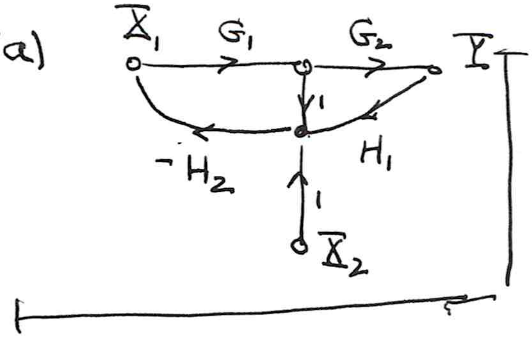
1° (a)



(b) $\underline{X_2 = 0}$

LOOPS

$L_1 = G_1 G_2 H_1 (-H_2)$

$L_2 = -H_2 G_1$

$\Delta = 1 - L_1 - L_2$ | $P_1 = G_1 G_2$

$\Delta_1 = 1$

$$\left.\frac{Y}{X_1}\right|_{X_2=0} = \frac{P_1 \Delta_1}{\Delta} = \frac{G_1 G_2}{1 + G_1 G_2 H_1 H_2 + G_1 H_2}$$

(c) $X_1 = 0$

$\boxed{P_1 = 1(-H_2) G_1 G_2}$

$\Delta_1 = \emptyset$

$\Delta = 1 - L_1 - L_2$

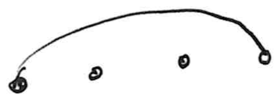
$$\left.\frac{Y}{X_2}\right|_{X_1=0} = \frac{-H_2 G_1 G_2}{1 + G_1 G_2 H_1 H_2 + G_1 H_2}$$

(d)

$$Y = \left.\left(\frac{Y}{X_1}\right)\right|_{X_2=0} X_1 + \left.\left(\frac{Y}{X_2}\right)\right|_{X_1=0} X_2$$

2.

$P_1 = H_0 G_2 H_1$

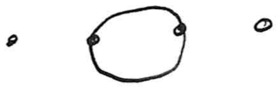


$P_2 = G_0$

$\Delta_1 = 1$

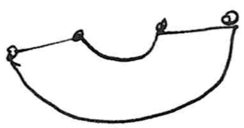
$\Delta_2 = 1 - L_1$

Loops



$L_1 = G_1 G_2$

$L_2 = G_0 G_4$



$L_3 = H_0 G_2 H_1 G_4$

$\Delta = 1 - (L_1 + L_2 + L_3) + L_1 L_2$

$$\frac{Y}{X} = \frac{P_1 \Delta_1}{\Delta} + \frac{P_2 \Delta_2}{\Delta}$$

3

(a) $\dfrac{Y}{X} = \dfrac{GH}{1+GH}$

(b) $1+GH=0$

(c) $1+GH = 1+\dfrac{k(s+2)}{s^2(s+1)(s+3)} \Rightarrow s^4+4s^3+3s^2+ks+2k=0$

$$
\begin{array}{c|ccc}
s^4 & 1 & 3 & 2k \\
s^3 & 4 & k & \\
s^2 & \dfrac{12-k}{4} & 2k & \longrightarrow\ 12-k>0 \\
s & \dfrac{(12-k)k-32k}{(12-k)} & \longrightarrow & \dfrac{-k(k+20)}{12-k} > 0 \\
s^0 & 2k & & \longrightarrow\ k>0
\end{array}
$$

$$\underbrace{(12-k>0)\cap(k>0)}_{12>k>0}\cap\left(-\frac{k(k+20)}{12-k}\right) \Rightarrow$$

$\emptyset$ (") no intersection

unstable for ~~∀~~ ~~k<12~~

all k

(4) (a) $\frac{\underline{Y}}{\underline{X}} = \frac{G}{1+G}$ (b) $1+G=0 \Rightarrow s^4+12s^3+47s^2+(k+60)s+k=0$

s^4	1	47	k
s^3	12	$k+60$	
(A) s^2	$\frac{504-k}{12}$	k	
(B) s^1	$\frac{-k^2+300k+30240}{504-k}$		
(C) s^0	k		

Stable no sign changes in 1st column

(A) $\frac{504-k}{12} > 0 \Rightarrow \boxed{k < 504}$

(B) $\frac{(k-150)^2-(150)^2-30240}{504-k} < 0 \Rightarrow (k-150)^2 < (150)^2+30240$

$\Rightarrow 150+\underbrace{\sqrt{(150)^2+30240}}_{\sim 229} > k > 150-\sqrt{150^2+30240}$

$\boxed{379 > k > -79}$

(C)

$k > 0$

stable

$0 < k < 379$

5°

(a) $$\frac{Y}{X} = \frac{\left(\frac{1}{s+1}\right)}{1 + H\left(\frac{1}{s+1}\right)} \qquad \frac{E}{X} = 1 - \frac{Y}{X}H$$

$$\frac{E}{X} = 1 - \frac{\left(\frac{1}{s+1}\right)H}{1+H\left(\frac{1}{s+1}\right)} = \boxed{\frac{1}{1+H\left(\frac{1}{s+1}\right)} = \frac{E}{X}}$$

(b)

$$X = \frac{1}{s}$$

$$E(s) = \left(\frac{1}{s}\right)\left[\frac{1}{1+\frac{H}{s+1}}\right]$$

$$e(\infty) = \lim_{s \to 0} sE = \lim_{s \to 0} \frac{1}{1+\frac{H}{s+1}} = \frac{1}{20} \Rightarrow \begin{cases} \boxed{H = K} \\ \lim_{s \to 0} \frac{1}{1+\frac{K}{s+1}} = \frac{1}{1+K} \end{cases}$$

$$\frac{1}{1+K} = \frac{1}{20} \Rightarrow \boxed{K = 19}$$

(c) $$\frac{Y}{X} = \frac{1}{s+1+19} = \frac{1}{s+20} \qquad \boxed{s = -20}$$

<u>stable</u>