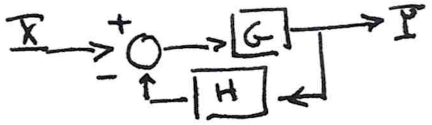
1°



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

(b) $1+GH=0 \Rightarrow 1+\left(\dfrac{4s+k}{s^2}\right)\left(\dfrac{1}{s+2}\right)=0 \Rightarrow s^3+2s^2+4s+k=0$

(c)

s^3	1	4
s^2	2	K
s	$\frac{8-k}{2}$	
s^0	K	

Stable

$\rightarrow 8-k>0$

$\rightarrow k>0$

Stable if

$8>k>0$

(d) Marg. stable

$(k=8)$ aux eqn: $2s^2+k=0 \Rightarrow s^2+\frac{8}{2}=0$

$s=\pm j2 = j\omega$

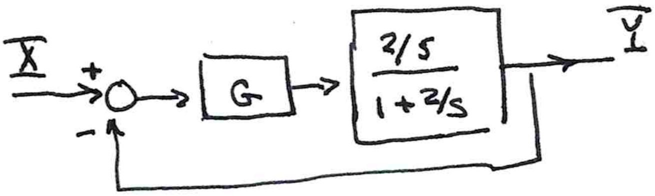
$\omega = 2$ rad/sec

$f=\frac{2}{2\pi}$ hz

$\frac{2}{s+2} = H$

2

(a)



$\frac{Y}{X} = \frac{GH}{1+GH}$

(b) $E = X - Y \Rightarrow \frac{E}{X} = 1 - \frac{Y}{X} = \frac{1}{1+GH}$

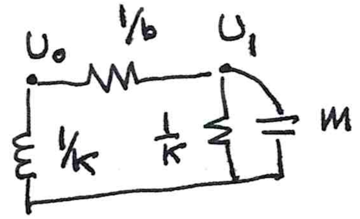
$X = \frac{1}{s^2}$; $\quad E = \left(\frac{1}{s^2}\right)\left[\frac{1}{1+\frac{G2}{s+2}}\right]$

$e(\infty) = \lim_{s \to 0} \frac{1}{s + \frac{2sG}{s+2}} = \frac{1}{2} \Rightarrow \lim_{s \to 0} \frac{1}{sG} = \frac{1}{2}$

$\boxed{G = \frac{k}{s} \Rightarrow k = 2}$

3.

(a)



$$\frac{U_1}{U_0} = \frac{\frac{s}{k} \parallel \frac{1}{Ms}}{1/b + \frac{s}{k} \parallel \frac{1}{Ms}}$$

$$\frac{s}{k} \parallel \frac{1}{Ms} = \left(\frac{k}{s} + Ms\right)^{-1} = \left(\frac{k + Ms^2}{s}\right)^{-1} = \frac{s}{k+Ms^2}$$

$$\frac{U_1}{U_0} = \frac{sb}{Ms^2+bs+k} = \frac{s\,\frac{1}{2}}{s^2+s/2+1}$$

$\delta \overset{\mathcal{L}}{\longleftrightarrow} 1$

$$U_1 = \frac{1}{2}\left(\frac{s}{s^2+s/2+1}\right)$$

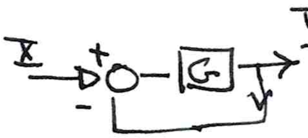
$\underline{t>0}$

$$u_1 = \frac{e^{-t/4}}{2}\left\{\cos\left[\frac{\sqrt{15}}{4}t\right] - \sin\left[\frac{\sqrt{15}}{4}t\right]\frac{1}{\sqrt{15}}\right\}$$

$t<0$

$$u_1(t) = 0$$

4.

(a) 

$$\frac{G}{1+G} = \frac{Y}{X}$$

$$1+G=0 \Rightarrow 1 + \frac{ks(s+2)}{(s^2-4s+8)(s+3)} = 0$$

$$s^3 + (k-1)s^2 + (2k-4)s + 24 = 0$$

$$\begin{array}{c|cc}
s^3 & 1 & 2k-4 \\
s^2 & (k-1) & 24 \\
s^1 & \frac{(k-1)(2k-4)-24}{(k-1)} & \\
s^0 & 24 &
\end{array}$$

stable

$(k-1) > 0 \Rightarrow \boxed{k>1}$

$$\frac{2k^2-6k-20}{(k-1)} > 0$$

analysis

$$2[k^2-3k-10] > 0$$

$$2[(k-3/2)^2 - (\tfrac{3}{2})^2 - 10] > 0$$

$$(k-\tfrac{3}{2})^2 > (\tfrac{3}{2})^2 + 10$$

$$k - \tfrac{3}{2} > \sqrt{(\tfrac{3}{2})^2 + 10}$$

stable if

$$\boxed{k > \tfrac{3}{2} + \sqrt{(3/2)^2 + 10}}$$

$$\boxed{k>5}$$

(b) $k=5$

aux. poly:

$$(k-1)s^2 + 24 = 0$$

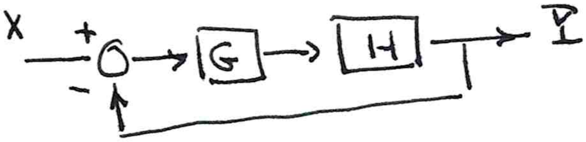
$$4s^2 + 24 = 0$$

$$s = \pm j\sqrt{6}$$

$$\omega = \sqrt{6}$$

$$f = \frac{\sqrt{6}}{2\pi}$$

5.



$$\frac{Y}{X} = \frac{GH}{1+GH}$$

$$1+GH = \frac{k(s+2)}{s(s+1)(s+3)}\,\frac{(s+6)}{(s+7)} + 1 = 0$$

$$s^4 + 11s^3 + (k+31)s^2 + (8k+21)s + 12k = 0$$

s^4	1	$k+31$	$12k$
s^3	11	$8k+21$	
s^2	$\frac{(11)(k+31)-(8k+21)}{11} = \frac{3k+320}{11}$	$12k$	
s^1	$\frac{\frac{(3k+320)(8k+21)}{11} - (11)(12k)}{\left(\frac{3k+320}{11}\right)} = \frac{24k^2+1171k+6720}{3k+320}$		
s^0	$12k$		

$$\boxed{k > -\frac{320}{3}}$$

$$k^2 + \frac{1171}{24}k + \frac{6720}{24} > 0$$

$$\left(k+\frac{1171}{48}\right)^2 - \left(\frac{1171}{48}\right)^2 + \frac{6720}{24} > 0$$

$$\left(k+\frac{1171}{48}\right)^2 > \left(\frac{1171}{48}\right)^2 - \frac{6720}{24}$$

$$k + \frac{1171}{48} > \frac{11}{48}\sqrt{6001}$$

$$k > \frac{11}{48}\sqrt{6001} - \frac{1171}{48} \Rightarrow \boxed{k > -6.64}$$

$$\boxed{k > 0}$$

$\boxed{\text{Stable for } k > 0}$