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ECE-205

Exam 1

Winter 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 __________/15

Problem 2 __________/30

Problem 3 __________/10

Problem 4 __________/10

Problem 5 __________/15

Problem 6 __________/20

Total _______________

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

$$5\dot{y}(t) + 2y(t) = x(t)\ .$$

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

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

Determine the output of the system in each of the above time intervals. *Simplify your final answer as much as possible and box it.*

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2) (30 Points) For the following differential equations 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) $\ddot{y}(t) + 3\dot{y}(t) + 2y(t) = x(t), \quad x(t) = 6u(t)$

b) $\ddot{y}(t) + 6\dot{y}(t) + 13y(t) = 2x(t), \quad x(t) = 13u(t)$

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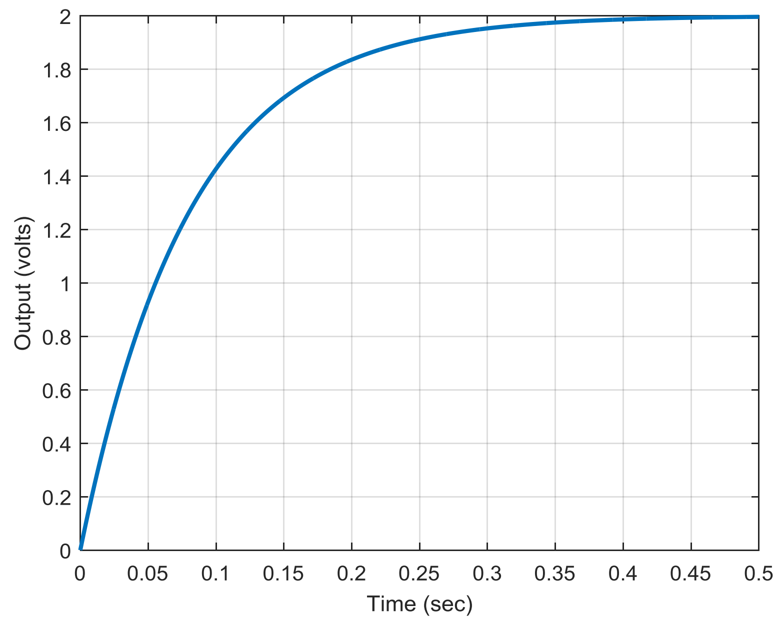
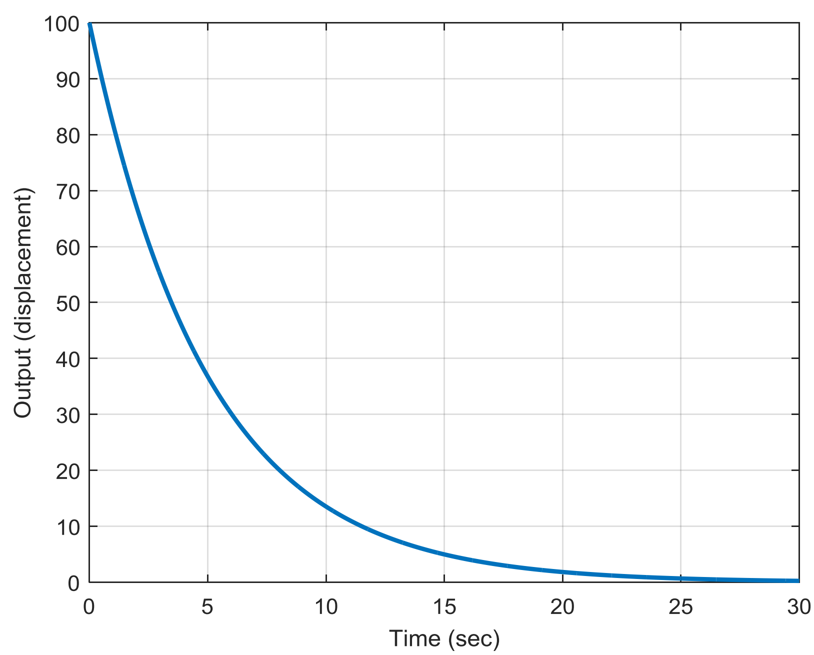
3) (10 Points) The following graphs showing the response of two different first order systems to a step input (top graph) and due only to initial conditions (bottom graph). Estimate the ***time constants*** of each system. (The time constants are different for each of the systems.)





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4) (10 points) Using the <u>integrating factor method</u>, determine the expression of the response $y(t)$ for the following system:

$$\dot{y}(t) = 2t \cdot y(t) + e^{t^2} x(t)\,.$$

The initial condition is $y(0) = 1$ with $t_0 = 0$. *Simplify your answer as much as possible.*

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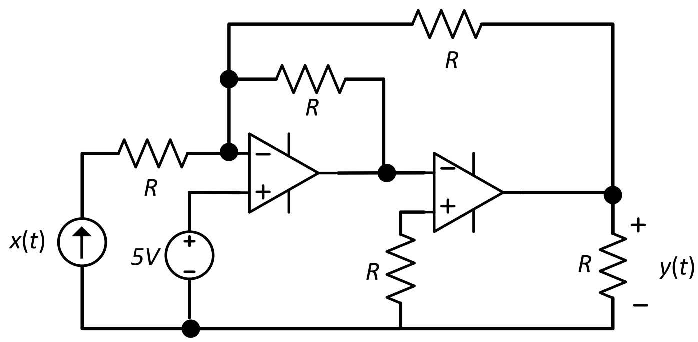
5) (15 points) We can write $y(t) = Gx(t) + C$ for the following op-amp circuit. Determine expressions for G and C.



Careful: Be sure to account for the 5V voltage source at the positive terminal of the first op-amp.

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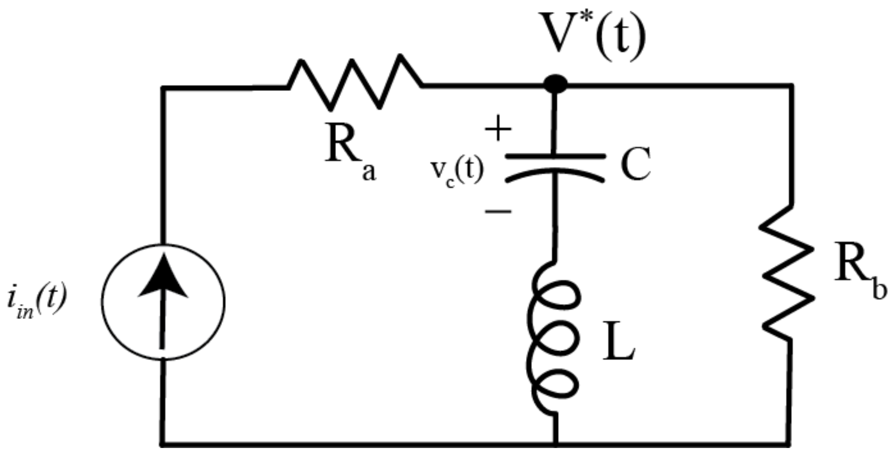
6) (20 Points) Determine the governing 2nd order differential equation for the following circuit. The output should be the voltage across the capacitor, $v_C(t)$.

Hint: Determine two expressions for the voltage $V^*(t)$ *and then eliminate this voltage.*



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