

# ECE-205

## Exam 1

### Fall 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** \_\_\_\_\_/10

**Problem 2** \_\_\_\_\_/20

**Problem 3** \_\_\_\_\_/30

**Problem 4** \_\_\_\_\_/22

**Problems 5-10** \_\_\_\_\_/18

**Total** \_\_\_\_\_

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**1) (10 points)** For a first order system described by the differential equation

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

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

$$0.4\dot{y}(t) + y(t) = 3x(t)$$

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

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

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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**3) (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  $y(0) = \dot{y}(0) = 0$

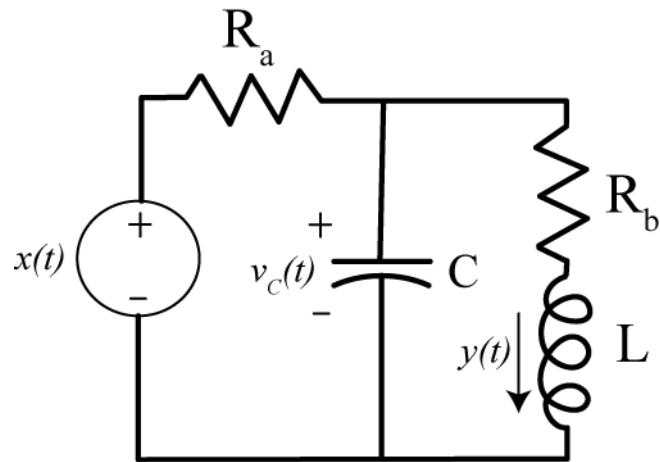
Determine the solution to each of the following differential equations and put your final answer in a box. Be sure to use the initial conditions to solve for all unknowns. You must show all your work to receive credit.

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

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

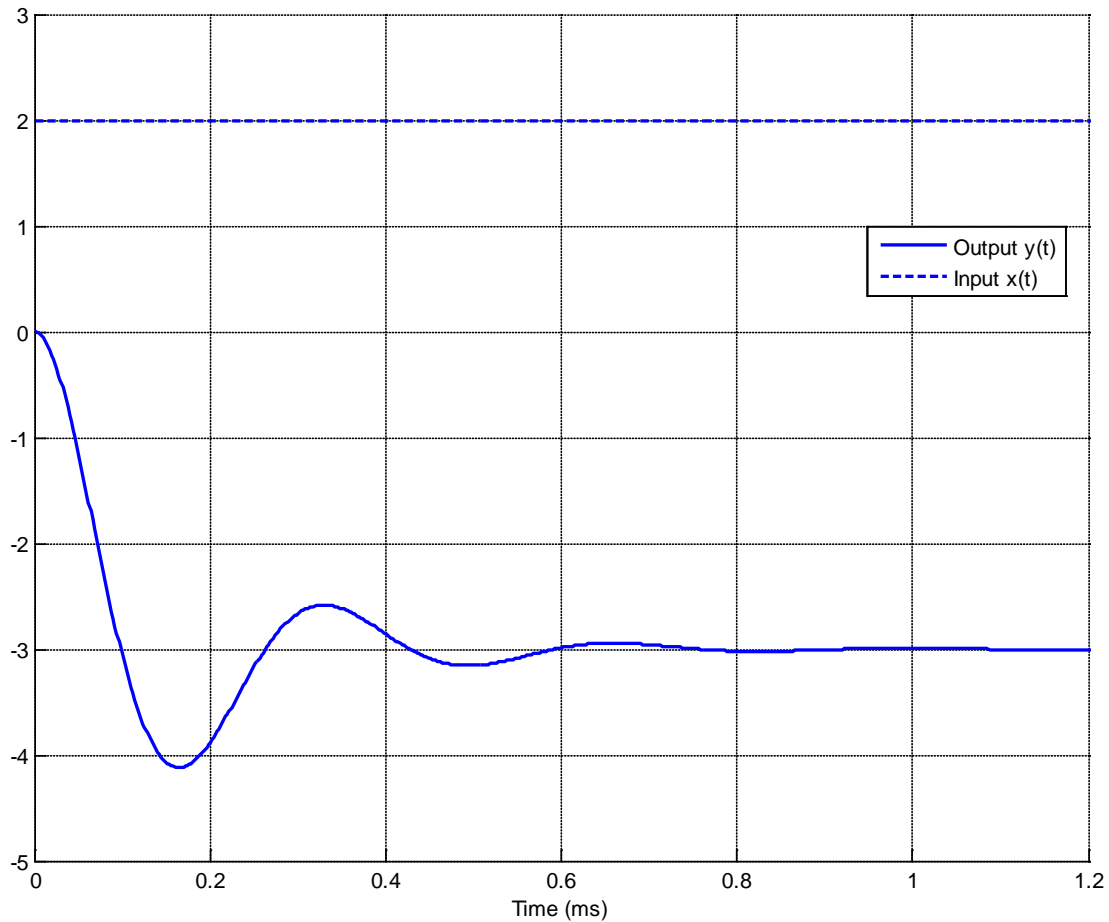
**c)**  $\ddot{y}(t) + 4\dot{y}(t) + 16y(t) = 4x(t)$

4) (22 points) Derive the governing differential equation for the following circuit. You do not need to put the differential equation into standard form.



**Problems 5-10, 3 points each, no partial credit (18 points)**

Problems 5-7 refer the following graph showing the response of a second order system to a step input.



5) The percent overshoot for this system is best estimated as

- a) 400%   b) -400 %   c) 300%   d) -300 %   e) -33%   f) 33%

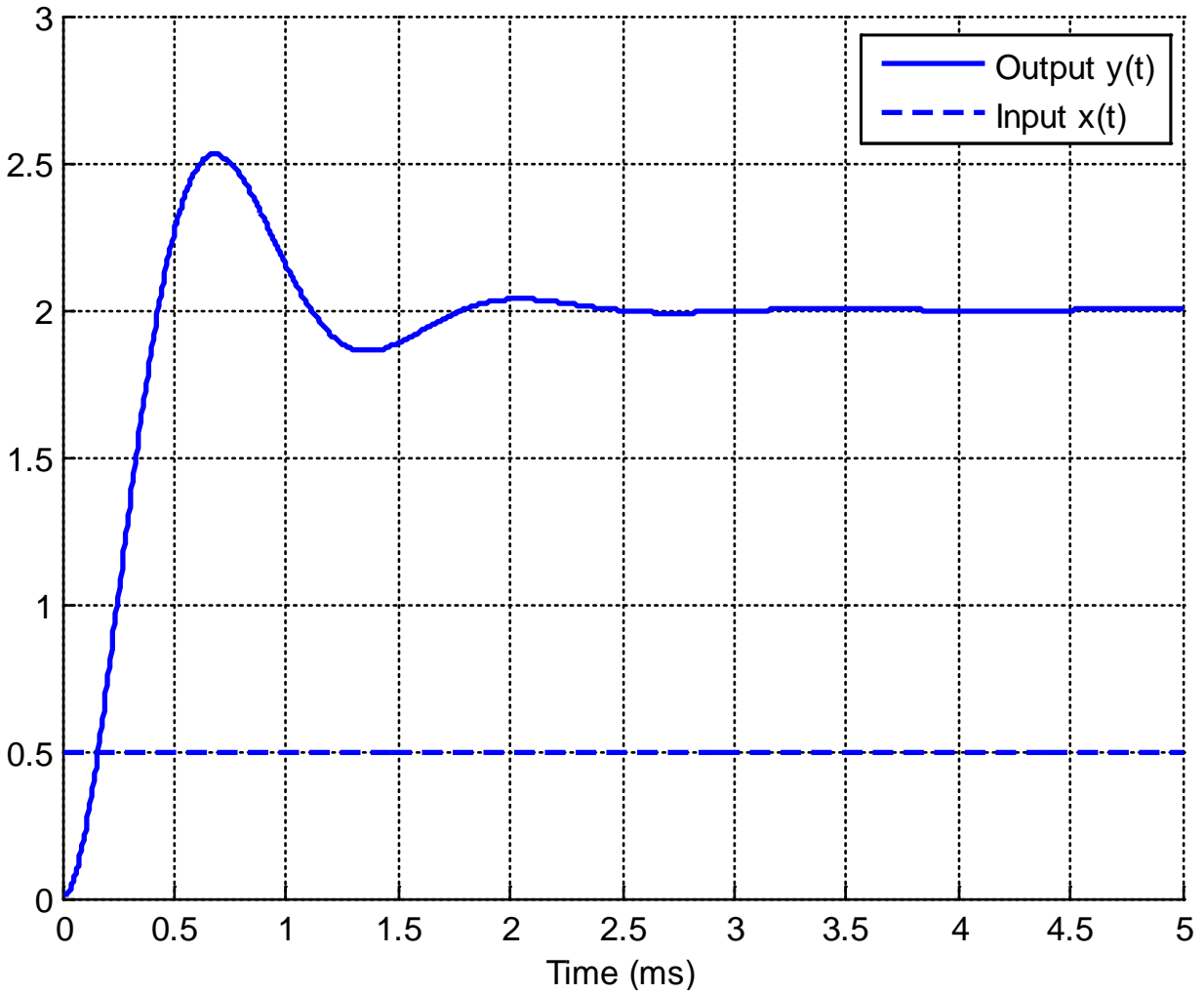
6) The (2%) settling time for this system is best estimated as

- a) 0.3 ms   b) 0.6 ms   c) 1.0 ms   d) 1.2 ms

7) The static gain for this system is best estimated as

- a) 1.5   b) 3   c) -1.5   d) -3

Problems 8-10 refer the following graph showing the response of a second order system to a step input.



- 8) The percent overshoot for this system is best estimated as  
a) 400%   b) 250 %   c) 200%   d) 150 %   e) 100 %   f) 25%
- 9) 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
- 10) The static gain for this system is best estimated as  
a) 1   b) 2   c) 3   d) 4

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