Due Date: Tuesday September 14

Problems:

$\boxed{1}$ For systems with the following transfer functions:

$$System\ a:\ H(s)\ =\ \frac{1}{s+2}$$

$$System\ b:\ H(s)\ =\ \frac{s+6}{(s+2)(s+3)}$$

1) Determine the step and ramp response of each system using Laplace transforms. Your answer should be time domain functions $y(t)$.

2) From these time domain functions, determine the position and velocity errors.

3) Using the equations derived in class (and in the notes) determine the position and velocity errors directly from the transfer functions.

The following Matlab code can be used to estimate the step and ramp response for 5 seconds for system b.

```
H = tf([1 6],[1 5 6]);                     % enter the transfer function
t = [0:0.01:5];                            % t goes from 0 to 5 by increments of 0.01
ustep = ones(1,length(t));                 % the step input is all ones, u(t) = 1;
uramp = t;                                 % the ramp input is has the input u(t) = t;
ystep = lsim(H,ustep,t);                   % find the step response
yramp = lsim(H,uramp,t);                   % find the ramp response
figure;                                    % make a new figure
orient tall                                % or orient landscape, use more of the page
subplot(2,1,1);                            % put two graphs on one piece of paper
plot(t,ustep,'.-',t,ystep,'-');            % plot input/output with different line types
grid;                                      % put a grid on the graph
legend('Step Input','Step Response',4);    % put a legend on the graph
subplot(2,1,2);                            % second of two graphs on one piece of paper
plot(t,uramp,'.-',t,yramp,'-');            % plot input/output with different line types
grid;                                      % put a grid on the graph
legend('Ramp Input','Ramp Response',4);    % put a legend on the graph
```

4) Plot the step and ramp response for <u>both</u> system a and b and indicate the position and velocity errors on the graph Draw on the graphs to show you know what the position and velocity error is.
Turn in your Matlab plots for each system!
Ans: $e_p = 0.5, 0$, $e_v = \infty, 0.666$

2 An ideal second order control system has the transfer function $G_0(s)$. The system specifications for a step input follow:

a) Percent Overshoot $\leq 5\%$

b) Settling Time ≤ 4 seconds (2% criteria)

c) Peak Time ≤ 1 second.

Show the permissible area for the poles of $G_0(s)$ in order to achieve the desired response.

3 For a system with the following transfer function

$$H(s) \;=\; \frac{a}{s^2 + 2s + 3}$$

What is the range of values for a so that $e_p \leq 0.2$. Note that we only care about absolute values here. (*Ans.* $2.4 \leq a \leq 3.6$)

4 For a system with the following transfer function

$$H(s) \;=\; \frac{bs + 3}{s^2 + 2s + 3}$$

What is the range of values for b so that $e_v \leq 0.1$. Note that we only care about absolute values here. (*Ans.* $1.7 \leq b \leq 2.3$)