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ECE-205

Exam 1

Winter 2012

Calculators can only be used for simple calculations. Solving integrals, differential equations, systems of equations, etc. does not count as a simple calculation.

You must show your work to receive credit.

Problem 1 _____/15

Problem 2 _____/20

Problem 3 _____/10

Problem 4 _____/16

Problem 5 _____/15

Problem 6-11 _____/24

Total _____

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1) (15 points) Assume we have a first order system with the governing differential equation

$$0.01\dot{y}(t) + y(t) = 2x(t)$$

The system has the initial value of 0.1, so $y(0) = 0.1$. The input to this system is

$$x(t) = \begin{cases} 0 & t < 0 \\ 0.2 & 0 \le t < 0.02 \\ -0.6 & 0.02 \le t \end{cases}$$

Determine the output of the system in each of the above time intervals. *Simplify your final answer as much as possible and box it. Be sure to include the correct initial value in the first interval!*

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2) (20 points) For the following three differential equations, assume the input is $x(t) = u(t)$ (the input is equal to one for time greater than zero), and the initial conditions are $y(0) = \dot{y}(0) = 0$

Determine the solution to each of the following differential equations and put your final answer in a box. Be sure to use the initial conditions to solve for all unknowns. You must show all your work to receive credit.

a) $\ddot{y}(t) + 3\dot{y}(t) + 2y(t) = 2x(t)$

b) $\ddot{y}(t) + 2\dot{y}(t) + y(t) = 2x(t)$

c) $\ddot{y}(t) + 4\dot{y}(t) + 16y(t) = 4x(t)$

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3) (10 points) For the following first order differential equation,

$$\dot{y}(t) + 2ty(t) = \cos(t)x(t)$$

determine an expression for the output assuming $t_0 = 0$ and $y(t_0) = y(0) = 1$.

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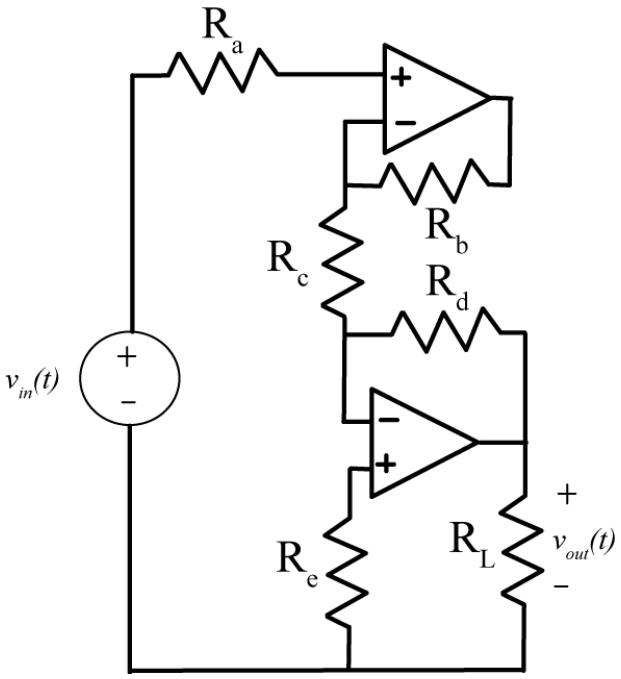
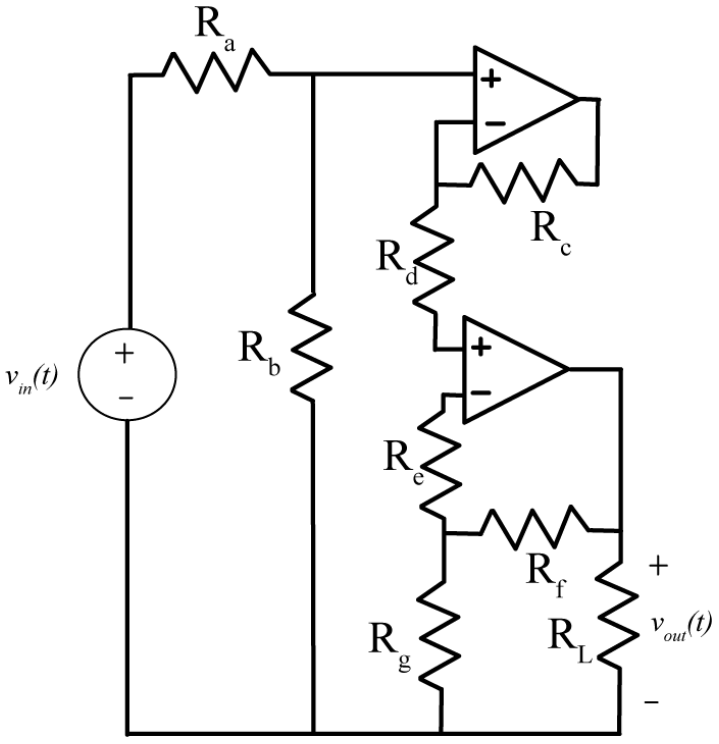
4) (16 points) For the following two op-amps circuits, we can write $v_{out}(t) = G\, v_{in}(t)$. Determine the value of G for each circuit.





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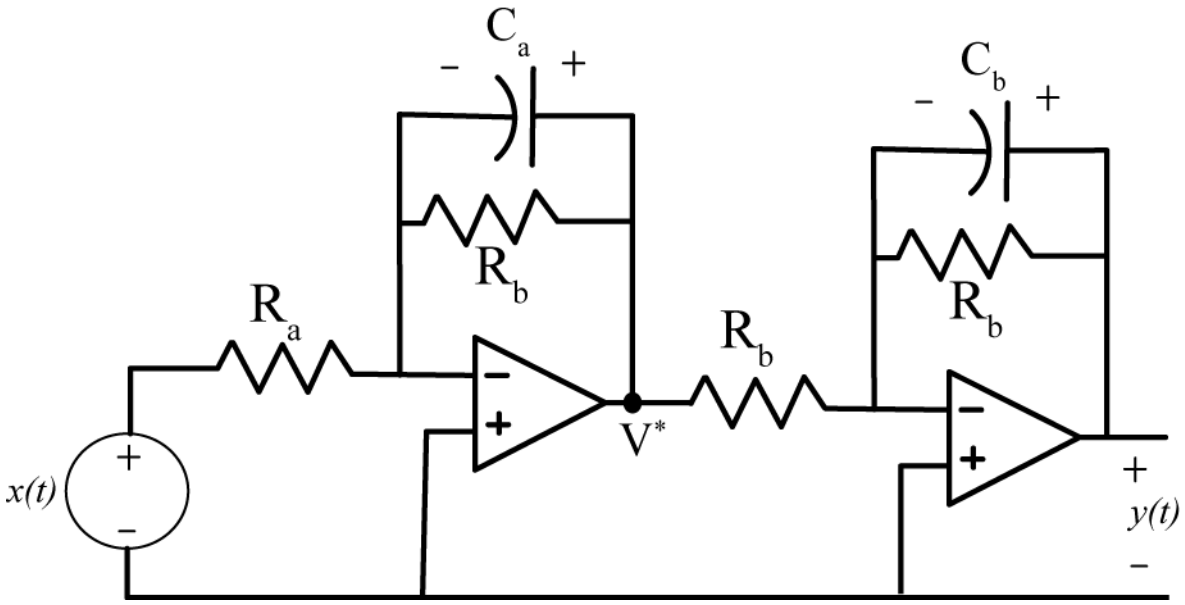
5) (15 points) For the second order circuit below, derive the governing second order differential equation for the output $y(t)$ and input $x(t)$. You do not need to put it into a standard form, but it must be simplified as much as possible.



Hint: Write the equations for each op amp in terms of V^*, and then eliminate this node voltage.

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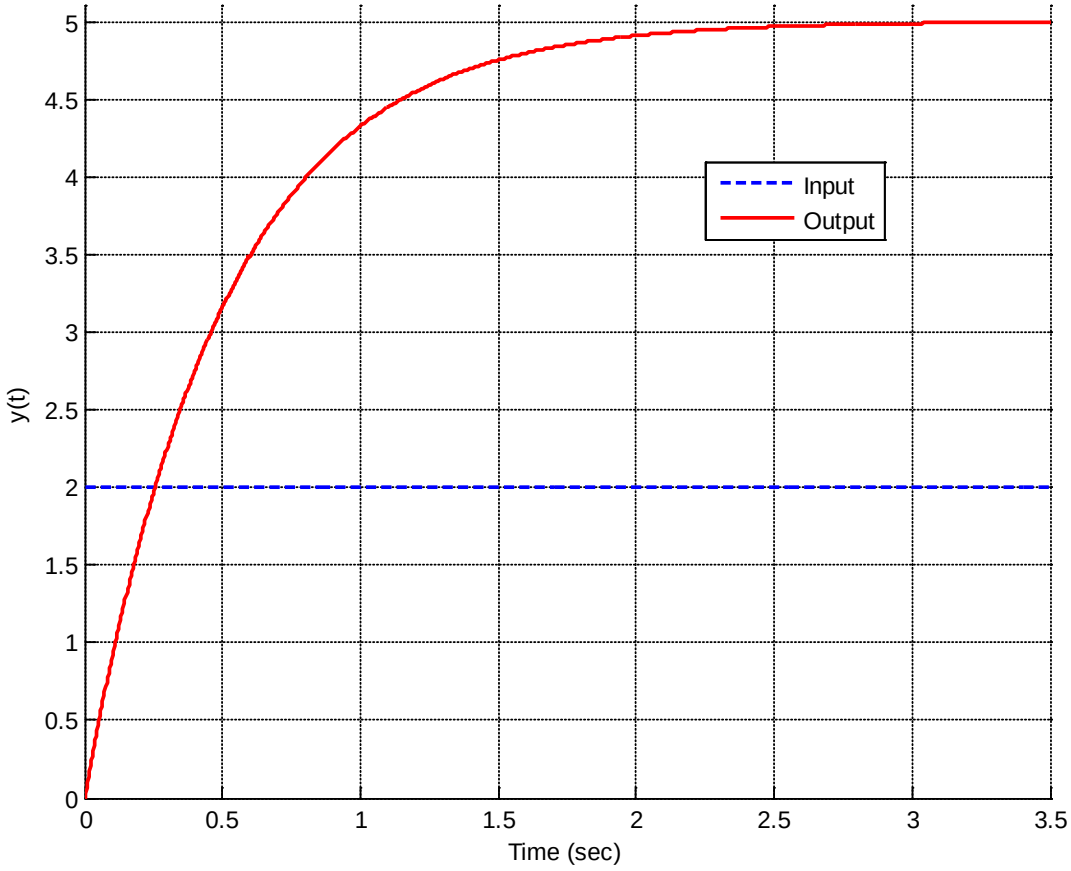
Problems 6-10, 4 points each (24 points)

For problems 6 and 7, refer to the following graph showing the input and output of a first order system. For this system the input is a step of amplitude 2.



6) What is the static gain?

7) What is the time constant?

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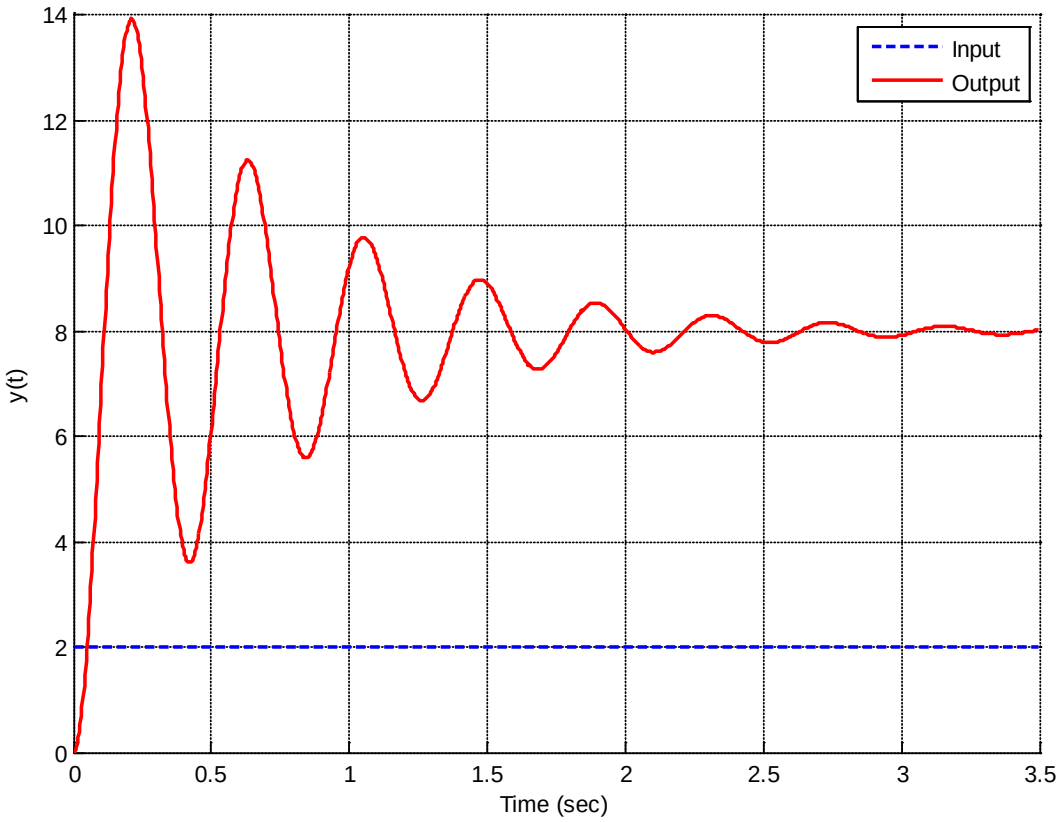
For problems 8 and 9, refer to the following graph showing the input and output of a second order system. For this system the input is a step of amplitude 2.



8) What is the static gain of the system?

9) What is the percent overshoot?

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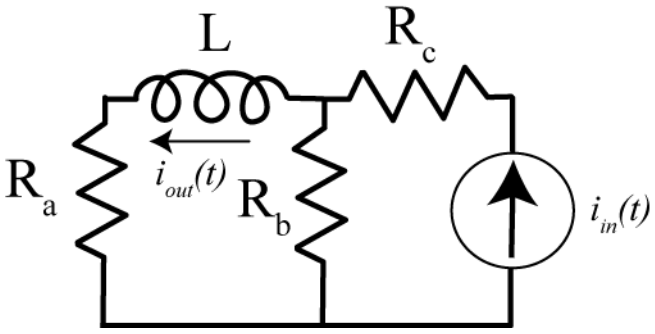
Problems 10 and 11 refer to the following first order circuit



10) Determine an expression for the time constant (you do not need to simplify it).

11) Determine an expression for the static gain (you do not need to simplify it).

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