Assignment-0

Part-A : Transfer function & Bode Plots.

A.1 $G_1(s) = \dfrac{10}{s+10}$

1. Pole : $s+10 = 0$

$s = -10$

$G_1(0) = \dfrac{10}{0+10} = 1$

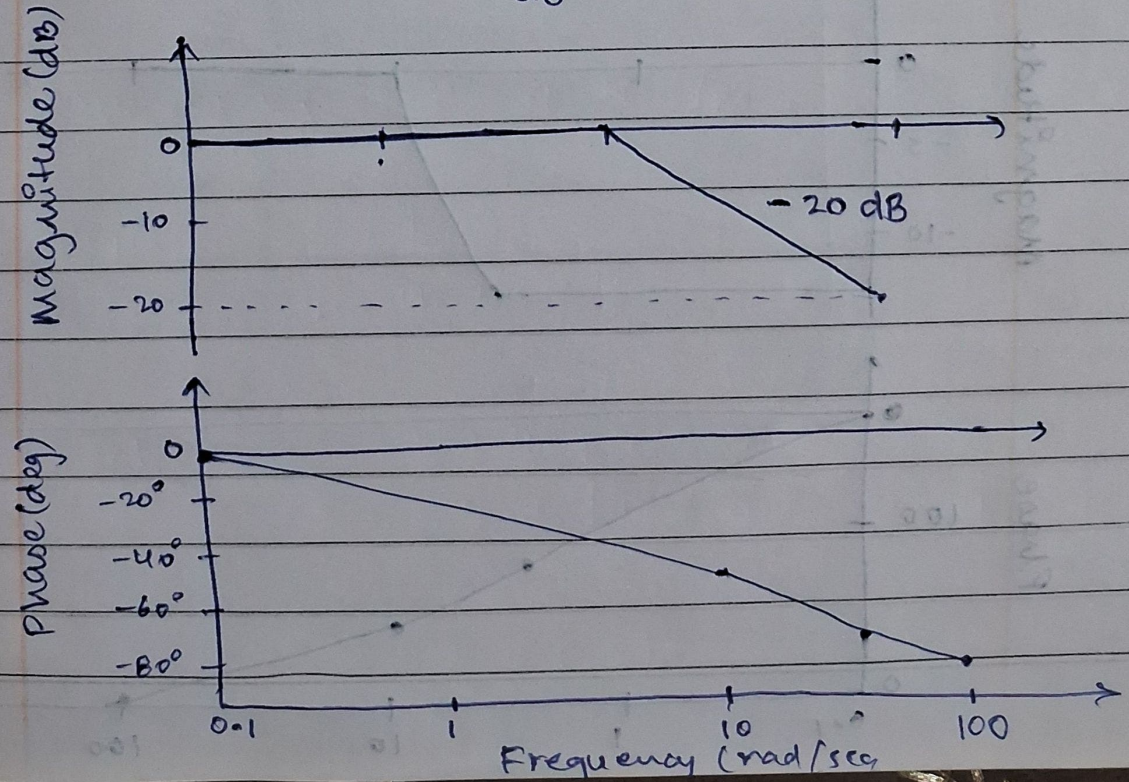
2. $G_1(s) = \dfrac{10}{10\left(1 + s/10\right)} = \dfrac{1}{\left(1 + s/10\right)}$

$G_1(j\omega) = \dfrac{1}{\left(1 + j\omega/10\right)}$

$\omega < 10 \qquad G_1 = \dfrac{1}{1} = 1 \Rightarrow G_{1_{dB}} = 20 \log 1 = 0$

$\omega > 10 \qquad G_1 = \dfrac{1}{j\omega/10} = \dfrac{10}{j\omega} = -\dfrac{10}{\omega} j$

$G_{1_{dB}} = 20 \log 10 - 20 \log \omega$



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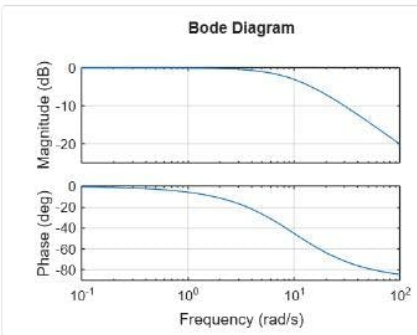
```
1  s=tf('s');
2  G1=10/(s+10);
3  figure; bode(G1, {0.1, 100}); grid on;
```



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G1	*1×1 tf*	1×1
s	*1×1 tf*	1×1

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A.2 $G_2(s) = \frac{s-2}{s+10}$

1. Zeros : $s - 2 = 0$

$s = 2$

Pole : $s + 10 = 0$

$s = -10$

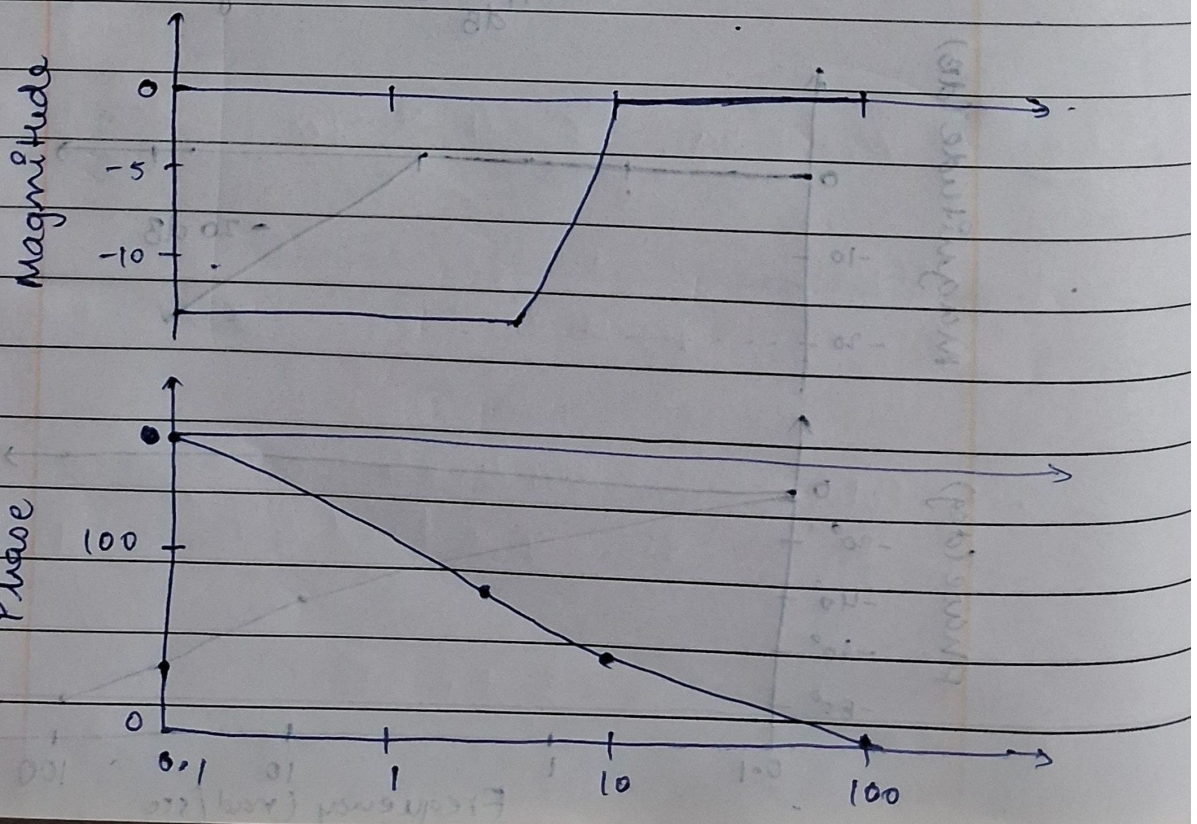
$G_2(0) = \frac{0-2}{0+10} = \frac{-1}{5}$

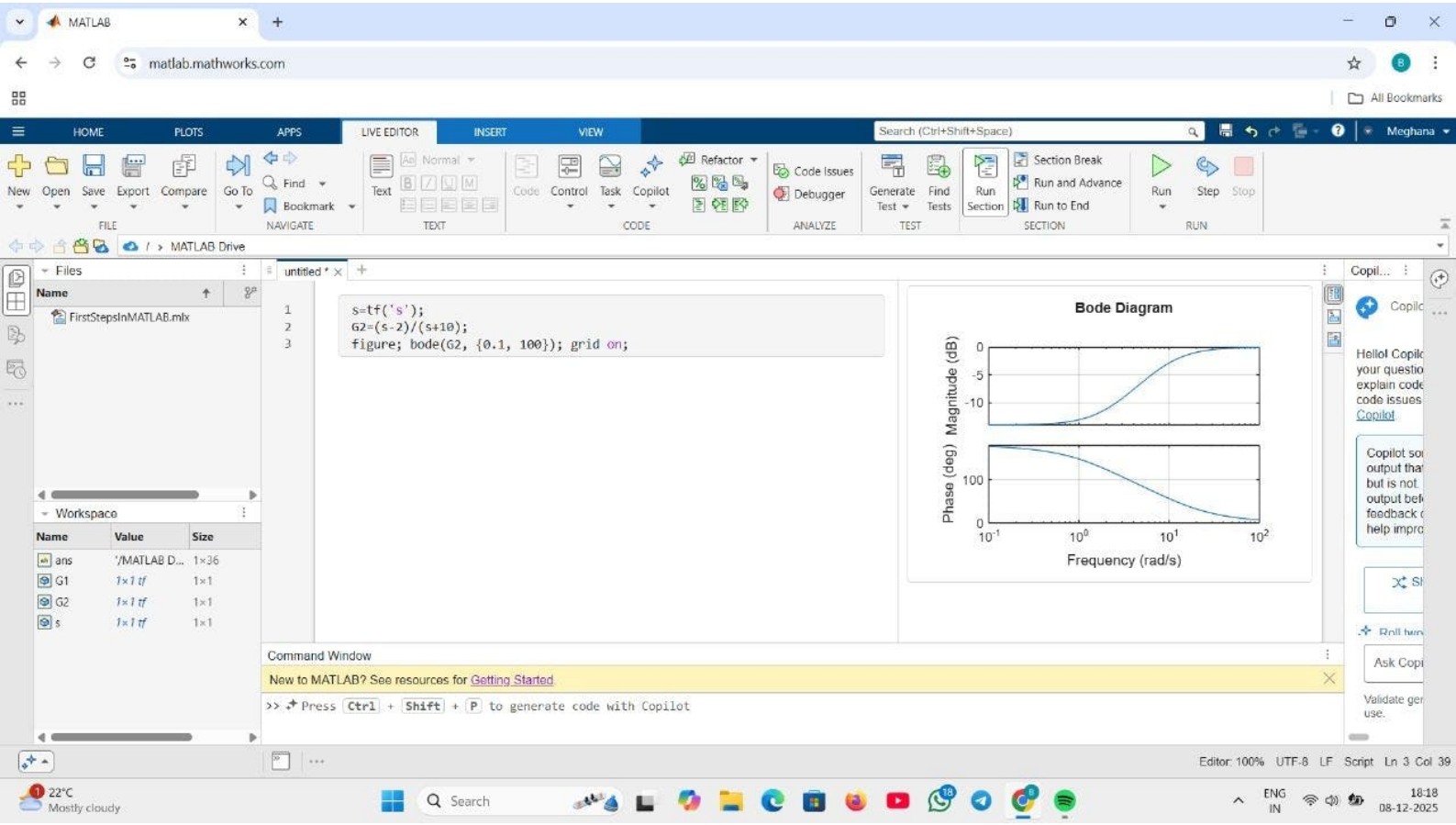
2. $G_2(j\omega) = \frac{-2(1 - j\omega/2)}{10(1 + j\omega/10)} = \frac{-(1 - j\omega/2)}{5(1 + j\omega/10)}$

$\omega < 2 \quad G_{2_{dB}} = \frac{-1}{5} \Rightarrow G_{2_{dB}} = 20\log(-1/5)$

$2 < \omega < 10 \quad G_{2_{dB}} = \frac{-j\omega/2}{5} = \frac{-j\omega}{10}$

$\Rightarrow G_{2_{dB}} = 20\log$

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FirstStepsInMATLAB.mlx
untitled *
1 s=tf('s');
2 G2=(s-2)/(s+10);
3 figure; bode(G2, {0.1, 100}); grid on;
Bode Diagram
Phase (deg) Magnitude (dB)
Frequency (rad/s)
Workspace
Name Value Size
ans '/MATLAB D... 1×36
G1 1×1 tf 1×1
G2 1×1 tf 1×1
s 1×1 tf 1×1
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A.3 $G_3(s) = \dfrac{100}{s^2 + 10s + 100}$

1. Poles : $s^2 + 10s + 100 = 0$

$$s = \frac{-10 \pm \sqrt{100 - 400}}{2} = \frac{-10 \pm 10\sqrt{3}\,i}{2}$$

$$= -5 \pm 5\sqrt{3}\,i$$

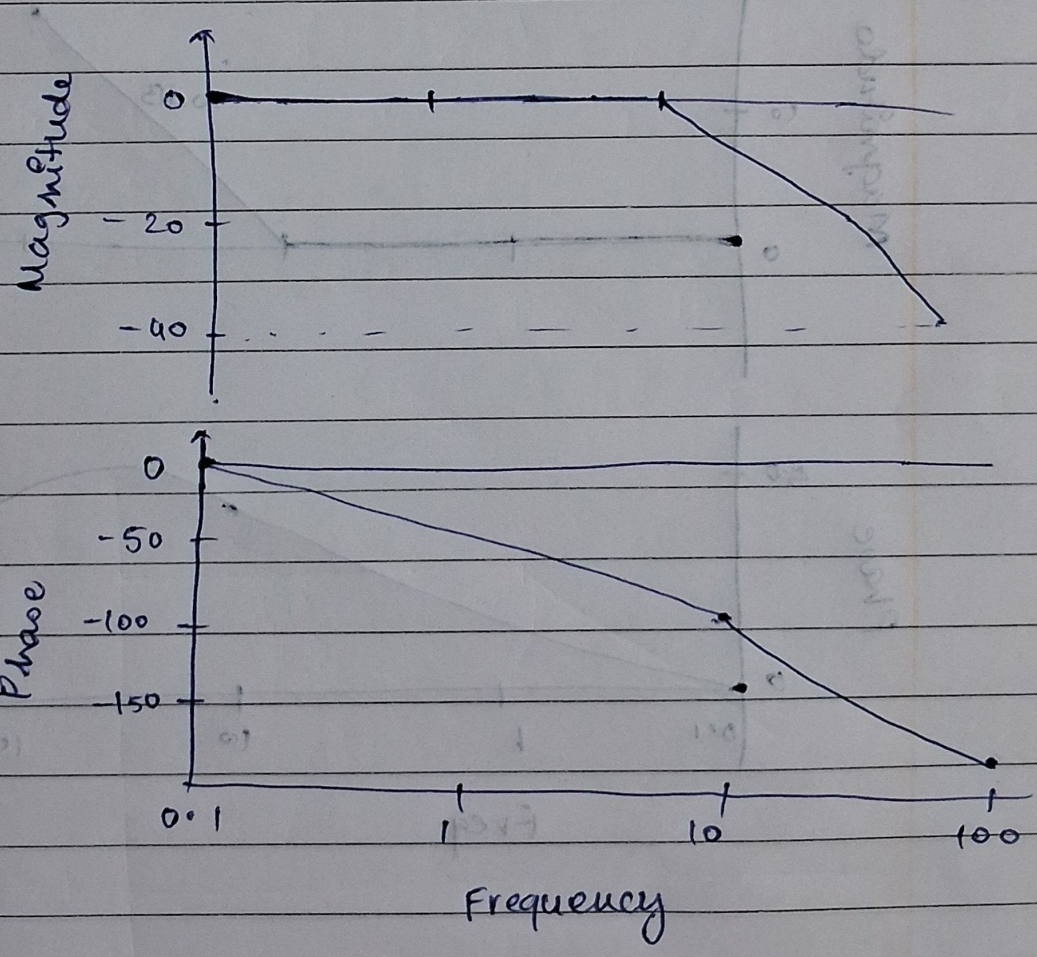
$s_1 = -5 + 5\sqrt{3}\,i$, $s_2 = -5 - 5\sqrt{3}\,i$.

$\omega_n = \sqrt{100} = 10$

$\zeta = \dfrac{10}{2\omega_n} = \dfrac{10}{20} = 0.5$

$G_3(0) = \dfrac{100}{100} = 1$

2.



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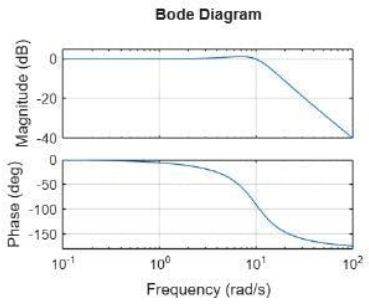
```
1  s=tf('s');
2  G3=100/(s^2+10*s+100);
3  figure; bode(G3, {0.1, 100}); grid on;
```



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G2	1×1 tf	1×1
G3	1×1 tf	1×1
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A.4 $G_4(s) = \dfrac{0.1s + 1}{0.01s + 1}$

1. Zero : $0.1s + 1 = 0$

$s = -10$

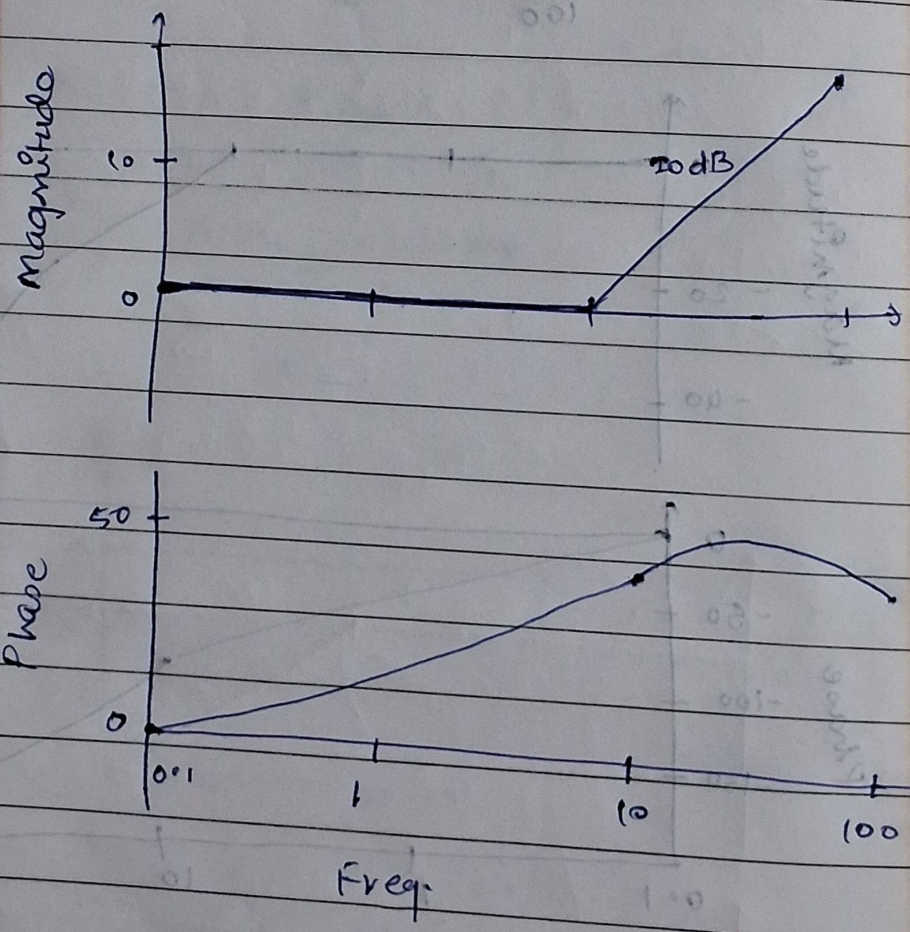
Pole : $0.01s + 1 = 0$

$s = -100$

$G_4(0) = \dfrac{1}{1} = 1.$

2.

$$G_4(j\omega) = \frac{0.1(1 + s/0.1)}{0.01(1 + s/0.01)}$$



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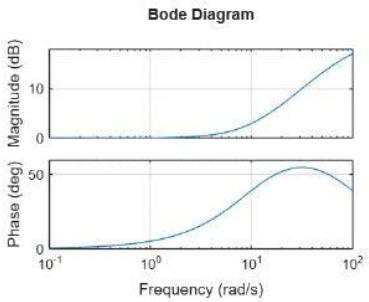
```
1  s=tf('s');
2  G4=(0.1*s+1)/(0.01*s+1);
3  figure; bode(G4, {0.1, 100}); grid on;
```



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G3	1×1 tf	1×1
G4	1×1 tf	1×1
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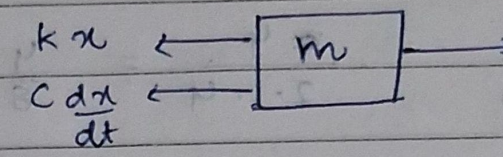
Part B - Mass-spring damper

B1.

1.



$$F - kx - c\frac{dx}{dt} = ma = m\frac{d^2x}{dt^2}$$

$$m\frac{d^2x}{dt^2} + c\frac{dx}{dt} + kx = F$$

2. Laplace transform., zero initial cond^s

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

3. Transfer function $G(s) = \frac{X(s)}{F(s)}$

$$G(s) = \frac{1}{ms^2 + cs + k}$$

B2. $m = 1\ kg$, $c = 4\ N \cdot s/m$, $k = 16\ N/m$

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

2. **Poles** :- $s^2 + 4s + 16 = 0$

$$s = \frac{-4 \pm \sqrt{16 - 4 \cdot 16}}{2} = \frac{-4 \pm 4\sqrt{3}\,i}{2}$$

$$s = -2 \pm i\,2\sqrt{3}$$

$s_1 = -2 + i\,2\sqrt{3}$

$s_2 = -2 - i\,2\sqrt{3}$

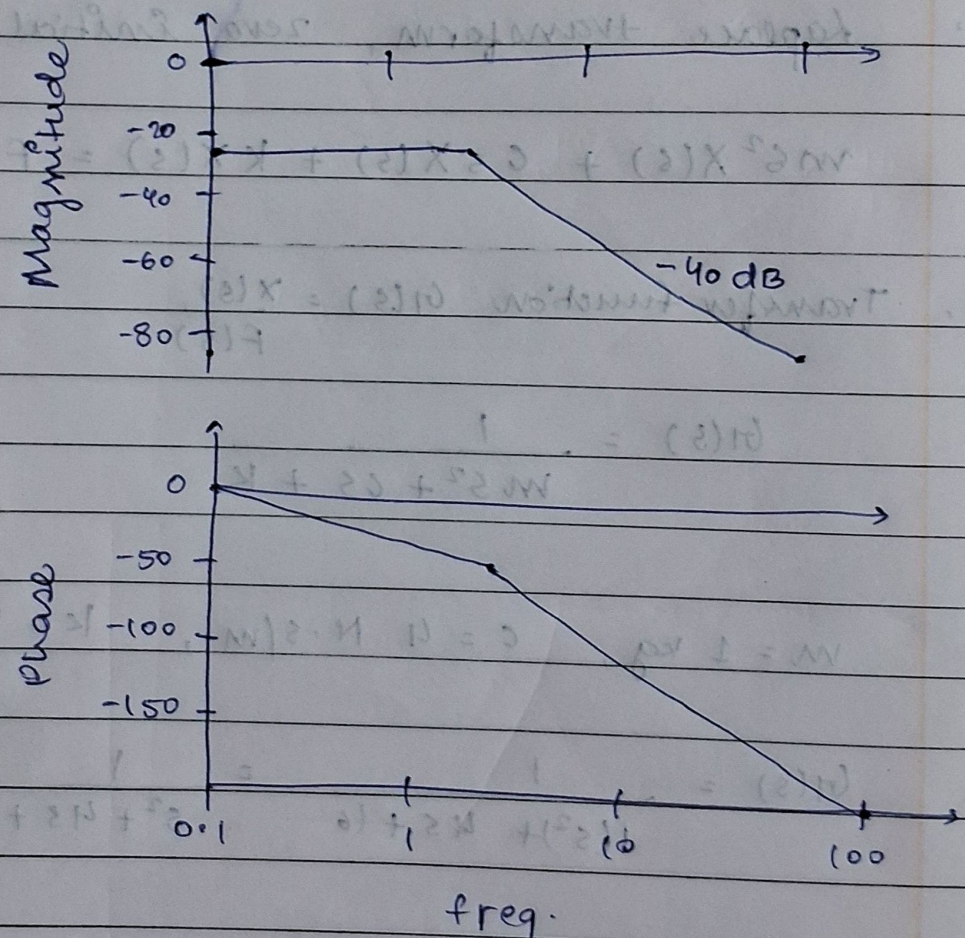
$\omega_n = \sqrt{16} = 4$

$\xi = \frac{d}{2m\omega_n} = \frac{4}{2 \cdot 1 \cdot 4} = \frac{4}{8} = 0.5$

$G(0) = \frac{1}{16}$

$20 \log_{10}\left(\frac{1}{16}\right) \approx -24.08$ dB

3.



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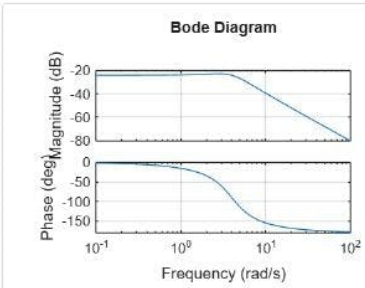
```
1  s=tf('s');
2  G=1/(s^2+4*s+16);
3  figure; bode(G, {0.1, 100}); grid on;
```



Workspace

Name	Value	Size
G	1×1 tf	1×1
s	1×1 tf	1×1

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Generate noisy data fro

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