Sh3

Notes

ii) $E(s) = R(s) - C(s)\,H(s)$

$\hookrightarrow e_{ss} = r_{ss} - c_{ss}$

$\hookrightarrow c_{ss} = r_{ss} - e_{ss}$ أغلب الوقت بتغالت، لو طالع صح، ارجع للحل التقليدي!

$C(s) = TF * R(s)$

$\hookrightarrow c_{ss} = \lim_{s \to 0} s\,C(s)$

Routh $\rightarrow$

iii) - لو طلع عندي row كل Zero، بيلحه وهات تفاضل الـ row اللي قبله

eg

$$\begin{array}{llll} s^5 & 1 & 1 & 1 \\ s^4 & 2 & 2 & 2 \\ s^3 & \cancel{0}\ 8 & \cancel{0}\ 4 & \end{array}$$

$\nearrow 2s^4 + 2s^2 + 2 = 0 \xrightarrow{d/ds} 8s^3 + 4s$

iii) - لو طلع عندي Zero في أول col، حط بدلها ε حيث $\varepsilon \to 0^+$ وكمل حل عادي، وشوف الـ sign بتاعت الحاجات اللي تحت

iv) - في ii و iii الـ sys هيكون على الأقل critically stable

v) 

- قبل Routh لو فيه -ve Coff يبقى unstable

لو فيه Zero Coff يبقى critically stable

vi) Simple G(s) $\nearrow$ 2^{nd} order $\rightarrow$ stable iff $[a_i > 0]$

$\searrow$ 3^{rd} order $\rightarrow$ stable iff $[a_i > 0]$ & $[\overset{\text{جوا}}{a_2 a_1} > \overset{\text{برا}}{a_0 a_3}]$

vii) $TF = \dfrac{G(s)_{Num}}{G(s)_{Den} + G(s)_{Num}\,H(s)} \Big] \rightarrow$ CLS Eq

VIII

$$\begin{array}{lll} s^{n} & a & \boxed{b} \\ s^{n-1} & c & 0 \\ s^{n-2} & \boxed{b} & \end{array}$$

لو في zero ، اللي فوقه هينزل زي كده

IX

$$\begin{array}{ll} s^{n} & 1 \\ s^{n-1} & -1 \ \text{①} \\ s^{n-2} & 2 \ \text{②} \\ s^{n-3} & -2 \ \text{③} \end{array}$$

No of changes = No of Poles in the R.H.P

X

لو ال Const ب zero ، $0 \times s^0$ يبقى فيه Pole عند ال origin
و معنى كده نلغى ال Freq=0 !

Q.1

$* \ TF = \dfrac{G(s)}{\underbrace{1+G(s)H(s)}_{\to\ c/cs\ eq}}$

$* \ c/cs\ eq \Rightarrow 1 + G(s)H(s) = 1 + \dfrac{K_1}{s(s+2)(s+K_2)} = 0$

$\Rightarrow s(s+2)(s+K_2) + K_1 = 0$

$\Rightarrow s^3 + (2+K_2)s^2 + 2K_2 s + K_1$

$* \ s^2 : 2+K_2 > 0 \rightarrow \boxed{K_2 > -2}$

$* \ s^1 : 2K_2 > 0 \rightarrow \boxed{K_2 > 0}$

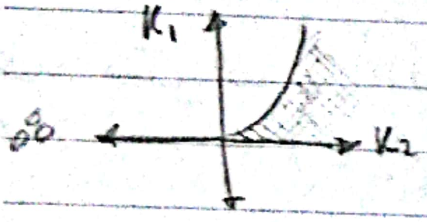
$* \ s^0 : K_1 > 0 \rightarrow \boxed{K_1 > 0}$

1st Quarter

From Routh $\rightarrow \boxed{2K_2(2+K_2) > K_1}$

$K_2^2 \rightarrow$ Parabola

Parabola



$\therefore$ - لو عاوز نـPlot قيم K_1 و K_2 اللي تخلي

الـ S/S stable، فرسمت K_1 و K_2 كـ جراف

وعرفت انه في أول ربع ولازم تحت الـ Parabola.

Q.3

$\therefore G(s) = \dfrac{K_v}{\underbrace{s(4s+1)(s+1)}_{Type\ 1}}$, $\underbrace{r(t) = 1+t}_{ramp}$ $\Bigg] \rightarrow e_{ss} = 0 + 1/K_v$

$K_v \leftarrow$ Const عادي

velocity

a) $K_v = \lim_{s\to 0} s\,GH(s) = K_v$

$\therefore e_{ss} \leq 0.1 \rightarrow 1/K_v \leq 0.1 \rightarrow K_v \geq 10$

b) $c/cs \Rightarrow s(4s+1)(s+1) + K_v \rightarrow 4s^3 + 5s^2 + s + K_v$

$s^0 : \boxed{K_v > 0}$

Routh : $5 \times 1 > 4K_v$

$\boxed{K_v < 5/4}$

* There are No values of K_v to make the S/S stable with $e_{ss} \leq 0.1$

$* \ e_{ss})_{min} = 1/K_v)_{max} = \dfrac{4}{5}$

$\boxed{Q:2}$ $G(s) = \dfrac{12(s+4)}{s(s+1)(s+3)(s^2+2s+10)}$ $\Big\} \rightarrow$ Type 1

a] $K_P = \lim\limits_{s\to 0} GH(s) = \infty$, $K_V = \lim\limits_{s\to 0} sGH(s) = \dfrac{12*4}{1*3*8} = \dfrac{48}{30} = 1.6$

$K_a = \lim\limits_{s\to 0} s^2\, GH(s) = \text{Zero}$

b]

i) $r(t) = \overbrace{16+2t}^{\text{ramp}}$, $e_{ss} = 0 + \dfrac{2}{K_V} = \dfrac{2}{1.6} = 1.25$

$e_{ss} = r_{ss} - c_{ss} \Rightarrow c_{ss} = r_{ss} - e_{ss} = \infty - 1.25 = \infty$

ii] $r(t) = 5t^2 = 5*2\,\dfrac{t^2}{2}$] Parabola

عشان نقدر نستخدم الجدول

لازم نشكلها ← $\left(\frac{M}{2}t^2\right)$

$c_{ss} = r_{ss} - e_{ss} = \infty - \infty$

- معرفتش اطلعها

- عوض في الشكل الأصلي

$C(s) = \dfrac{12(s+4)}{s(s+1)(s+3)(s^2+2s+10)+12(s+4)}$

$c(s) = \lim\limits_{s\to 0} s\,C(s) = \infty$

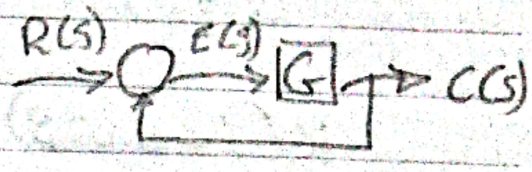
c] C/cs eln $\Rightarrow s(s+1)(s+3)(s^2+2s+10) + 12(s+4) = 0$

$s^5 + 6s^4 + 21s^3 + 46s^2 + 42s + 48 = 0$

s^5	1	21	42
s^4	6	46	48
s^3	40/3	34	0
s^2	30.7	48	
s^1	4038/307	0	
s^0	48		

$\therefore$ The sys is stable

Q.4 The diagram is reduced to $\nearrow$ $G(s) = \dfrac{5K}{s[(1+0.1s)(1+0.5s)+100K_t]}$



at $e_{ss} = 0 \rightarrow K_p = \infty$

$\rightarrow K_v = \lim_{s\to 0} sGH(s) = \dfrac{5K}{1+100K_t}$

$e_{ss} = \infty \rightarrow K_a = \text{zero}$

b)

i) $r(t) = 6 + 8t \overset{\text{ramp}}{\Rightarrow} e_{ss} = 0 + \dfrac{8}{K_v} = \dfrac{8(1+100K_t)}{5K}$

ii) $r(t) = 2t + 14\dfrac{t^2}{2} \Rightarrow e_{ss} = \dfrac{2}{K_v} + \dfrac{14}{K_a} = \infty$

a)

$C/cs \Rightarrow 1 + GH(s) = s[(1+0.1s)(1+0.5s)+100K_t] + 5K$

$0.05s^3 + 0.6s^2 + (100K_t + 1)s + 5K$

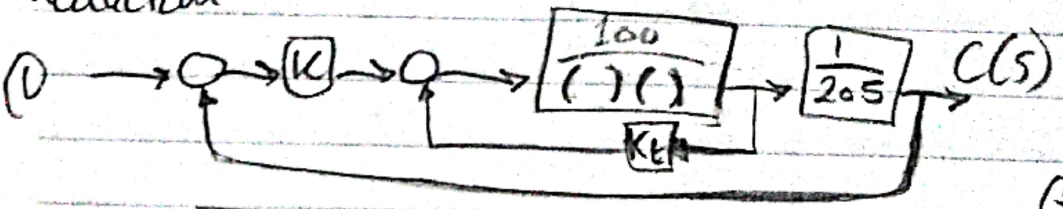
$s^0: 5K > 0 \rightarrow \boxed{K > 0}$

$s^1: 100K_t + 1 > 0 \rightarrow \boxed{K_t > 0.01}$

Routh: $\boxed{0.6(100K_t+1) > 5 * 0.05K}$

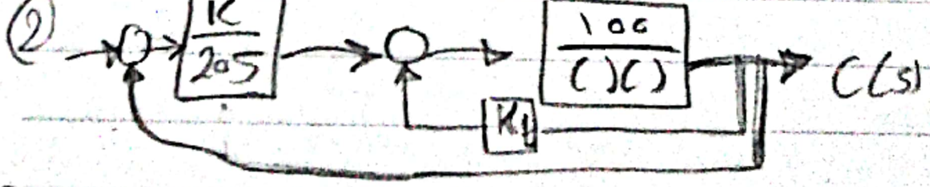
$K_v = \dfrac{5K}{1+100K_t}$, but $\dfrac{0.6}{0.05} > \dfrac{5K}{1+100K_t} \Rightarrow \boxed{K_v < 12}$

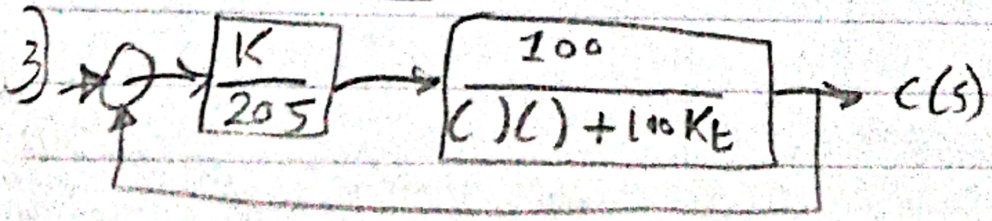
Reduction



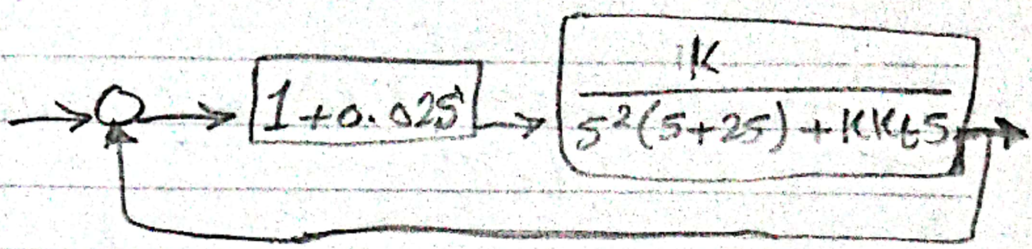
$G_i = \dfrac{G(i-1)_{Num}}{G(i-1)_{Den} + G(i-1)_{Num} * H(s)}$

بتبسط ال loop!





$\boxed{Q:5}$ Same as Q:4



$$G(s) = \frac{K(1+0.02s)}{s(s(s+25)+KK_t)}$$

$$ess = 1/K_v = K_t \Leftarrow K_v = \lim_{s\to 0} sGH(s) = \frac{K}{KK_t} = \frac{1}{K_t}$$

ckseqn $\Rightarrow s^3 + 25s^2 + (K_tK + 0.02K)s + K$

s^0: $\boxed{K>0}$

s^1: $K_tK + 0.02K > 0 \Rightarrow \boxed{K_t > -0.02}$

$\boxed{25(K_tK + 0.02K) > K}$ ← from Routh!

$K_t + 0.02 > 1/25 \rightarrow \boxed{K_t > 0.02}$