E13.3 $y(kT) = kT$

$y(t) = t$

$Y(z) = \frac{Tz}{(z-1)^2}$

E13.4 $Y(s) = \frac{5}{s(s+2)(s+10)} = \frac{A}{s} + \frac{B}{s+2} + \frac{C}{s+10}$

$A = \frac{1}{4} \quad B = -\frac{5}{16} \quad C = \frac{1}{16}$

$Y(z) = \frac{1}{4} \cdot \frac{z}{(z-1)} - \frac{5}{16} \cdot \frac{z}{z-e^{-2T}} + \frac{1}{16} \frac{z}{z-e^{-10T}}$

$Y(z)\big|_{T=1} = \frac{1}{4} \frac{z}{z-1} - \frac{5}{16} \frac{z}{z-e^{-0.2}} + \frac{1}{16} \frac{z}{z-e^{-1}}$

E13.6 $KG_p(s) = \frac{1-e^{-Ts}}{s} \cdot \frac{40}{s(s+2)}$

P631 S10.8 P830 E13.26

$G_c(j\omega)GH(j\omega) = \frac{20(6.66j\omega+1)}{j\omega(0.5j\omega+1)(66.6j\omega+1)}$

$G_c(s) = \frac{(6.66s+1)}{(66.6s+1)} = 0.1 \frac{s+0.15}{s+0.015}$

$= 0.1 + \frac{0.0135}{s+0.015}$

$D(z) = 0.1 + \frac{0.0135 z}{z-e^{-0.015T}}$

$T=0.01$

$= 0.1 + \frac{0.000135 z}{z-0.999985}$

$= 0.1 \cdot \frac{z-0.99865}{z-0.999985}$

E13.7 $$Y(z)=\frac{z^3+2z^2+1}{z^3-1.5z^2+0.5z}$$

$$=1+3.5z^{-1}+4.75z^{-2}+6.375z^{-3}+\cdots$$

$$\begin{array}{r l}
 & 1+3.5z^{-1}+4.75z^{-2}+6.375z^{-3} \\
z^3-1.5z^2+0.5z \,\big) & z^3+2z^2+0z+1 \\
 & \underline{z^3-1.5z^2+0.5z} \\
 & 3.5z^2-0.5z+1 \\
 & \underline{3.5z^2-5.25z+1.75} \\
 & 4.75z-0.75 \\
 & \underline{4.75z-7.125+2.375z^{-1}} \\
 & 6.375-2.375z^{-1}
\end{array}$$

$$Y(z)=\sum_{k=0}^{\infty}y(kT)z^{-k}$$

$y(0)=1$ $y(1)=3.5$ $y(2)=4.75$ $y(3)=6.375$

E13.9 (a) $$Y(z)=\frac{z+1}{z^2-1}=z^{-1}+z^{-2}+z^{-3}+\cdots$$

$$\begin{array}{r l}
 & z^{-1}+z^{-2}+z^{-3} \\
z^2-1 \,\big) & z+1 \\
 & \underline{z\quad -z^{-1}} \\
 & 1+z^{-1} \\
 & \underline{1\quad -z^{-2}} \\
 & z^{-1}+z^{-2}
\end{array}$$

$$Y(z)=\sum_{k=0}^{\infty}y(kT)z^{-k}$$

$y(0)=0$, $y(T)=1$, $y(2T)=1$, $y(3T)=1$

? (b) $y(kT) = 1 - \delta(k)$

$k=0$ 时， $\delta(k) = 1$;

$k \neq 0$ 时， $\delta(k) = 0$

题写错的

E13.12 $\quad X(s) = \dfrac{s+1}{s^2+5s+6} = \dfrac{(s+1)}{(s+2)(s+3)} = \dfrac{A}{s+2} + \dfrac{B}{s+3}$

$A = -1 \quad B = 2$

$X(z) = 2\dfrac{z}{z-e^{-3T}} - \dfrac{z}{z-e^{-2T}}$

$\underline{\underline{T=1}} \quad \dfrac{2z}{z-e^{-3}} - \dfrac{z}{z-e^{-2}}$

E13.13 $\quad z^2 + (k-1.5)z + 0.5 = 0$

$z = \dfrac{w+1}{w-1}$

$\dfrac{(w+1)^2}{(w-1)^2} + (k-1.5)\dfrac{w+1}{w-1} + 0.5 = 0$

$kw^2 + w + (3-k) = 0$

w^2	k	$3-k$
w^1	1	
w^0	$3-k$	

$\begin{cases} 3-k > 0 \\ k > 0 \end{cases} \Rightarrow \quad 0 < k < 3$

P13.5

$$G_p(s)=\frac{2}{s+2} \qquad T=1$$

$$G_{h0}(s)=\frac{1-e^{-Ts}}{s}$$

$$G_0G_p(z)=(1-z^{-1})Z\left\{\frac{2}{s(s+2)}\right\}$$

$$=\frac{z-1}{z}\cdot\frac{2\cdot z(1-e^{-2T})}{(z-1)(z-e^{-2T})}$$

$$=\frac{2(1-e^{-2T})}{z-e^{-2T}}$$

$$G_{cl}(z)=\frac{G_0G_p(z)}{1+G_0G_p(z)}=\frac{2(1-e^{-2T})}{z-3e^{-2T}+2}\overset{T=1}{=}\frac{2(1-e^{-2})}{z+(2-3e^{-2})}$$

$$R(s)=\frac{1}{s} \qquad R(z)=\frac{z}{z-1}$$

$$Y(z)=R(z)\cdot G_{cl}(z)$$

$$=\frac{z}{z-1}\cdot\frac{2(1-e^{-2})}{z+(2-3e^{-2})}$$

$$=\frac{1.73z}{z^2+0.59z-1.59}$$

$$=1.73z^{-1}-1.0207z^{-2}+3.3529z^{-3}+\cdots$$

$$\begin{array}{r|l}
 & 1.73z^{-1}\ -1.0207z^{-2}+3.3529z^{-3} \\
z^2+0.59z-1.59 & 1.73z \quad 0 \quad 0z^{-1} \\
 & 1.73z+1.0207-2.7507z^{-1} \\
\hline
 & -1.0207+2.7507z^{-1} \\
 & -1.0207-0.6022z^{-1}+1.623 \\
\hline
 & 3.3529z^{-1}
\end{array}$$

$$Y(z) = \sum_{k=0} y(kT)\, z^{-k}$$

$y(0)=0 \quad y(T)=1.73, \quad y(2T) = -1.0207$

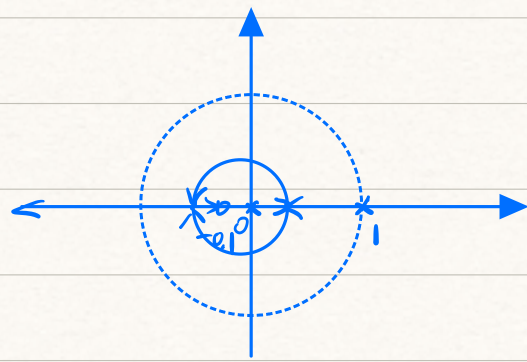
$y(3T) = 3.3529$

P13.6 $\lim\limits_{k\to\infty} y(kT) = \lim\limits_{z\to\infty} Y(z) = 0$

$$\lim_{z\to 1} (1-z^{-1})\, Y(z) = \lim_{z\to 1} \left(\frac{z-1}{z} \cdot \frac{z}{z-1} \cdot \frac{1.73}{z+1.59} \right)$$

$$= 0.67$$

P 13.12 $G(z) = \dfrac{K(z+0.1)}{z(z-1)}$



① $n=2 \quad p_1 = 0 \quad p_2 = 1$

$m = 1 \quad z_1 = -0.1$

② $\sigma = \dfrac{0+1+0.1}{2-1} = 1.1$

$\varphi = \dfrac{(2k+1)\pi}{2-1} = \pi \quad , k=0$

③ $\dfrac{1}{d} + \dfrac{1}{d-1} = \dfrac{1}{d+0.1}$

$d^2 + 0.2d - 0.1 = 0$

$d_1 = 0.23 \quad d_2 = -0.43$

$\dfrac{(2k+1)\pi}{2} = \dfrac{\pi}{2}, \dfrac{3\pi}{2}$

④ $1+G(z)=0$

$$z^2+(K-1)z+0.1K=0$$

$$z=\frac{w+1}{w-1}$$

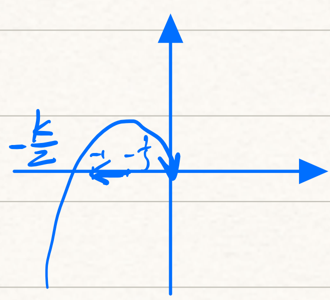
$$\left(\frac{w+1}{w-1}\right)^2+(K-1)\frac{w+1}{w-1}+0.1K=0$$

$$1.1Kw^2+(2-0.2K)w+(2-0.9K)=0$$

$$\begin{array}{lll} w^2 & 1.1K & 2-0.9K \\ w^1 & 2-0.2K & \\ w^0 & 2-0.9K & \end{array}$$

$$\begin{cases} 1.1K>0 \\ 2-0.2K>0 \\ 2-0.9K>0 \end{cases} \Rightarrow \quad 0<K<2.22$$

8-17 (1) $-\frac{1}{NA}=-\frac{A+2}{A+6}$



$$G(s)=\frac{K}{s(s+1)^2}$$

$$G(jw)=\frac{K}{jw(jw+1)^2}$$

$$|G(jw)|=\frac{K}{w(w^2+1)}$$

$$\angle\theta=-\frac{\pi}{2}-2\arctan w$$

w	0	1	5	10	$+\infty$
$\lvert G(jw)\rvert$	$+\infty$	$0.5K$	$0.008K$	$0.00099K$	0

$|G(j\omega)|$

$\angle\theta \quad -90^\circ \quad -180^\circ \quad -247^\circ \quad -259^\circ \quad -270^\circ$

$$-\frac{1}{N(A)} = -\frac{A+2}{A+6}$$

$$\frac{d}{dA}\left(-\frac{1}{N(A)}\right) = -\frac{A+6-A-2}{(A+6)^2} = -\frac{4}{(A+6)^2} < 0$$

$$-\frac{1}{N(A)} = \begin{cases} -\frac{1}{3}, & A=0 \\ -1, & A=+\infty \end{cases}$$

$-\frac{k}{2} > -\frac{1}{3}$，即 $k < \frac{2}{3}$，稳定，

$-\frac{k}{2} < -1$ 即 $k > 2$，不稳定

$-1 < -\frac{k}{2} < -\frac{1}{3}$ 即 $\frac{2}{3} < k < 2$，产生周期运动

(b) 稳定

$\omega = 1$

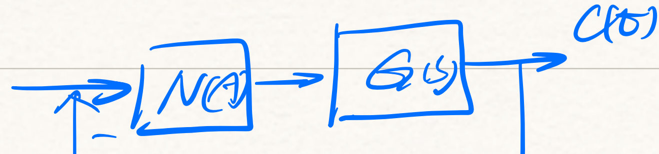
$$|G(j\omega)|_{\omega=1} = \frac{k}{2} = \frac{1}{N(A)} = \frac{A+2}{A+6}$$

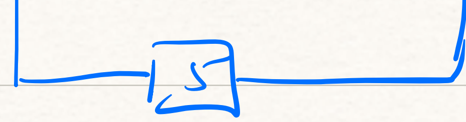
$$A = \frac{2-3k}{\frac{k}{2}-1}$$

8-18 $$N(A) = \frac{4M}{\pi A}\sqrt{1-\left(\frac{h}{A}\right)^2} - j\frac{4M}{\pi A^2}$$

$$= \frac{4}{\pi A}\sqrt{1-\left(\frac{0.2}{A}\right)^2} - j\frac{4}{\pi A^2}$$

$$G_0G(s) = \frac{10}{s(s+1)}$$

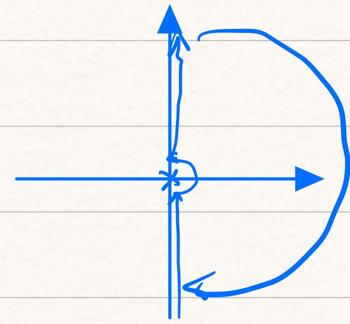




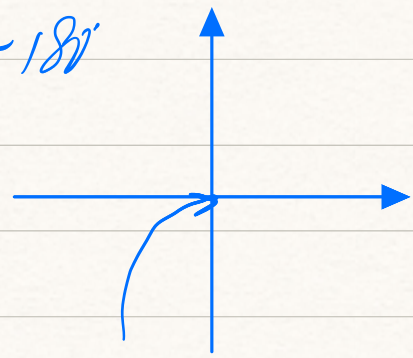
$$G_cG(j\omega)=\frac{10}{j\omega(j\omega+1)}$$

$$|G_cG(j\omega)|=\frac{10}{\omega\sqrt{\omega^2+1}}$$

$$\angle\theta=-\frac{\pi}{2}-\arctan\omega$$



ω	0	1	5	100	$+\infty$
$\lvert G_cG(j\omega)\rvert$	∞	7.1	0.4	0.001	0
$\angle\theta$	-90°	-135°	-169°	-174°	-180°



$$-\frac{1}{N(A)}=-\frac{1}{\frac{4}{\pi A}\sqrt{1-\left(\frac{0.2}{A}\right)^2}-j\frac{4}{\pi A^2}}$$

$$=-\frac{\sqrt{A^2-0.04}+j}{\frac{4}{\pi}\left(1-\frac{0.04}{A^2}\right)+\frac{4}{\pi A^2}}$$

$$=-\frac{\pi A^2}{4}\frac{1}{\sqrt{A^2-0.04}-j}$$

$$=-\frac{\pi A^2}{4}\frac{\sqrt{A^2-0.04}+j}{A^2+0.96}$$

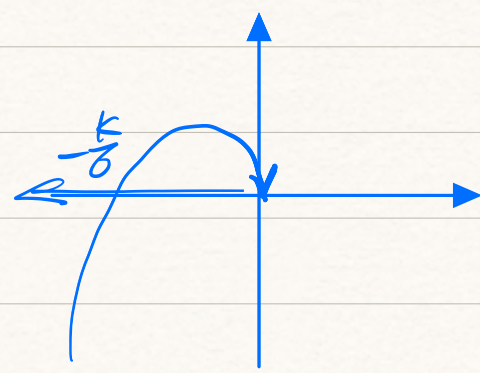
8-23

(1)

$$G(s)=\frac{K}{s(s+1)(s+2)}$$

$$G(j\omega)=\frac{K}{j\omega(j\omega+1)(j\omega+2)}$$

$$|G(j\omega)|=\frac{K}{\omega\sqrt{\omega^2+1}\sqrt{\omega^2+4}}$$



$$\angle\theta = -\frac{\pi}{2} - \arctan\omega - \arctan\frac{\omega}{2}$$

ω	0	1	5	10	$+\infty$
$\lvert G(j\omega)\rvert$	$+\infty$	$0.3K$	$0.007K$	$0.001K$	0
$\angle\theta$	-90°	-162°	-237°	-253°	-270°

$$\angle\theta = -180^\circ$$

$$\arctan\omega + \arctan\frac{\omega}{2} = 90^\circ$$

$$\arctan\frac{\omega+\frac{\omega}{2}}{1-\frac{\omega^2}{2}} = 90^\circ$$

$$\omega = \sqrt{2}$$

$$|G(j\omega)|_{\omega=\sqrt{2}} = \frac{K}{\sqrt{2}\sqrt{3}\sqrt{6}} = \frac{K}{6}$$

$$N(A) = \frac{4M}{\pi A} = \frac{4}{\pi A}$$

$$-\frac{1}{N(A)} = -\frac{\pi A}{4} = \begin{cases} -0, & A=0 \\ -\infty, & A=+\infty \end{cases}$$

$$\frac{K}{6} = \frac{\pi A}{4} \Rightarrow A = \frac{2K}{3\pi}$$

以 $\omega=\sqrt{2}$，$A=\frac{2K}{3\pi}$ 自振

(2) $$G(s) = \frac{Ke^{-\tau s}}{s(s+1)(s+2)}$$

$$G(j\omega) = \frac{Ke^{-\tau j\omega}}{j\omega(j\omega+1)(j\omega+2)}$$

$$|G(j\omega)| = \frac{K}{\omega\sqrt{\omega^2+1}\sqrt{\omega^2+4}}$$

$$\angle\theta = -\tau w - \frac{\pi}{2} - \arctan w - \arctan\frac{w}{2}$$

$$-\frac{1}{N(A)} = -\frac{\pi}{2}$$

$$|G(jw)|_{w=1} = \frac{k}{\sqrt{2}\sqrt{5}} = \frac{\pi}{2}$$

$$k = \frac{\sqrt{10}\pi}{2}$$

$$\angle\theta|_{w=1} = -\tau - 90^\circ - 45^\circ - 26.6^\circ = -180^\circ$$

$$\tau = 18.4^\circ$$

8-24 $G_c \cdot G(s) = \dfrac{10K}{s(Ts+1)(0.1s+1)}$

$$G_c G(jw) = \frac{10k}{jw(jwT+1)(0.1jw+1)}$$

$$|G_c G(jw)| = \frac{10k}{w\sqrt{w^2T^2+1}\sqrt{0.01w^2+1}}$$

$$\angle\theta = -\frac{\pi}{2} - \arctan Tw - \arctan 0.1w$$

$$N(A) = \frac{4M}{\pi A} = \frac{4\sqrt{2}}{\pi A}$$

$$-\frac{1}{N(A)} = -\frac{\pi A}{4\sqrt{2}}$$

$$|G_c G(jw)|_{w=10} = \frac{k}{\sqrt{100T^2+1}\ \sqrt{2}}$$

$$\angle\theta|_{w=10} = -90^\circ - \arctan 10T - 45^\circ = -180^\circ$$

$$\arctan 10T = 45^\circ$$

$$T = 0.1$$

$$\frac{k}{\quad} = \frac{\pi\, 0.1}{\quad}, \quad \frac{10}{\quad}$$

$\sqrt{2} \quad \sqrt{2} \quad = \quad 4\sqrt{2} \quad \sqrt{T^2+1}$

$$k = \frac{0.12}{2\sqrt{2}} \cdot \frac{10}{\sqrt{1.01}} = \frac{2}{2\sqrt{2.02}}$$