Assignment 0

1.1) A.1

$$G_1(s) = \frac{10}{s+10}$$

1) Pole : $s = -10$

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

2) $$G_1(s) = \frac{1}{1 + s/10} = \frac{1}{1 + s/\omega_0} \quad (\omega_0 = 10)$$

Now,

$$G_1(j\omega) = \frac{1}{1 + j\frac{\omega}{\omega_0}} = \frac{1 - \left(\frac{\omega}{\omega_0}\right)j}{1 + \left(\frac{\omega}{\omega_0}\right)^2}$$

$$|G_1(j\omega)| = \left[1 + \left(\frac{\omega}{\omega_0}\right)^2\right]^{-1/2}$$

$$\arg(G_1(j\omega)) = \tan^{-1}\left(\frac{-\omega}{\omega_0}\right)$$

So,

$$\text{gain} = 20\log_{10}\left(1 + \frac{\omega^2}{\omega_0^2}\right)^{-1/2} = -10\log_{10}\left(1 + \frac{\omega^2}{\omega_0^2}\right)$$

$$\phi = \text{phase} = \tan^{-1}\left(\frac{-\omega}{\omega_0}\right).$$

Now, CI : $\omega \ll \omega_0$

gain = 0

$\phi = 0$

CII : $\omega = \omega_0$

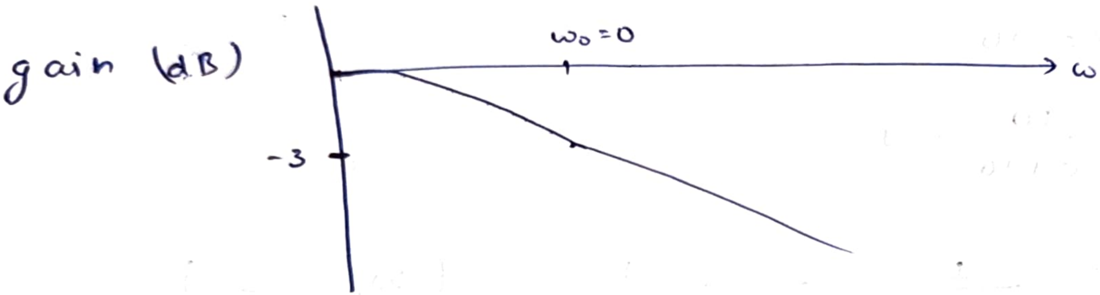
gain = -3

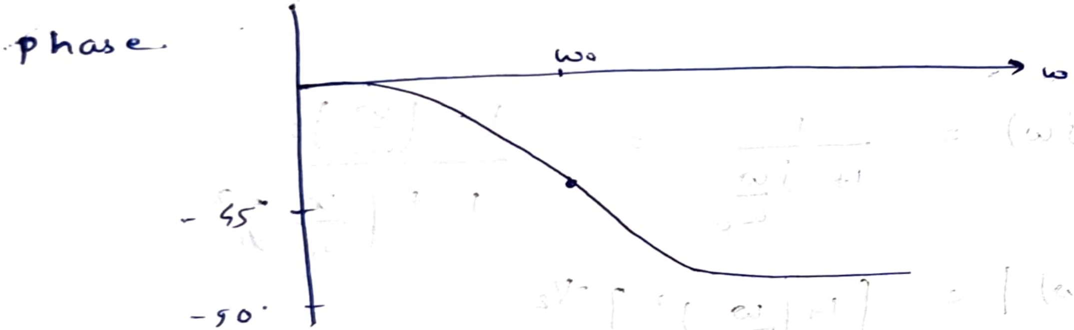
$\phi = -45^\circ$

C III : $\omega >> \omega_0$.

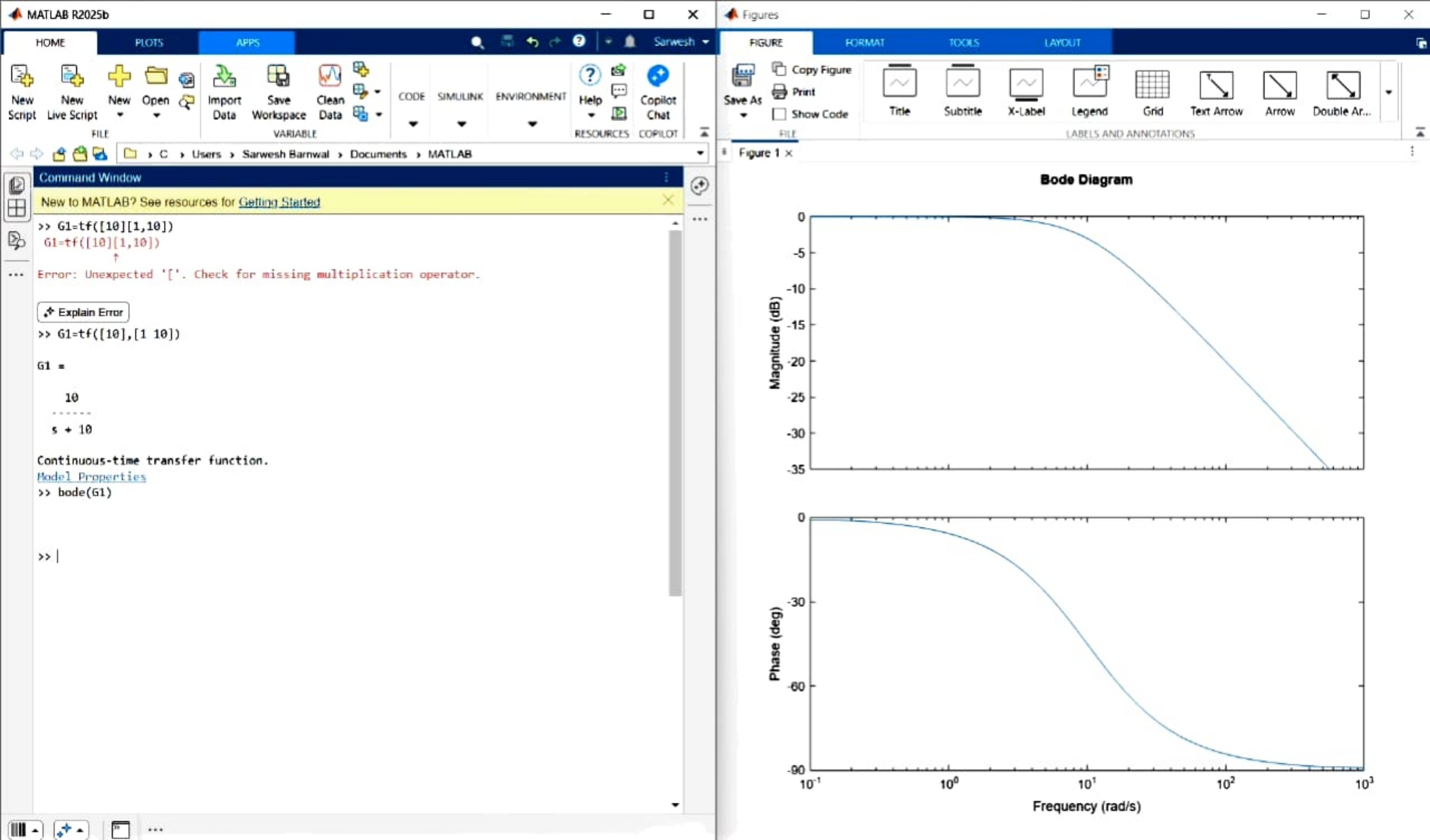
gain $\to -\infty$

$\phi = -90°$





1.2. $G_2(s) = \dfrac{s-2}{s+10}$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New to MATLAB? See resources for Getting Started
>> G1=tf([10][1,10])
G1=tf([10][1,10])
Error: Unexpected '['. Check for missing multiplication operator.
Explain Error
>> G1=tf([10],[1 10])
G1 =
10
------
s + 10
Continuous-time transfer function.
Model Properties
>> bode(G1)
>>
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LABELS AND ANNOTATIONS
Figure 1
Bode Diagram
Magnitude (dB)
0
-5
-10
-15
-20
-25
-30
-35
Phase (deg)
0
-30
-60
-90
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
Frequency (rad/s)

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

1. zero. $s = 2$

   pole. $s = -10$ $\quad 12w$

   $G_2(0) = -1/5$

2. $G_2(j\omega) = \dfrac{j\omega - 2}{j\omega + 10} \times \dfrac{-j\omega + 10}{-j\omega + 10}$

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

$$= \frac{10j\omega - 20 + \omega^2 + 2j\omega}{\omega^2 + 100} = \frac{\omega^2 + 12j\omega - 20}{\omega^2 + 100}$$

$$G_2(s) = \frac{s-2}{s+10} = \frac{-2\left(1-\frac{s}{2}\right)}{10\left(1+\frac{s}{10}\right)}$$

$$\text{gain} = \text{gain}(-2) + \text{gain}\left(1-\frac{s}{2}\right) - \text{gain}(10) - \text{gain}\left(1-\frac{s}{10}\right)$$

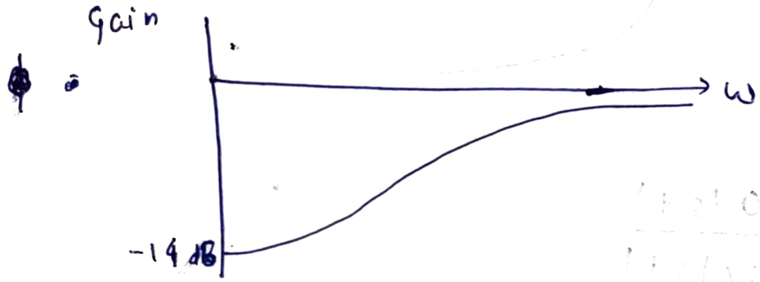
$$= 6 + 20\log\sqrt{1+\frac{\omega^2}{4}} - 20 - 20\log\sqrt{1+\frac{\omega^2}{100}}$$

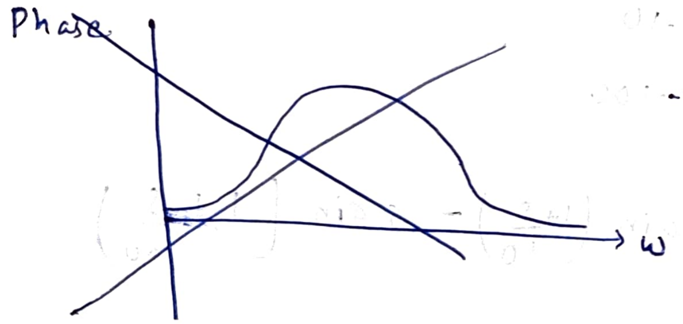
$$= -14 + 20\log\frac{\sqrt{1+\frac{\omega^2}{4}}}{\sqrt{1+\frac{\omega^2}{100}}}$$

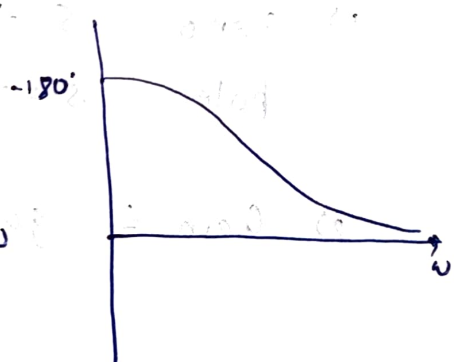
$$= -14 + 10\log\frac{1+\omega^2/4}{1+\omega^2/100}$$

at $\omega = 0$ gain $= -14$

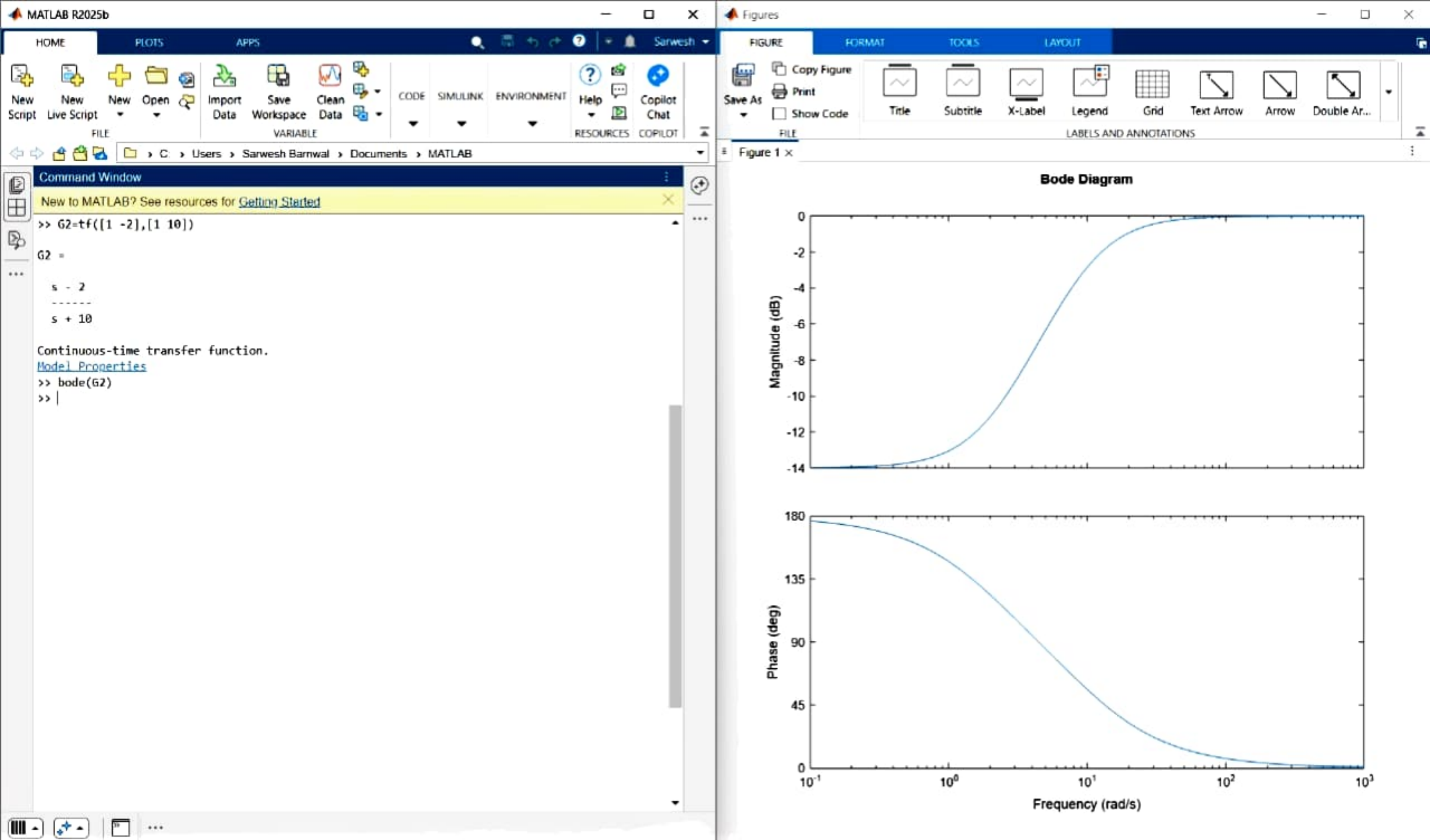
$\omega \to \infty$ gain $= 0$.







4. It causes a phase lag.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New to MATLAB? See resources for Getting Started
>> G2=tf([1 -2],[1 10])
G2 =
s - 2
------
s + 10
Continuous-time transfer function.
Model Properties
>> bode(G2)
>>
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LABELS AND ANNOTATIONS
Figure 1
Bode Diagram
Magnitude (dB)
0
-2
-4
-6
-8
-10
-12
-14
Phase (deg)
180
135
90
45
0
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
Frequency (rad/s)

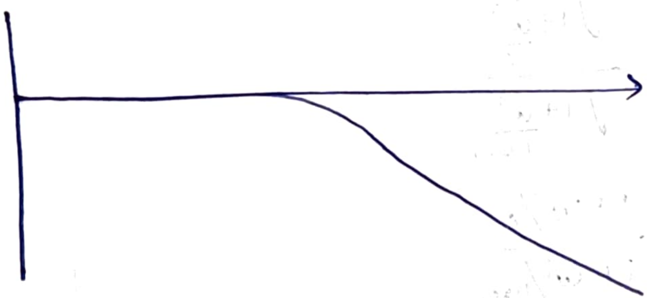
1.3. $G_3(s) = \dfrac{100}{s^2+10s+100}$

1. poles : $s = 5 \pm 5\sqrt{3}\,j$

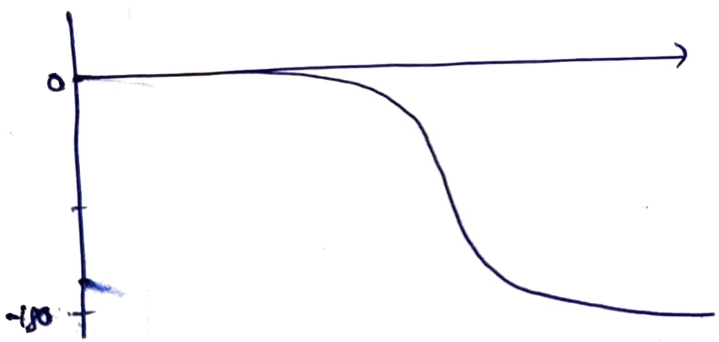
2. $G_3(s) = \dfrac{\omega_0^{2}}{s^2+2z\omega_0 s+\omega_0^{2}}$

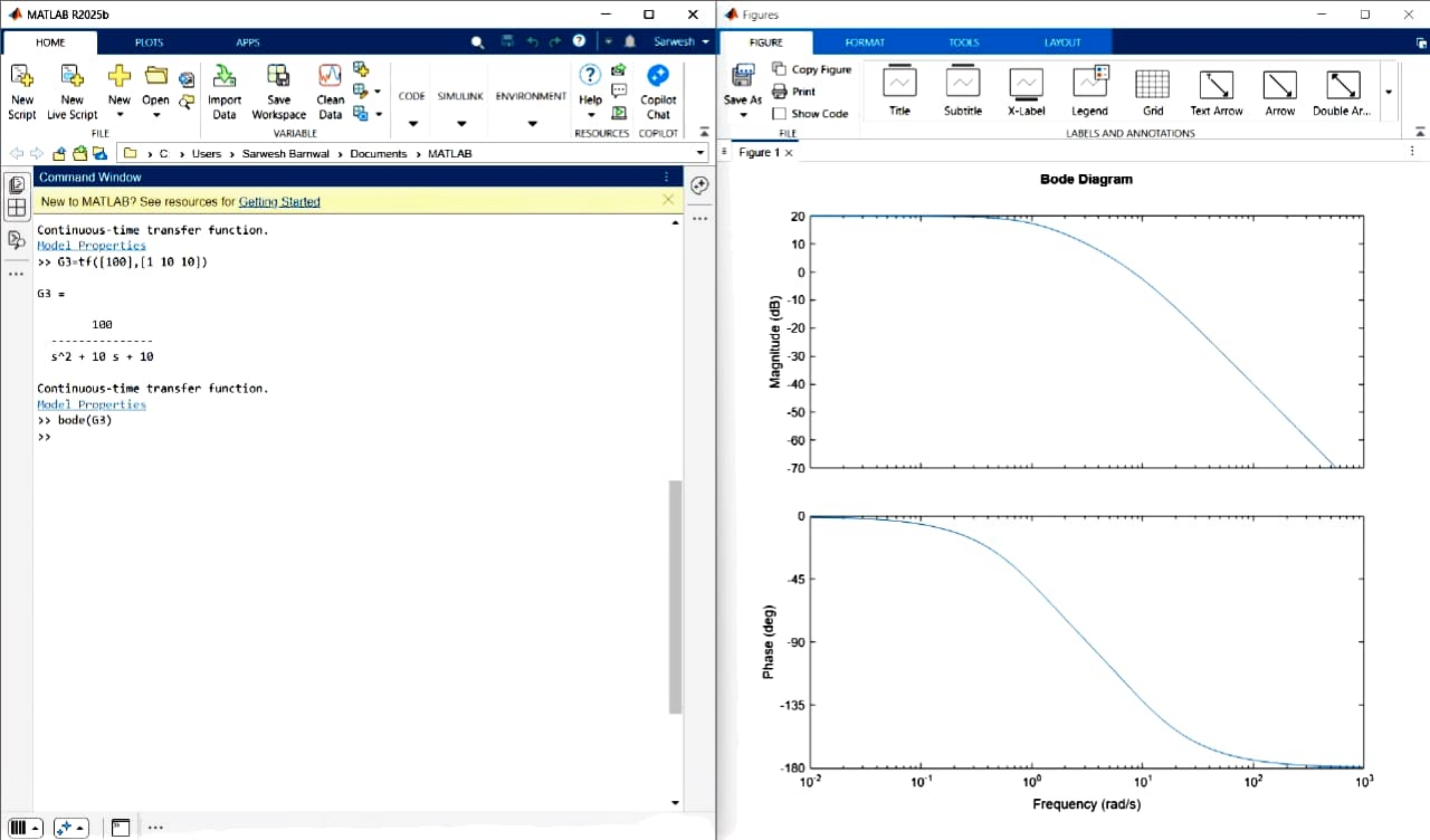
$\omega_0 = 10$, $2z\omega_0 = 10 \Rightarrow z = 1/2$

gain



phase

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Continuous-time transfer function.
Model Properties
>> G3=tf([100],[1 10 10])
G3 =
100
----
s^2 + 10 s + 10
Continuous-time transfer function.
Model Properties
>> bode(G3)
>>
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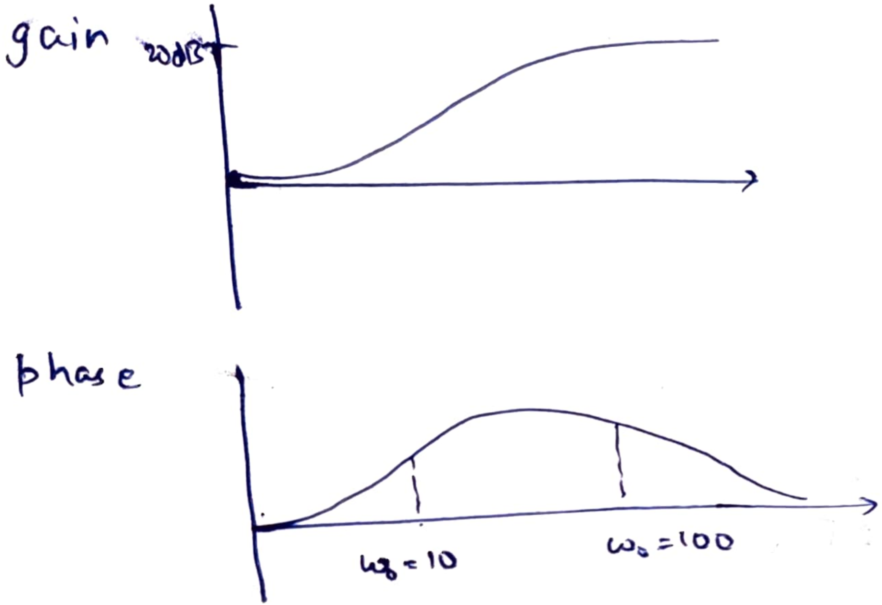
LABELS AND ANNOTATIONS
Figure 1
Bode Diagram
Magnitude (dB)
20
10
0
-10
-20
-30
-40
-50
-60
-70
Phase (deg)
0
-45
-90
-135
-180
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
Frequency (rad/s)

1.4. $G_4(s) = \dfrac{0.1s+1}{0.01s+1}$

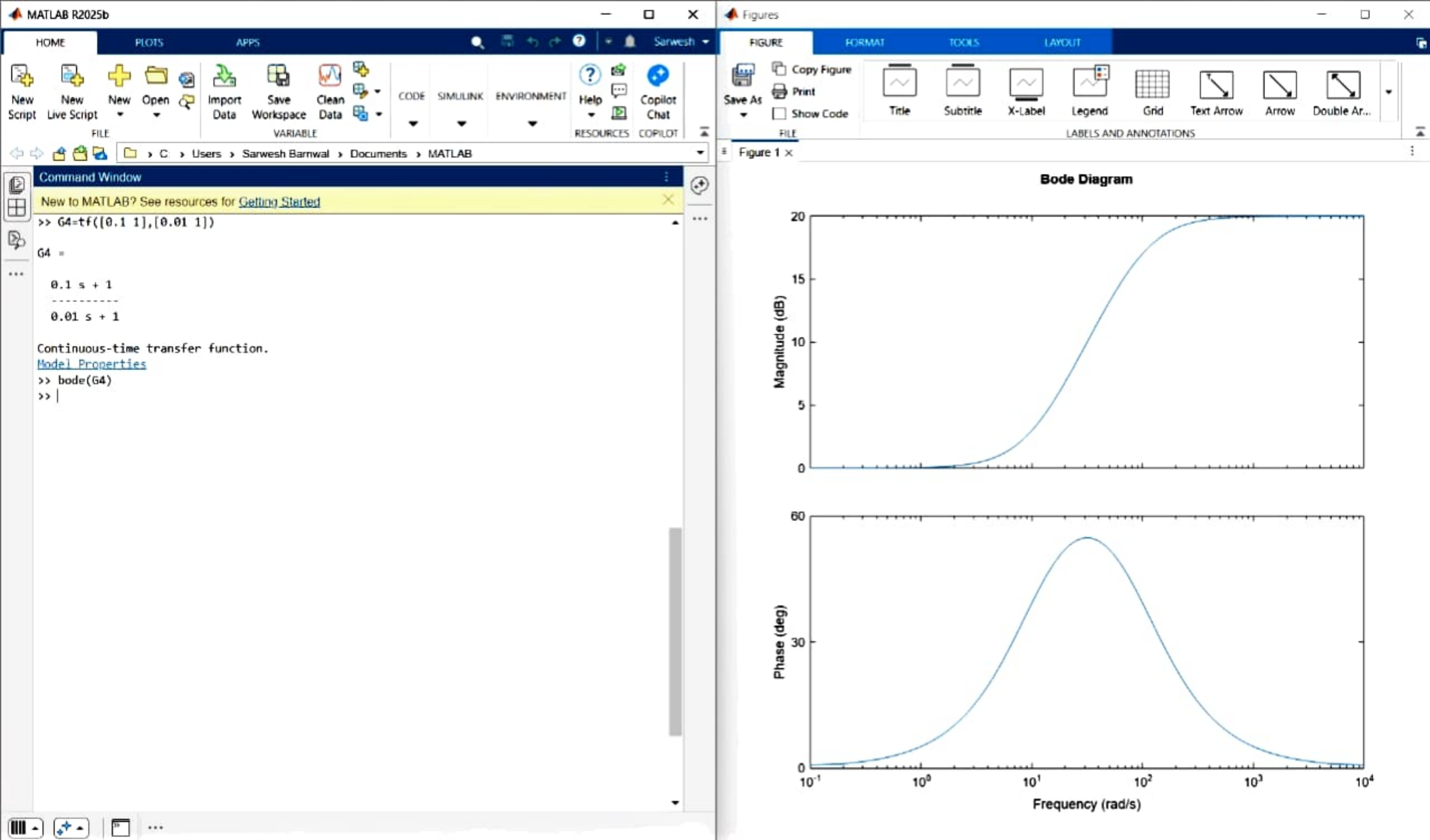
1) zero $s = -10$

pole $s = -100$

2) Gain $\doteq$ gain $\left(1+\frac{s}{10}\right)$ - gain $\left(1+\frac{s}{100}\right)$



4) Between zero and pole $G_4(s)$ tends to add +ve phase as seen from the plots.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>> G4=tf([0.1 1],[0.01 1])
G4 =
0.1 s + 1

0.01 s + 1
Continuous-time transfer function.
Model Properties
>> bode(G4)
>>
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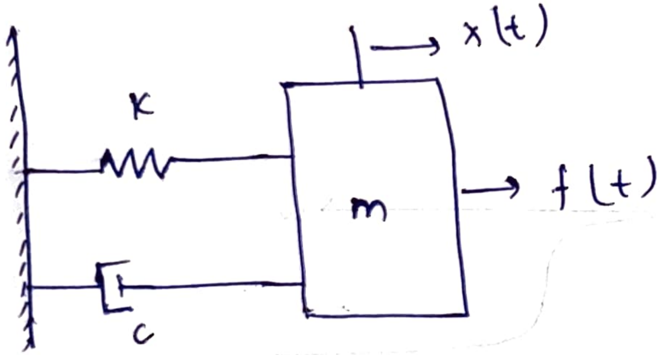
LABELS AND ANNOTATIONS
Figure 1
Bode Diagram
Magnitude (dB)
Phase (deg)
Frequency (rad/s)
20
15
10
5
0
60
30
0
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}

B. 1 . 1



$$f(t) - k\,u(t) - c\,\frac{d}{dt}\left(u(t)\right) = m\,\frac{d^2}{dt^2}\left(u(t)\right)$$

2.

$$F(s) = ms^2\,X(s) + cs\,X(s) + k\,X(s)$$

$$F(s) = X(s)\,[ms^2 + cs + k)$$

3.

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

B.2 $m = 1\,kg.$

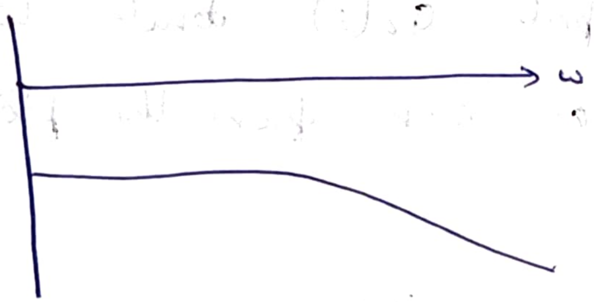
$c = 4.\ N \cdot s/m$

$K = 16\ N/m$

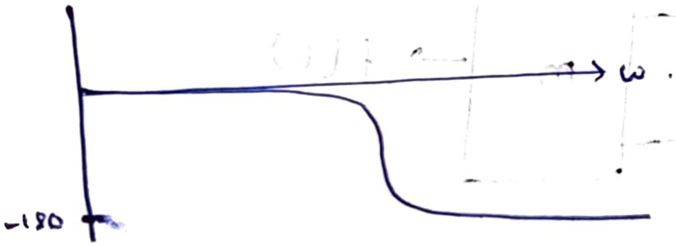
2) $G(s) = \dfrac{1}{s^2 + 4s + 16}$

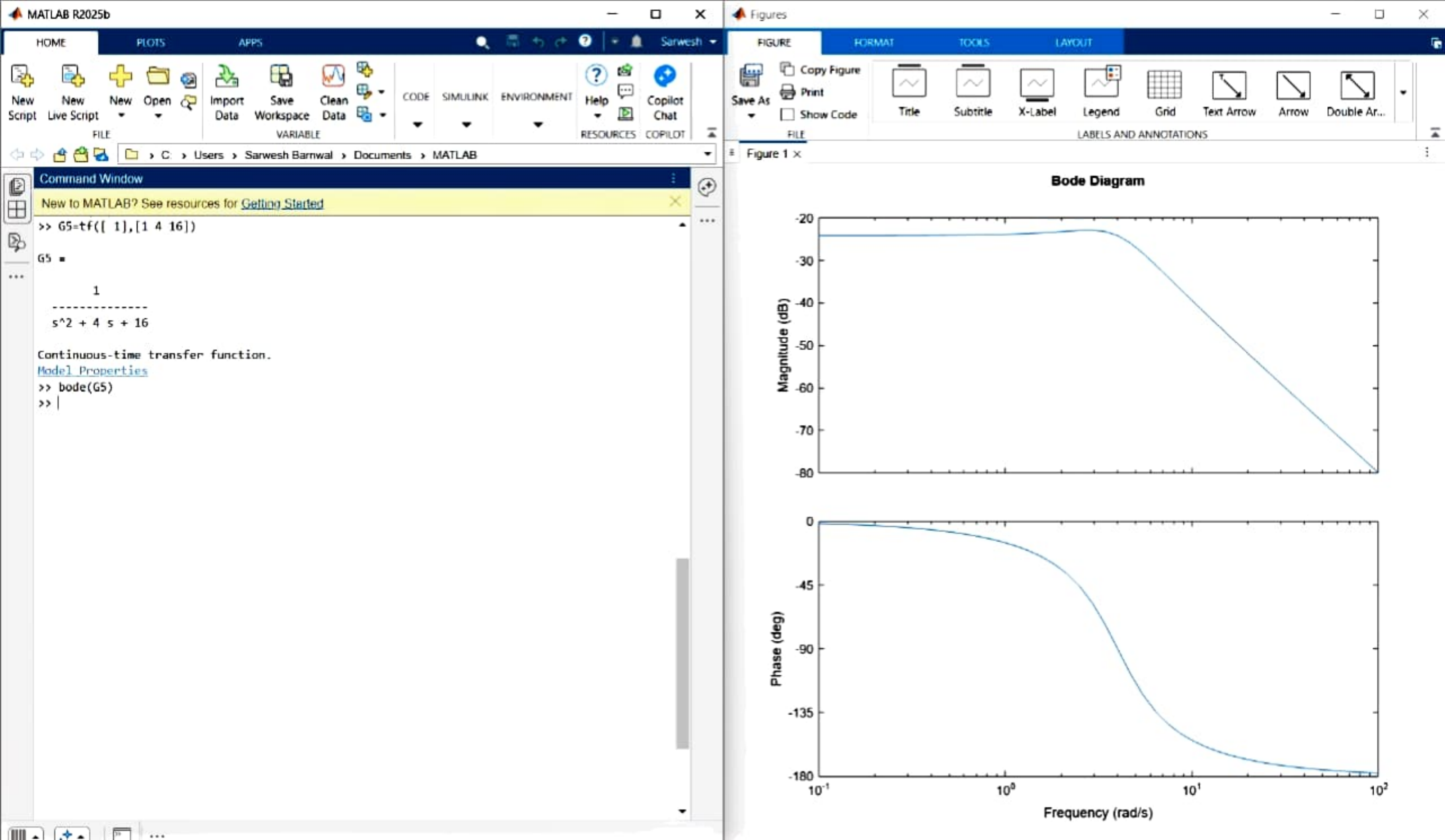
2) poles : $s = -2 \pm 2\sqrt{3}\,i$

Gain



phase

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Command Window
New to MATLAB? See resources for Getting Started
>> G5=tf([1],[1 4 16])
G5 =
1
----
s^2 + 4 s + 16
Continuous-time transfer function.
Model Properties
>> bode(G5)
>>
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Figure 1
Bode Diagram
Magnitude (dB)
-20
-30
-40
-50
-60
-70
-80
Phase (deg)
0
-45
-90
-135
-180
10^{-1}
10^{0}
10^{1}
10^{2}
Frequency (rad/s)