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

Homework 03 **Due Thursday, Sept. 25 by 11:59 pm**

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.

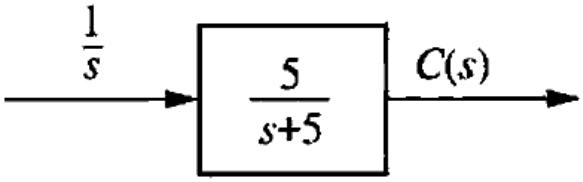
Problem 1 [30 points]

Consider the following two open-loop systems below.

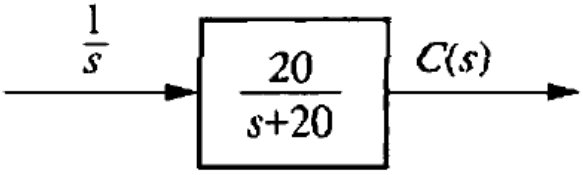
(a) Find the time equation for the response of the output c(t) when the inputs are shown below.

(b) Determine the time constant, rise time, and settling time for each case, and

(c) Use Matlab's 'step' function to obtain plots of the time responses to compare your results with the equations you obtained for part (a). Submit your Matlab code for this problem (m-file or Simulink model), along with Matlab plots and label the axes!



(a)



(b)

Problem 2 [30 points]

Consider the following spring-mass-damper system below.

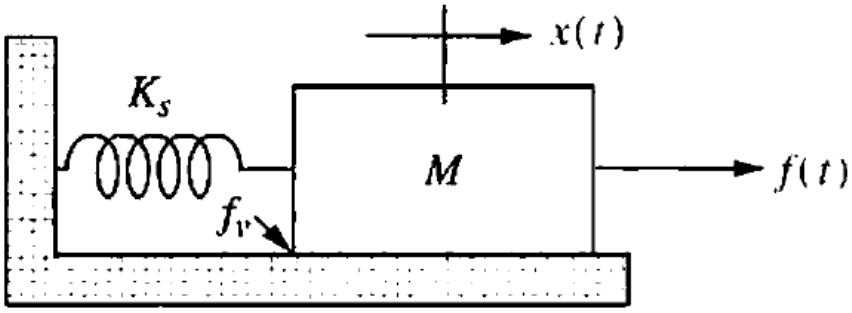
(a) Find the displacement x(t) when the input f(t) is a unit step

(b) Determine the percent overshoot, time to peak, and settling time

(c) Use Matlab's 'step' function to generate a plot to compare with your analytical solutions in Part (a) and (b). Note any differences and explain. Include your Matlab code (m-file and/or Simulink model).

(d) Explain how damp the system is, i.e., overdamp, underdamped, etc., and justify your answer.

$M = 1$ kg
$K_s = 5$ N/m
$f_v = 1$ N-s/m
$f(t) = u(t)$ N



Problem 3 [20 points]

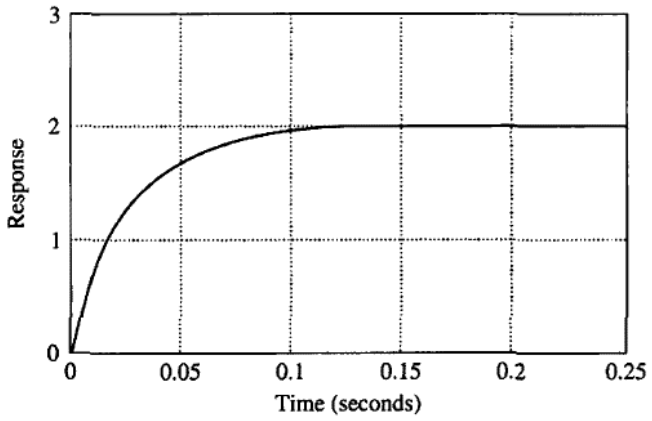
Find the percent overshoot, settling time, rise time, and peak time for the following system:

$$T(s) = \frac{14.145}{(s^2 + 0.842s + 2.829)(s + 5)}$$

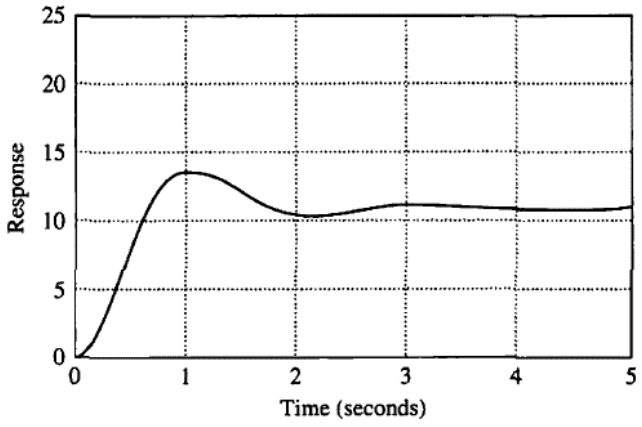
Hint: note, this is a 3rd order system, so think about the influence of the poles and how you can approximate the behavior of the 3rd order system based on the proximity of the poles.

Problem 4 [30 points]

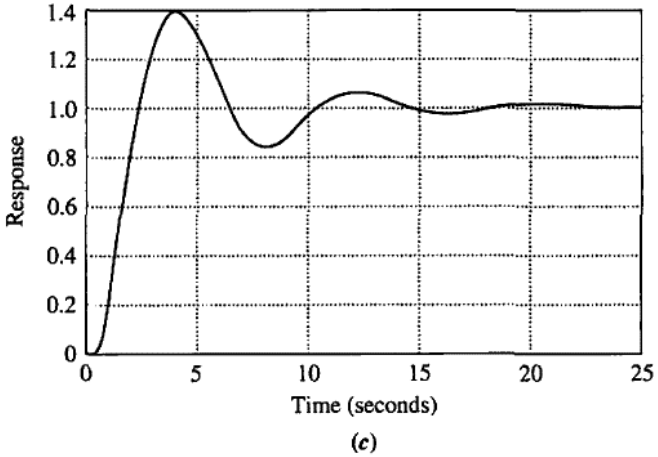
For each of the plots, find the transfer function that best represents the behavior, where it is assumed that the input is a unit step:



(a)



(b)



(c)