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 27, 2023 at 9:35 am
Please upload softcopy of your work and published Matlab scripts to Canvas

Student name:

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1 20	2 20	3 20	4 15	5 25	Total

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1. (20 points) Write differential equation describing displacement x of suspended weight m on spring with elastic constant k.

Example: A 1 kg weight is hung on the end of a vertically suspended spring, thereby stretching the spring L=10 cm. The weight is raised 5 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. Use g=10m/s^2.

2. (20 points) Use Matlab symbolic computation to find the Laplace transform of a real exponential

$$x(t) = 5e^{-2t}\cos(8t)u(t)$$

Plot the signal and the poles and zeros of their Laplace transform.

Repeat the analysis and plot the results for

$$x(t) = 5e^{-4t}\cos(8t)u(t)$$

Discuss the changes in the s plane and describe their effect on function in time domain.

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.

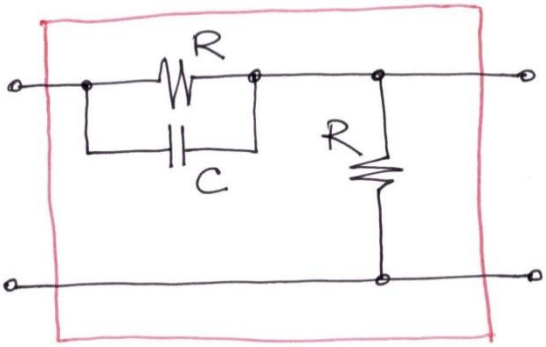
4. (15 points)

An unstable system can be stabilized by using negative feedback with a gain *K* in the feedback loop. Consider an unstable system with transfer function

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

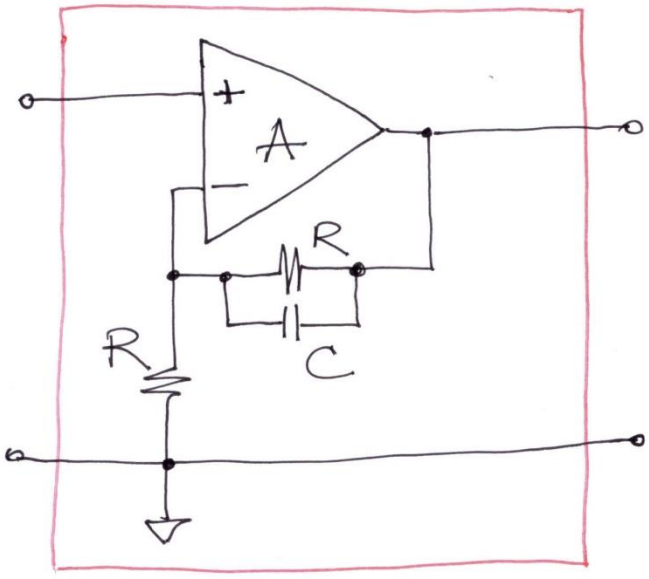
which has a pole in the right-hand *s*-plan, making the impulse response of the system *h(t)* grow as *t* increases. Use negative feedback with a gain *K>0* in the feedback loop, and put H(s) in the forward loop. Draw a block diagram of the system. Obtain the transfer function *G(s)* of the feedback 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).

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



b) (10 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?