ME EN 6200
Homework 3
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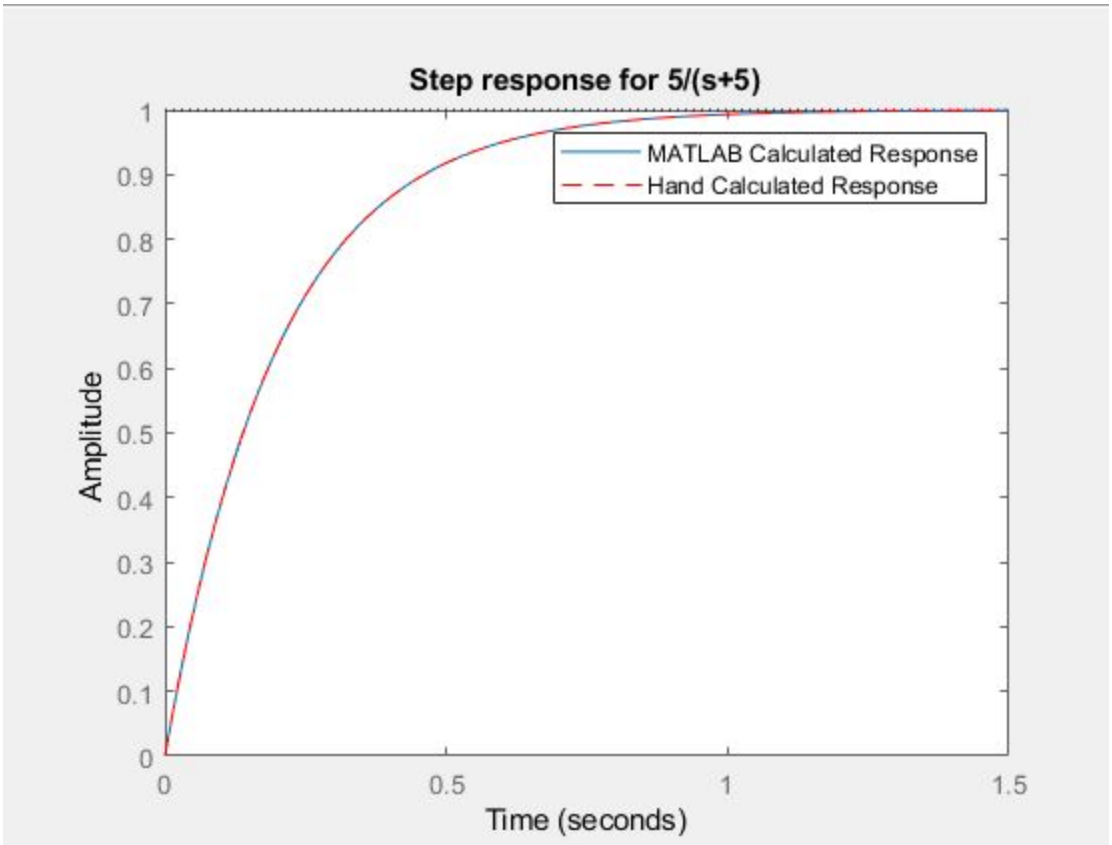
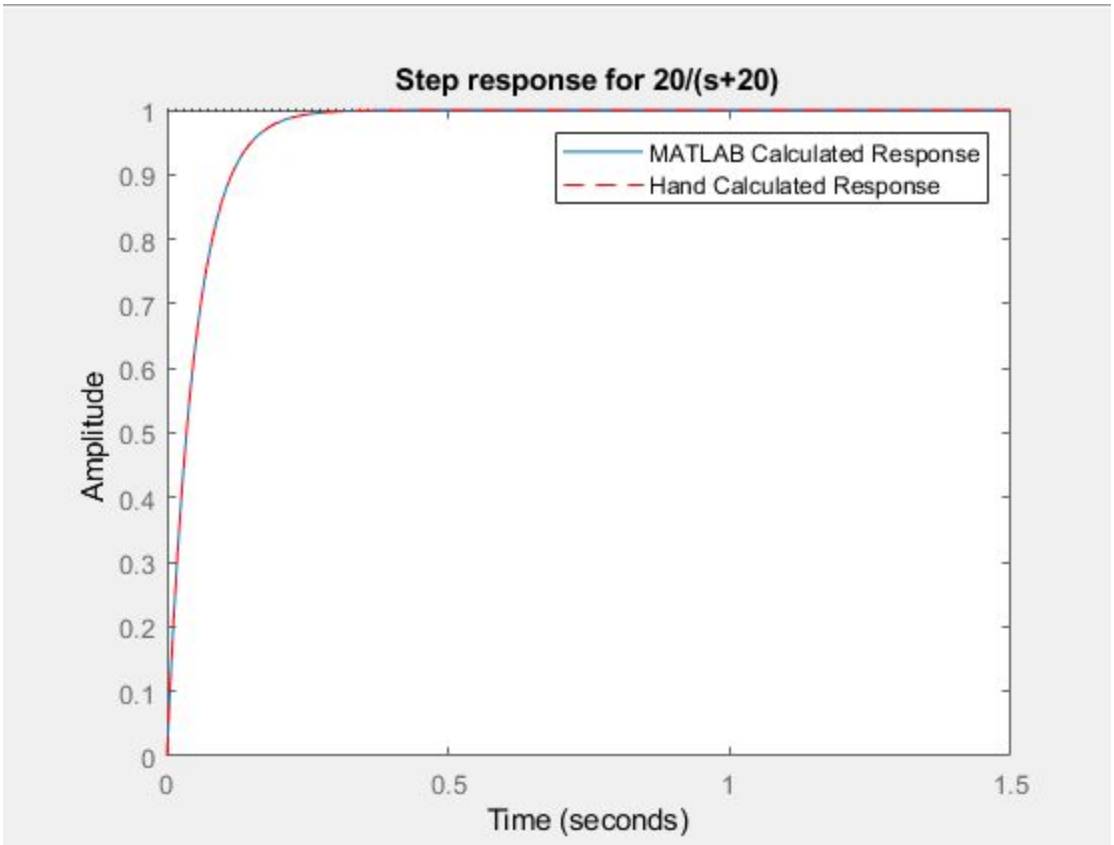
Problem 1

(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:



Comparison:

Both transfer functions for a and b exhibit the expected unit step response. This is evidenced by the same time to rise to .9 and same time to settle to .98 for both a and b. Plotting the time solutions on top of the step response the plots are the exact same.

Code:

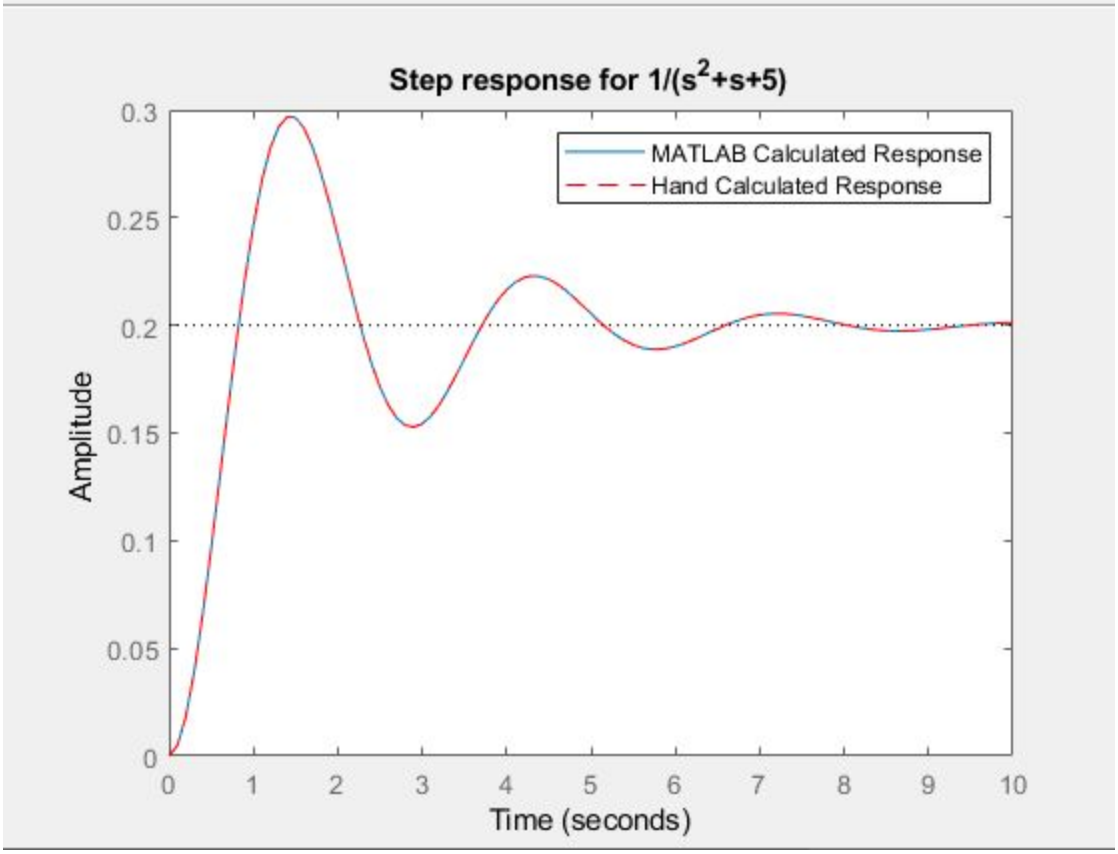
```
%% 1c
t_vals = 0:0.001:1.5;
% a
Ga = tf(5,[1,5]);
figure;
step(Ga,1.5);
title('Step response for 5/(s+5)');
hold on;
c = 1-exp(-5*t_vals);
plot(t_vals, c, 'r--');
legend('MATLAB Calculated Response', 'Hand Calculated Response');

% b
```

```
Gb = tf(20,[1,20]);
figure;
step(Gb,1.5);
title('Step response for 20/(s+20)');
hold on;
c = 1-exp(-20*t_vals);
plot(t_vals, c, 'r--');
legend('MATLAB Calculated Response', 'Hand Calculated Response');
```

Problem 2

(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).




```
%% 2c
t_vals = 0:0.1:10;

H = tf(1,[1,1,5]);
figure;
step(H,10);
title('Step response for 1/(s^2+s+5)');
hold on;
x = 1/5 - (1/5).*exp(-.5.*t_vals).*cos(sqrt(19).*t_vals/2) -
(1/(5.*sqrt(19))).*exp(-.5.*t_vals).*sin(sqrt(19).*t_vals/2);
plot(t_vals, x, 'r--');
legend('MATLAB Calculated Response', 'Hand Calculated Response');
```

The numerical MATLAB solution and my closed form solution for x(t) (given a step response) match up exactly as evidenced by the plots and the matching %OS, peak time, and settling time.

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

The system is underdamped. This is shown by the oscillatory behavior and approximately 50% overshoot. The system takes 8 seconds to settle from the oscillatory behavior that is initially shown by the system as soon as the step input begins. This long settling time where the response oscillates about a settling value also indicates that the system is underdamped.