Department of Electrical and Computer Engineering
The University of Alabama in Huntsville

CPE 381: Fundamentals of Signals and Systems for Computer Engineers

Homework #3

Due: Monday, February 24 at 9:35 am
Please bring hardcopy to the class and upload softcopy to Canvas

Student name:

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1 15	2 20	3 20	4 10	5 15	6 20	Total

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1. (15 points) Write differential equation describing displacement x of suspended weight m on spring with elastic constant k.

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

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

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

3. (20 points) Consider a second order differential equation,

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

with initial conditions $y(0) = 1$ and $\frac{dy(t)}{dt}|_{t=0} = 0$ and x(t) = u(t).

- Find the complete response y(t)
- Find the steady state response and the transient response.

4. (10 points) Suppose that the transfer function of the LTI system is

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

Find the unit-step response *s(t)*, and then use it to find the response to

$$x_1(t) = u(t) - u(t-1)$$

$$x_2(t) = \delta(t) - \delta(t-1)$$

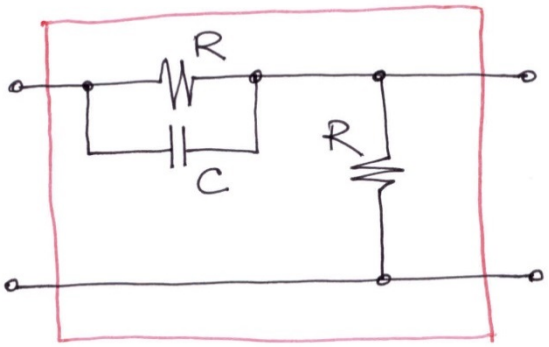
5. (15 points)

An unstable system can be stabilized by using negative feedback with a gain K in the feedback loop. For instance, consider an unstable system with transfer function

$$H(s) = \frac{2}{s-1}$$

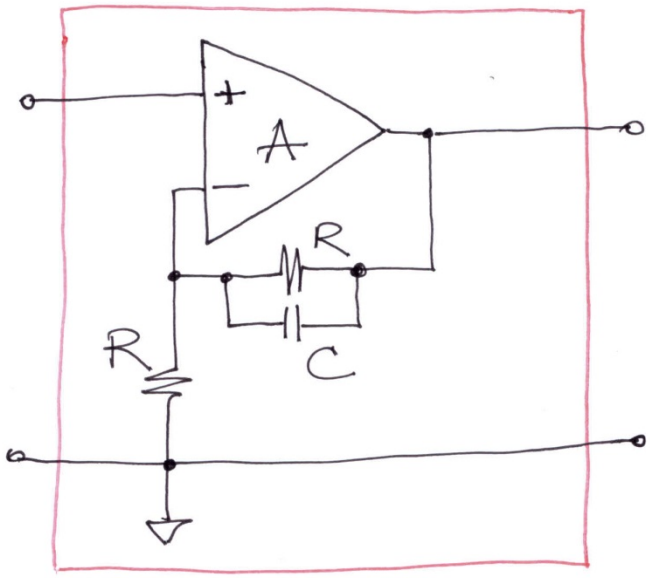
which has a pole in the right-hand s-plane, making the impulse response of the system $h(t)$ grow as t increases. Use negative feedback with a gain $K > 0$ in the feedback loop, and put $H(s)$ in the forward loop. Draw a block diagram of the system. Obtain the transfer function $G(s)$ of the feedback system and determine the value of K that makes the overall system BIBO stable (i.e., its poles in the open left-hand s-plane).

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



b) (5 points) What is the transfer function of the following circuit?
Hints:

- you can use solutions of problem #5 and #6a
- to simplify the result you can assume that A → ∞



c) (10 points) Find and plot the unit-step response *s*(t) of the system?