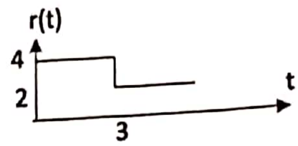
Problem-1 (5pts)

- Given the dynamical system $2r(t) - 6y(t) = 8\dot{y}(t)$ find the following
  - ✓ a. Stability
  - / b. Step response due to r(t)=3 (must solve and graph)
  - ✱ c. Steady state output when subjected to the following r(t)



$4\dot{y}(t) + 3y(t) = r(t)$ / $\mathcal{L}$ both sides

$\Rightarrow 4sY(s) + 3Y(s) = R(s)$

$\Rightarrow Y(s)[4s+3] = R(s)$

$$\Rightarrow \boxed{\frac{Y(s)}{R(s)} = \frac{1}{4s+3} = G(s)}$$

$\boxed{a}$ to ~~see~~ check the stability we need to find the Domination.

$4s+3=0$

$s = \frac{-3}{4} \Rightarrow$ Pole $\left\{\frac{-3}{4}\right\}$, so it $\boxed{\text{Asymptotically stable}}$

$\boxed{b}$ $Y(s) = G(s) * R(s) \Rightarrow \frac{3}{s} \cdot \frac{1}{4s+3} = \frac{3/3}{s(\frac{4}{3}s+1)}$

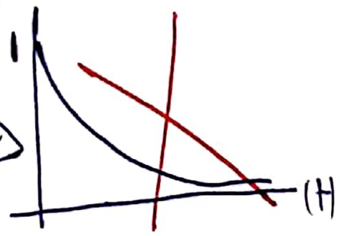
$$\frac{1}{s(\frac{4}{3}s+1)} = \frac{A}{s} + \frac{B}{\frac{4}{3}s+1}$$

$A \Rightarrow \frac{1}{(\frac{4}{3}s+1)}\Big|_{s=0}$ $\boxed{=1}$ (A), $B = \frac{1}{s}\Big|_{s=\frac{-3}{4}}$ $\boxed{=\frac{-4}{3}}$ (B)

$\Rightarrow Y(s) = \frac{1}{s} - \frac{4}{3}\left(\frac{1}{\frac{4}{3}s+1}\right)$

$Y(s) = \frac{1}{s} - \cancel{1}\left(\frac{1}{s+\frac{3}{4}}\right)$ / take $\mathcal{L}^{-1}$ Y(s)

$$\boxed{y(t) = 1 - e^{-\frac{3}{4}t}} \longleftrightarrow$$



$\boxed{c}$ 1) when subjected to r(t) = 4

$Y(s) \Rightarrow \frac{4}{s} \cdot \frac{1}{4s+3}$

$Y_{s.s} = \lim_{s \to 0} s\,Y(s) = \boxed{\frac{4}{3}}$

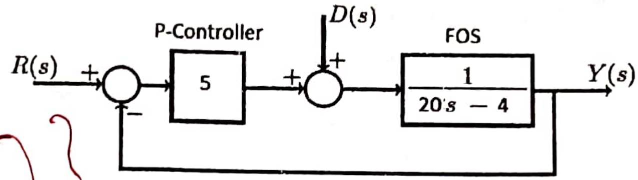
2) when subjected to r(t) = 2

$Y(s) = \frac{2}{s} \cdot \frac{1}{4s+3}$

$Y_{s.s} = \lim_{s \to 0} s\,Y(s) = \boxed{\frac{2}{3}}$

Problem-2 (5pts)

- Given the block diagram
  1. Draw the Bode plot of the output and disturbance
  2. How does the system behave to disturbance below a certain frequency?
  3. Why the controller was used in this application?



①

$$G(s)_{cl/D} = \frac{K_p G_s}{1 + K_p G(s) * H(s)} = \frac{\frac{5}{20s-4}}{1 + \frac{5}{20s-4}} \; ?$$

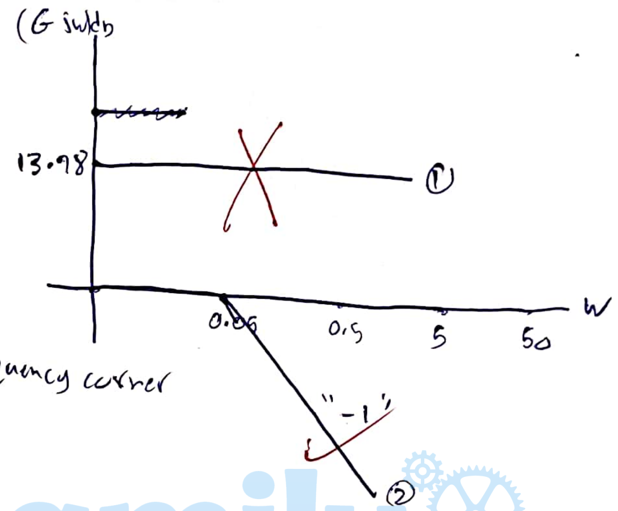
$$\Rightarrow \frac{5}{20s+1} = G(s) = \frac{5}{\frac{s}{0.05}+1}$$ NO

0.05 → frequency corner

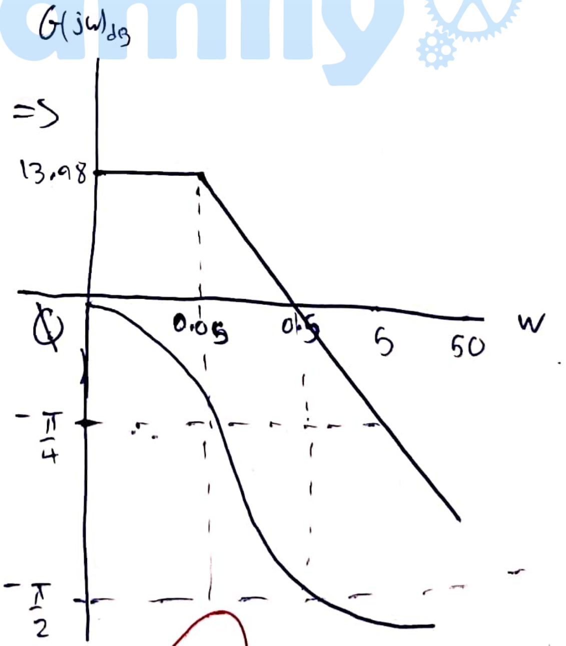
$$|G(s)|_{db} = 20\log(5) - 20\log|20s+1|$$

$$|G(j\omega)| = 13.98 - 20\log|20j\omega+1|$$

$$= 13.98 - 20\log\sqrt{1^2 + \left(\frac{\omega}{0.05}\right)^2}$$



$\boxed{2}$ It will be more stable and less disturbance at low frequency.



$\boxed{3}$ A. beat the disturbance.

B. to stibilize the unstable system.

C. enhance the performance.

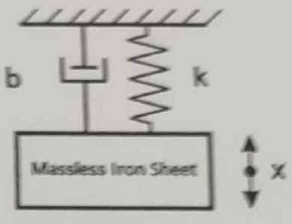
→ before use P.C ⇒ Pole $= \{\frac{4}{20}\}$ so unstable.

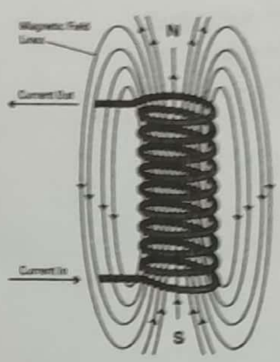
→ After use P.C ⇒ Pole $= \{-0.05\}$ so stable.

2

problem-3 (5pts)

- Given the following dynamical electro-mechanical system Where a mass-less iron sheet is subjected to an electrical Magnetic field as shown. Assuming a proportional to current electromagnetic force is generated by the coil. Find
  a. Transfer function $G = \frac{X(s)}{V(s)}$ where V is the coil input voltage and X is the sheet vertical displacement
  b. Draw a block diagram of the DEs





a) $\sum T = m\ddot{x}$

mass less

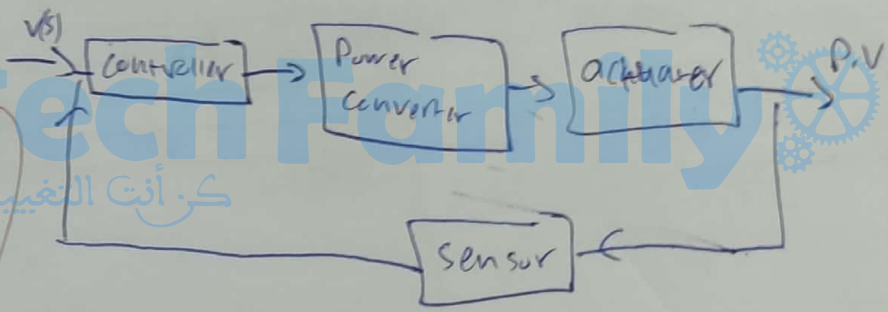
$\Rightarrow V_{in} - c\dot{x} - Kx = 0$

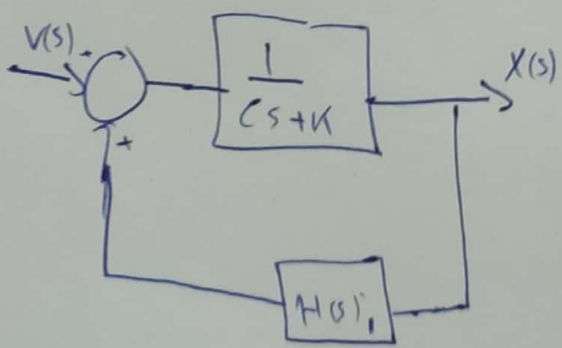
$\Rightarrow V(s) = s\,X(s)\,c + X(s)\,K$

$\Rightarrow V(s) = X(s)[cs + K]$

$\Rightarrow \frac{X(s)}{V(s)} = \frac{1}{cs+K} = G(s) = \frac{1/K}{\tau s+1}$

b)





3.5