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ECE-205

Exam 1

Spring-2011

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	**__________/20**
Problem 2	**__________/30**
Problem 3	**__________/20**
Problem 4	**__________/10**
Problem 5	**__________/10**
Problem 6	**__________/10**

Total ______________

Name ____ Mailbox __________________

1) (20 points) Assume we have a first order system with the governing differential equation

$$0.1\dot{y}(t) + y(t) = 2x(t)$$

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

$$x(t) = \begin{cases} 0 & t < 0 \\ -1 & 0 \le t < 0.2 \\ -2 & 0.2 \le t < 0.5 \\ 3 & 0.5 < t \end{cases}$$

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!*

Name ____ Mailbox __________________

2) (30 points) For the following three 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) $\ddot{y}(t) + 5\dot{y}(t) + 4y(t) = 2x(t)$

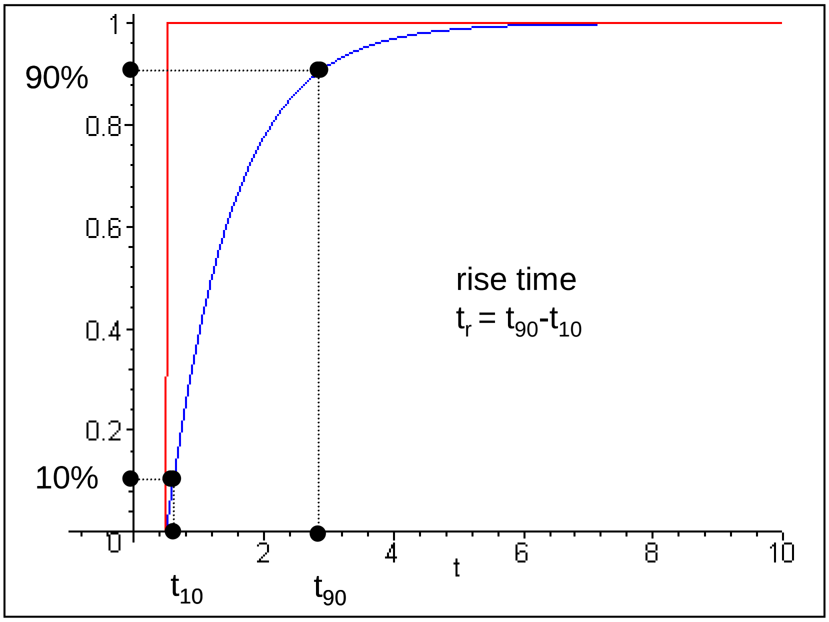
b) $\ddot{y}(t) + 6\,\dot{y}(t) + 9y(t) = 9x(t)$

c) $\ddot{y}(t) + 4\dot{y}(t) + 13y(t) = 6.5x(t)$

3) (20 points) For a simple series RC circuit the response of the system when the input is a unit step is

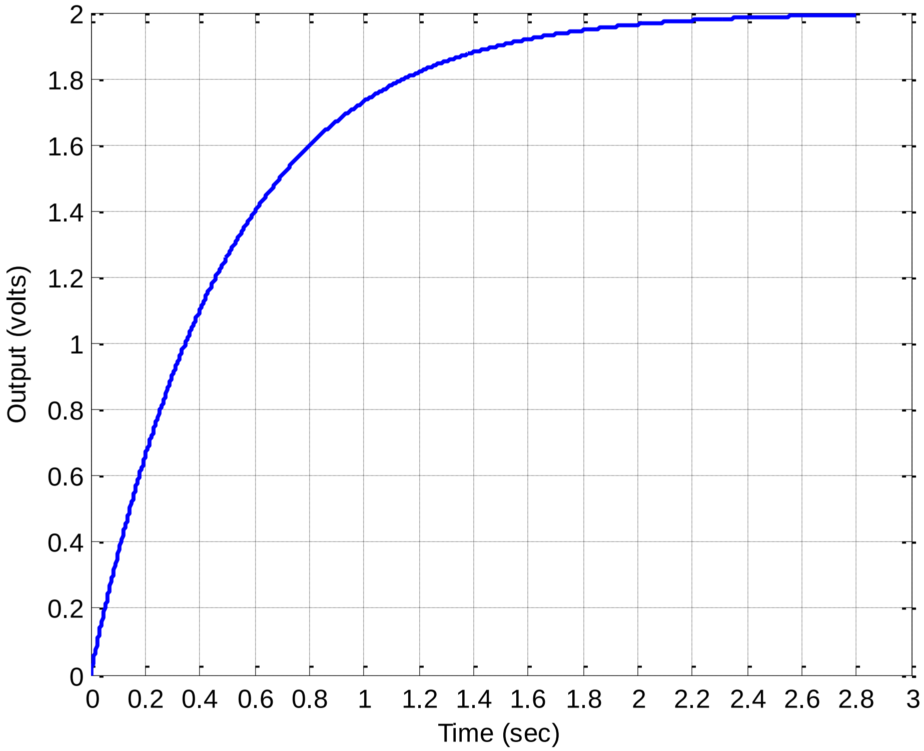
$$y(t) = 1 - e^{-t/RC} = 1 - e^{-t/\tau}$$

The 10-90% rise time, t_r, as shown below. The rise time is simply the amount of time necessary for the output to rise from 10% to 90% of its final value. Show that for this system the rise time is given by $t_r = \tau \ln(9)$



Name ____ Mailbox __________________

4) (10 points) The initial portion of the response of a first order circuit to a step input is shown in the figure below. The steady state value of the output is 2.0 volts. Using this data, estimate the time constant of the system. ***Show your work or you receive no credit!*** *(This requires very little work, but be sure to show it.)*



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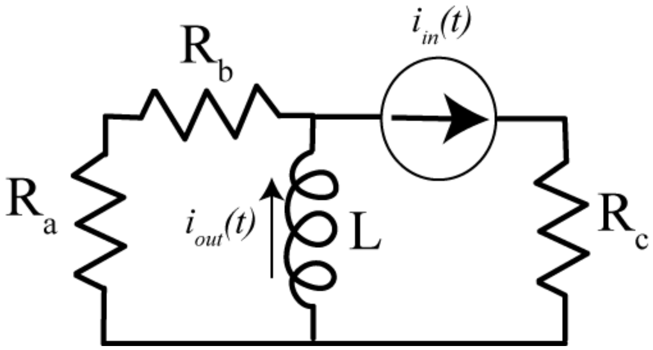
5) (10 points) For the following circuit, determine an expression for the time constant and the static gain. *(This can pretty much be done by inspection.)*



Name ____ Mailbox __________________

6) (10 points) Using integrating factors, solve the following differential equation for an arbitrary input $x(t)$ for the initial conditions $t_0 = 0$ and $y(0) = 1$. Note that your solution will involve an integral, since you do not know what the input $x(t)$ is. ***Show your work or you receive no credit!***

$$\frac{1}{2}\dot{y}(t) - ty(t) = 3x(t)$$

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