ECE-320: Linear Control Systems
Homework 4

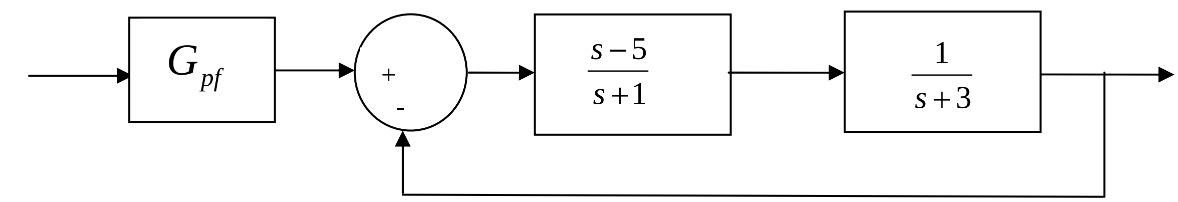
Due: Tuesday March 30 at the beginning of class

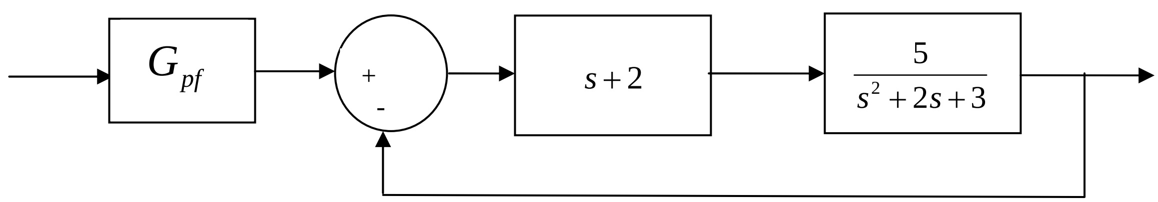
1) For the following systems

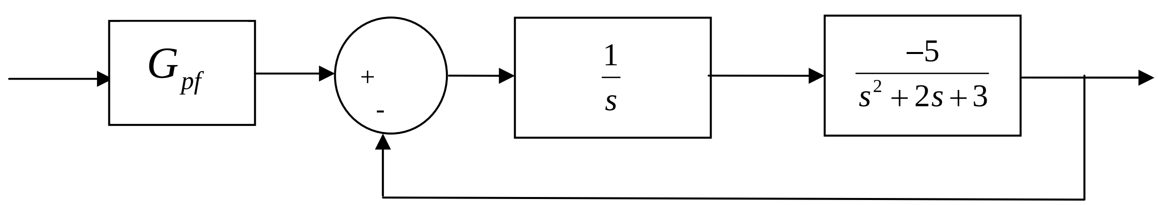
a) Determine the system type (0, 1, 2, ...)

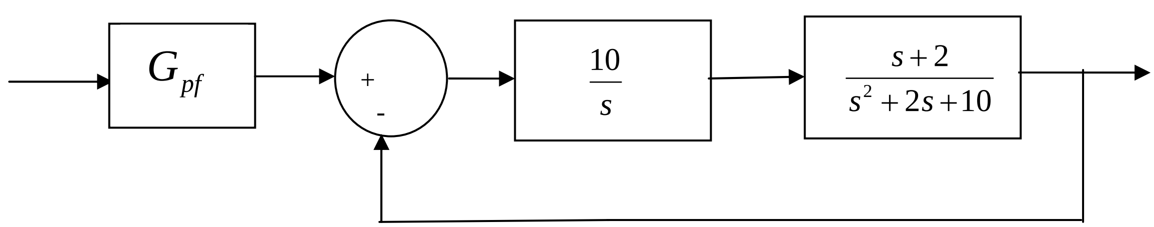
b) If the system is type 0 assume $G_{pf} = 1$ and determine the position error constant K_p and the steady state error for a unit step input. Then determine the value of G_{pf} to make this error zero. If the system is type 1, assume $G_{pf} = 1$ and determine the steady state error for a unit step, the velocity error constant K_v, and the steady state error for a unit ramp. Is there any constant value of G_{pf} that can change the steady state error for a ramp?

Ans. (steady state errors) $-\frac{3}{2}, \frac{3}{13}, -\frac{3}{5}, \frac{1}{2}$; (prefilers) $\frac{2}{5}, \frac{13}{10}$, G_{pf} has no effect

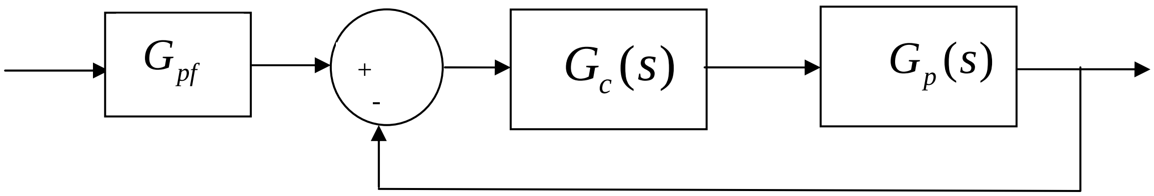








2) Consider the following control system.



We can compute the position error constant K_p as $K_p = G_c(0)G_p(0)$

a) Determine an expression for the closed loop transfer function (from input to output) $G_o(s)$ in terms of G_{pf}, $G_c(s)$, and $G_p(s)$.

b) For a steady state error of zero for a step input we want $G_o(0) = 1$. Use this information to show that we can determine the prefilter gain to be

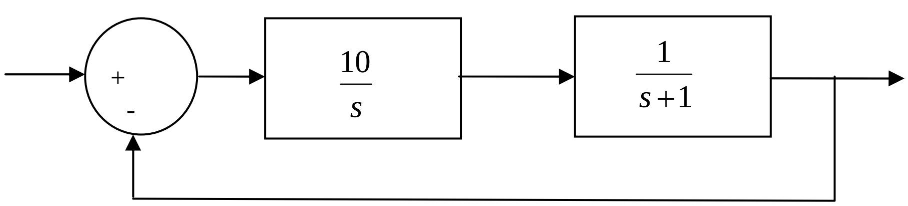
$$G_{pf} = 1 + \frac{1}{K_p}$$

c) We can find the steady state error for a unit step input as $e_{ss} = \frac{1}{1+K_p}$. Using this, show that we can determine the prefilter gain to be

$$G_{pf} = \frac{1}{1-e_{ss}}$$

Note that if $K_p = \infty$ *(or equivalently* $e_{ss} = 0$*), we get* $G_{pf} = 1$)

3) Consider the following control system:



a) If the input to the system is $r(t) = 8u(t)$, what is the steady state output?

b) If the input to the system is $r(t) = 8\sin(3t)u(t)$, what is the output in steady state? What is the time lag between the input signal and the output signal?
Hint: you can write $\omega t - \theta = \omega(t - t_d)$ *if* θ *is measured in radians.*
Answers: $y(t) = 8, y(t) = 8\sqrt{10}\sin(3t - 71.57^\circ), t_d = 0.416\sec$