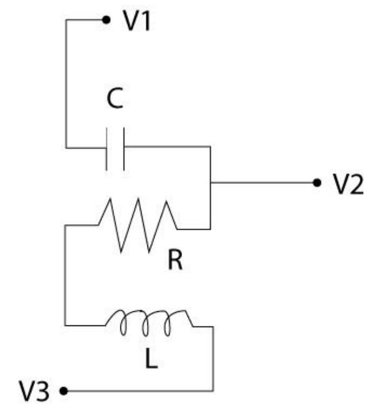
ME 5200/6200 Classical Controls **Fall 2020**

Homework 02 **Due Tues, Sept. 15 by 11:59 pm (Submit via CANVAS)**

Do the following problems and show all your work for full credit. Note: not all problems will be graded, but you must complete all problems to get full credit.

Problem 1 [20 pts]



For this problem, you will use your results from Homework 01, Problem 3, and answer the following question.

Consider the following circuit on the right. Using the differential equation(s) you found for the circuit shown on the right, assume zero initial conditions, find the following transfer functions:

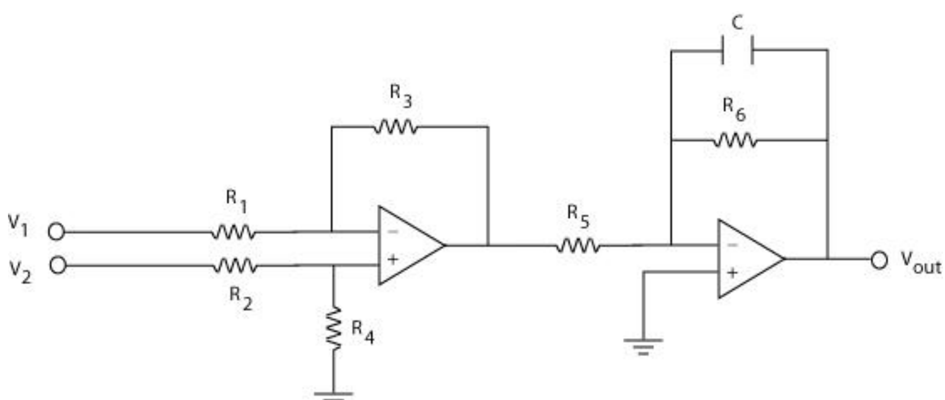
(a) V2(s)/V1(s)
(b) V2(s)/V3(s)

Problem 2 [20 pts]

For this problem, you will use your results from Homework 01, Problem 4, and answer the following question.

Consider the following op-amp circuit, where V1 and V2 are input voltages, and Vout is the output voltage. Using the differential equation(s) you found for the circuit shown below, assume zero initial conditions, find the following transfer functions:

(a) Vout(s)/V1(s)
(b) Vout(s)/V2(s)



Problem 3 [50 pts]

Find the time function corresponding to each of the following Laplace transforms using partial-fraction expansion:

(a) $F(s) = \frac{1}{s(s+1)}$

(b) $F(s) = \frac{5}{s(s+1)(s+5)}$

(c) $F(s) = \frac{3s+2}{s^2+2s+10}$

(d) $F(s) = \frac{3s^2+6s+6}{(s+1)(s^2+6s+10)}$

(e) $F(s) = \frac{1}{s^2+16}$

Problem 4 [30 pts]

Solve the following ordinary differential equations using Laplace transforms:

(a) $\ddot{y}(t) + \dot{y}(t) + 3y(t) = 0; y(0) = 1,\ \dot{y}(0) = 2$

(b) $\ddot{y}(t) - 2\dot{y}(t) + 4y(t) = 0; y(0) = 1,\ \dot{y}(0) = 2$

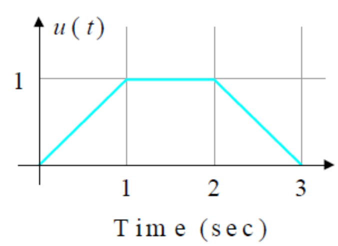
(c) $\ddot{y}(t) + \dot{y}(t) = \sin t; y(0) = 1,\ \dot{y}(0) = 2$

Problem 5 [30 pts]

Consider the following second order system with a transfer function given by:

$$G(s) = \frac{K\,\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}.$$

Let the natural frequency be 100 Hz, the damping constant be 0.01, and the constant K=3.6. Suppose the input to the system is given by:



Using Matlab, simulate the output response of the system and provide the following:

(a) Show a plot of output vs. time, label all axes.
(b) Briefly describe the response based on the input from Part (a) -- what's happening?
(c) Now suppose the input is a unit step instead of the input u(t) shown above. Simulate the response and provide a plot of output vs. time. Label all axes appropriately.
(d) For Part (c), what is the final value?
(e) Rather than get the final value from the plot in Part (c), how else could you have done it?
(f) Provide print out of your Matlab code (m-file, Simulink model, etc.) to justify how you created your plots.