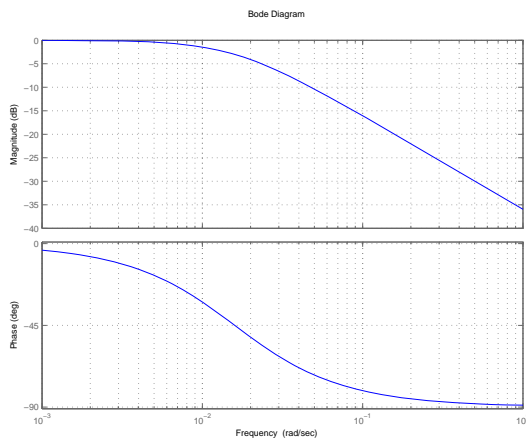


HW #8 Solutions

1.

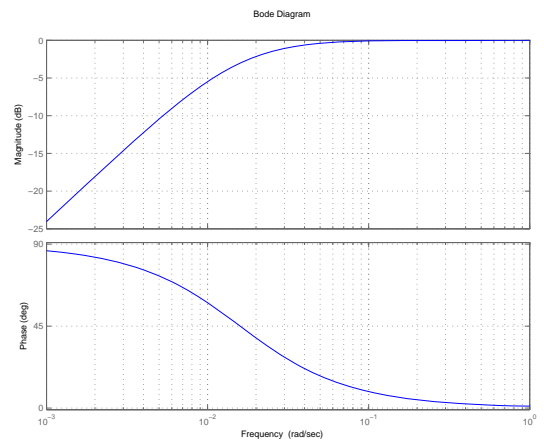
$$\frac{V_{cap}}{V_{in}} = \frac{1}{RCs + 1} = \frac{1}{(20\pi)s + 1}$$

```
>>bode(1,[20*pi 1]);
```



$$\frac{V_{res}}{V_{in}} = \frac{RCs}{RCs + 1} = \frac{(20\pi)s}{(20\pi)s + 1}$$

```
>>bode(20*pi 0,[20*pi 1]);
```

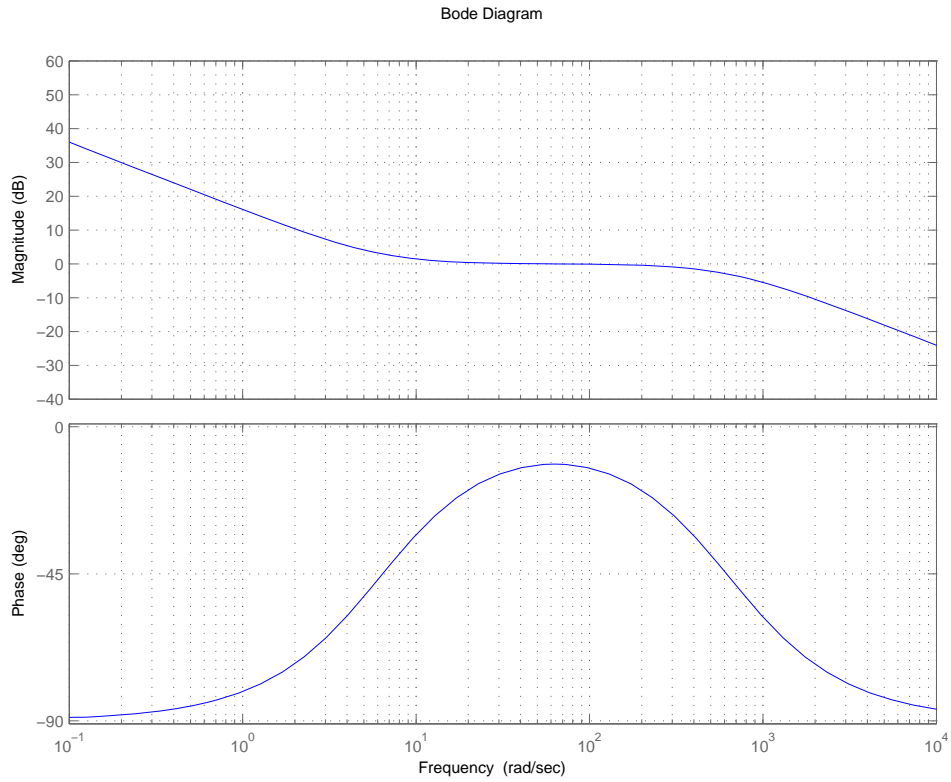


2. See attached scanned solutions

3.

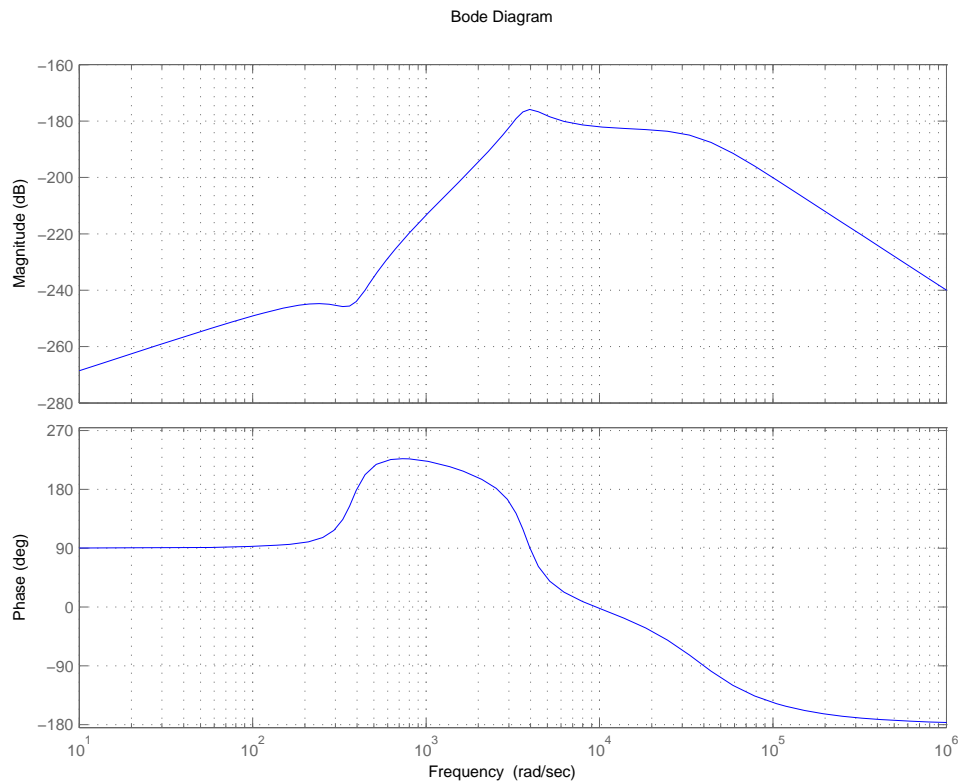
$$\frac{X(s)}{U(s)} = \frac{200\pi(s + 2\pi)}{s(s + 200\pi)}$$

$$\ddot{x} + (200\pi)\dot{x} = (200\pi)\dot{u} + (400\pi^2)u$$



4.

$$\frac{X(s)}{U(s)} = \frac{s(s^2 + (2)(0.2)(120\pi)s + (120\pi)^2)}{(s + 600\pi)(s^2 + (2)(0.2)(1200\pi)s + (1200\pi)^2)(s^2 + (2)(0.707)(12000\pi)s + (12000\pi)^2)}$$



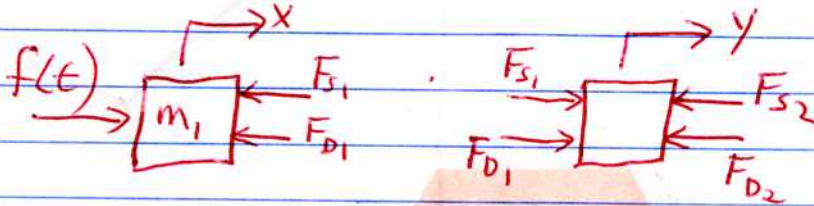
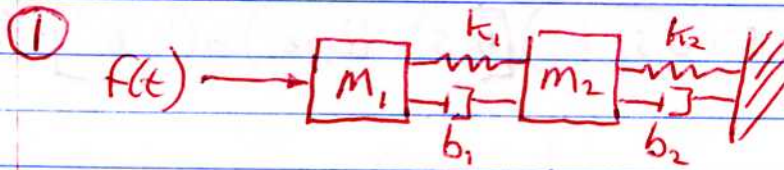
5. See attached scanned solutions

6.

13 Hz



H.W. * 6 Solutions



$$F_{s1} = k_1(x-y) \quad F_{s2} = k_2y$$

$$F_{D1} = b_1(\dot{x}-\dot{y}) \quad F_{D2} = b_2\dot{y}$$

$$\begin{aligned} \rightarrow \Sigma F_x &= m_1\ddot{x} = f(t) - k_1(x-y) - b_1(\dot{x}-\dot{y}) \\ \rightarrow \Sigma F_y &= m_2\ddot{y} = k_1(x-y) + b_1(\dot{x}-\dot{y}) - k_2y - b_2\dot{y} \end{aligned}$$

$$m_1\ddot{x} + k_1(x-y) + b_1(\dot{x}-\dot{y}) = f(t)$$

$$m_2\ddot{y} + k_2y + b_2\dot{y} - k_1(x-y) - b_1(\dot{x}-\dot{y}) = 0$$

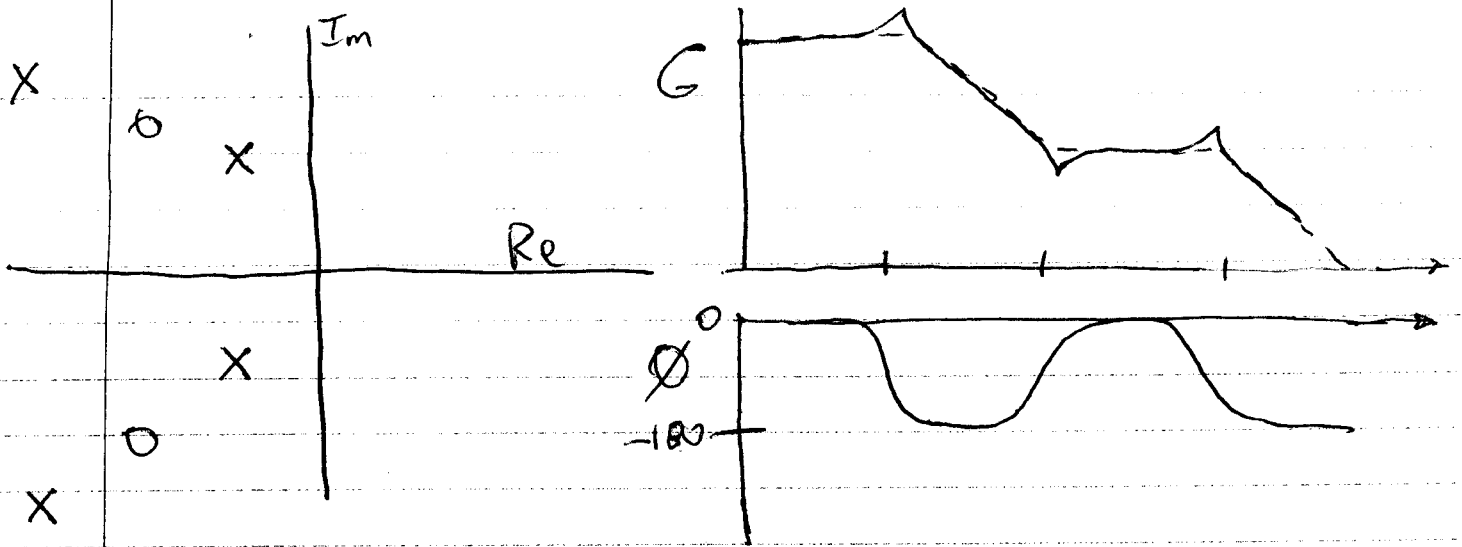
$$(m_1s^2 + b_1s + k_1)X(s) + Y(s)(-k_1 - b_1s) = F(s)$$

$$\left[(m_2s^2 + b_2s + k_2) + (b_1s + k_1) \right] Y(s) + X(s)(-k_1 - b_1s) = 0$$

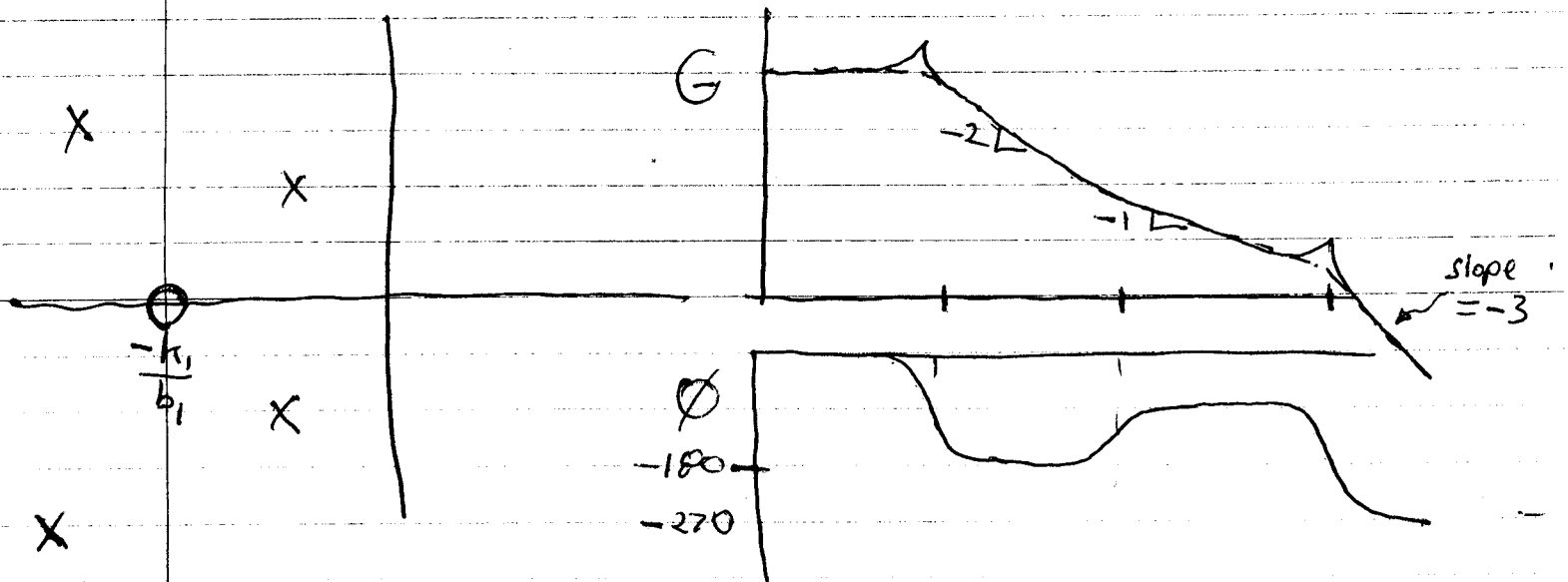
$$\frac{Y(s)}{X(s)} = \frac{k_1 + b_1s}{m_2s^2 + (b_1 + b_2)s + (k_1 + k_2)}$$

$$\left[m_1s^2 + b_1s + k_1 \right] X(s) + \frac{(k_1 + b_1s)(-k_1 - b_1s)X(s)}{m_2s^2 + (b_1 + b_2)s + (k_1 + k_2)} = F(s)$$

$$\frac{X(s)}{F(s)} = \frac{m_2 s^2 + (b_1 + b_2)s + (k_1 + k_2)}{(m_1 s^2 + b_1 s + k_1) [m_2 s^2 + (b_1 + b_2)s + (k_1 + k_2)] + (k_1 + b_1 s)(-k_1 - b_1 s)}$$



$$\frac{Y(s)}{F(s)} = \frac{k_1 + b_1 s}{[m_1 s^2 + b_1 s + k_1] [m_2 s^2 + (b_1 + b_2)s + (k_1 + k_2)] + (k_1 + b_1 s)(-k_1 - b_1 s)}$$

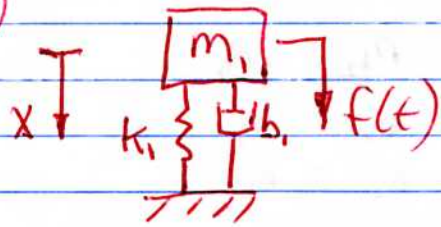


d) Note: Same Denominator (Poles) for both TF's



HW # 7 Solutions

①



$$m_1 \ddot{x} + b_1 \dot{x} + k_1 x = f(t)$$

$$\frac{X}{F} = \frac{1}{m_1 s^2 + b_1 s + k_1}$$

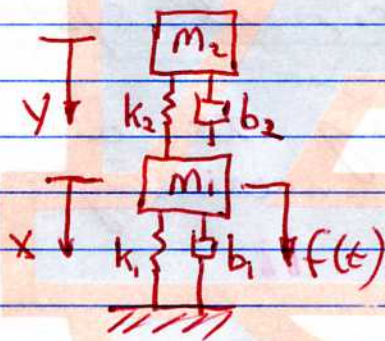
$$m_1 s^2 + b_1 s + k_1 = 0$$

$$s^2 + \frac{b_1}{m_1} s + \frac{k_1}{m_1} = 0$$

$$\frac{k_1}{m_1} = \omega_n^2 = (60 \times 2\pi)^2 \quad \frac{b_1}{m_1} = 2 \times \zeta \times \omega_n$$

$$k_1 = 1.42 \times 10^6 \text{ N/m}$$

$$b_1 = 7.54 \times 10^4 \text{ NS/m}$$



From Problem # 1 on HW # 6

$$\frac{X}{F} = \frac{m_2 s^2 + b_2 s + k_2}{[m_1 s^2 + (b_1 + b_2) s + (k_1 + k_2)] [m_2 s^2 + b_2 s + k_2] - [b_2 s + k_2]^2}$$

Choose any m_2, b_2, k_2 such that the natural frequency of the zero is @ 60 Hz

SP

Easiest choice \Rightarrow

$$\begin{aligned} m_2 &= m_1 \\ b_2 &= b_1 \\ k_2 &= k_1 \end{aligned}$$

gives a zero with $\omega_n = 60 \text{ Hz}$
 $\zeta = 0.1$

b) See Bode Plot

- c)
- Add more mass to change ω_n of the original system
 - Add more damping to decrease the "peak" by increasing ζ

Bode Diagrams

From: U(1)

