

ECE-205

Exam 1

Winter 2013

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 _____/11

Problem 2 _____/20

Problem 3 _____/20

Problem 4 _____/20

Problem 5 _____/20

Problems 6-8 _____/9

Total _____

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1) (11 points) For a first order system described by the differential equation

$$\dot{y}(t) + 2y(t) = e^{-2t} x(t-1)$$

with $t_0 = 0$ and $y(t_0) = 1$, use integrating factors to solve the differential equation. Include the initial conditions in your solution.

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2) (20 points) Assume we have a first order system with the governing differential equation

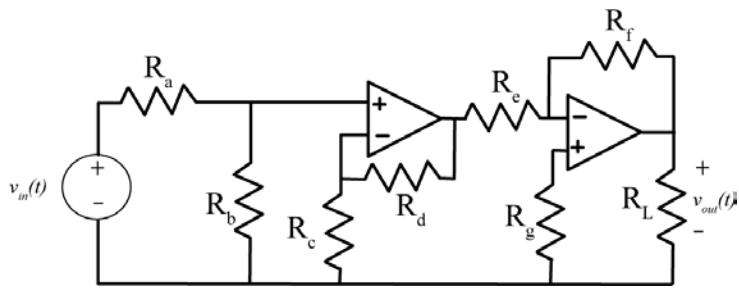
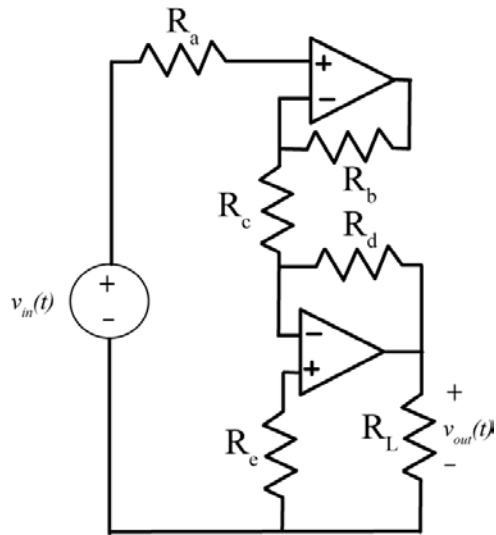
$$0.5\dot{y}(t) + y(t) = 2x(t)$$

The system has the initial value of 1, so $y(0) = 1$. The input to this system is

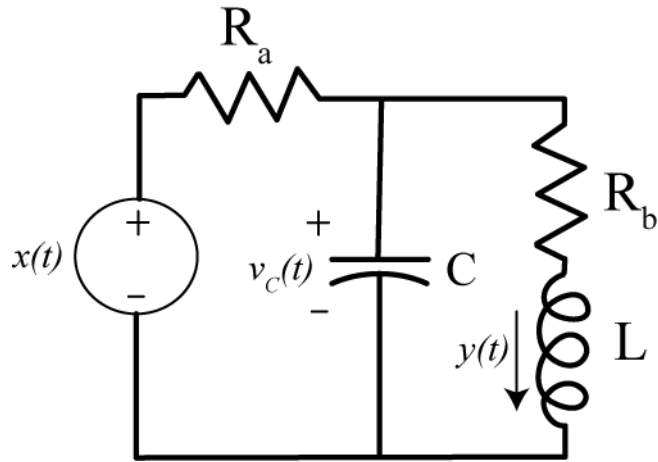
$$x(t) = \begin{cases} 0 & t < 0 \\ -1 & 0 \leq t < 1 \\ 3 & t \geq 1 \end{cases}$$

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!*

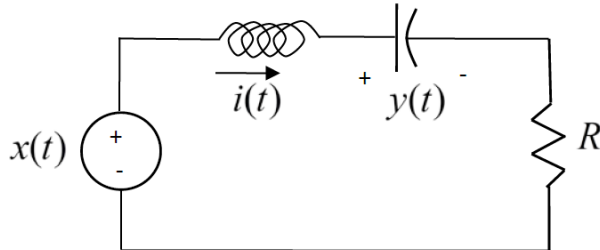
3) (20 points) For the following op-amp circuits we can write $v_{out}(t) = Gv_{in}(t)$. Determine an expression for G .



4) (20 points) Derive the governing differential equation for the following circuit. You do not need to put the differential equation into standard form.



5) (20 points) Consider the circuit shown in the figure below:



The input $x(t)$ is 1 V for $t > 0$ and the output, $y(t)$, is the voltage across the capacitor. For this circuit, the inductor has $L = 33$ mH, the capacitor has $C = 0.01$ μ F, and the resistor has $R = 6.6$ k Ω . Assume that the circuit is initially at rest (i.e., $y(0) = \dot{y}(0) = 0$). In this problem use the approximations $\frac{1}{LC} \approx 3.0 \times 10^9$ and $\frac{R}{L} \approx 2 \times 10^5$

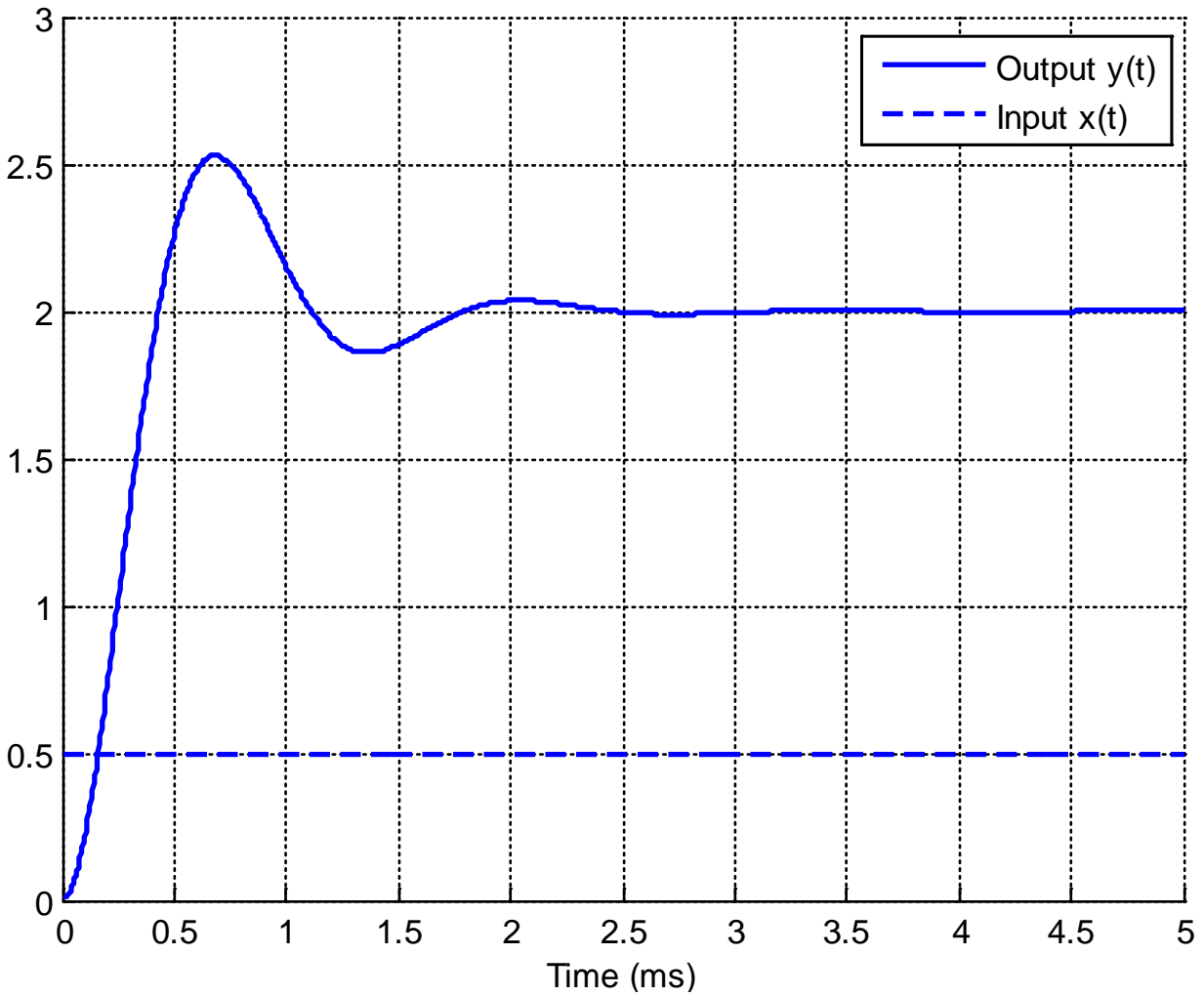
Recall that the governing second order differential equation of the above circuit is given by

$$\frac{d^2 y(t)}{dt^2} + \frac{R}{L} \frac{dy(t)}{dt} + \frac{1}{LC} y(t) = \frac{1}{LC} x(t)$$

Solve for $y(t)$ and put your final answer in a box. You must show all your work to receive credit.

Problems 6-8, 3 points each, no partial credit (9 points)

Problems 6-8 refer the following graph showing the response of a second order system to a step input.



- 6) The percent overshoot for this system is best estimated as
 a) 400% b) 250 % c) 200% d) 150 % e) 100 % f) 25%
- 7) The (2%) settling time for this system is best estimated as
 a) 1.5 ms b) 2.5 ms c) 4 ms d) 5 ms
- 8) The static gain for this system is best estimated as
 a) 1 b) 2 c) 3 d) 4

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