

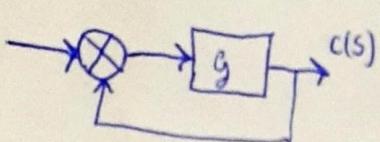
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Data: 21/09/2021

Matrícula: 96708

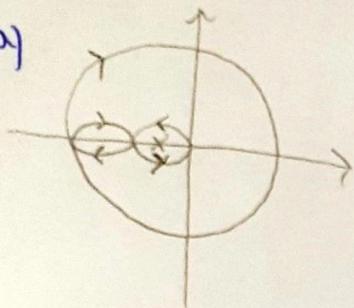
P2-Elet331 - Controle 2

①



} Posse um polo no semiplano direito ($P=1$)

a)



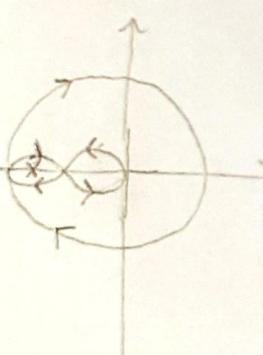
$$N = 1 - 1 = 0 \text{ (sentido horário e antihorário)}$$

$$P = 1$$

Instável, pois o gráfico possui 2 esvaltérios, um no sentido horário e um no sentido anti-horário, o possui um polo no semiplano direito, logo, $Z \neq 0$ diferente de zero.

$$Z = N + P = (1 - 1) + 1 = 1 //$$

b)



$$N = 2 \text{ (2 esvaltérios, no sentido horário)}$$

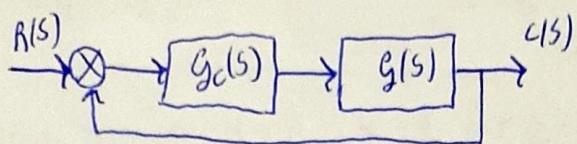
$$P = 1$$

Instável, pois pelo gráfico, percebe-se a presença de 2 esvaltérios no sentido horário e como existe um polo no semiplano direito, o número de zeros (Z) é diferente de zero.

$$Z = N + P = 2 + 1 = 3 //$$

Werner Alves

②



$$g(s) = \frac{5}{s(s+1)}$$

a) Averga de fase, MF $\geq 50^\circ$, $e_{ss} = 2\%$ (rampa unitaria), usar 5° no ângulos.

$$; \left\{ \begin{array}{l} G_c(s) = K_c \alpha \frac{(Ts+1)}{(T\alpha s+1)} = K \frac{(Ts+1)}{(T\alpha s+1)} ; K = K_c \alpha \end{array} \right.$$

$$\left\{ \begin{array}{l} G_c(s) G(s) = K \frac{(Ts+1)}{(T\alpha s+1)} \cdot \frac{5}{s(s+1)} = \frac{(Ts+1)}{(T\alpha s+1)} \cdot G_1(s) ; G_1(s) = \frac{5K}{s(s+1)} \end{array} \right.$$

$$ii \quad \left\{ \begin{array}{l} e_{ss} = 0,02 \Rightarrow K_V = \frac{1}{e_{ss}} \Rightarrow [K_V = 50] \end{array} \right.$$

$$\left\{ \begin{array}{l} K_V = \lim_{s \rightarrow 0} \left[\beta \frac{(Ts+1)}{(T\alpha s+1)} \cdot \frac{5K}{s(s+1)} \right] \Rightarrow 50 = \frac{1}{1} \cdot \frac{5K}{1} \Rightarrow [K = 10] \end{array} \right.$$

$$iii \quad \left\{ \begin{array}{l} G_1(s) = \frac{50}{s(s+1)} \Rightarrow G_1(jw) = \frac{50}{w\sqrt{w^2+1}} \angle 0^\circ - 90^\circ - \operatorname{tg}^{-1}\left(\frac{w}{1}\right) \end{array} \right.$$

$$iv \quad \left\{ \begin{array}{l} 20 \log_{10} \left| G_1(jw) \right| = 0 \text{ dB} \Rightarrow \frac{50}{w\sqrt{w^2+1}} = 1 \Rightarrow 50 = w\sqrt{w^2+1} \Rightarrow w_f = 7.036 \text{ rad/s} \end{array} \right.$$

$$\left. \begin{array}{l} 0^\circ - 90^\circ - \operatorname{tg}^{-1}\left(\frac{w_f}{1}\right) = -171.91^\circ \approx -172^\circ \Rightarrow \phi = 180^\circ - 172^\circ = 8^\circ // \psi = 50^\circ - 8^\circ + 5^\circ = 47^\circ \end{array} \right.$$

$$\sin \psi = \frac{1-\alpha}{1+\alpha} \Rightarrow \alpha = 0.155 \Rightarrow \left| G_1(jw_m) \right| = -20 \log_{10} \left| \frac{1}{\sqrt{\alpha}} \right| = -8.092 \text{ dB}$$

$$v \quad \left\{ \begin{array}{l} 20 \log_{10} \left| \frac{50}{w\sqrt{w^2+1}} \right| = \left| G_1(jw_m) \right| \Rightarrow [w_c = 11.244 \text{ rad/s}] \end{array} \right. \quad \left\{ \begin{array}{l} w_1 = \frac{1}{T} = w_c \sqrt{\alpha} = 4.429 \text{ rad/s} \\ w_2 = \frac{1}{2T} = \frac{w_c}{\sqrt{\alpha}} = 28.545 \text{ rad/s} \end{array} \right.$$

$$G_c(s) = K_c \frac{s + \frac{1}{T}}{s + \frac{1}{T\alpha}} \Rightarrow [G(s) = 64.447 \frac{s + 4.429}{s + 28.545}]$$

$$K_c = \frac{K}{\alpha} = 64.447$$

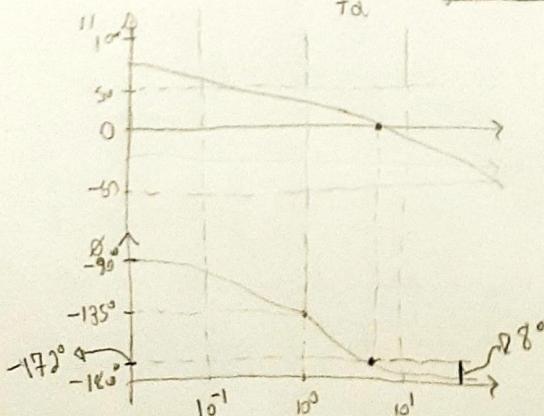


Diagrama de Bode de $G_1(s)$

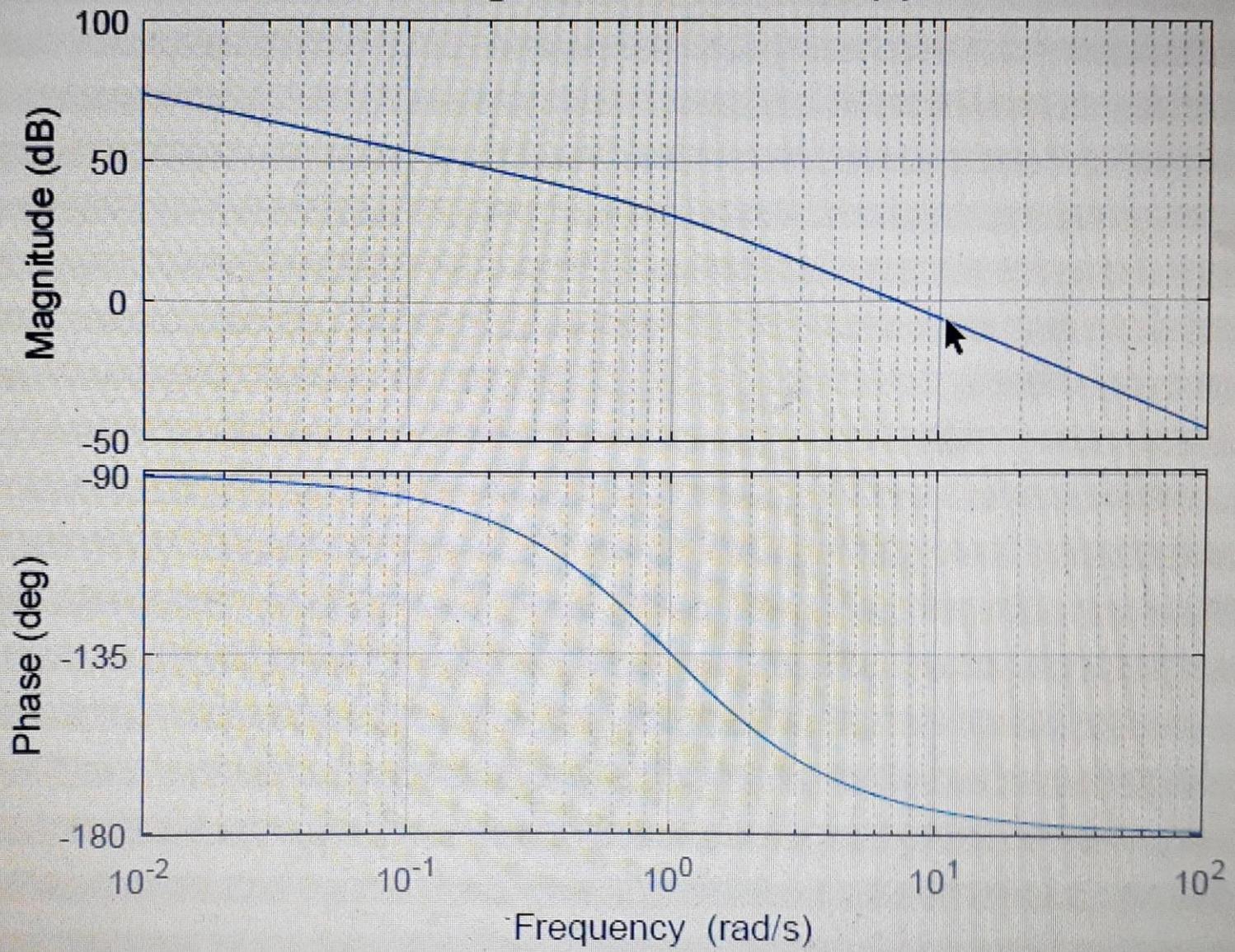
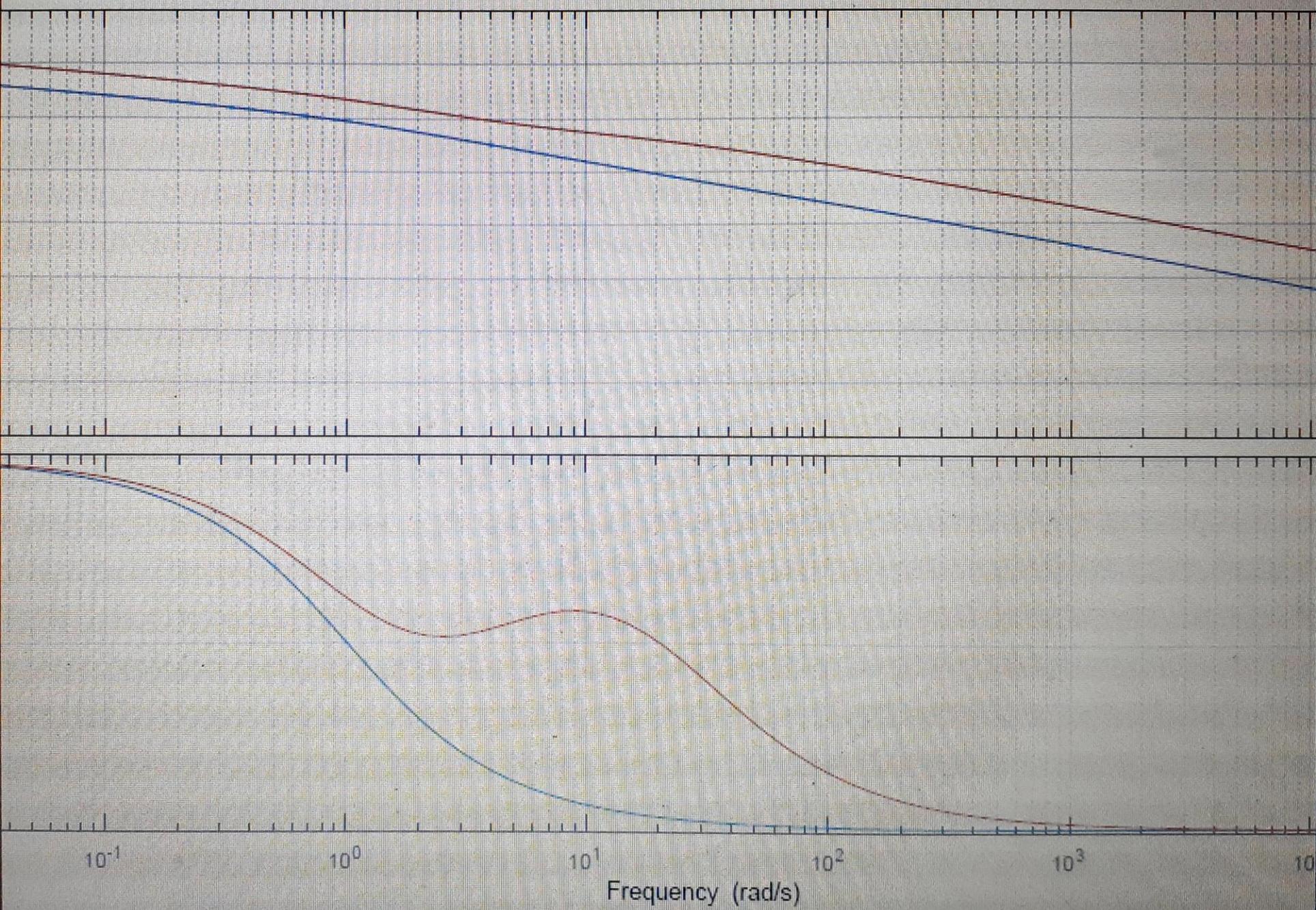
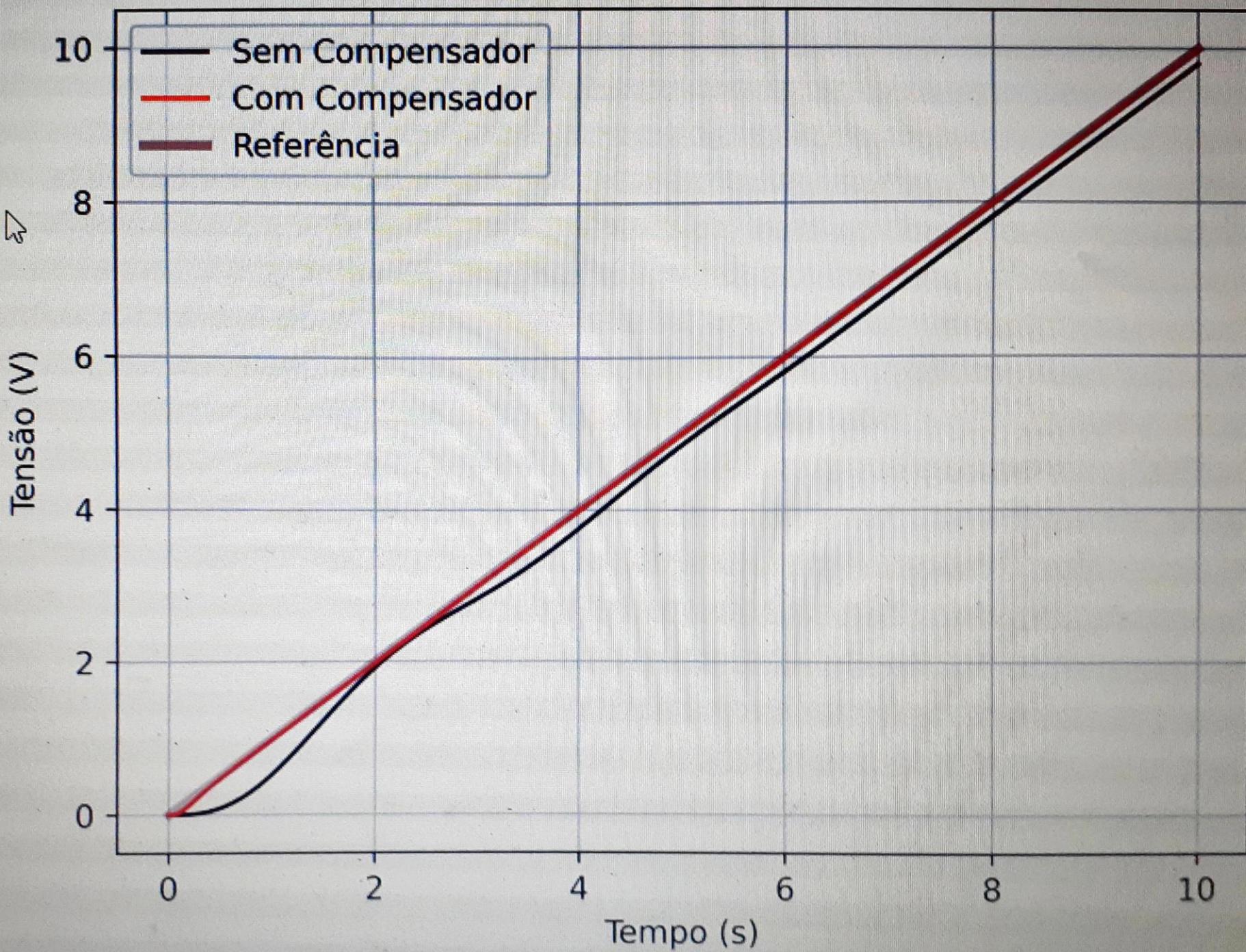
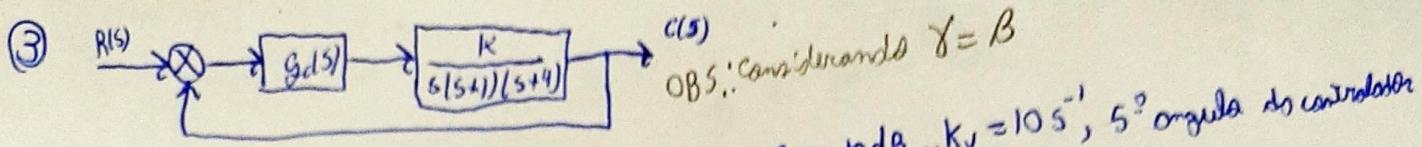


Diagrama de Bode: Comparação entre $G(s)$ e $G_c G(s)$







a) drama-orange, $\alpha = B \cdot e K_c = 1$, MF $\geq 50^\circ$, MG $\geq 10 \text{ dB}$, $K_v = 10^5$, 5° angular do controlador

$$i) \left\{ G_c(s) = K_c \frac{(s + \frac{1}{T_1})}{(s + \frac{\gamma}{T_1})} \frac{(s + \frac{1}{T_2})}{(s + \frac{1}{BT_2})}; \gamma = B \Rightarrow G_c(s) = \frac{(s + \frac{1}{T_1})}{(s + \frac{B}{T_1})} \frac{(s + \frac{1}{T_2})}{(s + \frac{1}{BT_2})} \cdot 1 \right.$$

$$ii) \left\{ G_1(s) = \frac{40}{s(s+1)(s+9)} \Rightarrow G(j\omega) = \frac{40}{\omega\sqrt{\omega^2+1}\sqrt{\omega^2+16}} \quad \boxed{0^\circ - 90^\circ - \tan^{-1}\left(\frac{\omega}{1}\right) - \tan^{-1}\left(\frac{\omega}{4}\right)}$$

$$iii) \left\{ K_v = \lim_{s \rightarrow 0} \left[\frac{K_c (s + \frac{1}{T_1})}{(s + \frac{B}{T_1})} \frac{(s + \frac{1}{T_2})}{(s + \frac{1}{BT_2})} \cdot \frac{K}{s(s+1)(s+9)} \right] \Rightarrow 10 = 1 \cdot 8 \cdot \frac{1}{4} \cdot \frac{K}{4} \Rightarrow K = 40 \right.$$

$$\left\{ \angle G(j\omega) = -90^\circ - \tan^{-1}(\omega) - \tan^{-1}\left(\frac{\omega}{4}\right) = -180^\circ \Rightarrow \boxed{\omega_{mg} \approx 2.5 \text{ rad/s}} \right.$$

$$iv) \left\{ \phi = 50^\circ + 5^\circ = 55^\circ \Rightarrow \tan \phi = \frac{B-1}{B+1} \Rightarrow \boxed{B=10.059} \right.$$

$$\left\{ \frac{1}{T_2} = \frac{\omega_{mg}}{10} = 0.200 \quad \boxed{\frac{1}{T_2} = 0.020} \right.$$

$$v) P = (\omega_{mg}, -20 \log_{10} |G_1(j\omega_{mg})|) = \left(2 \frac{\pi \text{ rad}}{2}, -6.021 \text{ dB} \right)$$

$$\left\{ \begin{array}{l} ax+b=\gamma \Rightarrow b = -6.021 - 20 \log_{10}(2) = -12.092 \Rightarrow \boxed{y = 20 \log_{10}(w) - 12.092 \text{ [dB]}} \\ 0 = 20 \log_{10}(w) - 12.092 \Rightarrow \boxed{\frac{B}{T_1} = 4} \\ -20 \log_{10}(10) = 20 \log_{10}(w) - 12.092 \Rightarrow \boxed{\frac{1}{T_1} = 0.400} \end{array} \right\} \left\{ \boxed{G_d(s) = 1 \cdot \frac{(s+0.4)}{(s+4)} \cdot \frac{(s+0.2)}{(s+0.02)}} \right\}$$

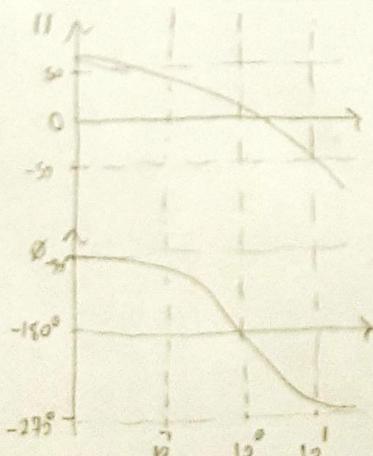


Diagrama de Bode de $G_1(s)$

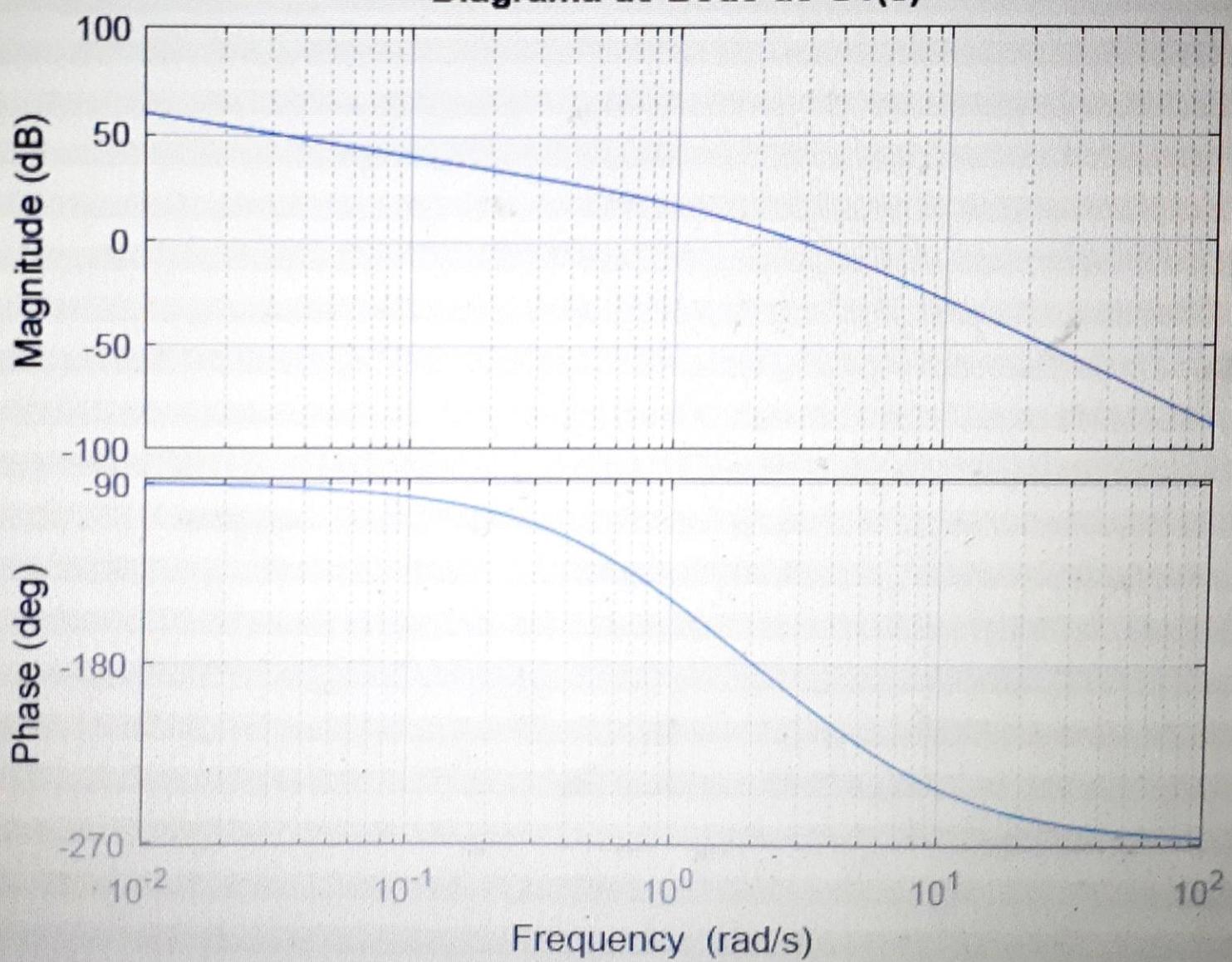
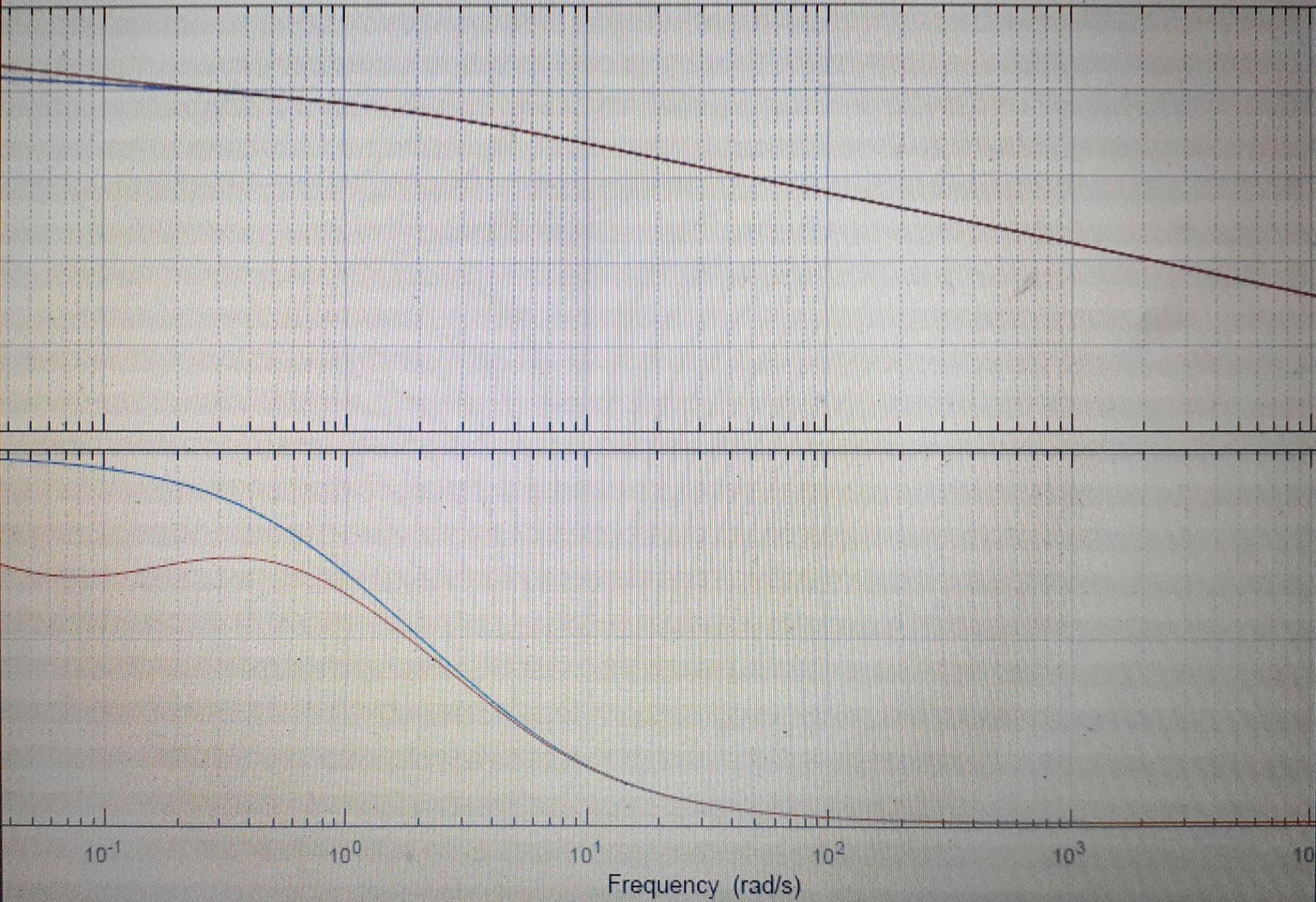
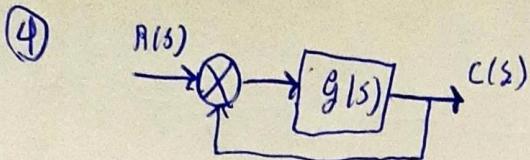


Diagrama de Bode: Comparação entre $G(s)$ e $G_c G(s)$





a) $E_{SS} = ?$ para uno campo montañoso

Para gráficos, pode-se realizar as seguintes aproximações:

The 0.1 rad/s ate 1 rad/s: decreasesments de -40 dB

Logo pode-se concluir que a inclinação do reto é -20 dB por decaida.

Pela gráfica podemos encontrar b requerido para $P(0,1,40)$

$$b = 40 + 20 \log_{10} |0.1| = 20 \Rightarrow y = -20 \log_{10} |M| + 20$$

As malhação é reta, obtemos: $y = -20 \log_{10} |w| + 20 = 0 \Rightarrow |w| = 10^{\text{med}}\%$

$$K_V = \omega_1 \Rightarrow [K_V = 10^{-5}]$$

$$E_{SS} = \frac{1}{K_V}$$

6) $e_{55} = ?$ para degrau unitário

Observando o gráfico, quando $W \rightarrow 0$, o gráfico tende a infinito, sendo assim esse sistema não é de tipo 0, logo: $C_{sg} = 0$.

Portanto, para $\text{ess} = 0$, K_V deve ser infinito.

$$e_{ss} = \frac{1}{1+K_V}$$