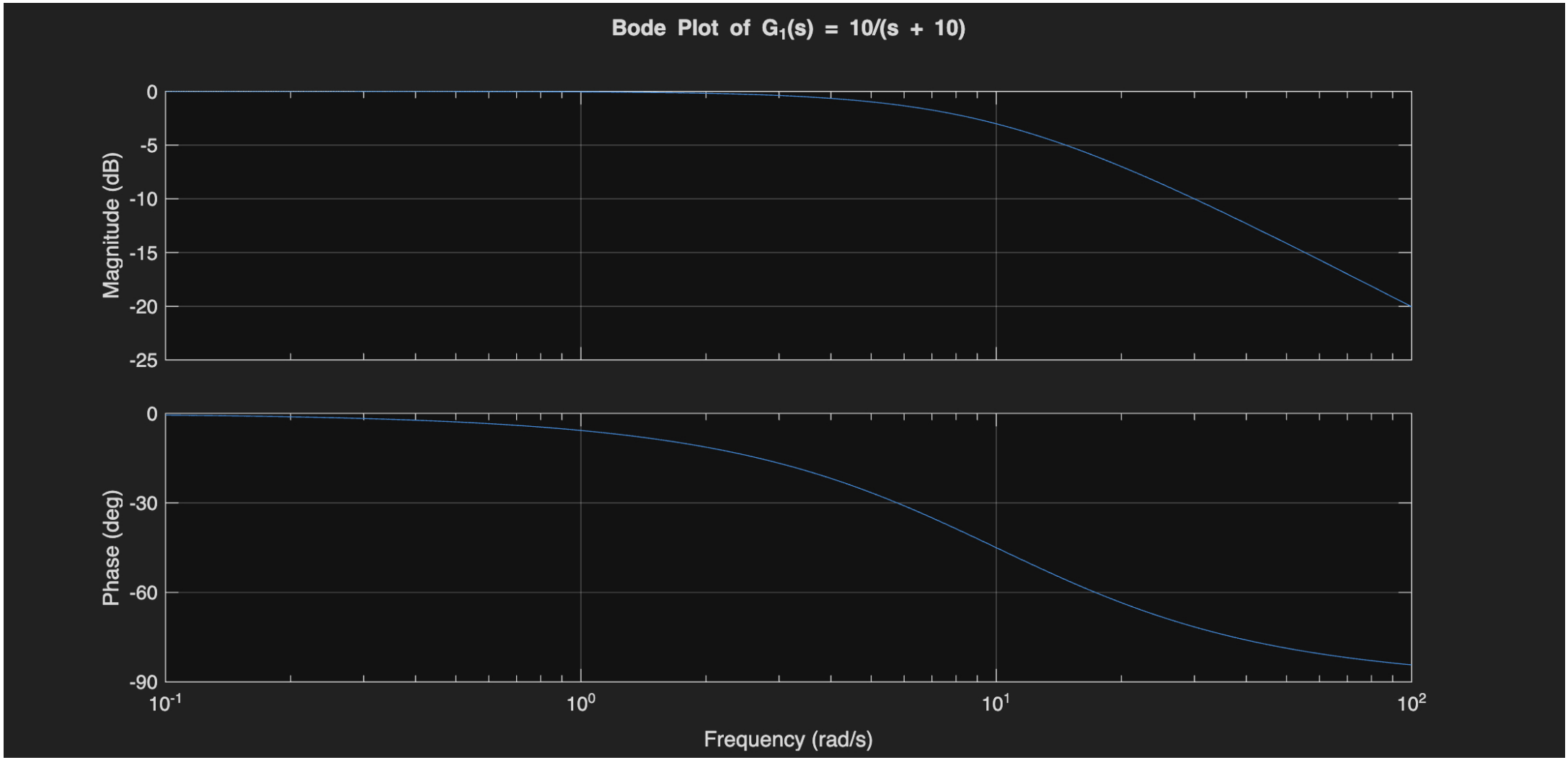
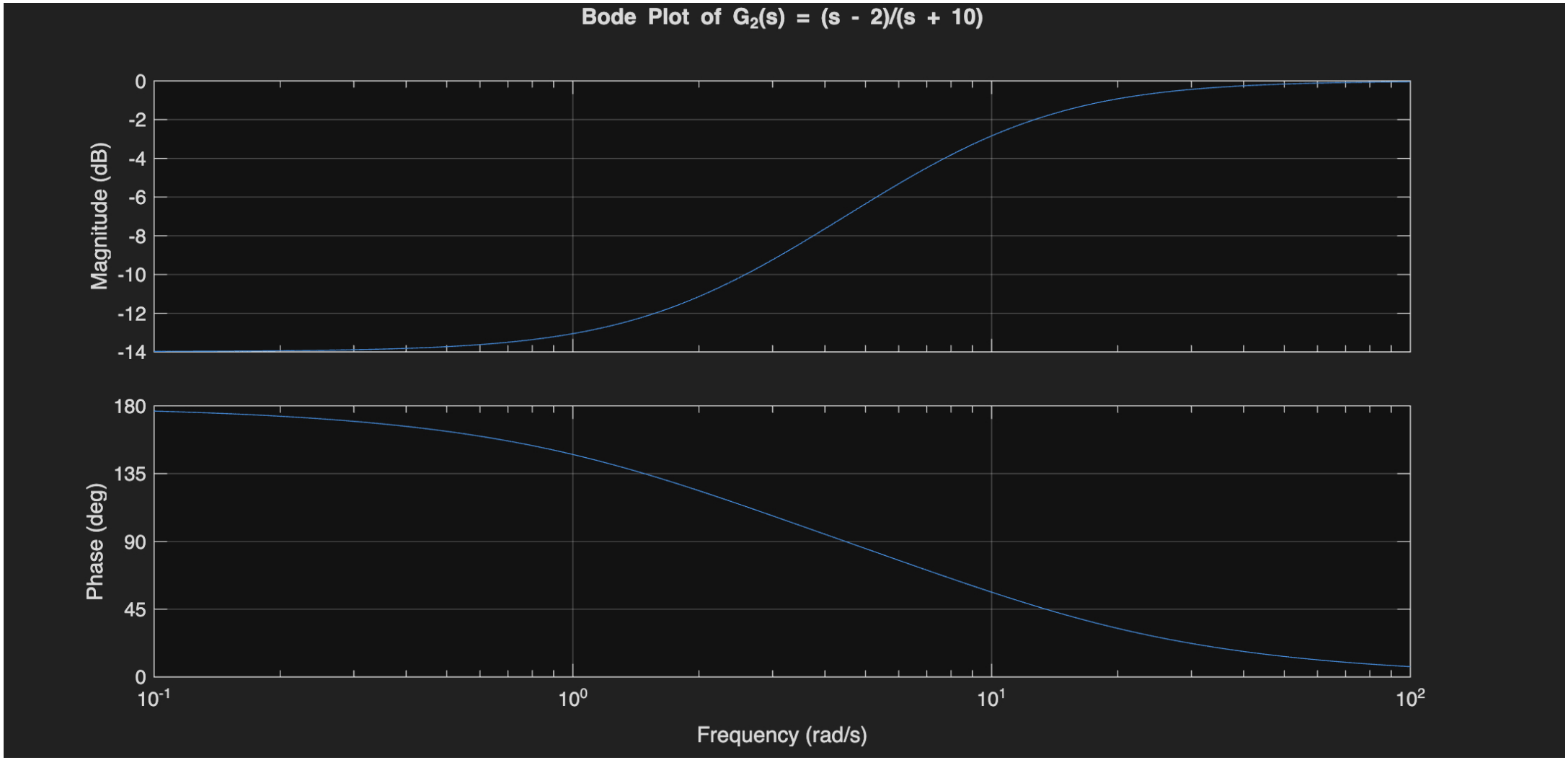
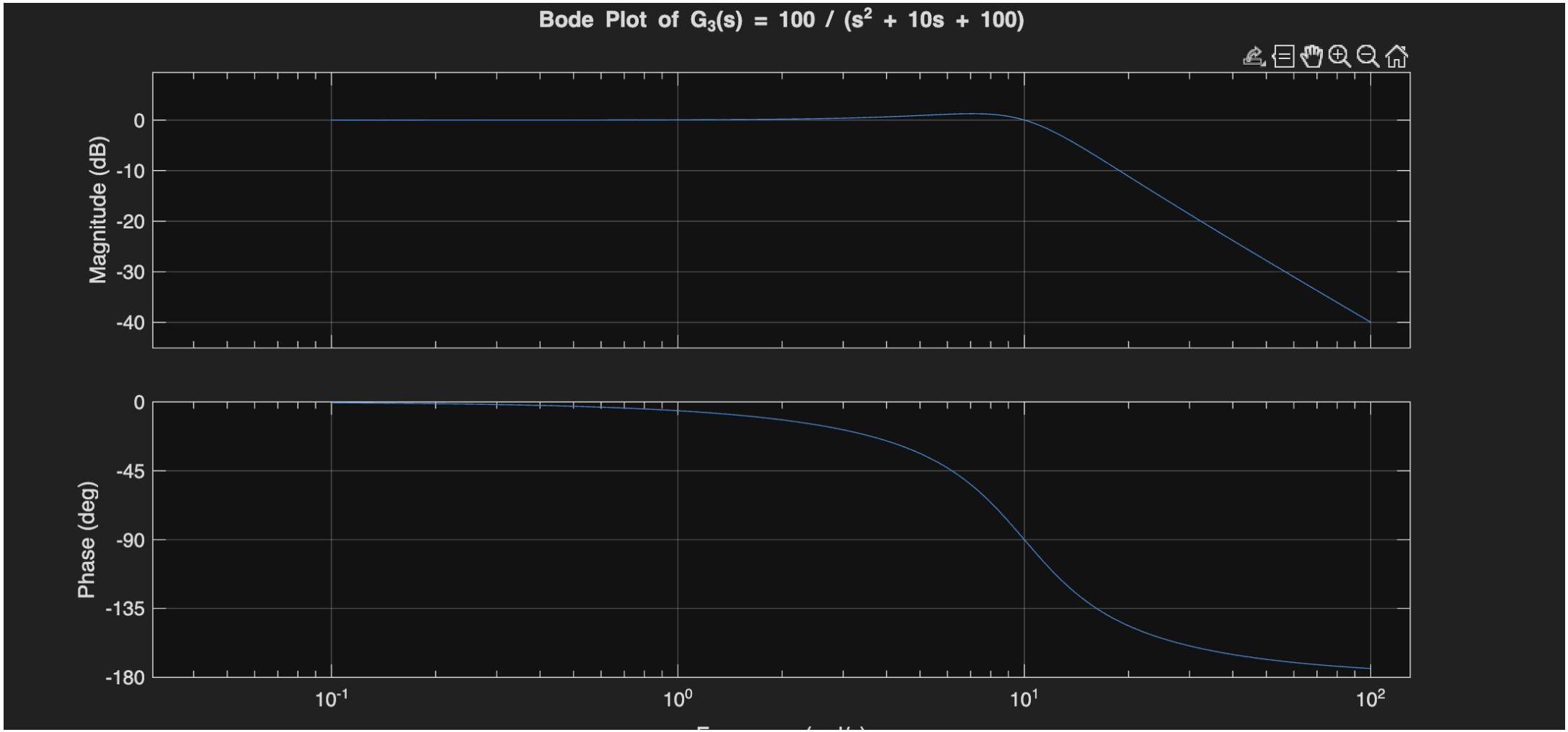
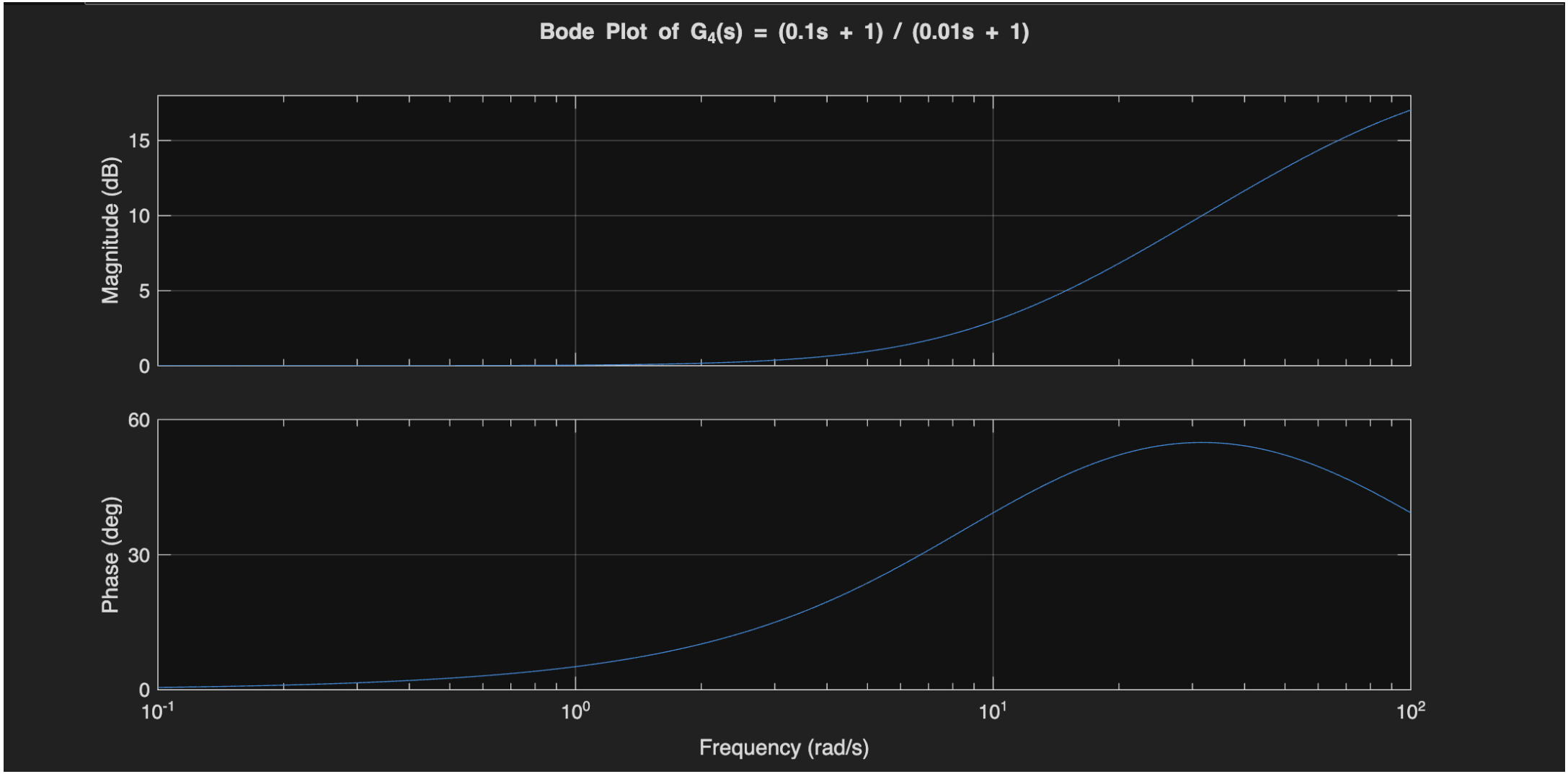

Bode Plot of G1(s) = 10/(s + 10)
Magnitude (dB)
0
-5
-10
-15
-20
-25
Phase (deg)
0
-30
-60
-90
10-1
100
101
102
Frequency (rad/s)


Bode Plot of G2(s) = (s - 2)/(s + 10)
Magnitude (dB)
0
-2
-4
-6
-8
-10
-12
-14
Phase (deg)
180
135
90
45
0
10-1
100
101
102
Frequency (rad/s)


Bode Plot of G3(s) = 100 / (s2 + 10s + 100)
Magnitude (dB)
0
-10
-20
-30
-40
Phase (deg)
0
-45
-90
-135
-180
10-1
100
101
102


Bode Plot of G4(s) = (0.1s + 1) / (0.01s + 1)
Magnitude (dB)
15
10
5
0
Phase (deg)
60
30
0
10-1
100
101
102
Frequency (rad/s)

PART-A

1.1 $G_1(s) = \dfrac{10}{s+10}$

Pole $\Rightarrow s = -10$

$G_1(0) = 1$

$G_1(s) = \dfrac{1}{\left(1+\frac{s}{10}\right)}$

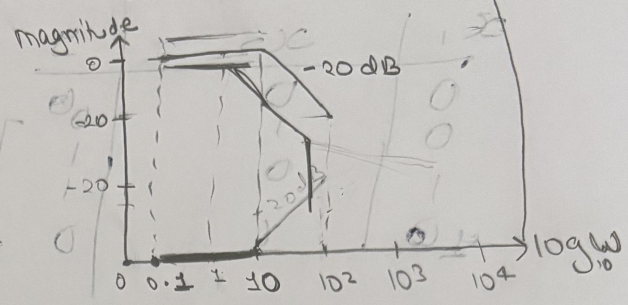
$\omega_c = 10$

$G_1 = 20\log_{10}\left(\frac{10}{10}\right) = 0$

$G_2 = 0 + -20\log_{10}\left(\frac{10}{10^2}\right) = -20\,dB$

$\phi = -\tan^{-1}\left(\frac{\omega}{10}\right)$

$\omega \in [0.1, 100]$



Phase

$0° \to -45° \to -90°$

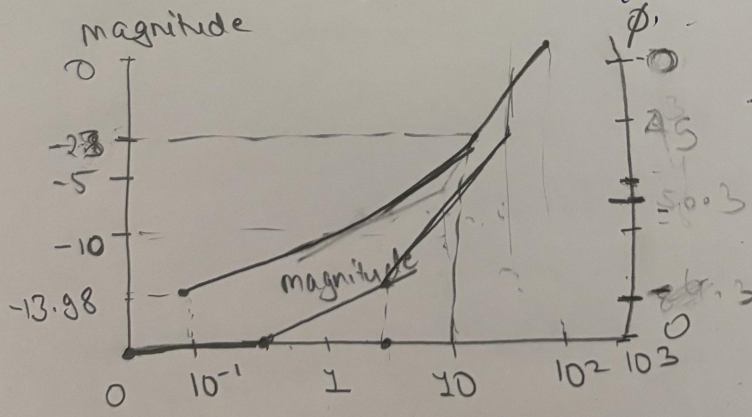
1.2) $G_2(s) = \dfrac{s-2}{s+10}$

Pole $s = -10$

Zero $s = 2$

$\dfrac{1}{5}\,\dfrac{-2\left(1+\left(-\frac{s}{2}\right)\right)}{10(1+0.1s)}$

$|G_2(0)| = \left|-\frac{1}{5}\right| = -0.2$



Phase

$= 90 - \tan^{-1}\left(\frac{\omega}{2}\right) - \left(-90 + \tan^{-1}\left(\frac{\omega}{10}\right)\right)$

$= 180 - \tan^{-1}\left(\frac{\omega}{2}\right) - \tan^{-1}\left(\frac{\omega}{10}\right)$

$G_2(j\omega) = -20\log\left(\dfrac{\omega^2+4}{\omega^2+100}\right)$ + from i

at $\omega = 0$, $\approx -13.98\,dB$

$\omega = 10$ $\approx -2.8\,dB$

4): A RHP zero decreases the phase that causes lag, usually it gives positive phase shift like left half-plane-zero

1.3 //

$$G_3(s) = \frac{100}{s^2+10s+100}$$

$$\frac{100}{(s-5+\sqrt{3}j)(s-5-5\sqrt{3}j)}$$

$j\omega$

$$G_3(j\omega) = \frac{100}{(100-\omega^2) + 10j\omega}$$

$$\cancel{20\log_{10}} -40 - 20\log_{10}\left((100-\omega^2)^2 + (10\omega)^2\right)^{\frac{1}{2}}$$

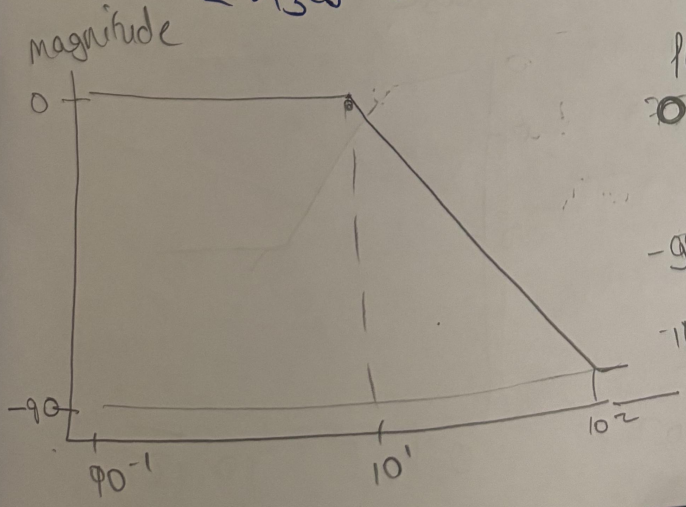
$|G_3(0)| = 0\,dB$

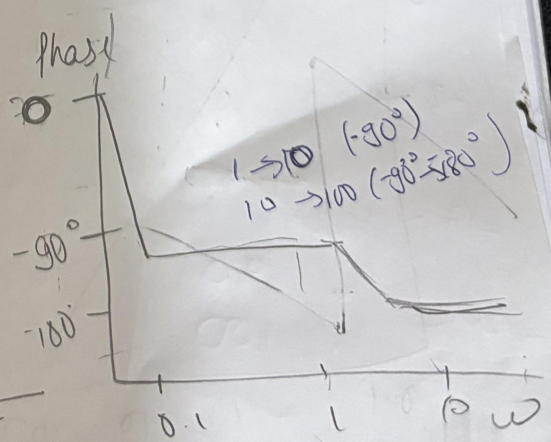
$|G_3(10j)| = 0\,dB$

$\omega >> 10.$

$\hookrightarrow G_3 = -40$

$$\angle G_3(j\omega) = -\tan^{-1}\left(\frac{10\omega}{100-\omega^2}\right)$$





1.4

$$G_u(s) = \frac{0.1s+1}{0.01s+1}$$

zero: $s = -10$
Pole: $s = -100$

$$G_u(j\omega) = \frac{1+0.1j\omega}{1+0.01j\omega}$$

$$G_u(j\omega) = 20\log_{10}\left(\frac{1+(\omega/10)^2}{1+(10^{-2}\omega)^2}\right)$$

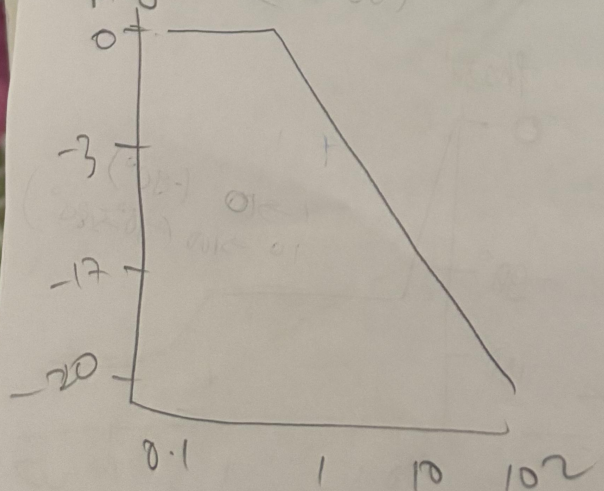
ω	$G_u(j\omega)$
0.1	0
1	0
10	-3
10^2	-17
$\omega >> 10$	-20

$\omega >> 10$

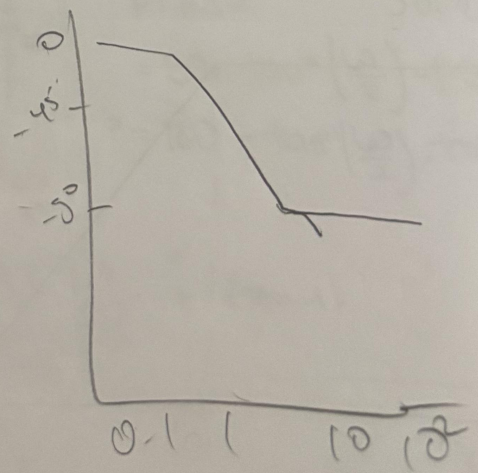
$$\angle G(j\omega) = \tan^{-1}\left(\frac{\omega}{10}\right) - \tan^{-1}\left(\frac{\omega}{100}\right)$$

ω	$\angle$
0.1	0.5
1	5°
10	39°
10^2	39°

magnitude

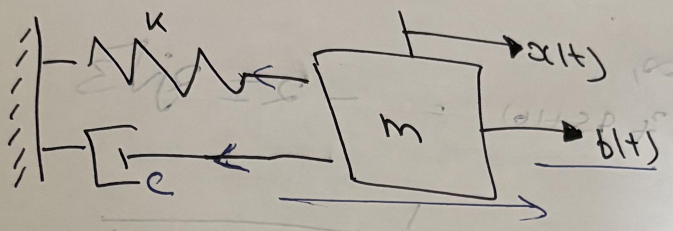


Phase



4) ~~at $\omega = 10$ rad/s~~ ~~phase is~~ zero(10) is at lower frequency than pole(100), so it leads to addition of (+)ve phase.

Part-B



B.1

① $b(t) - Kx - c\frac{dx}{dt} = m\frac{d^2x}{dt^2}$

$$\boxed{mx''(t) + c\,x'(t) + Kx(t) = F(t)}$$

② $\mathcal{L}:(\ \ ) \rightarrow \mathcal{L}:b(t)$, $x(0) = x'(0) = 0$

$ms^2X(s) + csX(s) = F(s)$

$+KX(s)$

$(ms^2 + cs + K)X(s) = F(s)$

③ Transfer Fxn

$G(s) = \frac{X(s)}{F(s)} = \frac{1}{K\left(\frac{m}{K}s^2 + \frac{c}{K}s + 1\right)}$

B.2 $m = 1kg$, $d = 4$, $c = 16$

$$G(s) = \frac{1}{16\left(\frac{s^2}{16} + \frac{1}{4}s + 1\right)}$$

zero: at $s = \infty$,

Poles: $(s^2 + 4s + 16) = -2 \pm 2j\sqrt{3}$

$$\cancel{G(s) = \frac{1}{16(s - 2 + 2j\sqrt{3})}}$$

$$G(s) = \frac{1}{s^2 + 4s + 16}$$

$$G(j\omega) = \frac{1}{-\omega^2 + 4j\omega + 16}$$

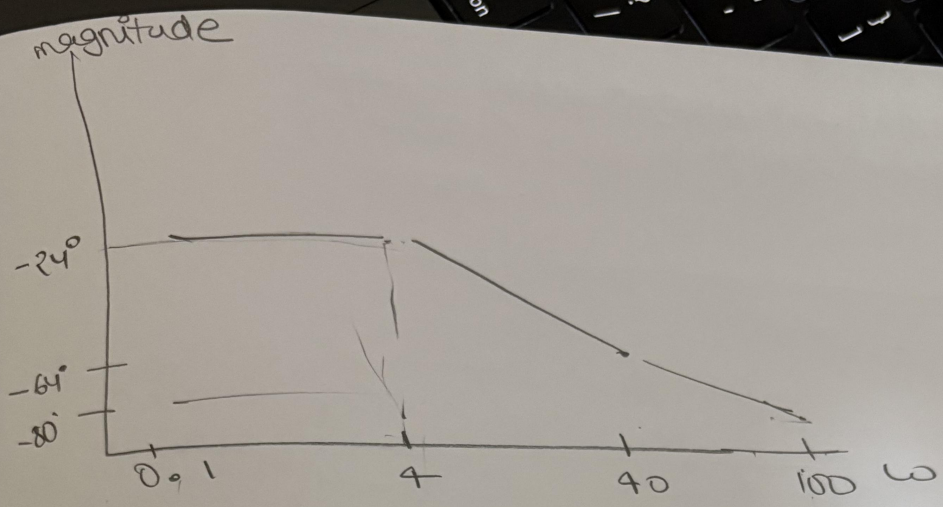
$$\frac{1}{(16 - \omega^2) + 4j\omega}$$

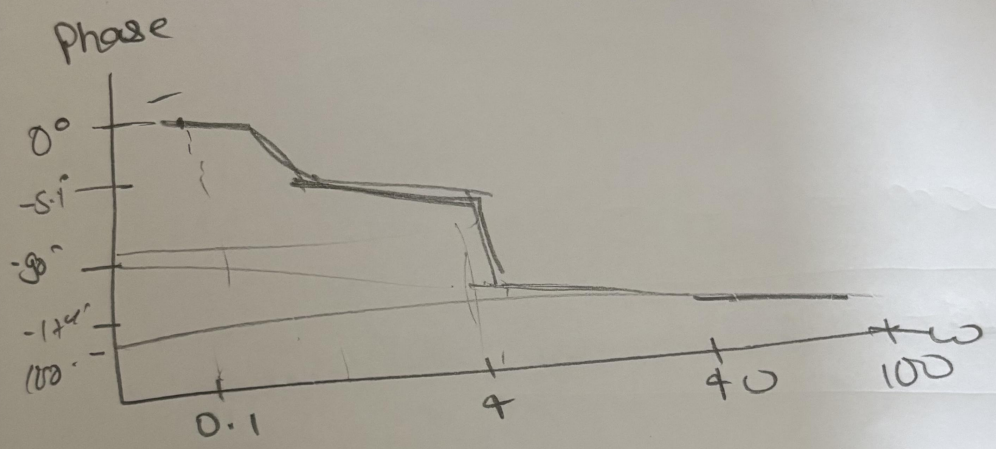
$\omega_c = 4$

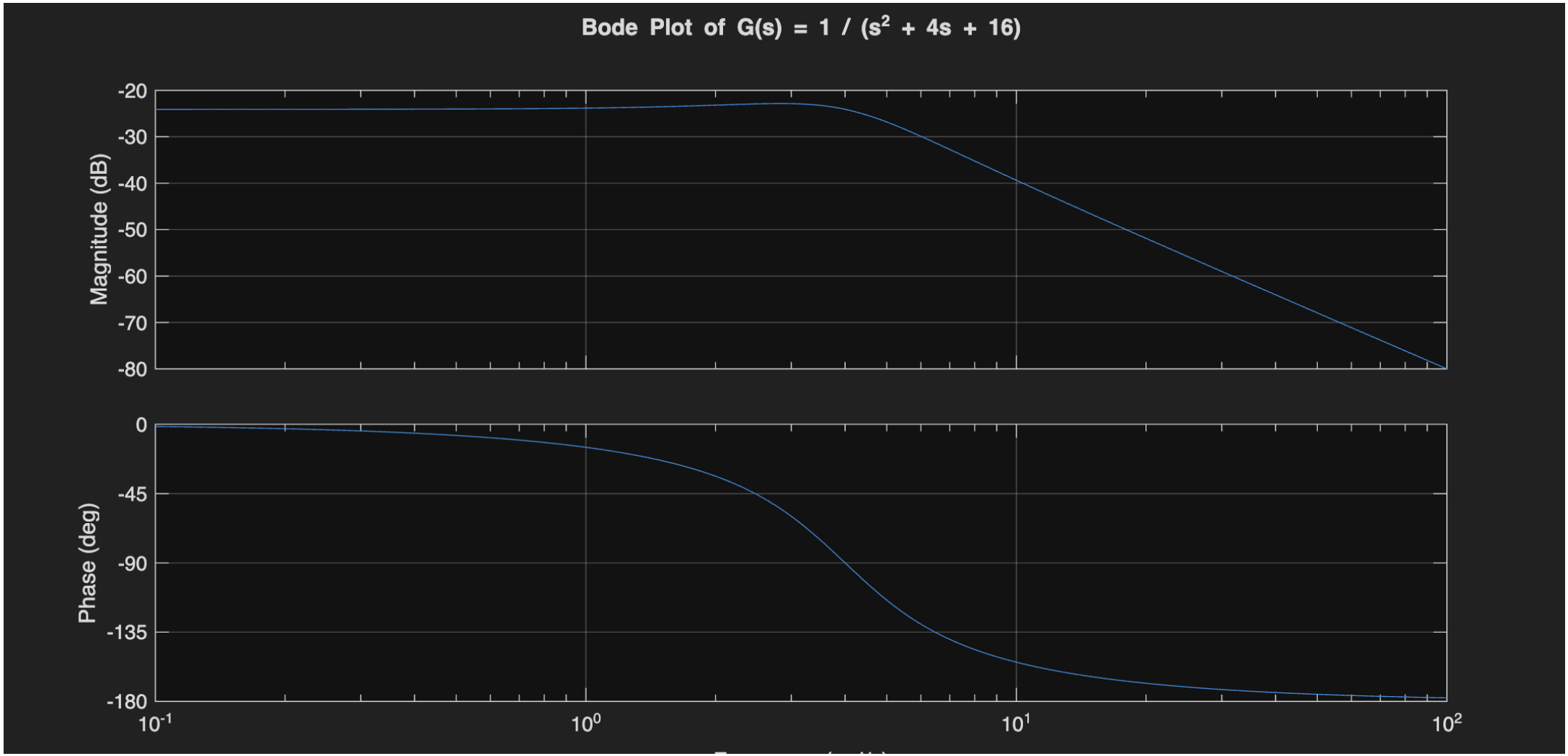
$\omega_L = 0.1 \times 4 = 0.4$

$\omega_H = 10 \times 4 = 40$

ω	$20\log_{10}\lvert G(j\omega)\rvert$	$\tan^{-1}\left(\frac{4\omega}{16-\omega^2}\right)$
0.1	-24 dB	0
0.4	-24 dB	0.5.7°
4	-24 dB	-90°
40	-64 dB	-174°
100	-80 dB	-180°


magnitude
-24°
-64°
-80°
0.1
4
40
100
ω


Phase
0°
-51°
-90°
-174°
180°
0.1
4
40
100
ω


Bode Plot of G(s) = 1 / (s^2 + 4s + 16)
Magnitude (dB)
-20
-30
-40
-50
-60
-70
-80
Phase (deg)
0
-45
-90
-135
-180
10^-1
10^0
10^1
10^2