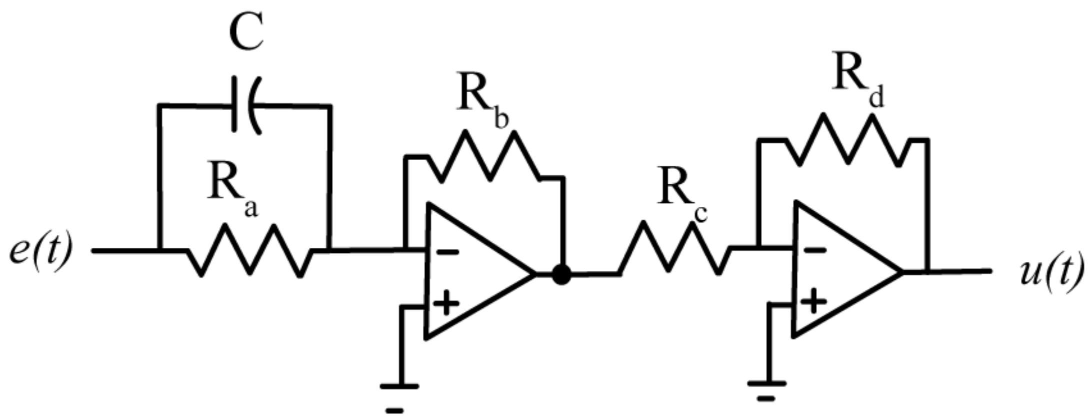
Determine expressions for k_p and k_i in terms of the parameters given in the circuit.



Name ____ CM ____________

b) The following circuit can be used to implement the PD controller $G_c(s) = \frac{U(s)}{E(s)} = k_p + k_d s$

Determine expressions for k_p and k_d in terms of the parameters given in the circuit.



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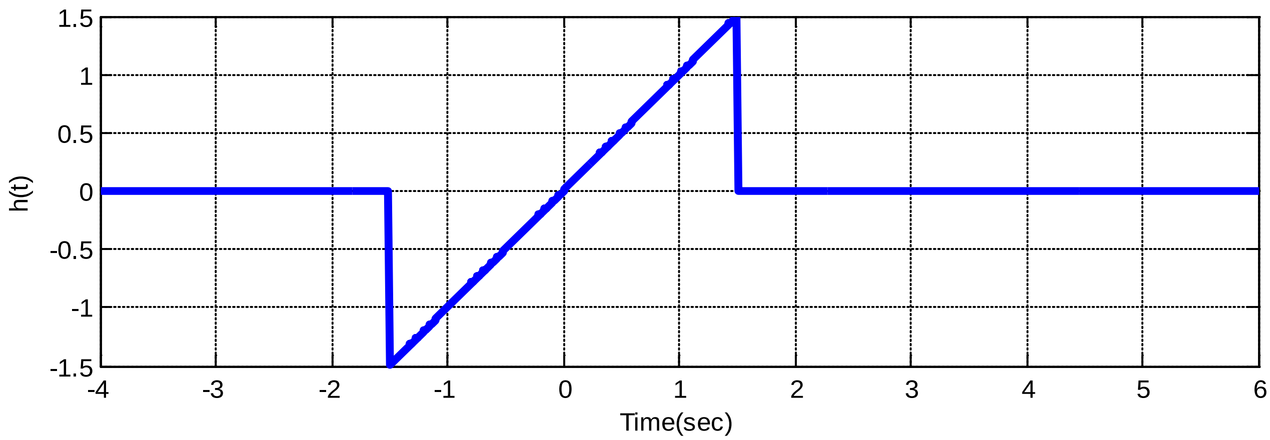
4) (25 points) Consider a linear time invariant system with impulse response given by

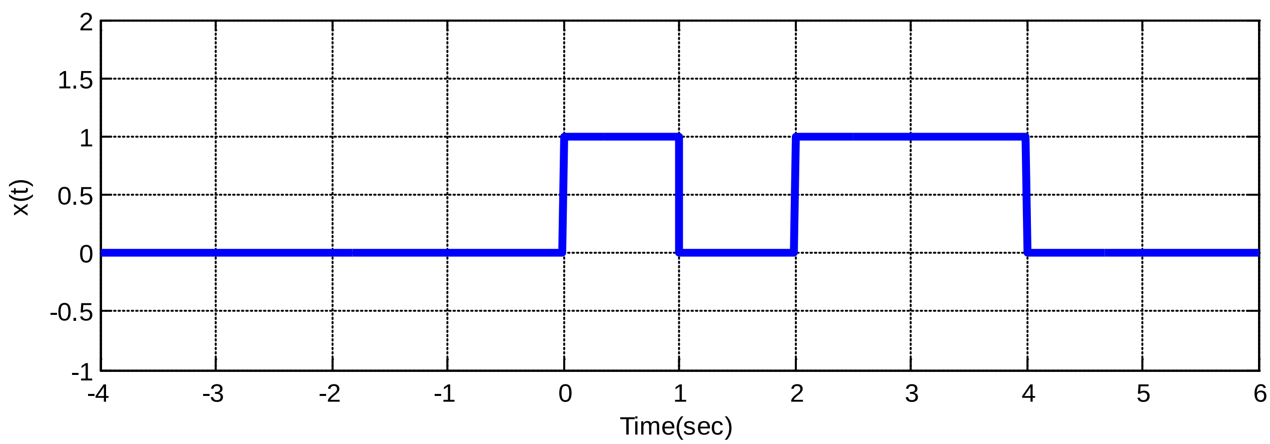
$$h(t) = t[(u(t+1.5) - u(t-1.5)]$$

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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