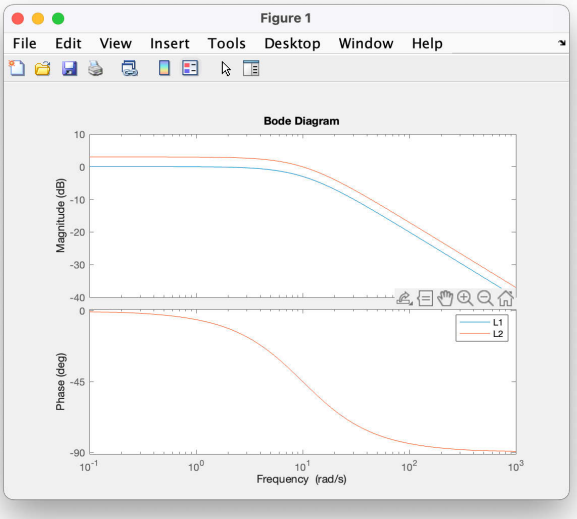
P1 we should increase the crossover frequency, because we want the system to respond to faster changes.

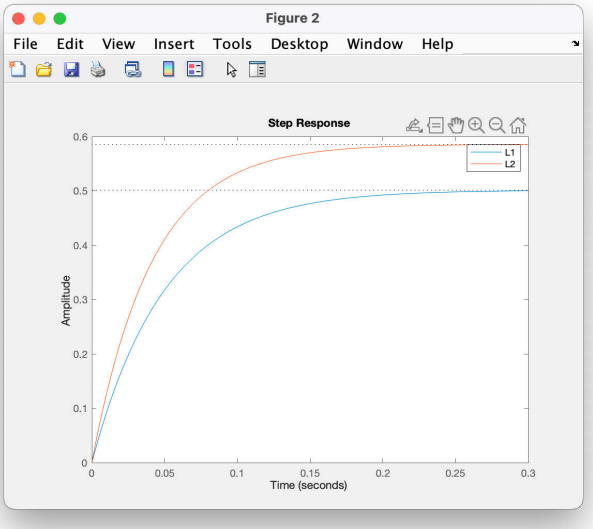
if we have a very high crossover frequency, the system would be sensitive to noise, less stable. and more likely to saturate

P2 $K_p = \frac{1}{|G(jw_c)|}$

when $w_c = 1$, $K_p = \frac{\sqrt{10}}{3} = 3.35$

when $w_c = 10$, $K_p = \frac{10}{3}\sqrt{2} = 4.71$





P3 (a) $\bar{e} = S(s)\bar{r}$

for $w < 0.1$, gain $= \frac{\bar{e}}{\bar{r}} = |S(jw)| < 0.01$

in which $S(jw) = \frac{1}{1+L(jw)}$

for $w < 0.1$, $|1+L(jw)| \geq 100$

$\bar{y} = T(s)\bar{r}$

for $w > 200$, gain $= \frac{\bar{y}}{\bar{r}} = |T(jw)| < 0.04$

in which $T(jw) = \frac{L(jw)}{1+L(jw)} = 1 - \frac{1}{1+L(jw)}$

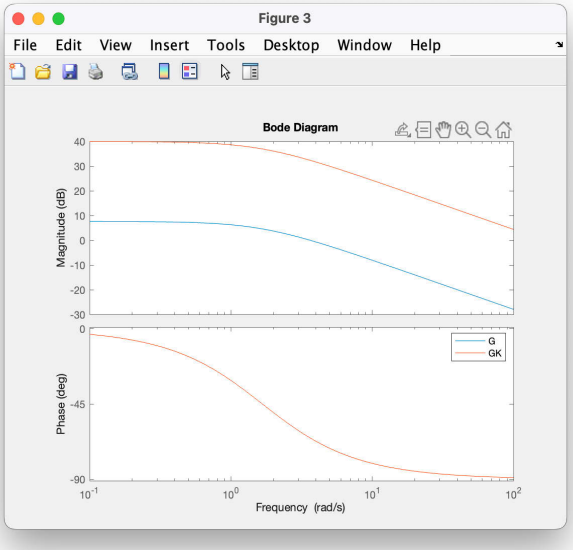
for $w > 200$, $|L(jw)| < \frac{1}{1-0.04} - 1 = 0.042$

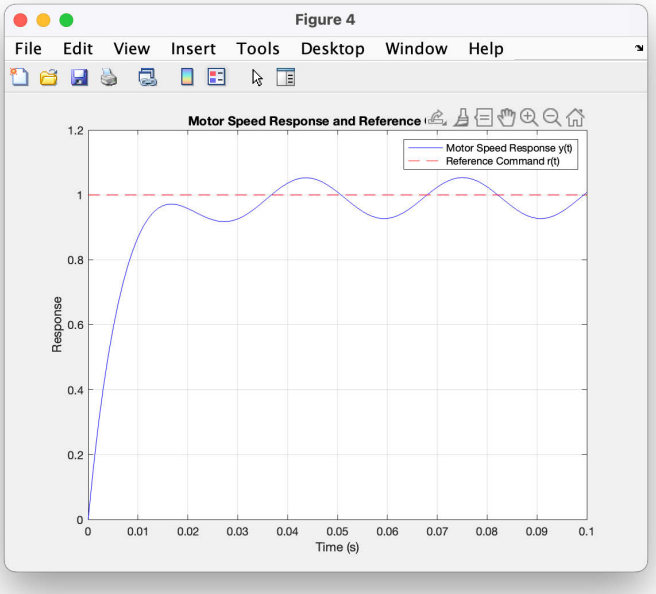
(b) $|1 + K_p G(s)| = |1 + K_p \frac{12}{3s+5}| \geq 100$

so $K_p \approx 41.33$

from the bode plot, the loop crossover frequency is 165.3

and $|L(j200)| = 0.827 >> 0.04$



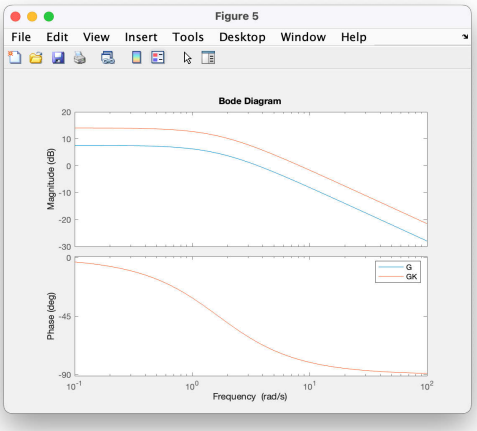


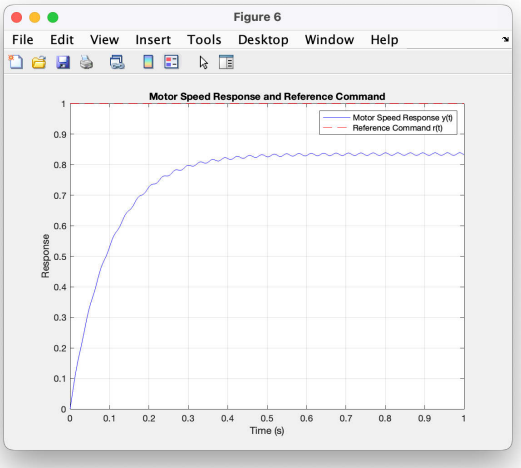
(c) $|G(j\omega)K_p| < 0.042$

so $K_p \approx 2.1$

from the bode plot, the loop crossover frequency is 8.233

and $|\angle(\omega_c j)| = 5.04$





(d) $K_p = \frac{1}{|G(j\omega_c)|} = 5.02$, in which $\omega_c = 20$

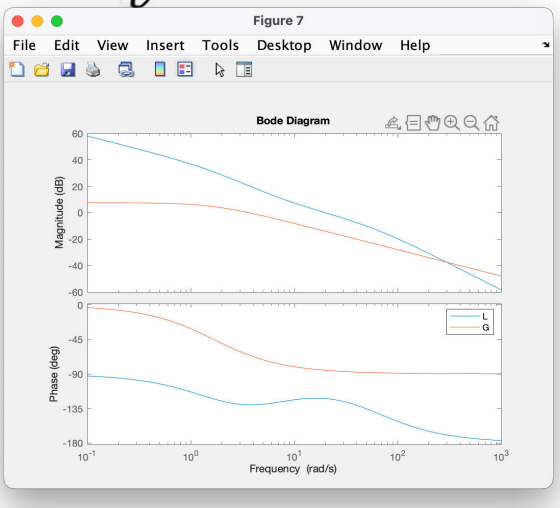
let $\omega_i = \frac{\omega_c}{3} = 6.67$ and $K_i(s) = \frac{s+6.67}{s}$

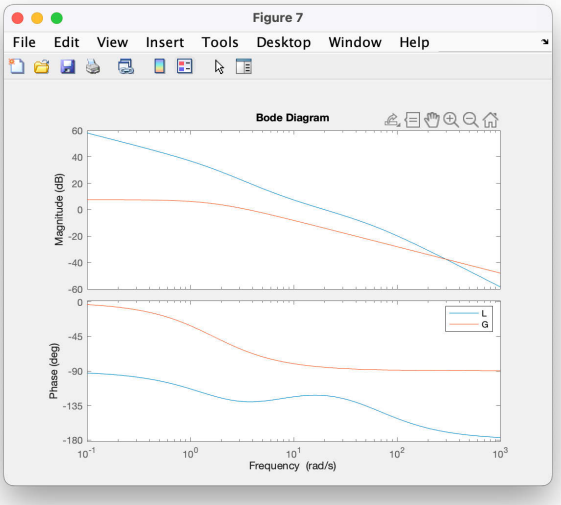
let $\omega_r = 3\omega_c = 60$ and $K_r(s) = \frac{60}{s+60}$

now, $\angle$ is $5.02 \frac{s+6.67}{s} \frac{60}{s+60} G$

$|\angle(9j)| = 802.2 >> 100$

$|\angle(200j)| = 0.0289 < 0.042$





(e) $K(s) = \dfrac{301.2s + 2009}{s^2 + 60s}$

so $\ddot{u} + 60\dot{u} = 301.2\,\dot{e} + 2009\,e$