ASSIGNMENT

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

(1)

Pole : $s = -10$

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

(2) $G(s) = \frac{1}{1+\left(\frac{s}{\omega_0}\right)}$ $(\omega_0 = 10)$

Put $s = j\omega$

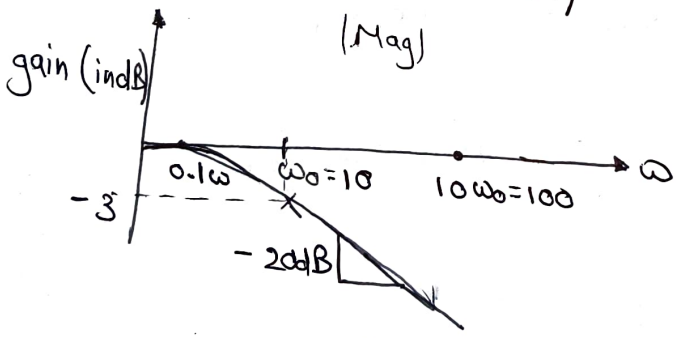
$\Rightarrow$

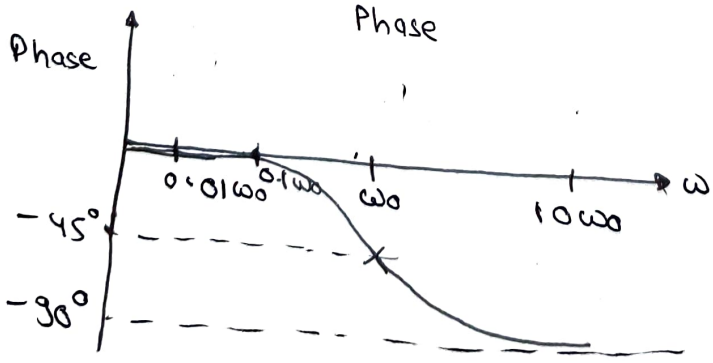
$$G(s)_{s=j\omega} = \frac{1}{1+\left(\frac{\omega}{\omega_0}\right)j} = \frac{1-j\omega/\omega_0}{1+\left(\frac{\omega}{\omega_0}\right)^2}$$

$$|G(j\omega)| = \left(1+\frac{\omega^2}{\omega_0^2}\right)^{-1/2} \qquad \arg(G(j\omega)) = \tan^{-1}\left(\frac{-\omega}{\omega_0}\right)$$

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

ϕ = Phase = $\tan^{-}\left(\frac{-\omega}{\omega_0}\right)$





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Command Window

```
G1 =

    10
  ------
  s + 10

Continuous-time transfer function.
Model Properties

       Numerator: {[0 10]}
     Denominator: {[1 10]}
        Variable: 's'
         IODelay: 0
      InputDelay: 0
     OutputDelay: 0
       InputName: {''}
       InputUnit: {''}
      InputGroup: [1×1 struct]
      OutputName: {''}
      OutputUnit: {''}
     OutputGroup: [1×1 struct]
           Notes: [0×1 string]
        UserData: []
            Name: ''
              Ts: 0
        TimeUnit: 'seconds'
    SamplingGrid: [1×1 struct]

>> bode(G1)

>>
```

Figures

FIGURE FORMAT TOOLS LAYOUT

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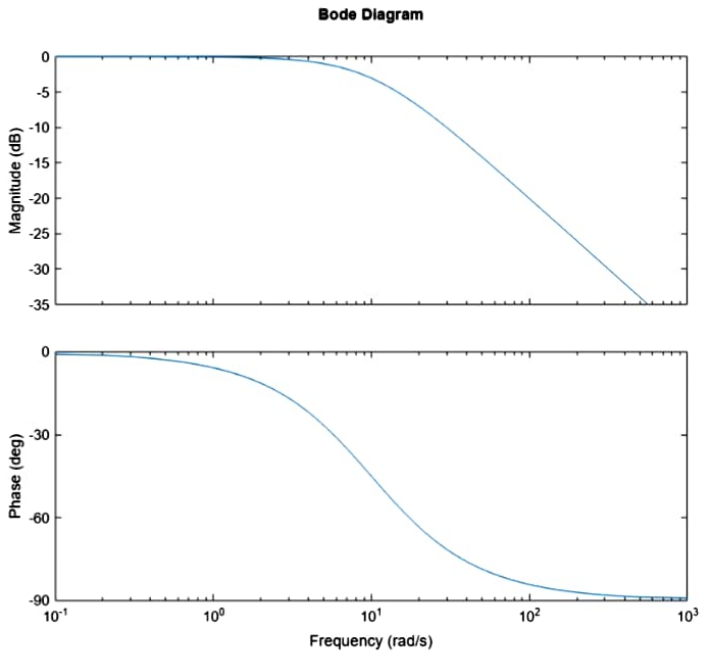
FILE LABELS AND ANNOTATIONS

Figure 1



22°C Sunny

Search

ENG US

13:38 06-12-2025

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

zero: $s = 2$ Pole: $s = -10$ $G_2(0) = -0.2$

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

⇒ By logarithmic property

Gain = ~~s-2~~ gain $(s-2)$ - gain $(s+10)$

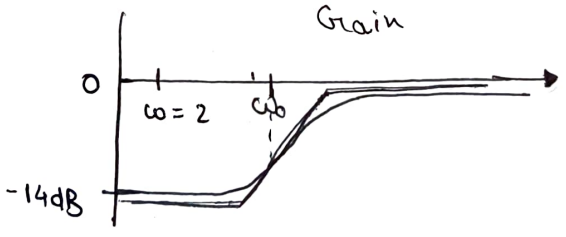
$$\text{gain}(s-2) = 2\left(\frac{s}{2} \cdot 1\right) = \frac{2}{\frac{1}{\frac{s}{2}-1}} = \frac{-2}{\frac{1}{1+\left(\frac{s}{-2}\right)}} = -\text{gain}(-2) - \text{gain of } \left(\frac{1}{1+\left(\frac{s}{-2}\right)}\right)$$

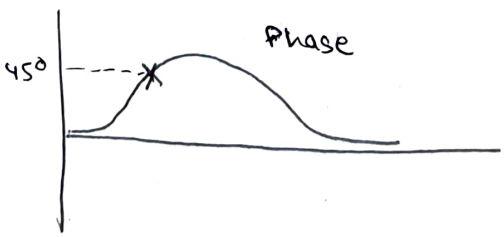
$$\text{gain}(s+10) = \frac{10}{\frac{1}{1+\left(\frac{s}{10}\right)}}$$

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

gain$(-2) = 6$ dB
gain$(+10) = 20$dB
} CONSTANT

Adding the gain plots ~~&~~ 4 we get





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Command Window

```
>> G2=tf([1 -2], [1 10])

G2 =

  s - 2
  ------
  s + 10

Continuous-time transfer function.
Model Properties
>> bode(G2)
>>
>>
>>
>> bode(G2)
>>
```

Name

G2

Figures

FIGURE FORMAT TOOLS LAYOUT

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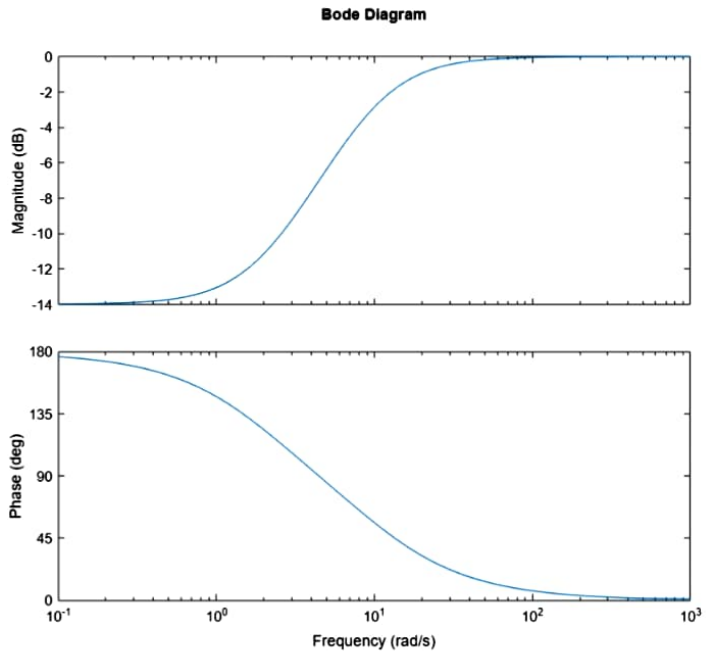
FILE LABELS AND ANNOTATIONS

Figure 1



CAD/INR +1.18%

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14:50 06-12-2025

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

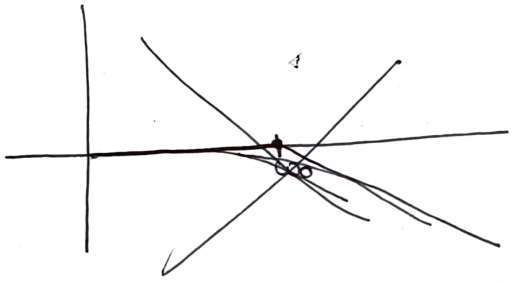
(1) Pole: $s = 5 \pm 5\sqrt{3}j$ $\quad j = \sqrt{-1}$

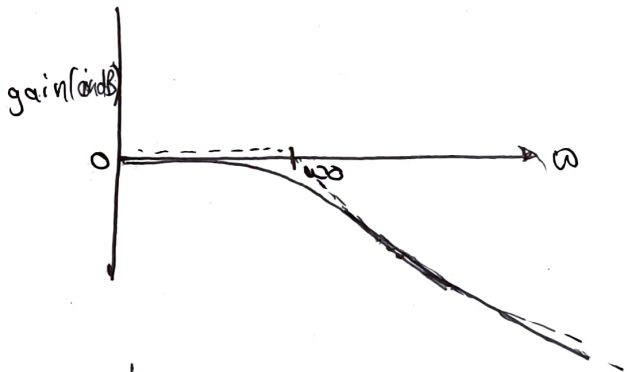
(2) BODE PLOT

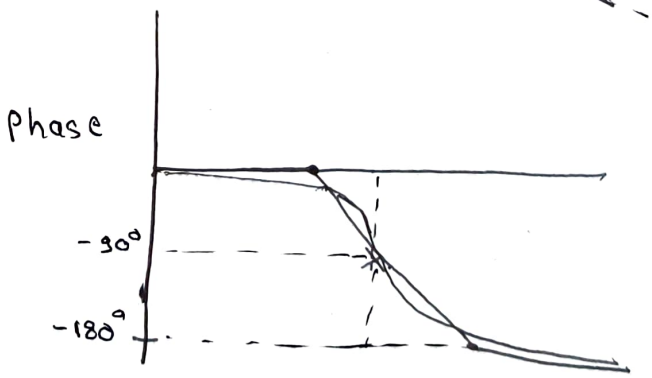
$$G(s) = \frac{\omega_0^2}{s^2 + 2z\omega_0 s + \omega_0^2}$$

$\omega_0 = 10$, $2z\omega_0 = 10 \Rightarrow z = \frac{1}{2}$

When $z = 0.5$, for $\omega = \omega_0$ gain $= 0$







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Command Window

```
>> bode(G3)
>> G4=tf([0.1 1], [.01 1])

G4 =

  0.1 s + 1
  ----------
  0.01 s + 1

Continuous-time transfer function.
Model Properties
>> bode(G4)
>>
```

Name

G3

G4

Figures

FIGURE FORMAT TOOLS LAYOUT

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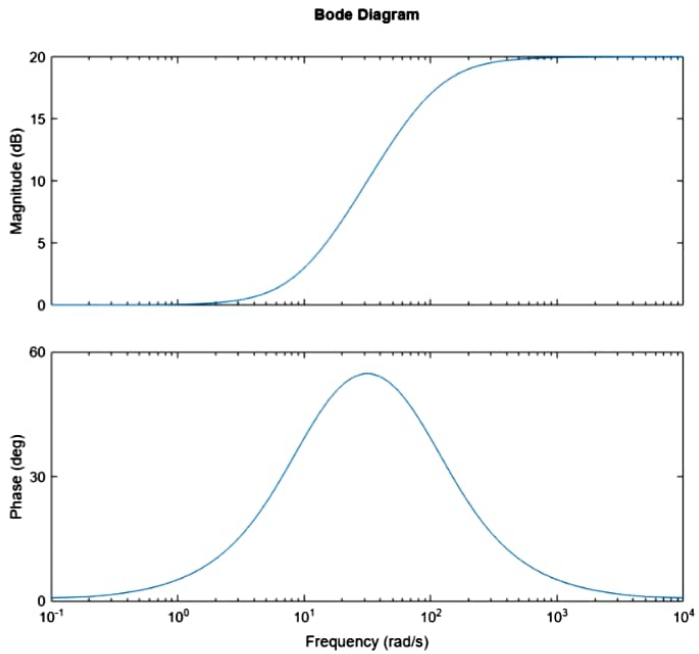
FILE LABELS AND ANNOTATIONS

Figure 1



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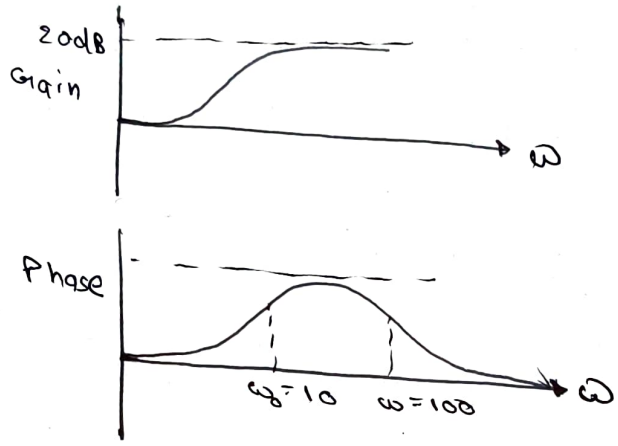
14:52 06-12-2025

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

(1) zero at $s = -10$

Pole at $s = -100$

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



(4) Zero is at $\omega = 10$

Pole at $\omega = 100$

∴ Between zero and pole $G_4(s)$ tends to add positive phase as seen from the plots.

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Command Window

```
>> G2=tf([1 -2], [1 10])

G2 =

  s - 2
  ------
  s + 10

Continuous-time transfer function.
Model Properties
>> bode(G2)
>>
>>
>>
>> bode(G2)
>> G3=tf([100], [1 10 100])

G3 =

        100
  ----------------
  s^2 + 10 s + 100

Continuous-time transfer function.
Model Properties
>> bode(G3)
>>
```

Name

G3

Figures

FIGURE FORMAT TOOLS LAYOUT

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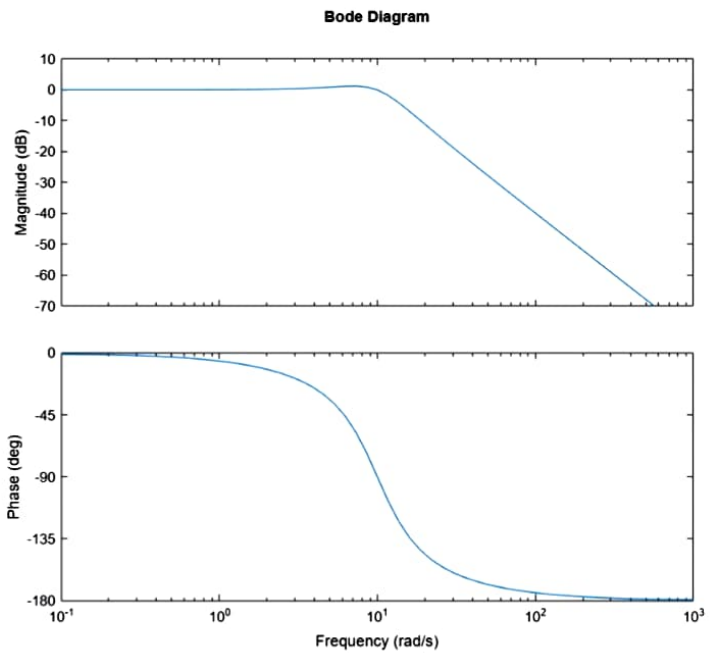
Figure 1



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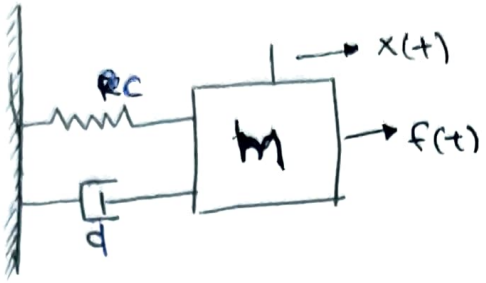
B.1)



The force to spring is directly proportional to $x(t)$ while force of Damper is proportional to velocity of mass m.

$$\Rightarrow \boxed{f(t) - Kx(t) - d\frac{dx(t)}{dt} = m\frac{d^2x}{dt^2}}$$

$$\boxed{F(s) = KX(s) + dsX(s) + ms^2X(s)}$$

$$F(s) = X(s)\left[K + ds + ms^2\right]$$

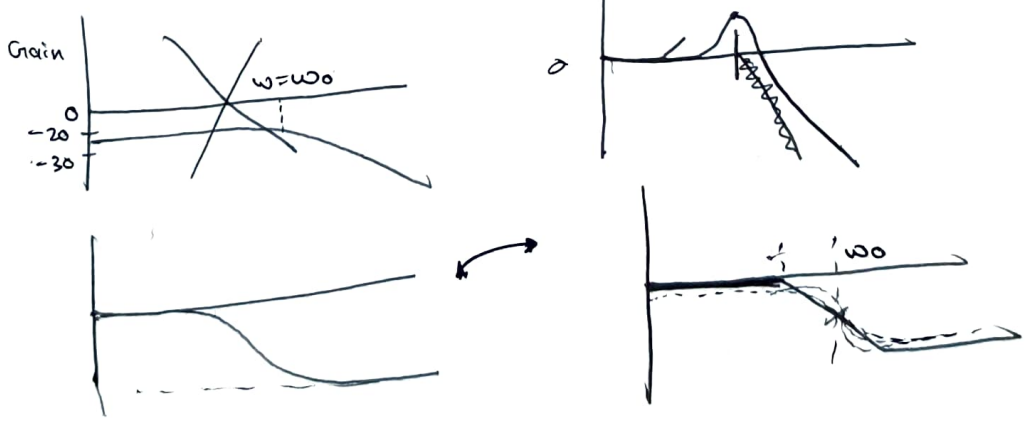
$$G_1(s) = \frac{X(s)}{F(s)}$$

$$\boxed{G_1(s) = \frac{1}{\left[K + ds + ms^2\right]}}$$

B.2)

$$\boxed{G_1(s) = \frac{1}{\left[16 + 4s + s^2\right]}}$$

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



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Command Window

```
>> G5=([1],[1 4 16])
 G5=([1],[1 4 16])
        ↑
Error: Unexpected ',' in parentheses. When creating a matrix, use square brackets [].
```

Explain Error

```
>> G5=tf([1],[1 4 16])

G5 =

        1
  --------------
  s^2 + 4 s + 16

Continuous-time transfer function.
```

Model Properties

```
>> bode(G5)

>>
```

Name

G5

Figures

FIGURE FORMAT TOOLS LAYOUT

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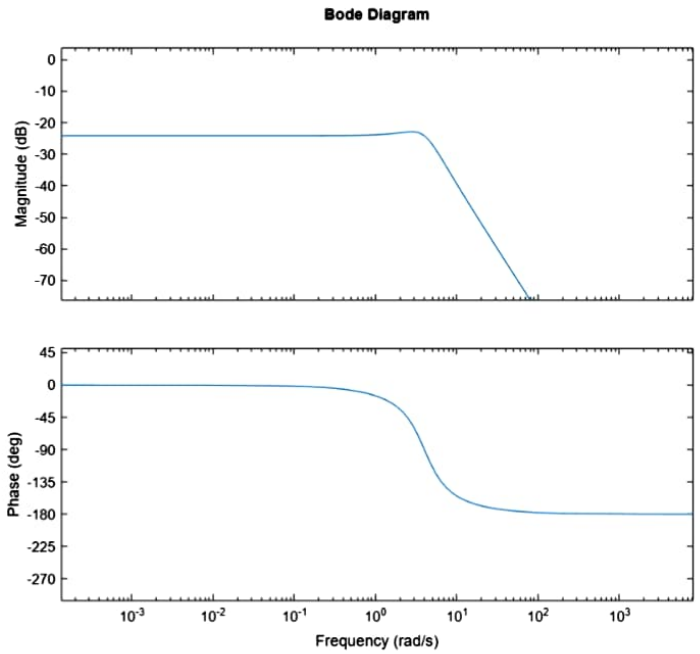
Figure 1



23°C Mostly sunny

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13:36 08-12-2025