Name _____ Mailbox _____

ECE-320 Linear Control Systems

Spring 2012, Exam 1

No calculators or computers allowed, except for Problem 8 when you should use Matlab's sisotool.

You must simplify your answers as much as possible, or points will be deducted.

Problem 1 _____/7

Problem 2 _____/7

Problem 3 _____/7

Problem 4 _____/7

Problem 5 _____/7

Problem 6 _____/20

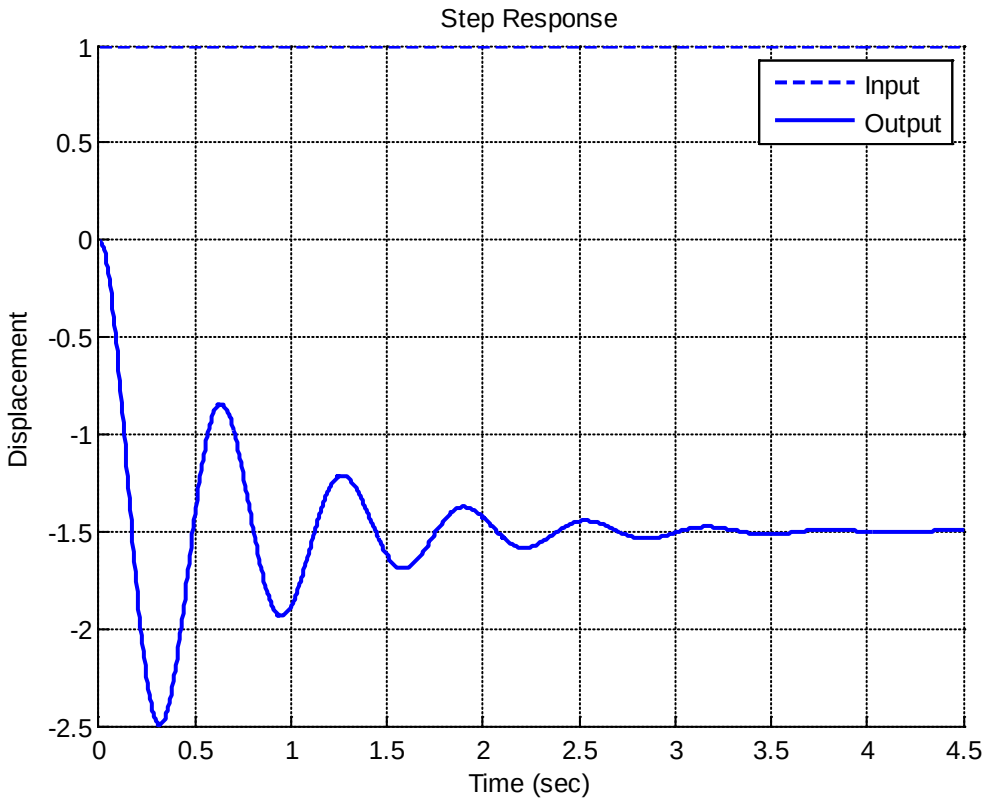
Problem 7 _____/20

Problem 8 _____/25

Total _____/100

Name _____ Mailbox _____

1) (7 points) The following graph shows the **unit step response** for a system.

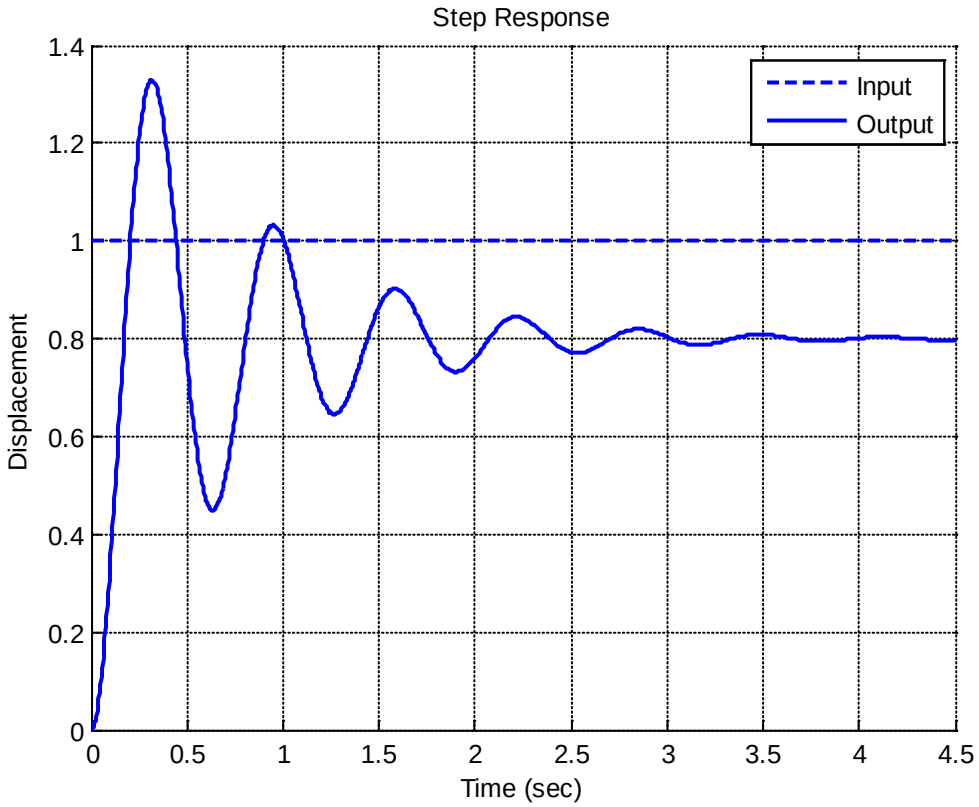


a) Estimate the **percent overshoot**

b) Estimate the **static gain**

Name _____ Mailbox _____

2) (7 points) The following graph shows the unit step response of a system.

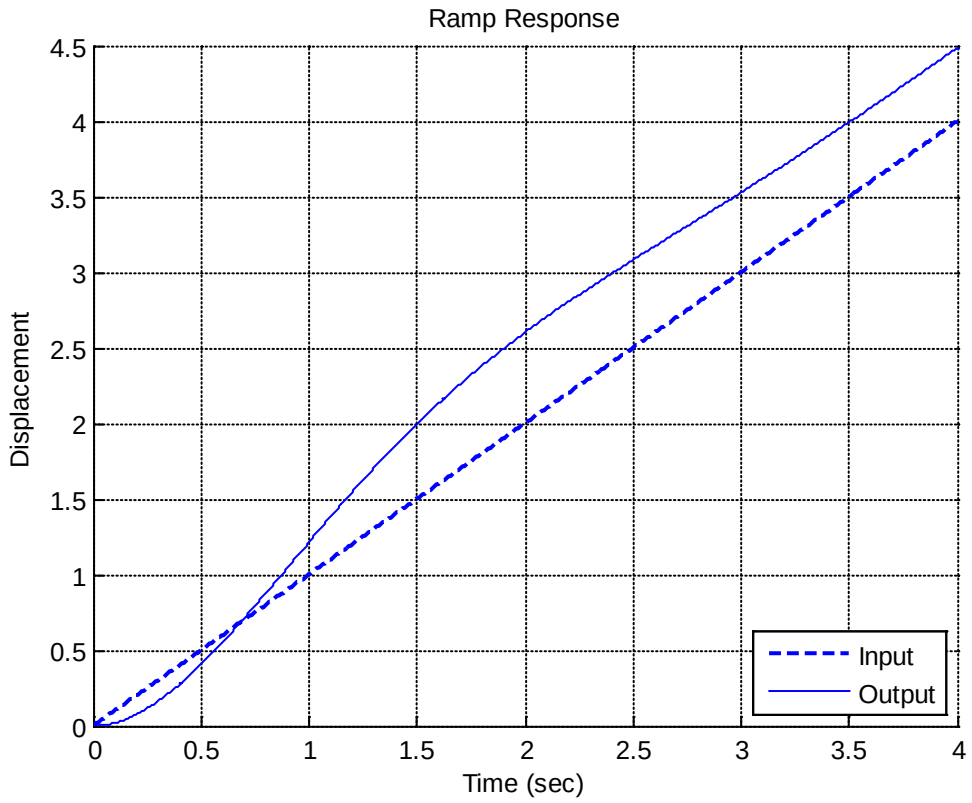


a) Estimate the **steady state error**.

b) Estimate the steady state error for a unit ramp input.

Name _____ Mailbox _____

3) (7 points) The following figure shows the unit ramp response of a system.

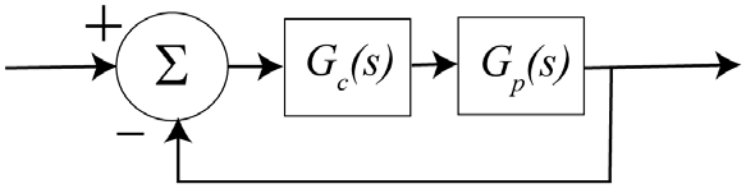


a) Estimate the **steady state error**.

b) Estimate the steady state error for a unit step input.

Name _____ Mailbox _____

4) (7 points) For the following systems, assume $G_c(s) = \dfrac{s+2}{s+3}$ and $G_p(s) = \dfrac{s+5}{s+4}$

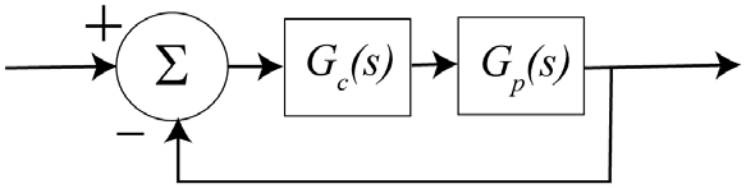


a) Determine the position error constant K_p

b) Determine the steady state error for a unit step input.

Name _____ Mailbox _____

5) (7 points) For the following systems, assume $G_c(s) = \frac{2}{s}$ and $G_p(s) = \frac{s+5}{s+4}$



a) Determine the velocity error constant K_v.

b) Determine the steady state error for a unit ramp input.

Name _____ Mailbox _____

6) (20 points) For a system with the transfer function $H(s) = \frac{1}{s(s+1)}$

a) Determine the **impulse response** $h(t)$

b) Determine the **unit step response.**

Name _____ Mailbox _____

7) (20 points) For the system with closed loop transfer function $G_o(s) = \dfrac{k}{s^2 + 2s + k}$

a) Determine an expression for the sensitivity of G_o to k as a function of s, $S_k^{G_o}$

b) Determine and expression for the magnitude of the sensitivity function as a function of frequency, ω. Simplify your answers as much as possible.

Name _____ Mailbox _____

8) (25 points) ***(sisotool problem)***

Consider the plant

$$G_p(s) = \frac{30}{s^2 + 6s + 10}$$

Design a PID controller using *sisotool* with ***real zeros*** so that

$$\begin{aligned} T_s &\leq 1.5\,\text{sec} \\ P.O. &\leq 10\% \end{aligned}$$

In addition, your controller must be designed so that

$$\begin{aligned} k_p &\leq 0.5 \\ k_i &\leq 2 \\ k_d &\leq 0.05 \end{aligned}$$

Write your final values for k_p, k_i, k_d, and the transfer function of the controller in the space below.

Name _____ Mailbox _____