1.1) $G_1(s) = \dfrac{10}{s+10} \Rightarrow$ **Pole:** $s = -10$

$G_1(0) = 1$

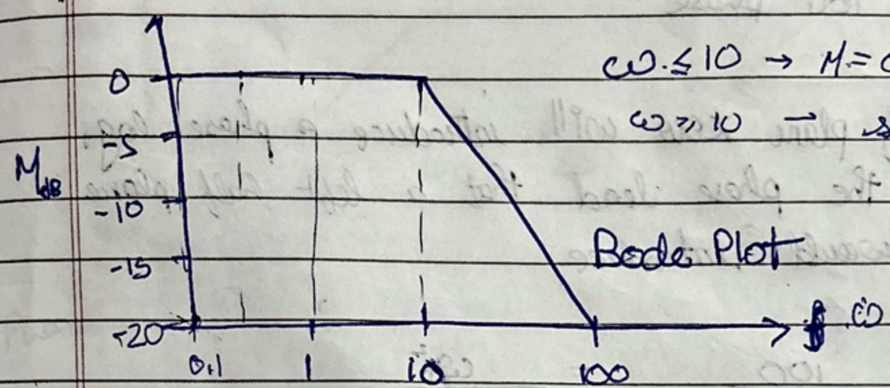
$= \dfrac{1}{1 + s/10}$

$\Rightarrow \omega_c = 10$ rad/s

$M_{dB} = 20 \log_{10} |G_1(j\omega)| = 0$ dB (at $s = 0$)

$\omega \leq 10 \rightarrow M = 0$ dB

$\omega \geq 10 \rightarrow$ slope $= -20$ dB/dec

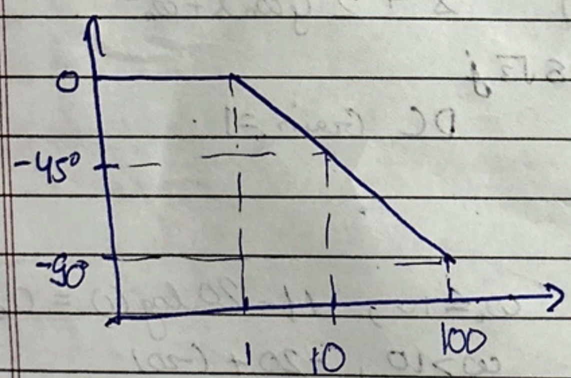


Bode Plot

$\omega \leq 1 \longrightarrow 0°$

$\omega \in (1, 100) \rightarrow 0$ to $-90°$

$\omega \geq 100 \longrightarrow -90°$



1.2) $G_2(s) = \dfrac{s-2}{s+10} \Rightarrow$ Zero: $s = 2$ $\qquad G_2(0) = -1/5$

Pole: $s = -10$

$= -1/5 \left(\dfrac{1 - s/2}{1 + s/10} \right) \Rightarrow \omega_z = 2, \ \omega_p = 10$

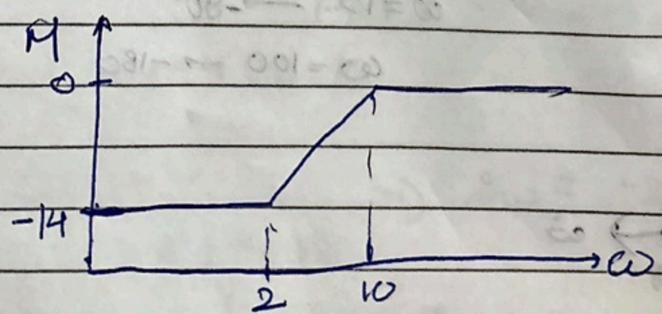
$K = -0.2$

$M_{dB} = 20 \log_{10} |-0.2| = 14$ dB

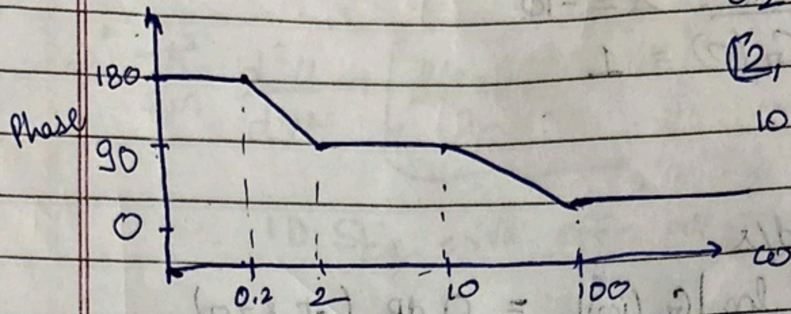
$\omega < 2 \rightarrow M = -14$ dB

$\omega \in (2, 10) \rightarrow$ slope $= +20$

$\omega \geq 10 \rightarrow$ slope $= 0$



Phase Plot



$0.2 \rightarrow 180^\circ$

$\boxed{2, 10} \rightarrow 90^\circ$

$100 \rightarrow 0^\circ$

$K < 0 \longrightarrow 180^\circ$ phase

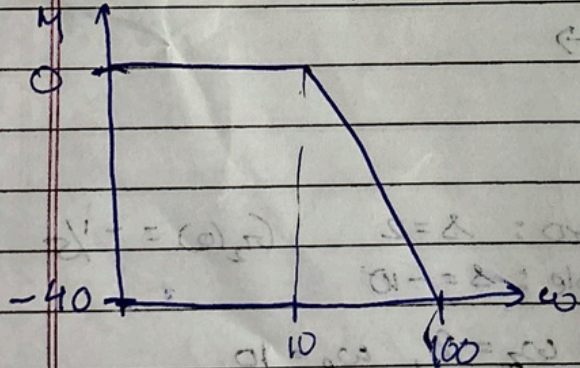
4) A right half plane zero will introduce a phase lag, contrary ~~compared~~ to the phase lead that a left half plane zero ~~could~~ would introduce

A3) $G_3(s) = \dfrac{100}{s^2 + 10s + 100} = \dfrac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$

$s_{1,2} = -5 \pm 5\sqrt{3}j$

$\omega_n = 10$ DC Gain $= 1$

Damping ratio $(\zeta) = 1/2$

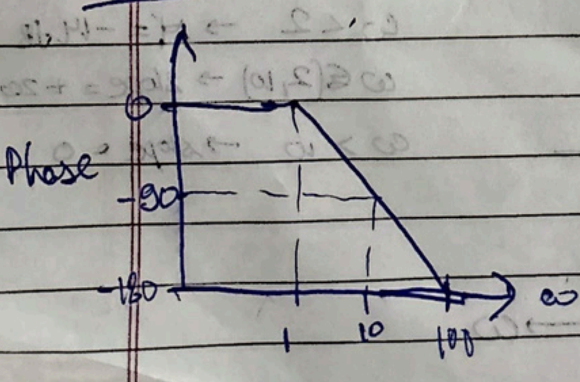


$\omega \le 10, \; M = 20 \log(1) = 0\,dB$

$\omega > 10, \; -20 + (-20)$

$= -40 \rightarrow$ slope

Phase Plot



$\omega \le 1 \rightarrow 0^\circ$

$\omega = 10 \longrightarrow -90^\circ$

$\omega = 100 \rightarrow -180$

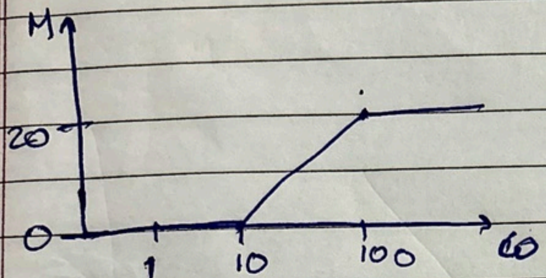
A4) $G(s) = \dfrac{0.1s+1}{0.01s+1}$, Zero :- $s = -10$

Pole :- $s = -100$

$G_4(0)' = 1$

$\omega_z = 10$ r/s

$\omega_p = 100$ r/s



$\omega < 10 \rightarrow M = 0$

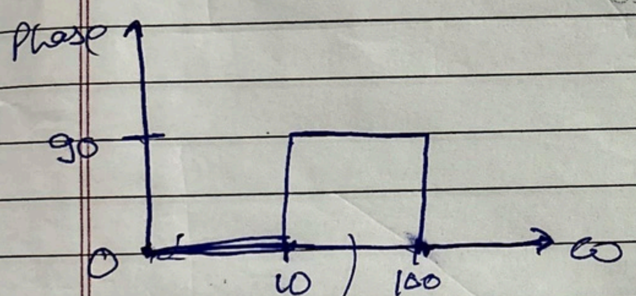
$\omega = 10 \rightarrow +20$ dB/dec

$\omega \geq 100 \rightarrow (20-20) = 0$ dB/dec

$M = 20 \log(10)$

$= 20$ dB

Phase Plot



$\omega \leq 10 \rightarrow 0°$

$\omega \in [10, 100) \rightarrow +90°$

$\omega \geq 100 \rightarrow (90-90)° = 0°$

4) B/w zero & Pole there is phase lead

B1) $m\ddot{x}(t) = F(t) - d\dot{x}(t) - c\,x(t)$

After Laplace Transform

$$ms^2 X(s) = F(s) - ds\,X(s) - cX(s)$$

$$\Rightarrow G(s) = \frac{X(s)}{F(s)} = \frac{1}{ms^2+ds+c}$$

B2) $m = 1$, $d = 4$, $c = 16$

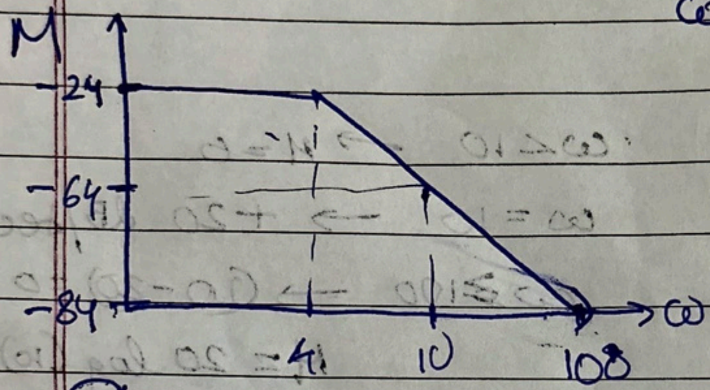
$$G(s) = \frac{1}{s^2+4s+16} \Rightarrow s_{1,2} = -2 \pm 2\sqrt{3}\,j$$

By Comparing,

$\omega_n = 4$, $\zeta = 0.5$

$M = 20 \log_{10} (1/16) \approx -24\ dB$

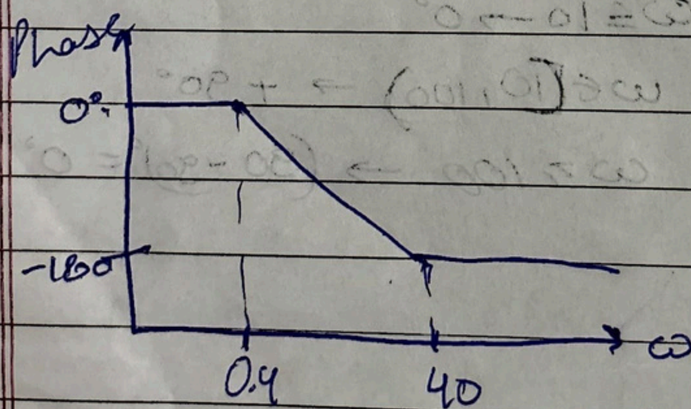
$\omega > 4 \rightarrow$ slope $= -40$



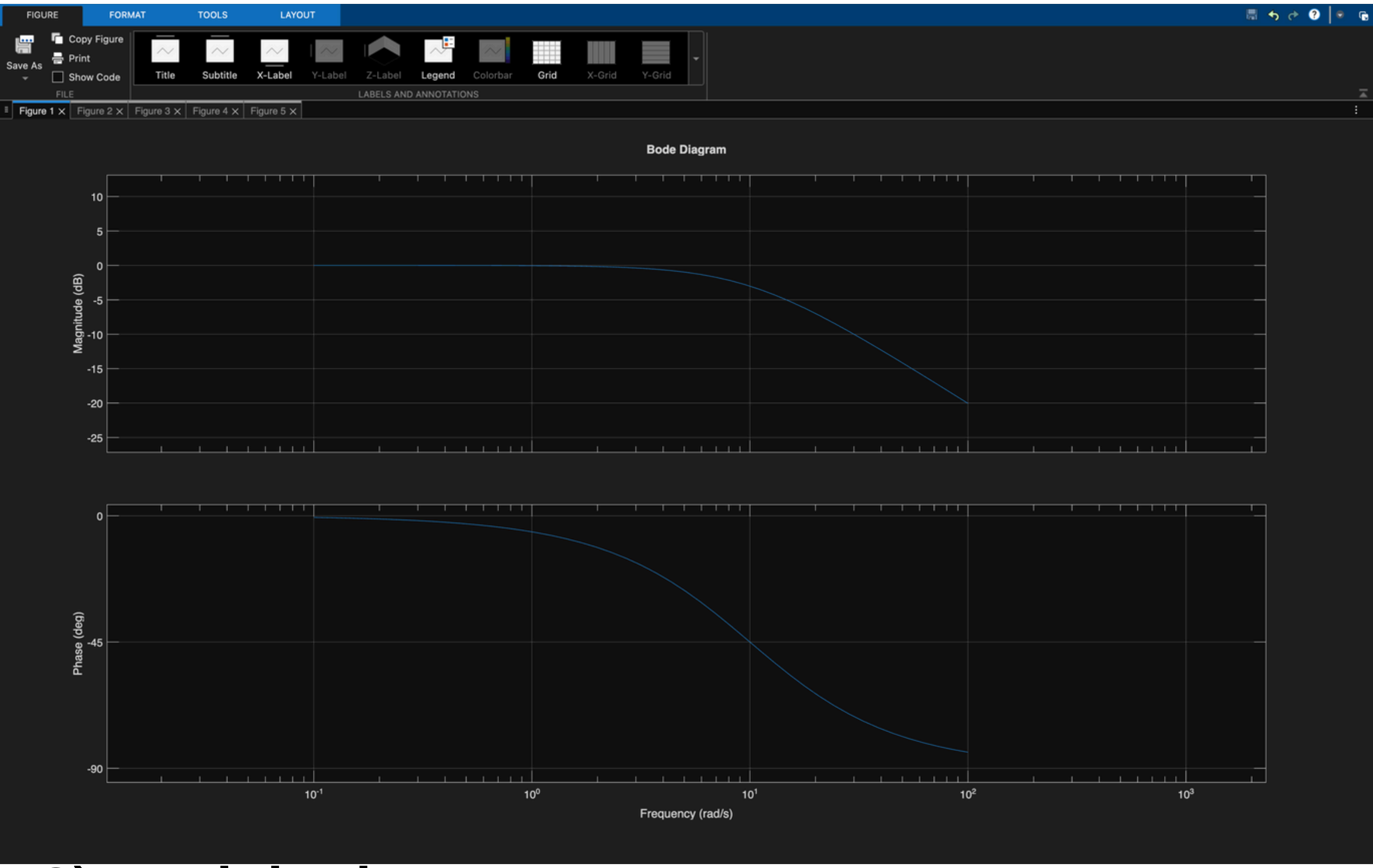
Phase Plot

$\omega \leq \frac{\omega_n}{10} \rightarrow 0°$

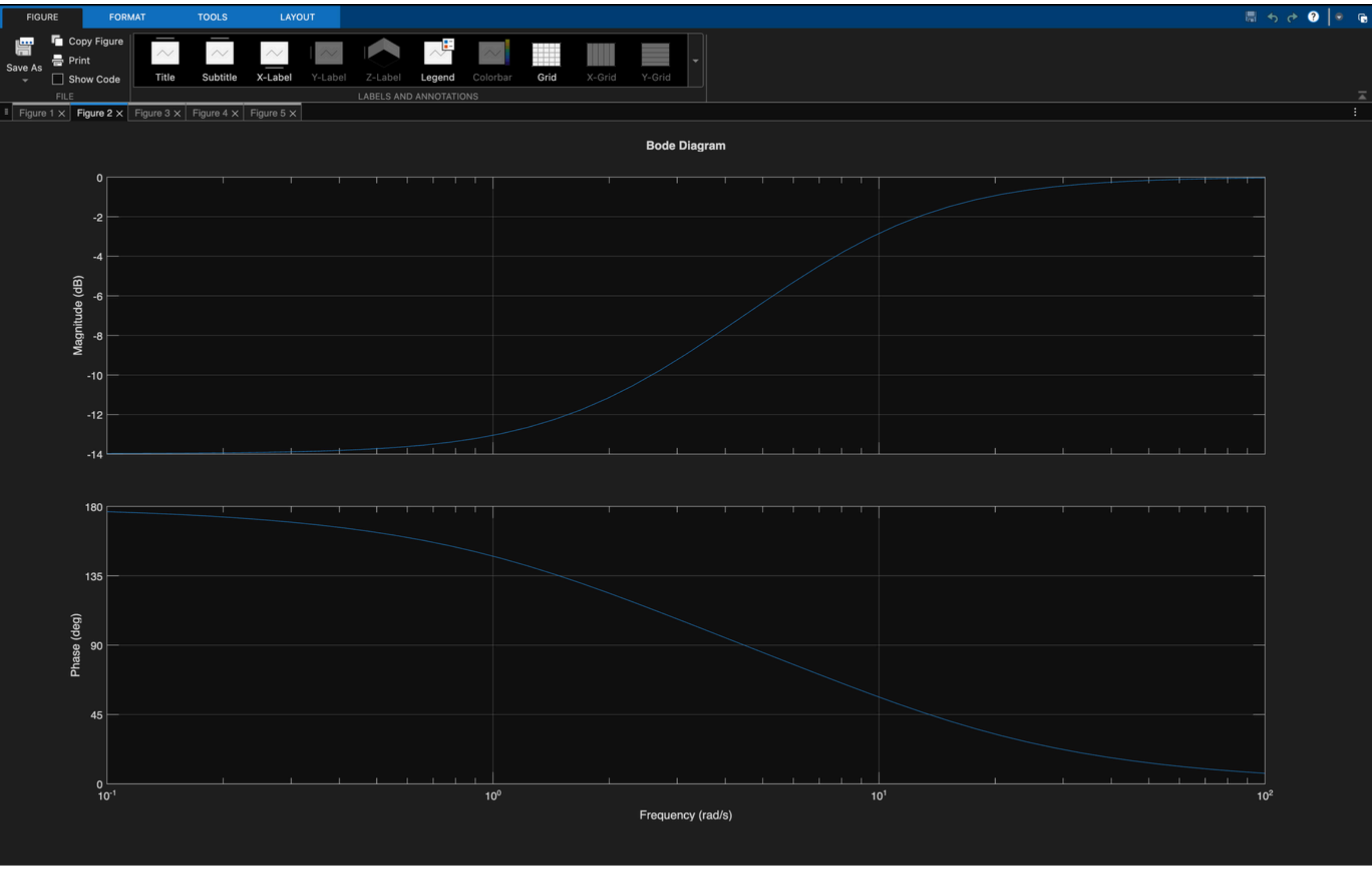
$\omega \geq 10\omega_n \rightarrow -180$



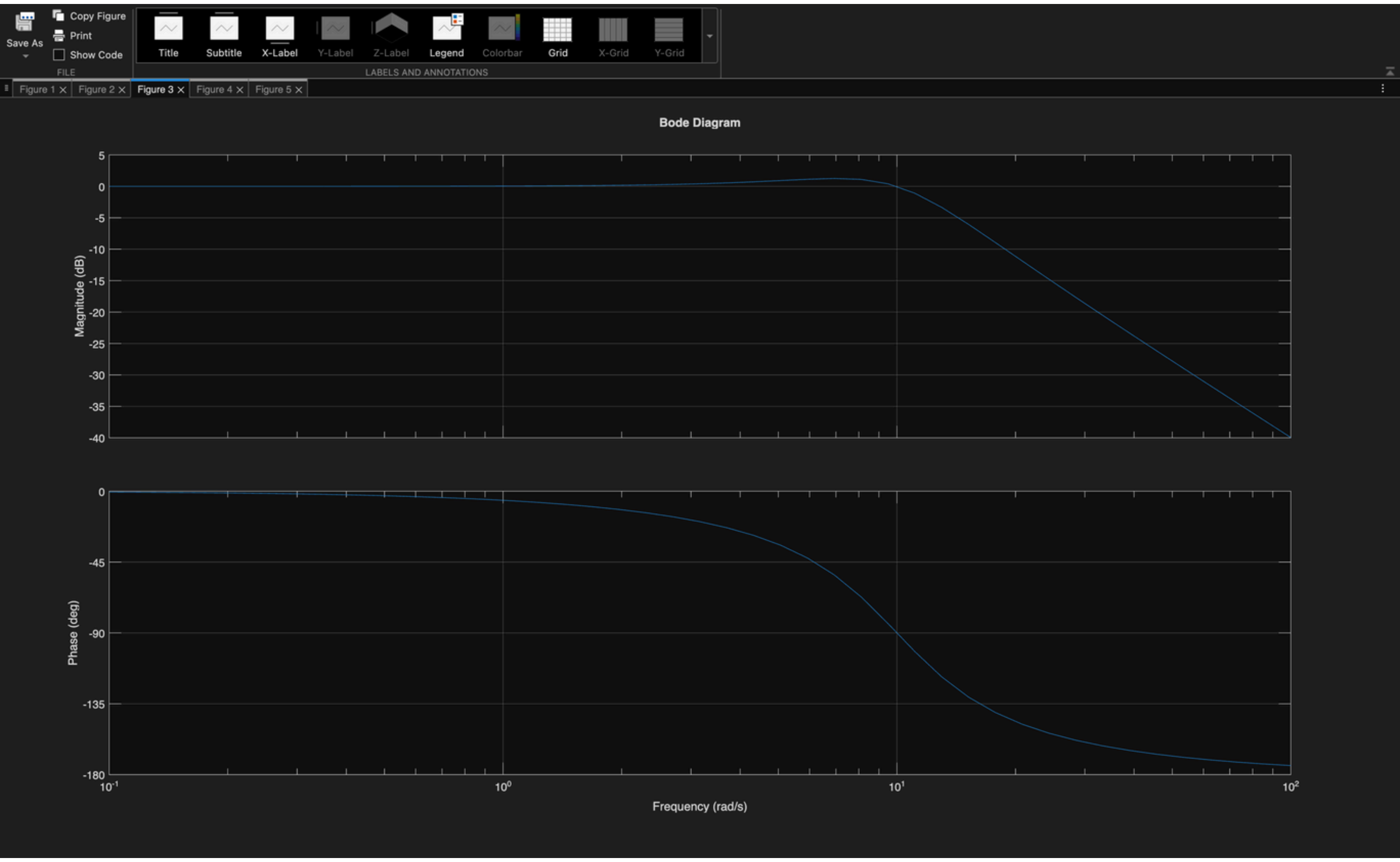
A1) Matlab Plots



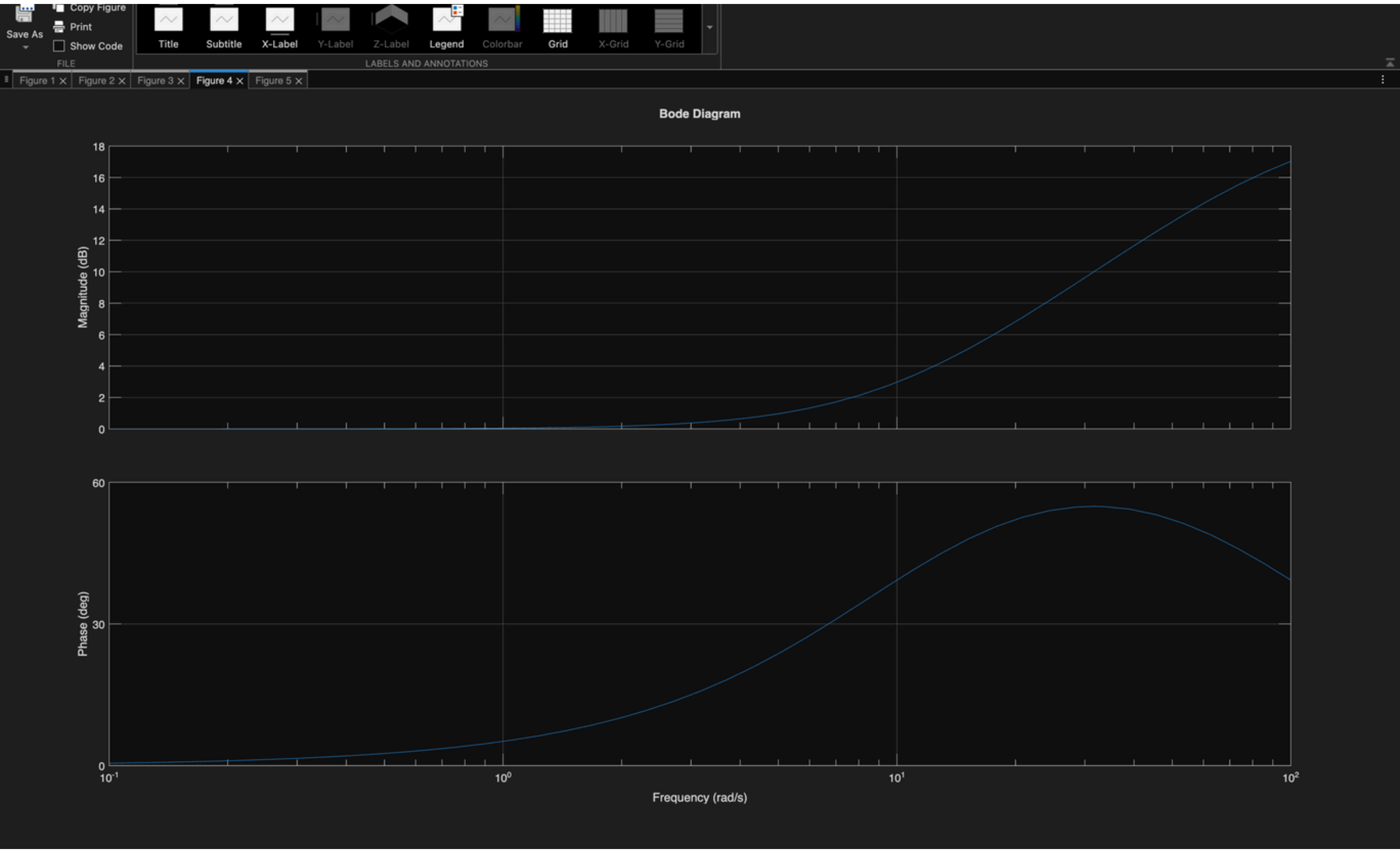
A2) Matlab Plots



A3) Matlab Plots



A4) Matlab Plots



B2) Matlab Plots