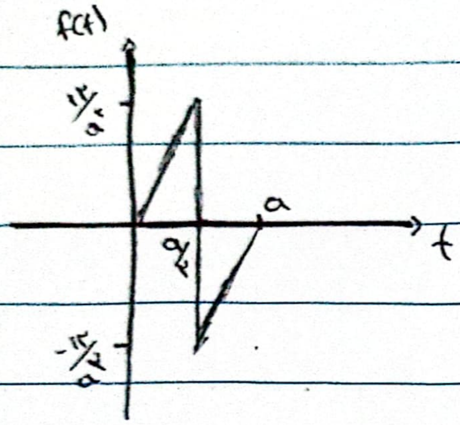
تمرین شماره ۱ کنترل خطی

نیلوفر ملا ۴۰۱۲۲۹۵۰۳



۱- تبدیل لاپلاس ؟

$$f(t)=\begin{cases}\frac{24}{a^3}t & 0\leqslant t<\frac{a}{2}\\ \frac{24}{a^3}(t-a) & \frac{a}{2}\leqslant t<a\end{cases}$$

$$f(t)=\frac{24}{a^3}t\left(u_0(t)-u_{a/2}(t)\right)+\frac{24}{a^3}(t-a)\left(u_{a/2}(t)-u_a(t)\right)$$

$$\boxed{\begin{aligned}&\ell\left(u_c(t)\,f(t)\right)=e^{-sc}\,\ell\left(f(t+c)\right)\\&\ell\left(u_c(t)\,f(t-c)\right)=e^{-sc}\,\ell\left(f(t)\right)\end{aligned}}$$

$$f(t)=\frac{24}{a^3}t\cdot u_0(t)-\frac{24}{a^3}t\cdot u_{a/2}(t)+\frac{24}{a^3}(t-a)\,u_{a/2}(t)-\frac{24}{a^3}(t-a)\,u_a(t)$$

$$=\frac{24}{a^3}t\cdot u_0(t)-\cancel{\frac{24}{a^3}t\cdot u_{a/2}(t)}+\cancel{\frac{24}{a^3}t\cdot u_{a/2}(t)}-\frac{24}{a^2}u_{a/2}(t)-\frac{24}{a^3}(t-a)\,u_a(t)$$

$$=\underbrace{\frac{24}{a^3}t}_{f(t)}\cdot u_0(t)-\underbrace{\frac{24}{a^2}}_{f(t)}u_{a/2}(t)-\underbrace{\frac{24}{a^3}t}_{f(t)}\cdot u_a(t)+\underbrace{\frac{24}{a^2}}_{f(t)}\cdot u_a(t)$$

$$L\rightarrow F(s)=e^{0}\,\ell\left(\frac{24}{a^3}t\right)-e^{-\frac{a}{2}s}\,\ell\left(\frac{24}{a^2}\right)-e^{-as}\,\ell\left(\frac{24}{a^3}(t+a)\right)$$

$$+\,e^{-as}\,\ell\left(\frac{24}{a^2}\right)$$

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$$F(s)=\frac{24}{a^3}\left(\frac{1}{s^2}\right)-e^{-\frac{a}{2}s}\,\frac{\frac{24}{a^2}}{s}-e^{-as}\,\mathcal{L}\left(\frac{24}{a^3}t+\frac{24}{a^2}\right)$$

$$+e^{-as}\,\frac{\frac{24}{a^2}}{s}=\frac{24}{a^3s^2}-\frac{\frac{24}{a^2}}{s}e^{-\frac{a}{2}s}-e^{-as}\left(\frac{24}{a^3s^2}+\frac{\frac{24}{a^2}}{s}\right)$$

$$+e^{-as}\,\frac{\frac{24}{a^2}}{s}$$

$$F(s)=\frac{24}{a^3s^2}-\frac{24}{a^2s}e^{-\frac{a}{2}s}-e^{-as}\left(\frac{24}{a^3s^2}+\frac{24}{a^2s}-\frac{24}{a^2s}\right)$$

$$\rightarrow F(s)=\frac{24}{a^3s^2}-\frac{24}{a^2s}e^{-a/2\,s}-\frac{24}{a^3s^2}e^{-as}$$

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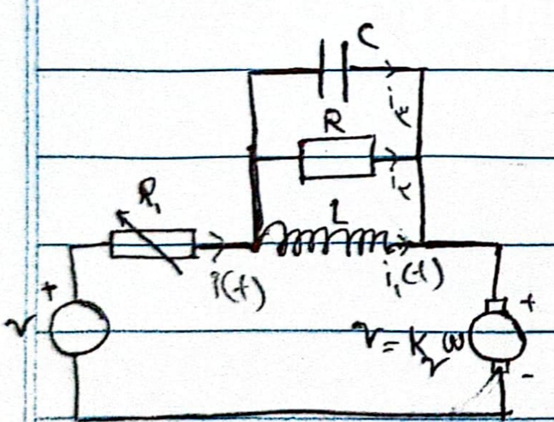

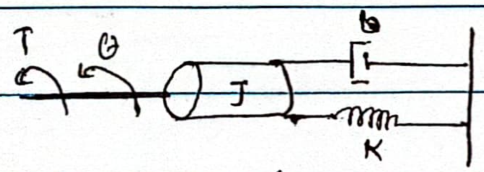

بخش مکانیکی

آ) مدل سازی

بخش الکتریکی

$$v(t)=R_1 i(t)+L\frac{di_1(t)}{dt}+v_{emf}$$

$$v_{emf}=K_2\,\omega(t)$$

$$T_m(t)=b\omega(t)+J\frac{d\omega(t)}{dt}+K\theta(t)$$

$$T_m=K_m\,i(t)$$

$$\left.\right\}\rightarrow \begin{cases} v(t)=R_1 i(t)+L\dfrac{di_1(t)}{dt}+K_2\,\omega(t)\\ K_m i(t)=b\omega+J\dfrac{d\omega(t)}{dt}+K\theta(t)\end{cases}$$

$$v_c=v_R=v_L\rightarrow RI_2=\frac{1}{Cs}I_3=LsI_1$$

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ب) نمودار بلوکی

$$V(s) = R_1 I(s) + L s I_1 + K_v W(s)$$

$$K_m I(s) = b W(s) + J s W(s) + K\Theta(s)$$

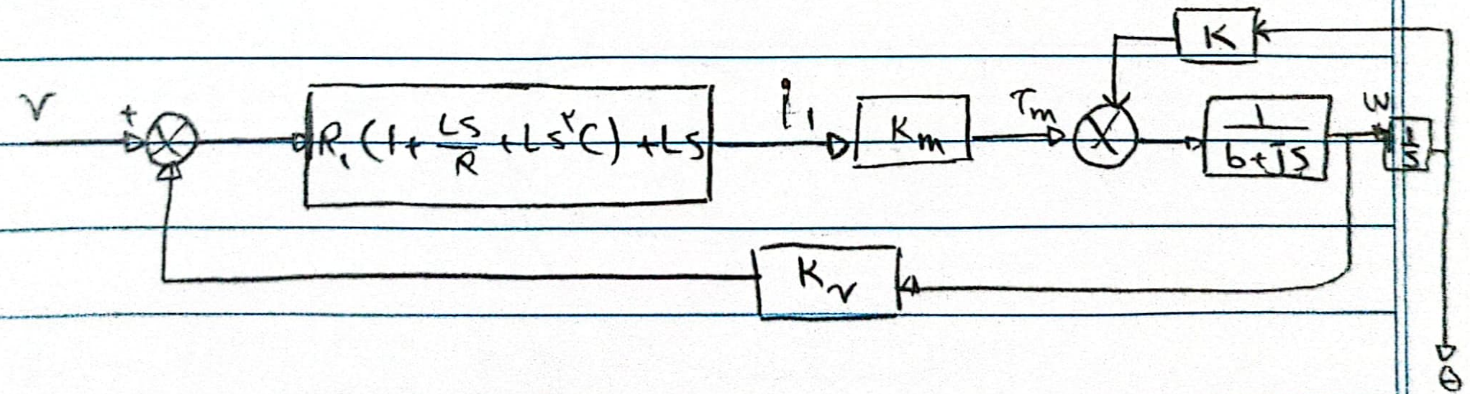
$$R I_2 = \frac{1}{Cs} I_3 = L s I_1 \qquad I = I_1 + I_2 + I_3$$

$$I_2 = \frac{Ls}{R} I_1 \qquad I_3 = L s^2 C I_1$$

$$V(s) = R_1 I_1 \left(1 + \frac{Ls}{R} + L s^2 C\right) + L s I_1 + K_v W(s)$$

$$K_m I_1 \left(1 + \frac{Ls}{R} + L s^2 C\right) = b W(s) + J s W(s) + K\Theta(s)$$

$$\frac{I_1}{V(s) - K_v W} = G = \frac{1}{R_1\left(1 + \frac{Ls}{R} + L s^2 C\right) + Ls}$$



$$v(s) = \frac{1}{s} \qquad G(s) = \frac{\Theta}{R_1}\,? \quad v_{in} = u(t) \quad \text{ج)}$$

$$\frac{1}{s} = R_1 \times \frac{b\omega + J s\omega + K\Theta}{\cancel{K_m\left(1 + \frac{Ls}{R} + L s^2 C\right)}} \cancel{\left(1 + \frac{Ls}{R} + L s^2 C\right)} + L s \times \frac{b\omega + J s\omega + K\Theta}{K_m\left(1 + \frac{Ls}{R} + L s^2 C\right)} + K_v W$$

$$\Rightarrow \frac{1}{s} = \frac{R_1}{K_m}(b\omega + J s\omega) + \frac{R_1}{K_m} K\Theta + \underbrace{\frac{Ls}{K_m\left(1 + \frac{Ls}{R} + L s^2 C\right)}}_{A} (b\omega + J s\omega) + \frac{Ls}{K_m \cdots} K\Theta + K_v W$$

$\Rightarrow$

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$$\Rightarrow \theta = \frac{\frac{1}{s} - \frac{R_1}{K_m}(bw + Jsw) - \frac{Ls}{A}(bw + Jsw) - K_r w}{\frac{KR_1}{K_m} + \frac{KLs}{A}}$$

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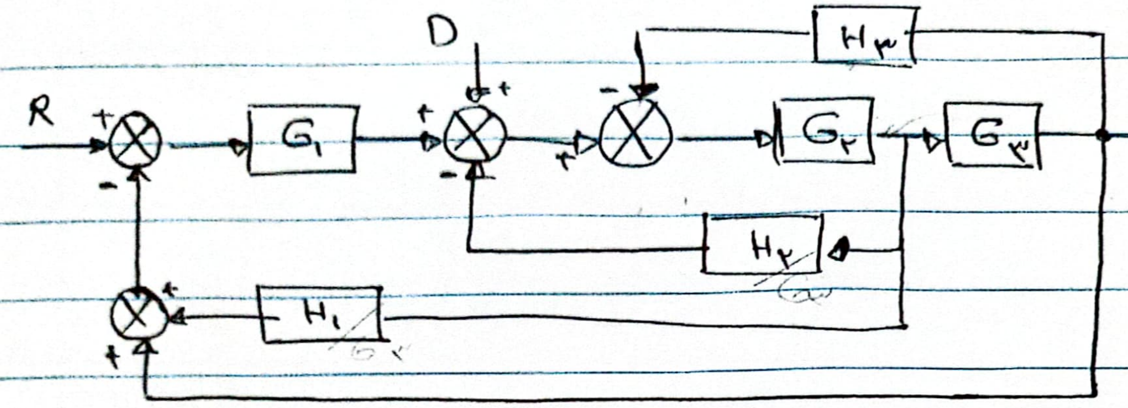
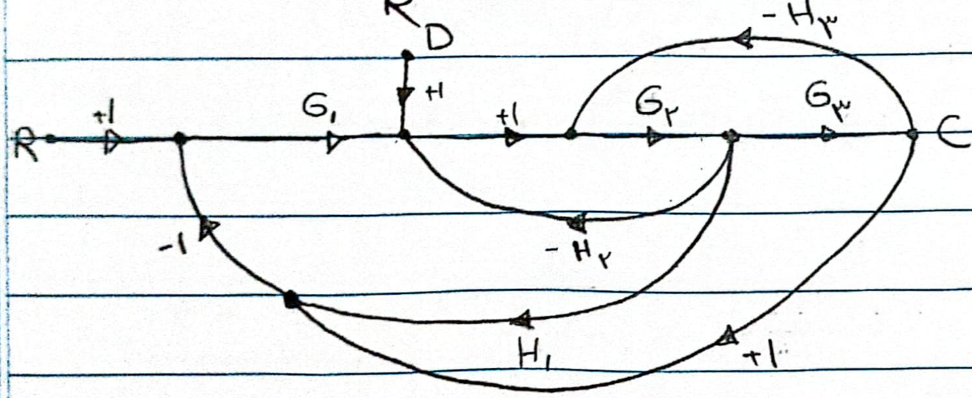
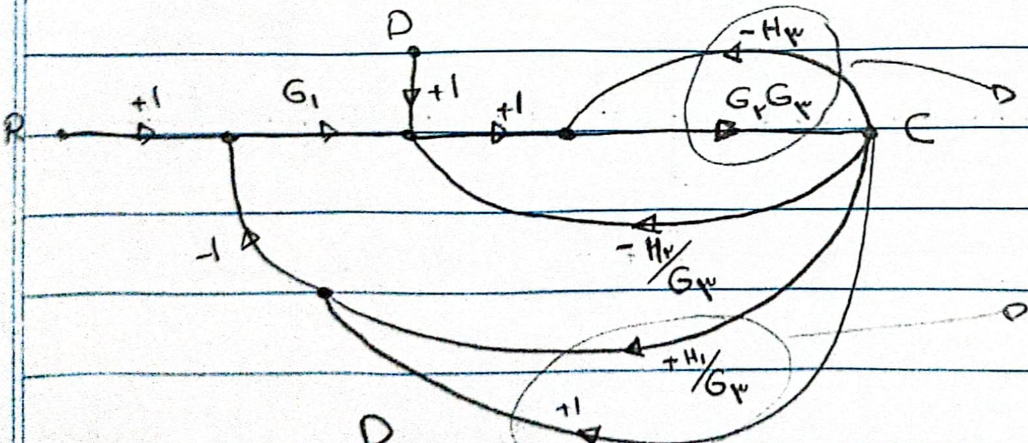


آ) نمودار جریان سیگنال ـ ساده سازی نمودار ـ بهره $Y = \frac{C}{R}$



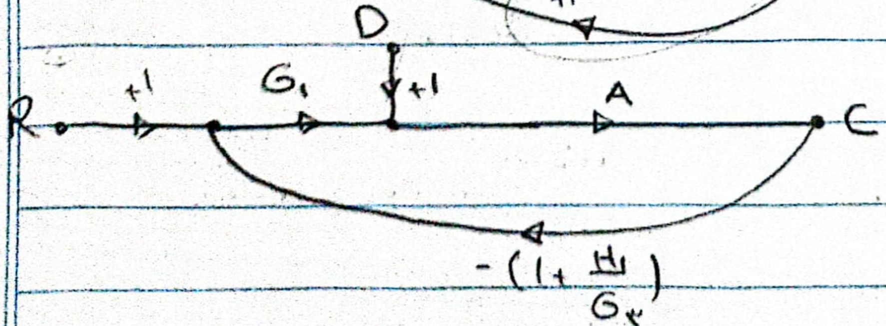
ساده سازی:



$$\frac{G_2 G_3}{1+H_3 G_2 G_3}$$

موازی

$$1+\frac{H_1}{G_3}$$



$$A = \frac{\frac{G_2 G_3}{1+H_3 G_2 G_3}}{1+\frac{H_2}{G_3}\times\frac{G_2 G_3}{1+H_3 G_2 G_3}}$$

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$$Y(s)=\sum_{K=1}^{N}\frac{M_K\Delta_K}{\Delta}$$

$$M_1=G_1A \qquad L_1=-G_1A\left(1+\frac{H_1}{G_3}\right)$$

$$\Delta_1=1 \qquad \Delta=1-L_1=1+G_1A\left(1+\frac{H_1}{G_3}\right)$$

$$Y(s)=\frac{G_1A}{1+G_1A\left(1+\frac{H_1}{G_3}\right)}$$

$$\frac{\dfrac{\dfrac{G_1G_2G_3}{1+H_3G_2G_3}}{1+\dfrac{H_2G_2}{1+H_3G_2G_3}}}{1+\dfrac{\dfrac{G_1G_2G_3}{1+H_3G_2G_3}}{1+\dfrac{H_2G_2}{1+H_3G_2G_3}}\times\dfrac{G_3+H_1}{G_3}}=\frac{\dfrac{G_1G_2G_3}{(1+H_3G_2G_3)+(H_2G_2)}}{1+\dfrac{G_1G_2(G_3+H_1)}{(1+H_3G_2G_3)+(H_2G_2)}}$$

$$=\frac{G_1G_2G_3}{(1+H_3G_2G_3)+(H_2G_2)+G_1G_2(G_3+H_1)}=\frac{G_1G_2G_3}{1+H_3G_2G_3+H_2G_2+G_1G_2G_3}$$

ادامه مخرج: $+G_1G_2H_1$

ب) برای رابطه اغتشاش (D)

$$X(s)=\frac{C(s)}{D(s)}=\sum\frac{M_K\Delta_K}{\Delta}$$

$$M_1=A \qquad L_1=-G_1A\left(1+\frac{H_1}{G_3}\right) \qquad \Delta_1=1 \qquad \Delta=1+G_1A\left(1+\frac{H_1}{G_3}\right)$$

$$X(s)=\frac{A}{1+G_1A\left(1+\frac{H_1}{G_3}\right)}=\frac{G_2G_3}{1+H_3G_2G_3+H_2G_2+G_1G_2G_3+G_1G_2H_1}$$

$\frac{Y}{X}=G_1=\infty$ برای از بین بردن تأثیر D ← $\frac{Y}{X}=\infty$ ← G_1 باید بسیار افزایش یابد تا اثر D از بین برود