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ECE-205

Exam 1

Fall 2015

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 _____/16

Problem 2 _____/20

Problem 3 _____/12

Problem 4 _____/15

Problem 5 _____/10

Problem 6 _____/10

Problem 7 _____/12

Problem 8 _____/5

Total _____

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1) (16 points) Assume we have a first order system with the governing differential equation

$$0.5\dot{y}(t) + y(t) = 2x(t)$$

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

$$x(t) = \begin{cases} 0 & t < 0 \\ 2 & 0 \le t < 1 \\ 3 & 1 \le t \end{cases}$$

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 each interval.*

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2) (20 points) For the following differential equations, assume the input is $x(t) = 4u(t)$ (the input is equal to four 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) $\ddot{y}(t) + 5\dot{y}(t) + 6y(t) = 3x(t)$

b) $\ddot{y}(t) + 4\dot{y}(t) + 4y(t) = 8x(t)$

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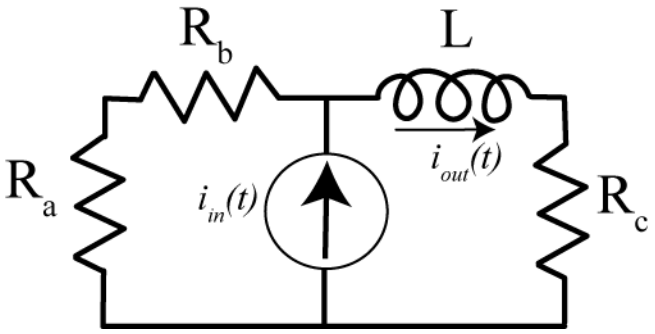
3) (12 points) For the following circuit:



- Determine the time constant
- Determine the static gain
- Determine the governing differential equation

You may solve this problem using the "short-cut methods", or you can derive the governing differential equation to find the time constant and static gain. Be sure you answer all three parts.

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4) (15 points) Determine the response ($y(t)$) for the following underdamped second order system,

$$\ddot{y}(t) + 3\dot{y}(t) + 225y(t) = 450x(t)$$

with intitial conditions $y(0) = 1,\ \dot{y}(0) = -2$ and input $x(t) = 3u(t)$ (a step input of amplitude 3 at time zero).

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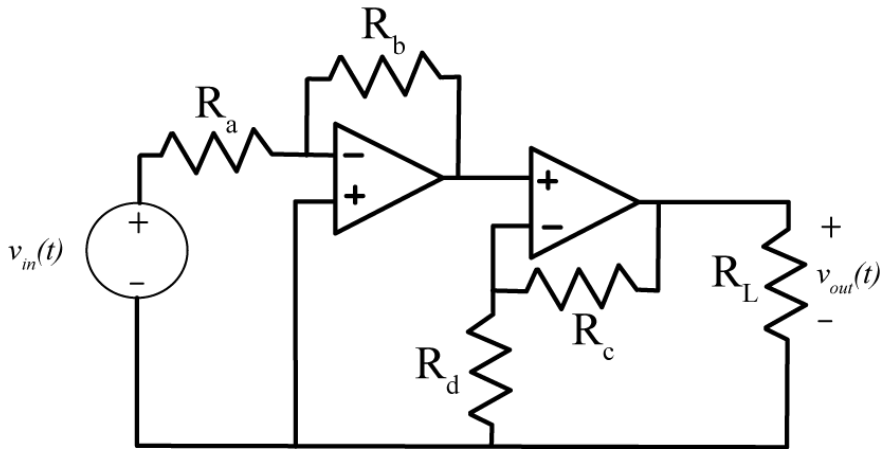
5) (10 points) For the following circuit, we can write $v_{out}(t) = G\, v_{in}(t)$. Determine an expression for the constant *G* in terms of the resisters given below.



Note that the polarity of the two op-amps are different!

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6) (10 points) For a first order system described by the differential equation

$$\dot{y}(t) + \frac{1}{t} y(t) = \cos(t) x(t)$$

with $t_0 = 1$ and $y(t_0) = 1$, use integrating factors to solve the differential equation. Include the initial conditions in your solution.

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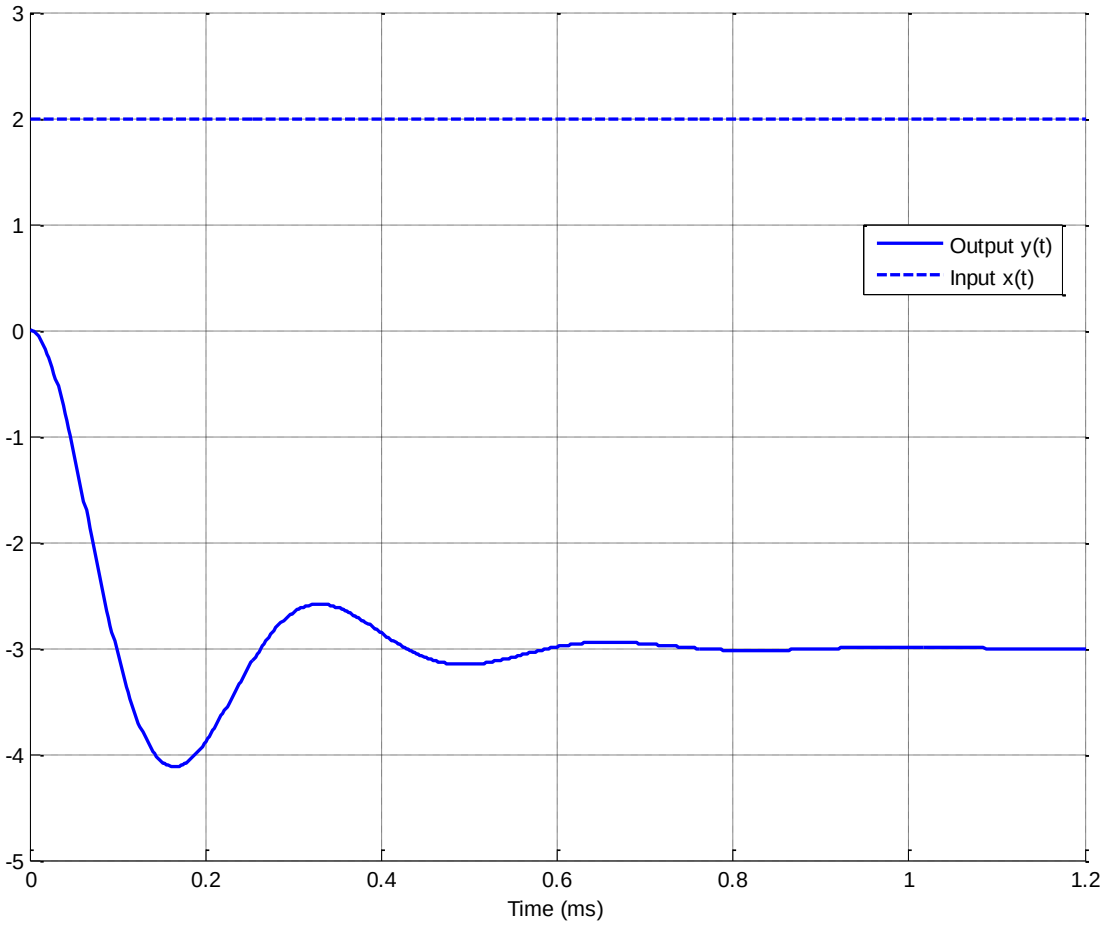
7) (12 points) The following graph showing the response of a second order system to a step input of amplitude 2.



a) Estimate the percent overshoot

b) Estimate the (2%) settling time

c) Estimate the static gain

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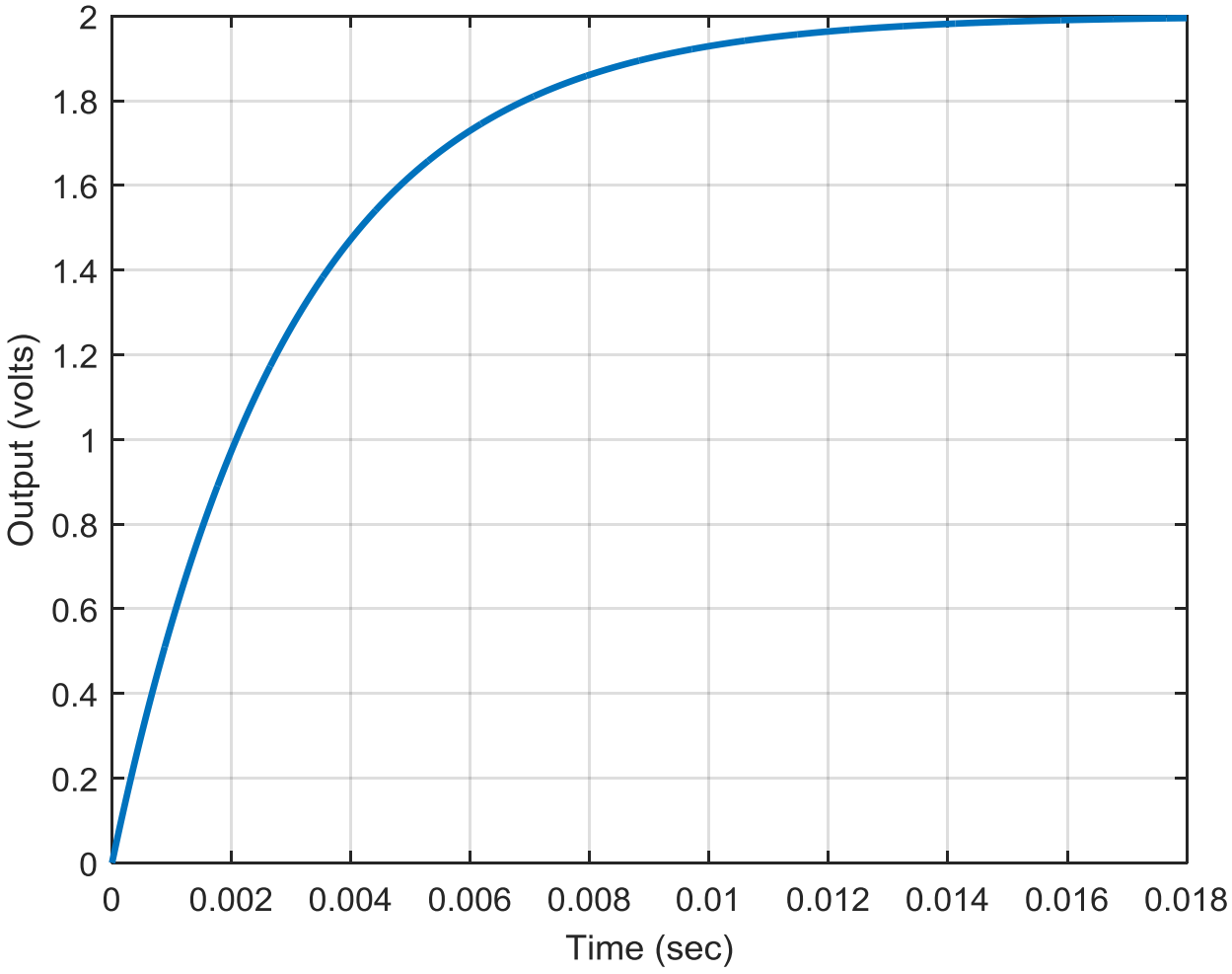
8) (6 points) The following graph showing the response of a first order system to a step input. Estimate the ***time consta***nt of the system.



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