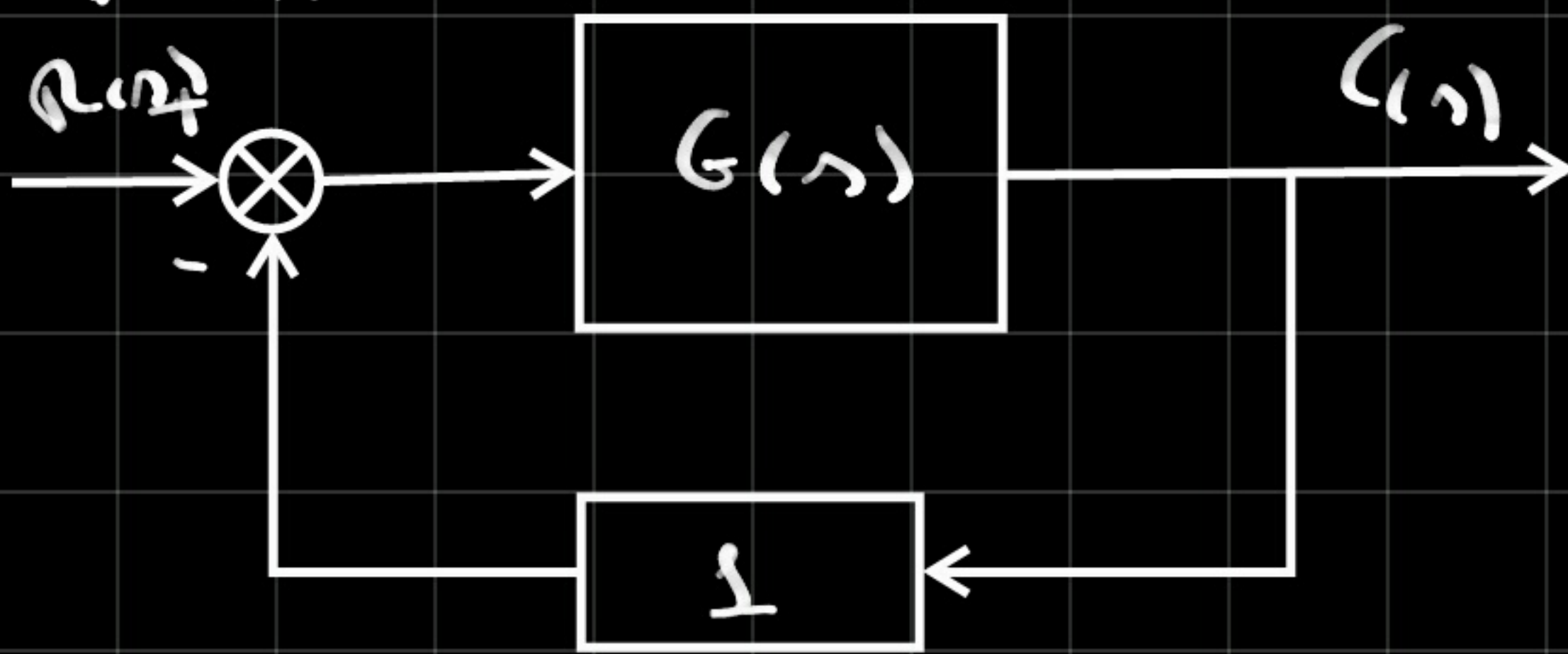Guilherme Shimabuko Silva Rocha - 11/0012623

B-7.1-

$$G_{cl} = \frac{GH}{1+GH} = \frac{10/s+1}{1+(10/s+1)} = \frac{10}{s+1+10} = \frac{10}{s+11}$$

a) $\left| \frac{10}{j+11} \right| = \frac{10}{\sqrt{11^2+1}} = 0,9053$

$\angle \left(\frac{10}{j+11} \right) = -5,1944$

$C_{ss} = 0,9053 \sin(t + 24,8°)$

b) $\left| \frac{10}{2j+11} \right| = 0,8944$

$\angle \left(\frac{10}{2j+11} \right) = -10,3048$

$C_{ss} = 1,7888 \cos(2t - 55,3048)$
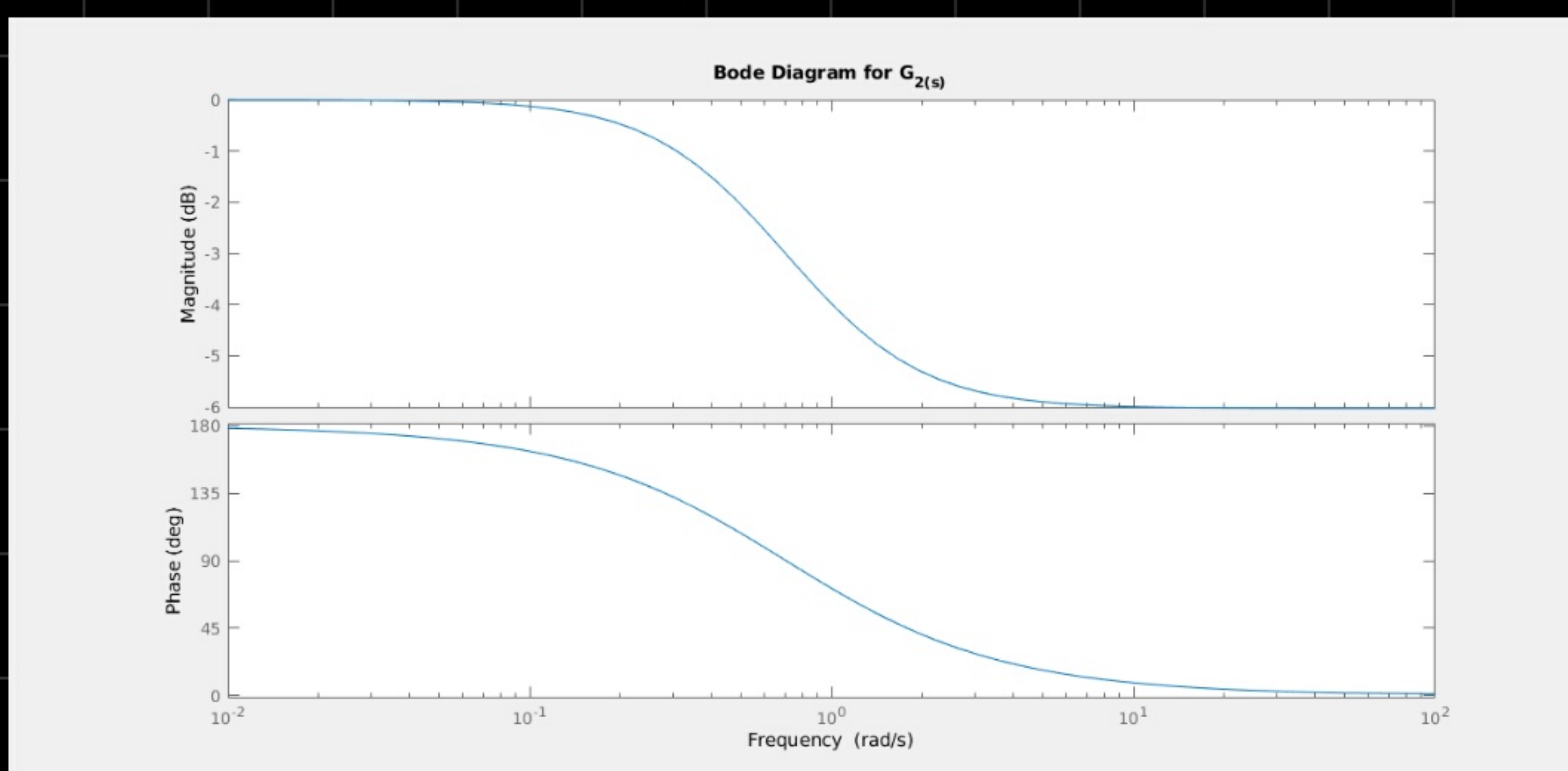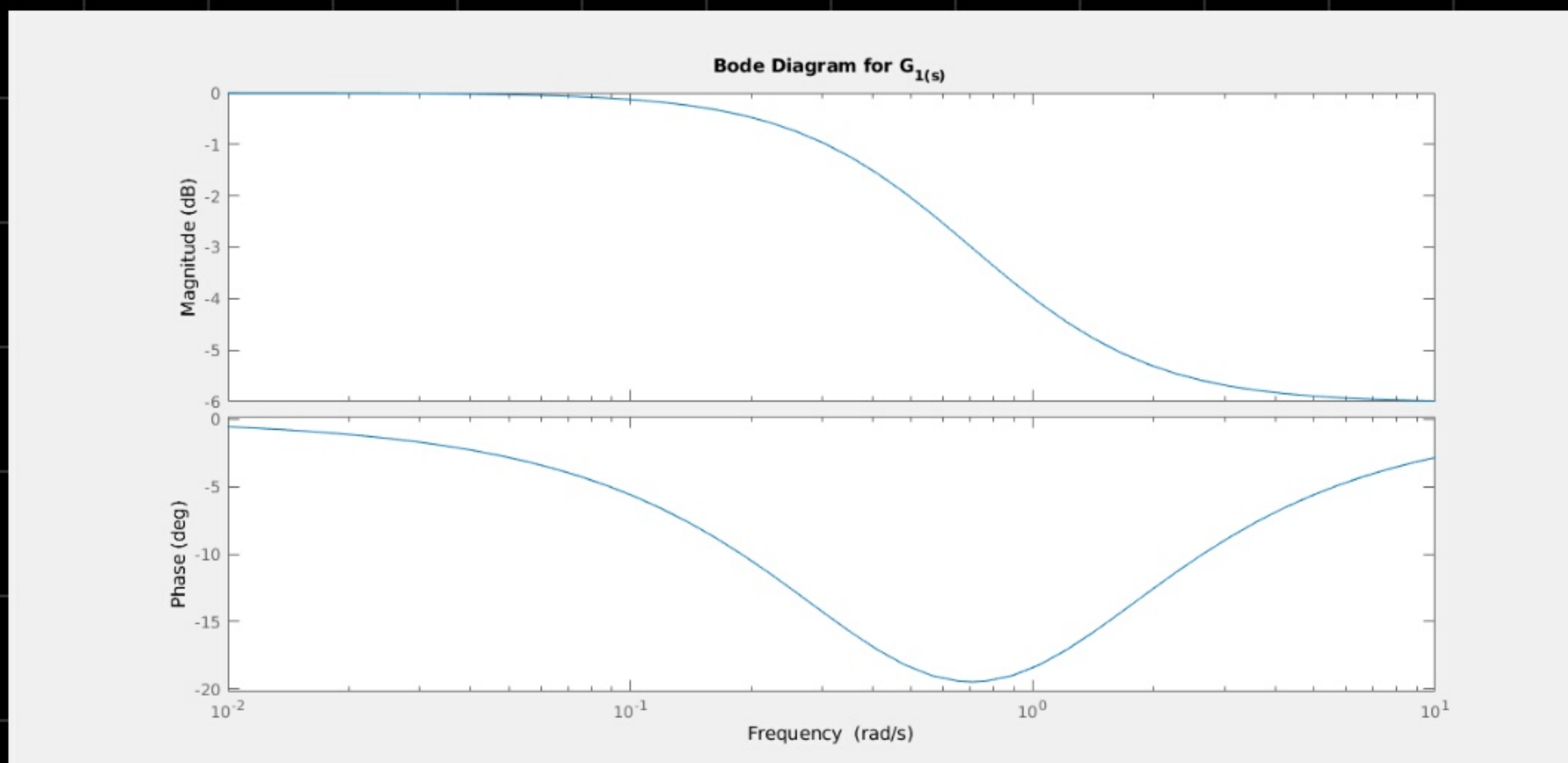
c) $C_{ss} = 0,9053 \sin(t+24,8°) - 1,7888 \cos(2t-55,3048)$

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B-7.2

$$C_{(s)} = KR\sqrt{\frac{(\omega^2 T_2^2 + 1^2)}{(\omega^2 T_1^2 + 1^2)}} \; \sin\left[\omega t + tg^{-1}(\omega T_2) - tg^{-1}(\omega T_1)\right]$$

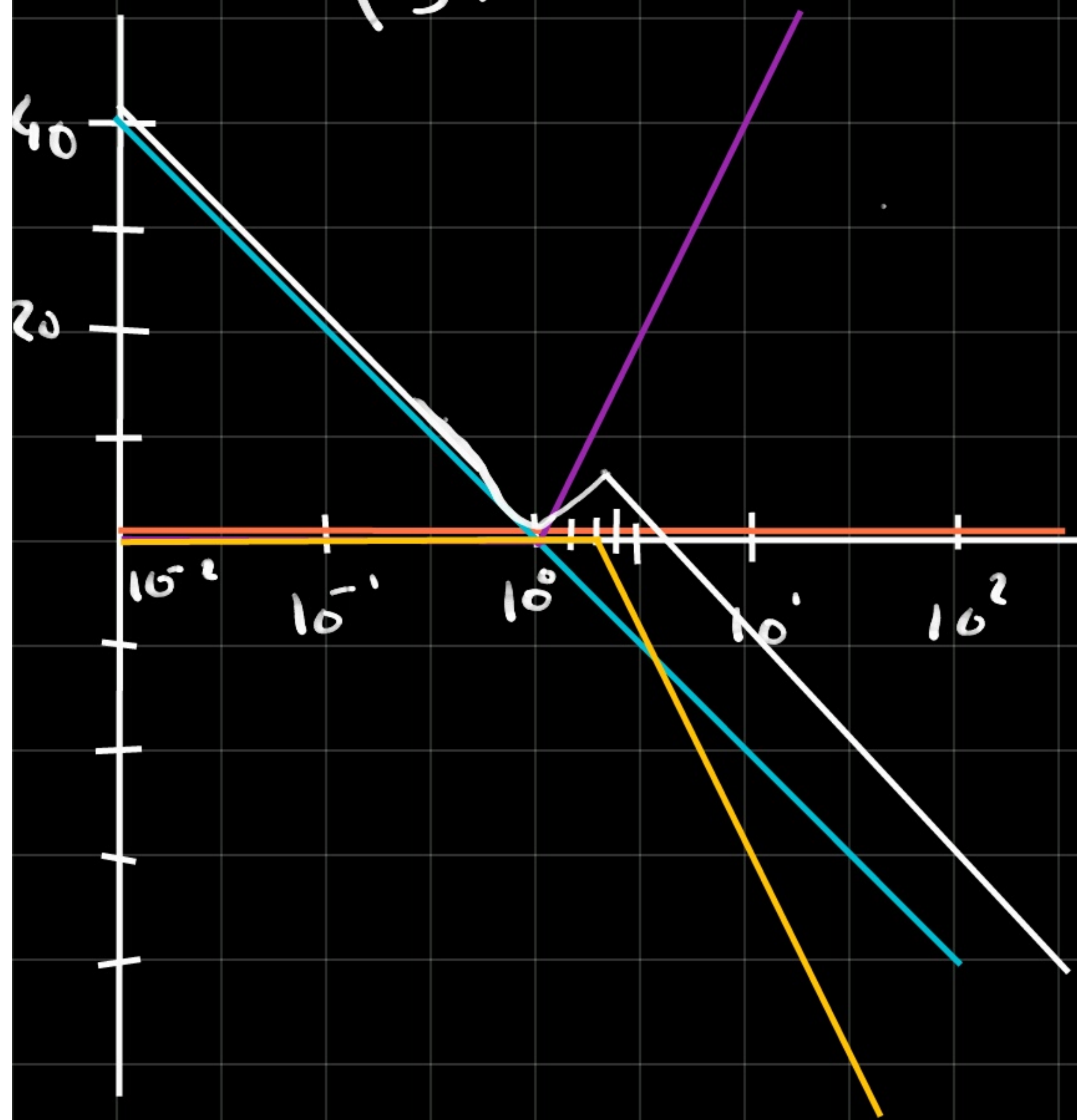B-7.3

Bode Diagram for G_{1(s)}

Bode Diagram for G_{2(s)}

```
Gs1=tf([1 1],[2 1])
figure
bode(Gs1)
Gs2=tf([1 -1],[2 1])
title("Bode Diagram for G_{1(s)}")
figure
bode(Gs2)
title("Bode Diagram for G_{2(s)}")
```

7.4' $G(s) = \dfrac{10(s^2 + 0.4s + 1)}{s(s^2 + 0.8s + 9)} = \boxed{\dfrac{10}{9}} \dfrac{\left[1 + (2 \cdot 0.2 j\omega/1) + (j\omega/1)^2\right]}{s\left[1 + 2 \cdot 0.4 j\omega/3 + (j\omega/3)^2\right]}$

$G_0 = 20\log\left(\dfrac{10}{9}\right) = 0,915$

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B-7.5

$$G(j\omega) = \frac{1}{(j\omega)^2 + 2\xi\omega_n(j\omega) + \omega_n^2} = \frac{1}{\left(\dfrac{j\omega}{\omega_n}\right)^2 + 2\xi\left(j\dfrac{\omega}{\omega_n}\right) + 1}$$
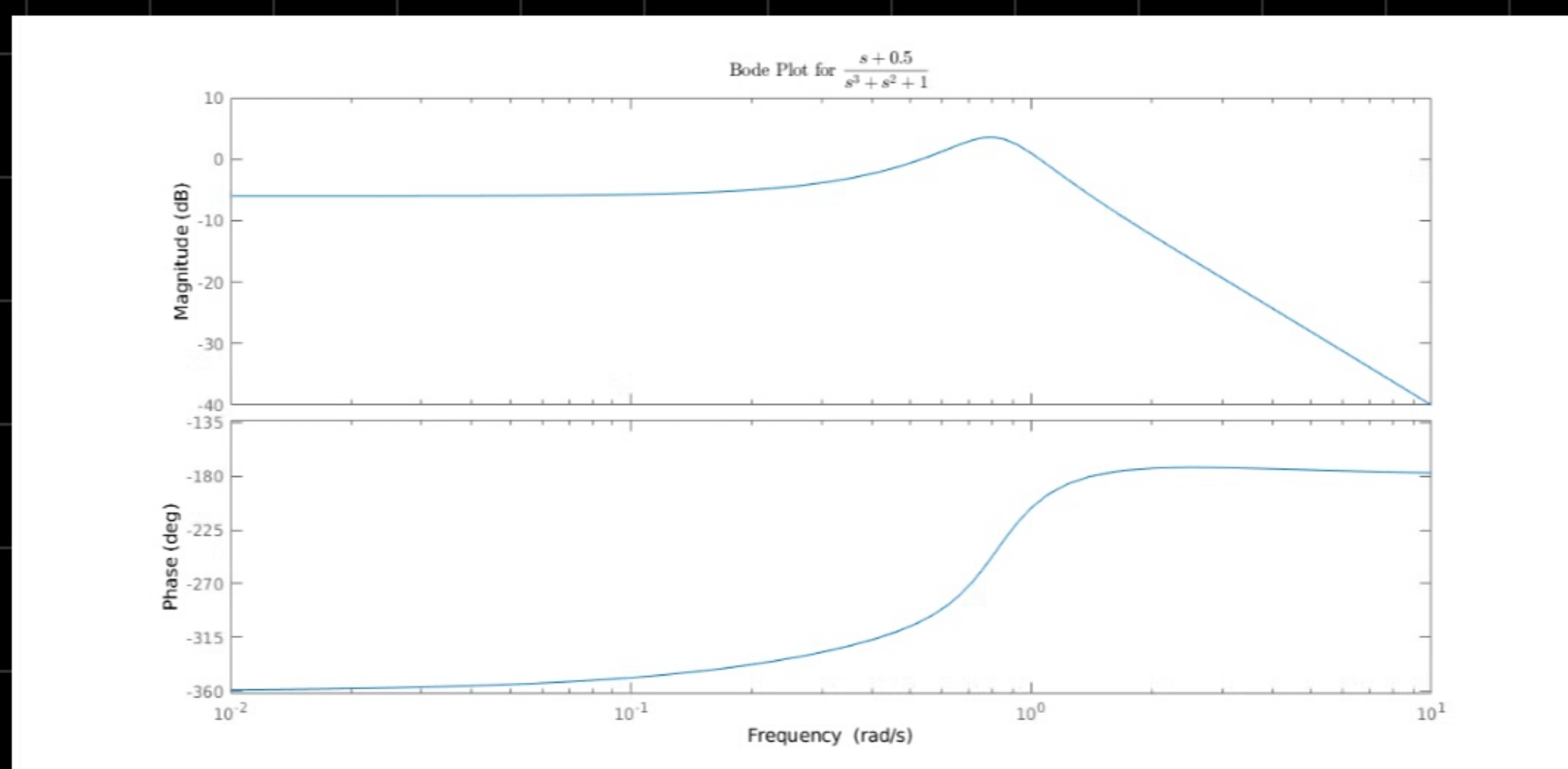
$$G(j\omega_n) = \frac{1}{-\dfrac{\omega_n}{\omega_m} + 2\xi j \dfrac{\omega_n}{\omega_m} + 1}$$

$$|G(j\omega_n)| = \left|\frac{1}{-1 + 2\xi j + 1}\right| = \frac{1}{2\xi}$$

B-7.6

```
Gs1=tf([1 0.5], [1 1 0 1])
figure
bode(Gs1)
```
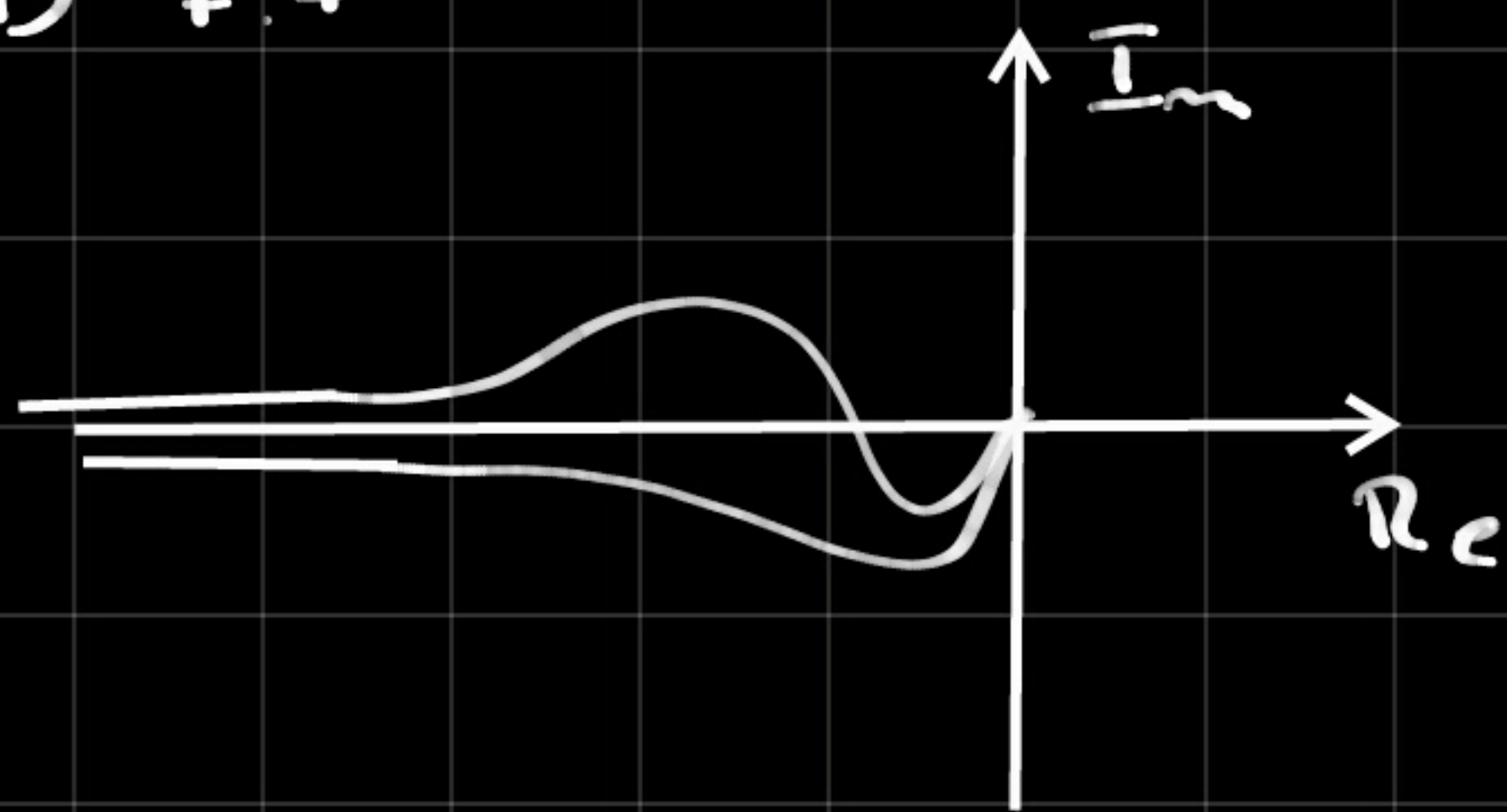

Bode Plot for $\frac{s + 0.5}{s^3 + s^2 + 1}$

O ângulo de fase do sistema acima vai de 0 a 180° pois o sistema é de fase não mínima. Assim, calculando a fase do sistema para $\omega \to 0$ e $\omega \to \infty$, temos:

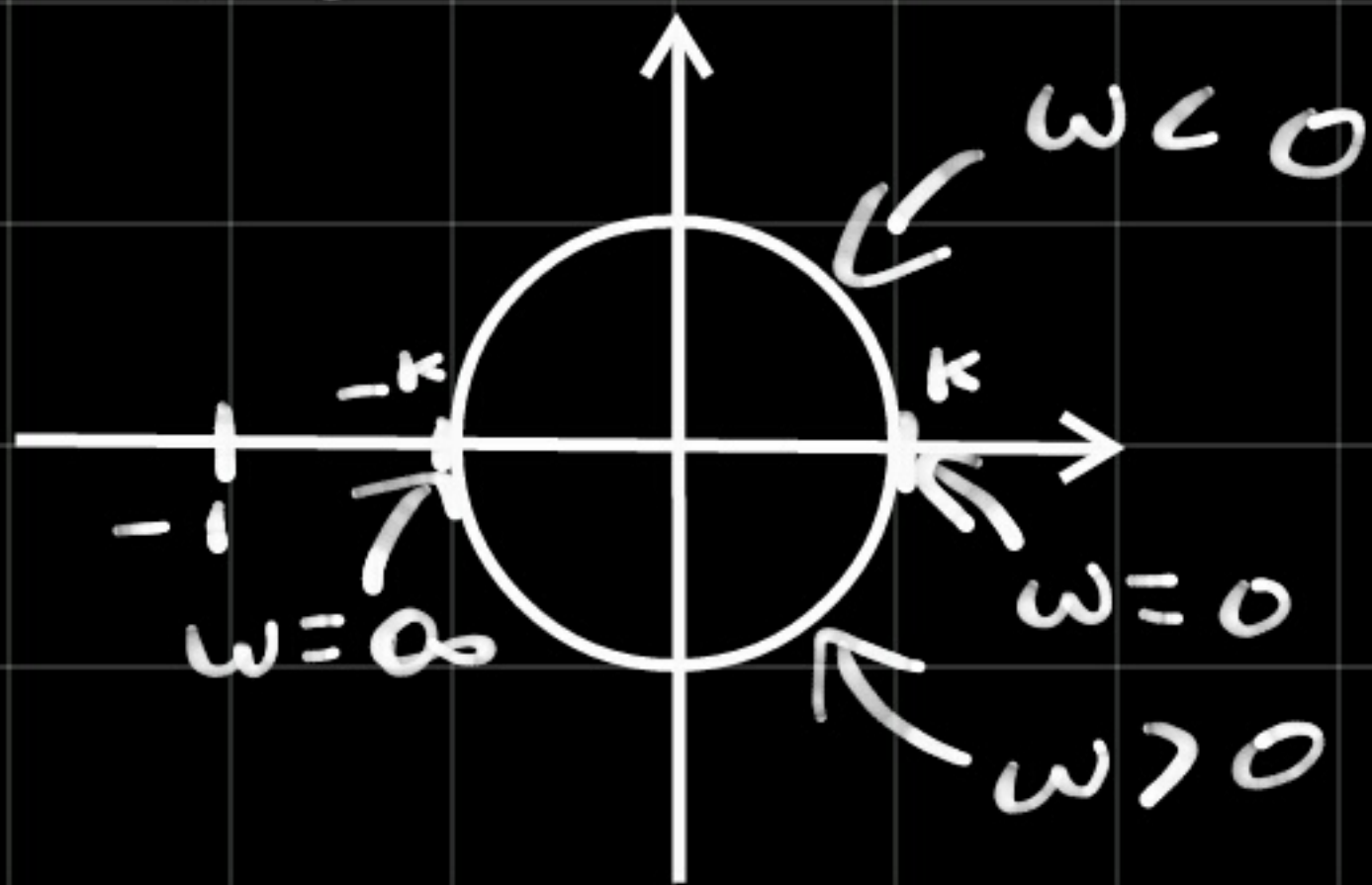$$\angle G(j0) = \angle 0{,}5 - \angle 1{,}4656 - tg^{-1}\left(\frac{0{,}7926}{0{,}2328}\right) + tg^{-1}\left(\frac{0{,}7926}{0{,}2328}\right) = 0$$

$$\angle G(j\infty) = 90 - 90 - tg^{-1}\left(\frac{\infty}{-0{,}2328}\right) - tg^{-1}\left(\frac{\infty}{-0{,}2328}\right) = 180°$$

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B-7.7

B-7.8

B-7.10

$$G_{(s)}H_{(s)} = \frac{10k(s+0.5)}{s^2(s+2)(s+10)}$$

Para $\omega = 0$

$$\lim_{\omega \to 0^+} G(j\omega)H(j\omega) = -\infty - j0 \left.\begin{cases} \lim_{\omega \to 0^-} G(j\omega)H(j\omega) = -\infty + j0 \end{cases}\right.$$

Para $\omega = \infty$

$$\lim_{\omega \to \infty^-} G(j\omega)H(j\omega) = -0 + j0 \left.\begin{cases} \lim_{\omega \to \infty^-} G(j\omega)H(j\omega) = -0 - j0 \end{cases}\right.$$

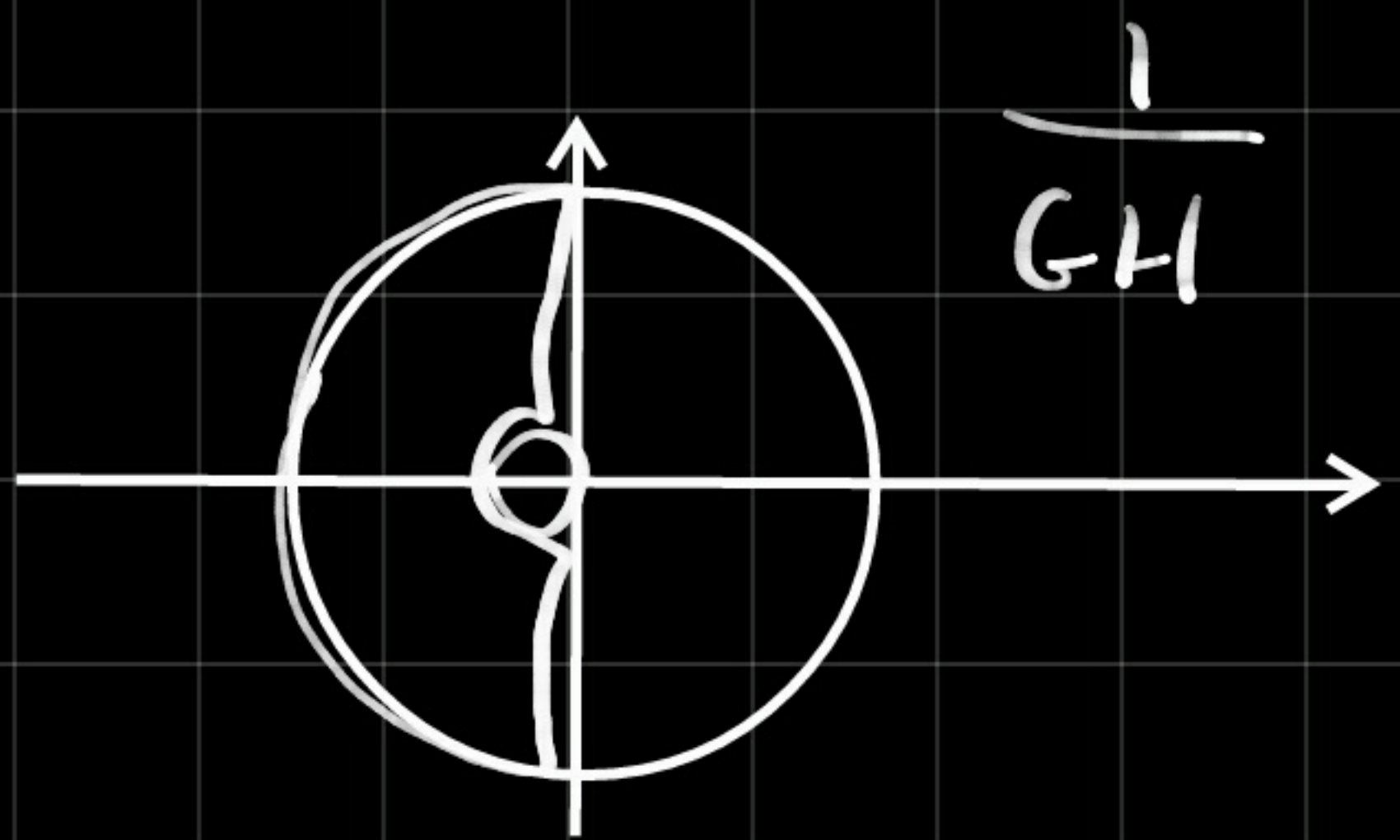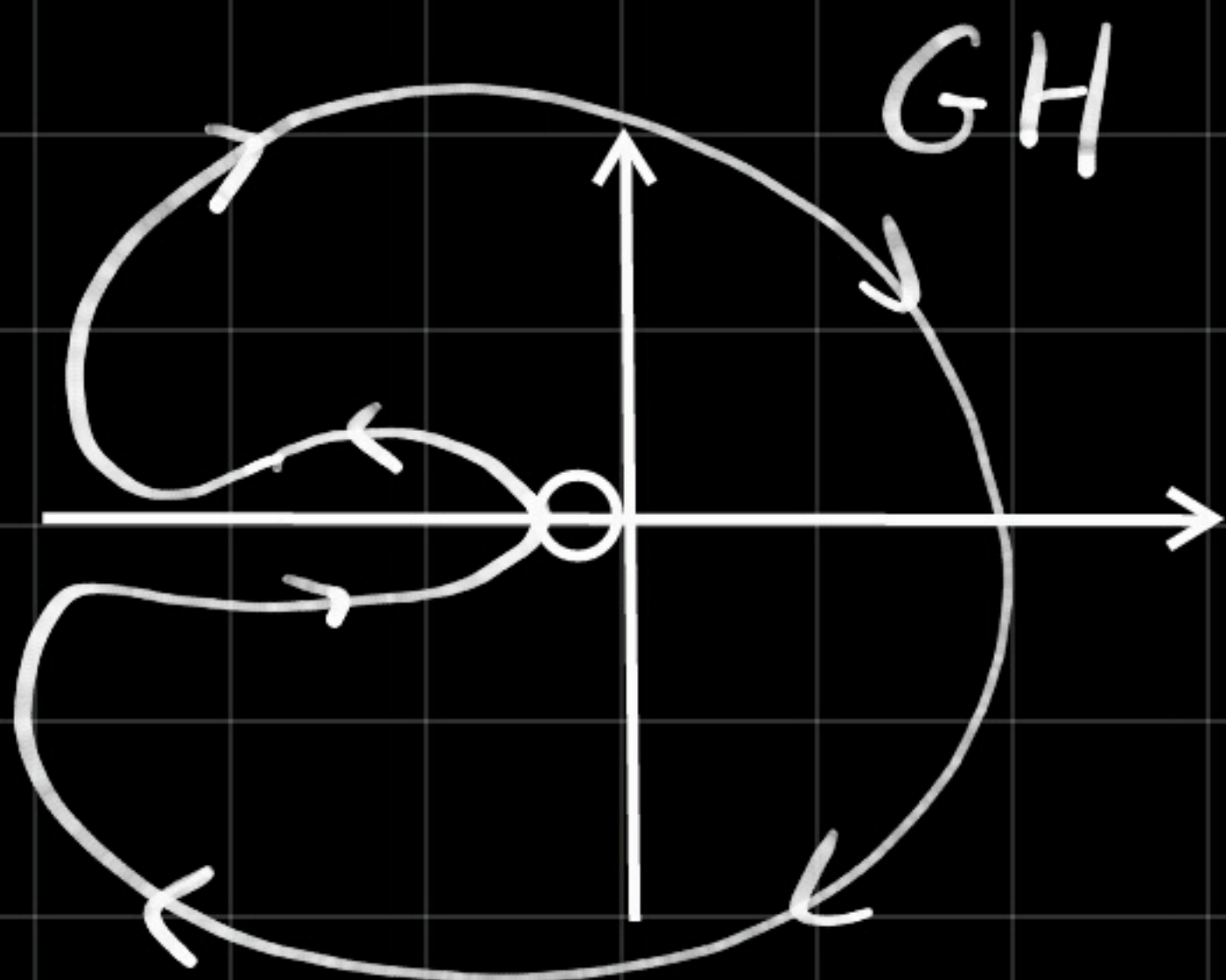Separando Parte real e imaginária, temos:

$$G(j\omega)H(j\omega) = \frac{10k(j\omega+0.5)}{(j\omega)^2(j\omega+2)(j\omega+10)} = \frac{10k(j\omega+0.5)}{-\omega^2(j\omega+2)(j\omega+10)} = \frac{10k(j\omega+0.5)}{\omega^4 - 12i\omega^3 - 20\omega^2}$$

$$= \frac{10k(j\omega+0.5)}{(\omega^4-20\omega^2)-i(12\omega^3)} \cdot \frac{(\omega^4-20\omega^2)+i(12\omega^3)}{(\omega^4-20\omega^2)+i(12\omega^3)} =$$

$$= \frac{-(5\omega^4+10\,\omega^2)+i(10\omega^5-140\omega^3)}{(\omega^4-20\omega^2)^2+(12\omega^3)^2}$$

$$= \frac{-(115\omega^4 + 10\,\omega^2) + i(10\omega^5 - 140\omega^3)}{(\omega^4 - 20\omega^2)^2 + (12\omega^3)^2 i}$$

$$\text{Real}\,(G(j\omega)\,H(j\omega)) = \frac{-(115\omega^4 + 10\omega^2)}{(\omega^4 - 20\omega^2)^2 + (1\,\omega^3)^2} =$$

$$= \frac{-(115\omega^4 + 10\omega^2) + i(10\omega^5 - 140\omega^3)}{\omega^8 - 104\omega^6 + 400\omega^4} = \frac{-(115\omega^2 + 10)}{\omega^6 - 104\omega^4 + 400\omega^2}$$

GH

$\frac{1}{GH}$

B-7.11

$$G(j\omega)\,H(j\omega) = \frac{k\,e^{-2j\omega}}{j\omega}$$

$$\angle G(j\omega)\,H(j\omega) = \angle [\cos(2\omega) - j\sin(2\omega)] - 90° =$$
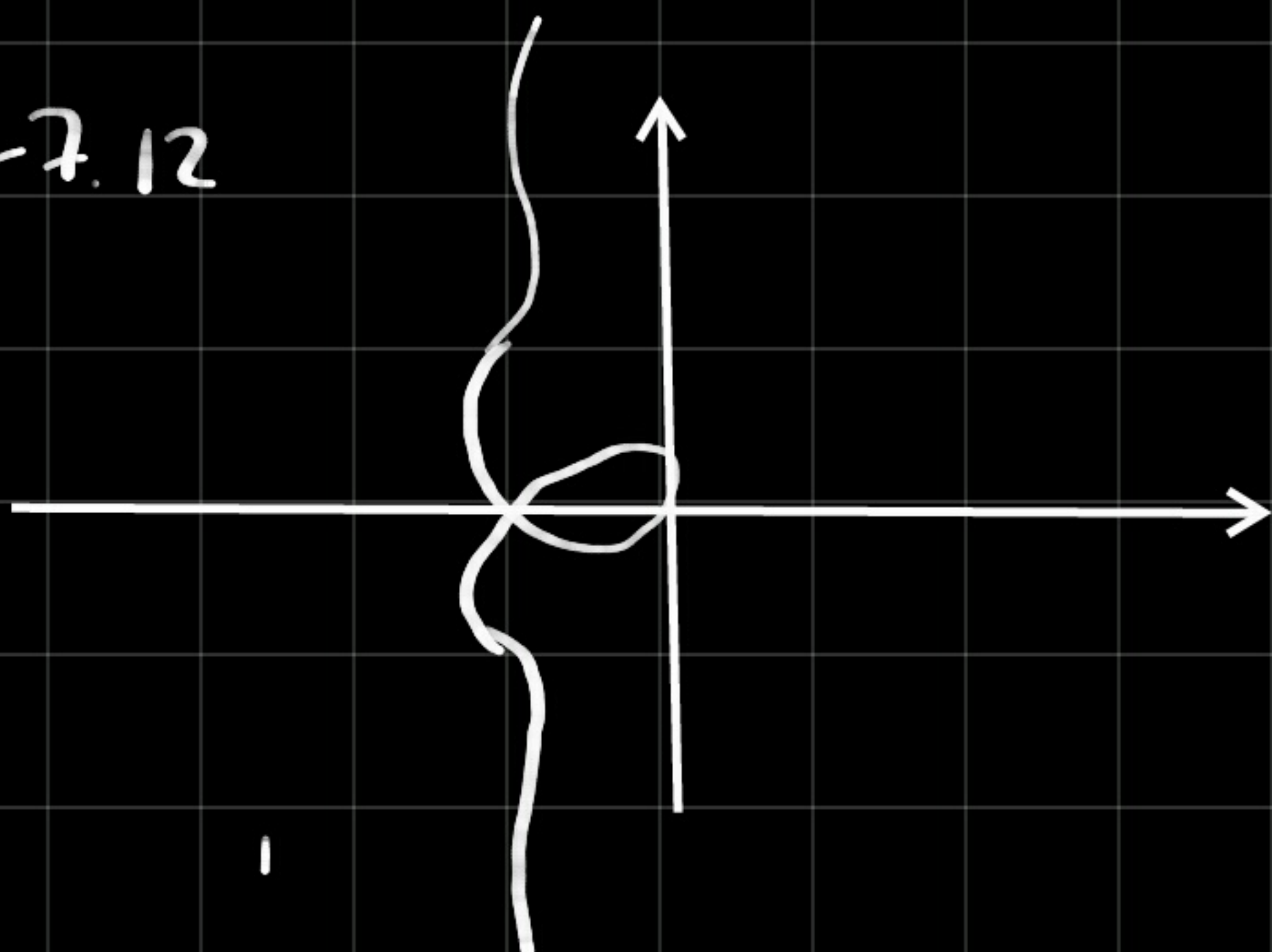
$$= -2\omega - 90°$$

Para $2\omega = 90°$, $\omega = 45°$, o ângulo alcança $180°$.

Com isso, precisamos que para $\theta = 45°$,

$|G(j\omega)H(j\omega)| < 1$

$$|G(j\omega)H(j\omega)| = \frac{k}{\omega}$$

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B-7.12

B-7-14

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