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ECE-320 Linear Control Systems

Winter 2012, Exam 1

No calculators or computers allowed, except for Problem 6 when you should use Matlab's sisotool.

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

Problem 1 _______/24

Problem 2 _______/12

Problem 3 _______/8

Problem 4 _______/8

Problem 5 _______/24

Problem 6 _______/24

Total _______/100

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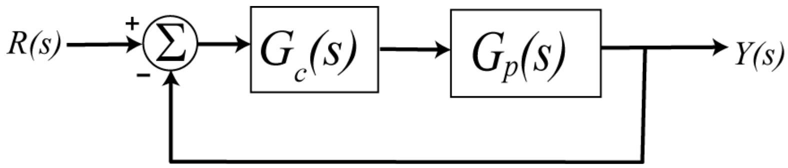
1) (24 points) Consider the following simple feedback control block diagram. The plant is $G_p(s) = \frac{3}{s+5}$. The input is a unit step.



a) Determine the settling time, steady state error for a unit step input, and the bandwidth of the plant alone (assuming there is no feedback)

b) Assuming a proportional controller, $G_c(s) = k_p$, determine the closed loop transfer function, $G_0(s)$

c) Assuming a proportional controller, $G_c(s) = k_p$, determine the value of k_p so the steady state error for a unit step is 1/4, and the corresponding settling time for the system.

d) Assuming a proportional controller, $G_c(s) = k_p$,determine the value of k_p so the settling time is 4/11 seconds, and the corresponding steady state error.

e) Assuming a proportional controller, $G_c(s) = k_p$, determine the value of k_p so the bandwidth is 17 rad/sec.

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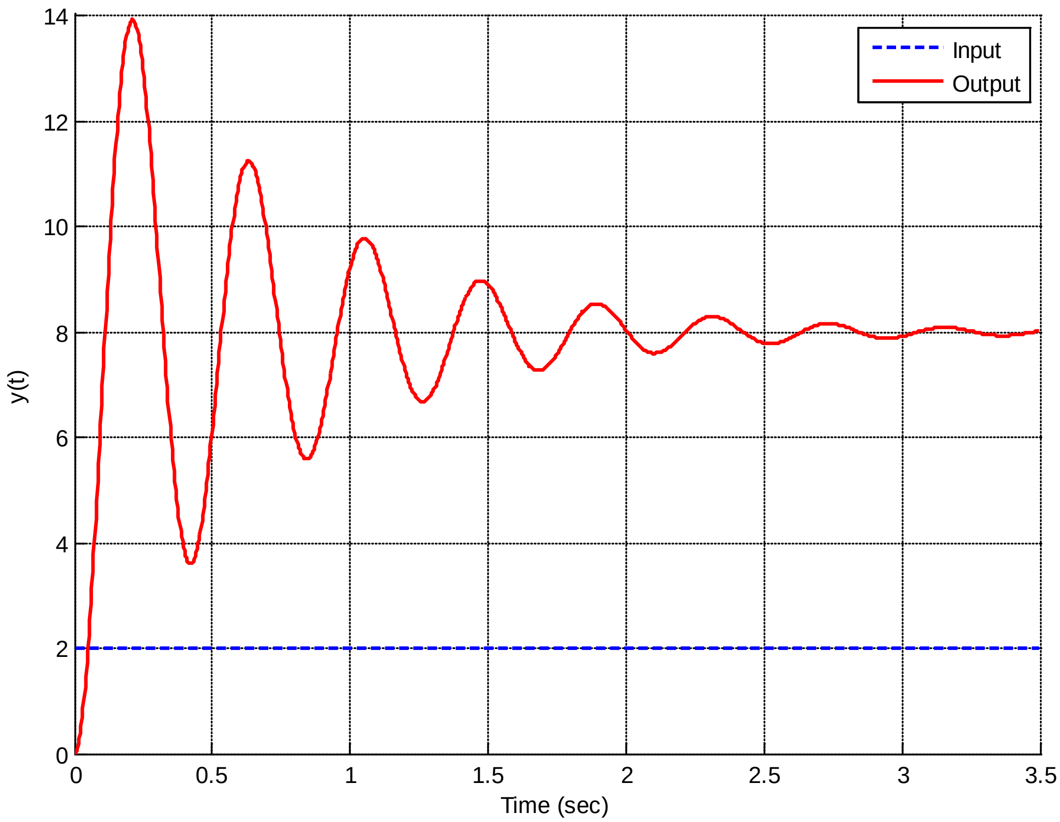
2) (12 points) For the following questions, refer to the following graph showing the input and output of a second order system. For this system the input is a step of amplitude 2. (You can leave your answers as fractions.)



a) What is the static gain of the system?

b) What is the percent overshoot?

c) What is the steady state error?

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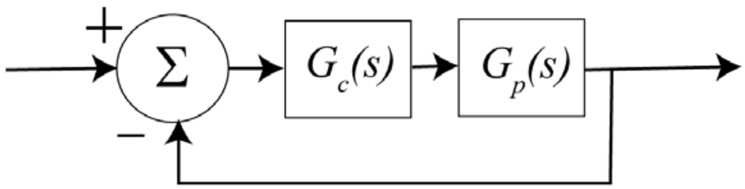
3) (8 points) For the following systems, assume $G_c(s) = \frac{1}{s+2}$ and $G_p(s) = \frac{1}{s+5}$



a) Determine the position error constant K_p

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

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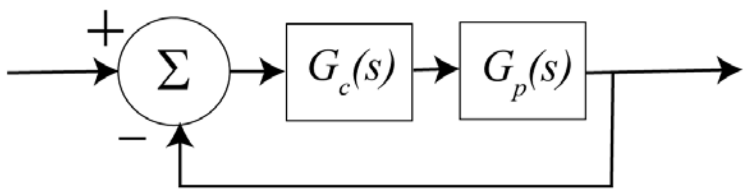
4) (8 points) For the following systems, assume $G_c(s) = \frac{3}{s}$ and $G_p(s) = \frac{1}{s+4}$



a) Determine the velocity error constant K_v.

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

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5) (24 points) For a system with the transfer function $H(s) = \dfrac{1}{(s+1)(s+2)^2}$

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

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

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6) (24 points) ***(sisotool problem)***

Consider the plant

$$G_p(s) = \frac{100}{s^2 + 2s + 20}$$

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

$$\begin{aligned} T_s &\le 1.0\,\text{sec} \\ P.O. &\le 10\% \end{aligned}$$

In addition, your controller must be designed so that

$$\begin{aligned} k_p &\le 0.5 \\ k_i &\le 5 \\ k_d &\le 0.1 \end{aligned}$$

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

$k_p =$

$k_i =$

$k_d =$

$G_c(s) =$

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