

CPE 381: Fundamentals of Signals and Systems for Computer Engineers

**Homework #3**

Due: Monday, March 8 at 9:35 am

Please upload PDF files of the assignment to Canvas

**Student name:**

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1 20	2 20	3 20	4 20	5 20	Total

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1. (20 points) What is the inverse Laplace transform of the function

$$X(s) = \frac{1}{(s+1)^2 + 4}$$

Plot the function in time domain.

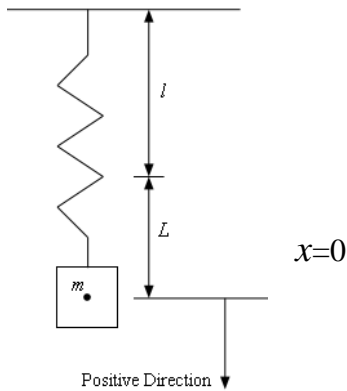
2. (20 points) A system with input  $x(t)$  and output  $y(t)$  is defined by the following differential equation:

$$\frac{d^2 y(t)}{dt^2} + 3 \frac{dy(t)}{dt} + 2y(t) = x(t)$$

Find the impulse response  $h(t)$  and the unit-step response  $s(t)$ .

3. (20 points) A 1 kg weight is hung on the end of a vertically suspended spring, thereby stretching the spring  $L = 20$  cm. The weight is raised 10 cm above its equilibrium position and released from rest at time  $t=0$ . Find the displacement  $x$  of the weight from its equilibrium position at time  $t=2.5$ s. Use  $g=10\text{m/s}^2$ .

All forces, velocities, and displacements in the upward direction will be negative, according to the Figure below.



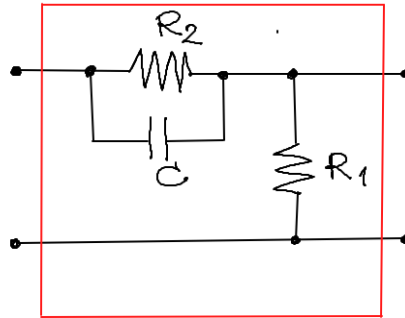
4. (20 points) An unstable system can be stabilized by using negative feedback with gain  $K$  in the feedback loop. For the given unstable system with pole in the right-hand  $s$ -plane:

$$F(s) = \frac{1}{2 \cdot s - 3}$$

what should be the value of the gain  $K$  ( $K$  is integer greater than zero) with  $F(s)$  in the forward loop that will make the system BIBO stable.

Draw block diagram of the system, write overall transfer function of the system  $H(s)$ , and impulse response  $h(t)$ .

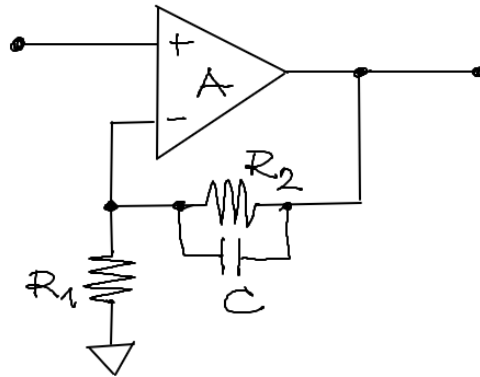
5. a) (4 points) What is the transfer function of the following circuit:



b) (6 points) What is the transfer function of the following circuit?

Hints:

- you can use solutions of problems #4 and #5a
- to simplify the result you can assume that  $A \rightarrow \infty$



c) (10 points) Find and plot the unit-step response  $s(t)$  of the system.  
Assume  $R_1=1\Omega$ ,  $R_2=2\Omega$ ,  $C=1F$ .