Date:

6.3

解：(a) $|H(j\omega)| = \dfrac{|1-j\omega|}{|1+j\omega|} = 1$ $\quad\therefore A=1$

(b) $\measuredangle H(j\omega) = -2\arctan\omega$. $\quad \dfrac{d\measuredangle H(j\omega)}{d\omega} = \dfrac{-2}{1+\omega^2}$

$\therefore$ 当 $\omega>0$ 时 $\tau(\omega) = -\dfrac{2}{1+\omega^2} < 0$ 即3说法正确.

6.6

解：$H(e^{j\omega}) = \begin{cases} 1 & \pi-\omega_c \le |\omega| \le \pi \\ 0 & |\omega| > \pi-\omega_c \end{cases}$

$\because h[n] = \left(\dfrac{\sin\omega_0 n}{\pi n}\right) g[n]$ 作傅里叶变换有

$H(e^{j\omega}) = F(e^{j\omega}) * G(e^{j\omega})$ $\quad F(e^{j\omega}) = \begin{cases} 1, & |\omega|<\omega_0 \\ 0, & \omega_0<|\omega|<\pi \end{cases}$

对$H(e^{j\omega})$作傅里叶反变换 由变换对 $\dfrac{\sin Wn}{\pi n} \xrightarrow{F} F(e^{j\omega}) \begin{cases} 1 & |\omega|<W \\ 0 & W<|\omega|<\pi \end{cases}$

得到 $H(e^{j\omega}) = F(e^{j(\omega-(\pi-\frac{\omega_c}{2}))}) + F(e^{j(\omega+(\pi-\frac{\omega_c}{2}))})$ $\quad W = \dfrac{\omega_c}{2}$

由频移和线性性质

$h[n] = e^{j(\pi-\frac{\omega_c}{2})n}\dfrac{\sin\frac{\omega_c}{2}n}{\pi n} + e^{-j(\pi-\frac{\omega_c}{2})n}\dfrac{\sin\frac{\omega_c}{2}n}{\pi n}$

$= (-1)^n \cdot 2\dfrac{\cos\frac{\omega_c}{2}n \cdot \sin\frac{\omega_c}{2}n}{\pi n}$ $\quad = (-1)^n \dfrac{\sin\omega_c n}{\pi n}$

$\therefore g[n] = (-1)^n \quad \omega_0 = \dfrac{\omega_c}{2}$

6.22

解：(a) $|H(j\omega)| = \begin{cases} \frac{\omega}{3\pi} & 0<\omega<3\pi \\ -\frac{\omega}{3\pi} & -3\pi<\omega<0 \end{cases}$ $\quad \measuredangle H(j\omega) = \begin{cases} \frac{\pi}{2} & 0<\omega<3\pi \\ -\frac{\pi}{2} & -3\pi<\omega<0 \end{cases}$

$\because x(t) = \cos(2\pi t+\theta)$ $\quad \therefore y(t) = \dfrac{2\pi}{3\pi}\cos(2\pi t+\theta+\frac{\pi}{2})$

$\omega_0 = 2\pi$ $\quad = -\dfrac{2}{3}\sin(2\pi t+\theta)$

(b) $x(t)=\cos(4\pi t+\theta)$ $w_0=4\pi$ 不在低通微分器的频率范围内

$\therefore\ y(t)=0$

6.28

解:(iv) $20\lg\left|\frac{1-\frac{1}{10}jw}{1+jw}\right| = 20\lg\left(\frac{1+\frac{1}{100}w^2}{1+w^2}\right)$

若 $w<<1$ $20\lg\left(\frac{1+\frac{1}{100}w^2}{1+w^2}\right) = 20\lg 1 = 0dB$ $w=10$和$w=1$为折断频率

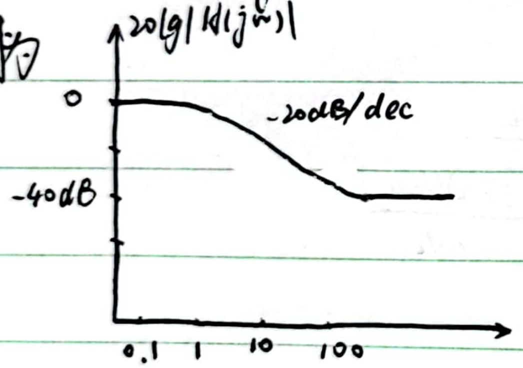
若 $w>>10$ $20\lg\left(\frac{1+\frac{1}{100}w^2}{1+w^2}\right) = 20\lg\left(\frac{1}{100}\right) = -40dB$

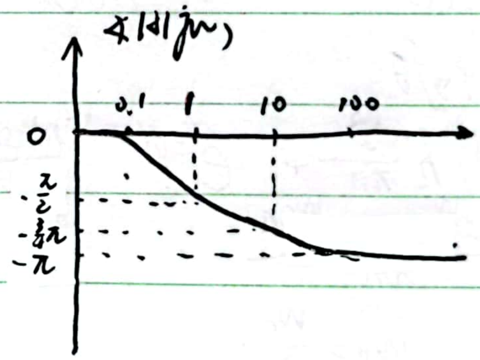
相频特性. $\angle H(jw) = -\arctan\frac{w}{10} - \arctan w$.

$w>>10$ $\angle H(jw) = -\pi$ $w=1$ $\angle H(jw) = -\frac{\pi}{4}$ $w=10$ $\angle H(jw) = -\frac{3\pi}{4}$

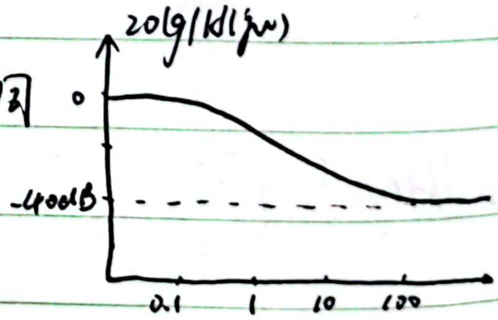
$w<<1$ $\angle H(jw) = 0$

作图为





(vi) 类似的 $20\lg\left|\frac{1+\frac{1}{10}jw}{1+jw}\right| = 20\lg\left(\frac{1+\frac{1}{100}w^2}{1+w^2}\right)$ 相同

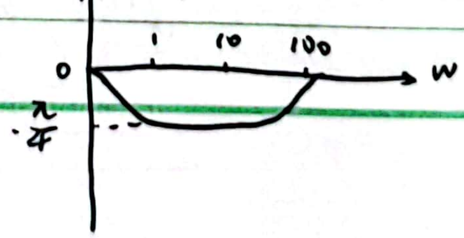


$\angle H(jw) = \arctan\frac{w}{10} - \arctan w$

$w<<1$ $\angle H(jw)=0$

$w>>10$ $\angle H(jw) = 0$

$w=1$ $\angle H(jw) = -\frac{\pi}{4}$ $w=10$ $\angle H(jw) = -\frac{\pi}{4}$



Date:

(b) $H_1(j\omega)=\frac{1-\frac{1}{10}j\omega}{1+j\omega}$ $\qquad H_2(j\omega)=\frac{1+\frac{1}{10}j\omega}{1+j\omega}$

$\delta(t)\xrightarrow{F}1 \qquad u(t)\xrightarrow{F}\frac{1}{j\omega}+\pi\delta(\omega)$

∴冲激响应: $Y_1(j\omega)=\frac{1-\frac{1}{10}j\omega}{1+j\omega}=\frac{11}{10}\frac{1}{1+j\omega}-\frac{1}{10}$

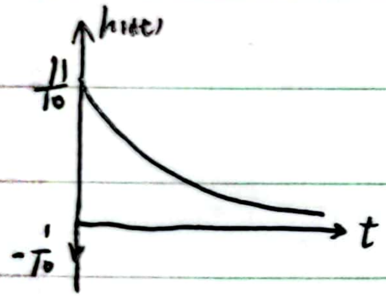
$$h_1(t)=\frac{11}{10}e^{-t}u(t)-\frac{1}{10}\delta(t)$$

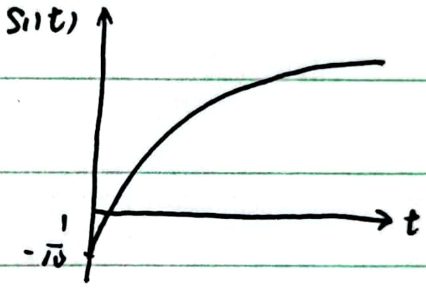
$$Y_2(j\omega)=\frac{1+\frac{1}{10}j\omega}{1+j\omega}=\frac{9}{10}\frac{1}{1+j\omega}+\frac{1}{10}$$

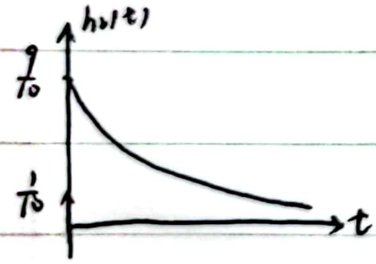
$$h_2(t)=\frac{9}{10}e^{-t}u(t)+\frac{1}{10}\delta(t)$$

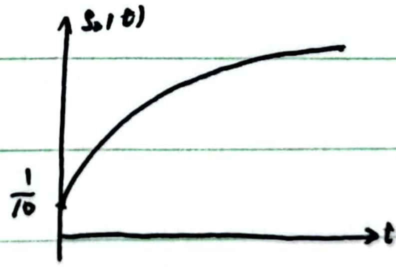
阶跃响应: $s_1(t)=\int_{-\infty}^{t}h_1(t)dt=\frac{11}{10}(1-e^{-t})u(t)-\frac{1}{10}u(t)$

$$s_2(t)=\int_{-\infty}^{t}h_2(t)dt=\frac{9}{10}(1-e^{-t})u(t)+\frac{1}{10}u(t)$$







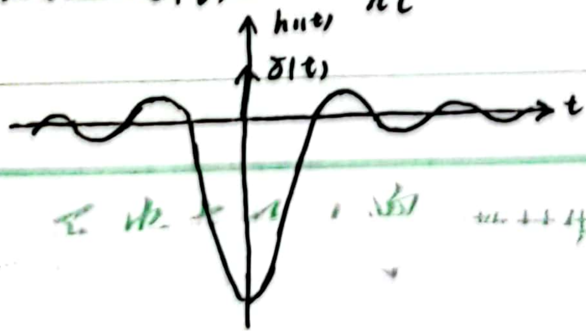


6.33.

解: (a) $H(j\omega)=\begin{cases}1 & |\omega|<\omega_{lp}\\ 0 & |\omega|>\omega_{lp}\end{cases}$

单位冲激响应 $H_1(j\omega)=1-H(j\omega)=\begin{cases}0 & |\omega|<\omega_{lp}\\ 1 & |\omega|>\omega_{lp}\end{cases}$ 截止频率 ω_{lp}

$$h_1(t)=\delta(t)-\frac{\sin\omega_{lp}t}{\pi t}$$



No:

Date:

(b) $H_d(j\omega)=\begin{cases}1 & |\omega|>\omega_{hp}\\ 0 & |\omega|<\omega_{hp}\end{cases}$

单位冲激响应 $H_2(j\omega)=1-H_d(j\omega)=\begin{cases}1 & |\omega|<\omega_{hp}\\ 0 & |\omega|>\omega_{hp}\end{cases}$ 截止在 ω_{hp} 低通

$$h(t)=\frac{\sin\omega_{hp}t}{\pi t}$$

(c) $H_d(e^{j\omega})=\begin{cases}1 & |\omega|<\omega_0\\ 0 & \omega_0<|\omega|<\pi\end{cases}$

$H_3(e^{j\omega})=1-H_d(e^{j\omega})=\begin{cases}0 & |\omega|<\omega_0\\ 1 & \omega_0<|\omega|<\pi\end{cases}$

是高通滤波器

6.15

解:(a) 作傅里叶变换 $(j\omega)^2 Y(j\omega) + 4j\omega Y(j\omega) + 4Y(j\omega) = X(j\omega)$

$\therefore H(j\omega) = \frac{Y(j\omega)}{X(j\omega)} = \frac{1}{(j\omega)^2+4j\omega+4} = \frac{1}{(j\omega+2)^2} = \frac{\frac{1}{4}}{(\frac{j\omega}{2})^2+j\omega+1}$ $\xi=1$ 临界阻尼

(b) $5(j\omega)^2 Y(j\omega)+4j\omega Y(j\omega)+5Y(j\omega)=7X(j\omega)$

$\therefore H(j\omega)=\frac{7}{5(j\omega)^2+4j\omega+5}=\frac{\frac{7}{5}}{(j\omega)^2+2\cdot(\frac{2}{5})j\omega+1}$ $\xi=\frac{2}{5}$ 欠阻尼

(c) $(j\omega)^2Y(j\omega)+20(j\omega)Y(j\omega)+Y(j\omega)=X(j\omega)$

$H(j\omega)=\frac{1}{(j\omega)^2+20j\omega+1}=\frac{1}{(j\omega)^2+2(10)j\omega+1}$ $\xi=10$ 过阻尼

(d) $5(j\omega)^2Y(j\omega)+4(j\omega)Y(j\omega)+5Y(j\omega)=7X(j\omega)+\frac{1}{3}(j\omega)X(j\omega)$

$H(j\omega)=\frac{7+\frac{1}{3}j\omega}{5(j\omega)^2+4j\omega+5}$ 分子无影响 故仍为欠阻尼

6.17

解:(a) 作F变换为

$Y(e^{j\omega})+e^{-j\omega}Y(e^{j\omega})+\frac{1}{4}e^{-j2\omega}Y(e^{j\omega})=X(e^{j\omega})$

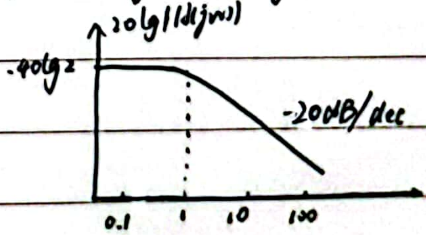
$H(e^{j\omega})=\frac{1}{\frac{1}{4}e^{-j2\omega}+e^{-j\omega}+1}=\frac{1}{(\frac{1}{2}e^{-j\omega})^2-2\times\frac{1}{2}\times(-1)e^{-j\omega}+1}$ $\cos\theta=-1$ $\theta=\pi$ 是振荡的

(b) $H(e^{j\omega})=\frac{1}{\frac{1}{4}e^{-j2\omega}-e^{-j\omega}+1}=\frac{1}{(\frac{1}{2}e^{-j\omega})^2-2\times\frac{1}{2}\times1e^{-j\omega}+1}$ $\cos\theta=1$ $\theta=0$ 不是振荡的

6.27

解:作傅里叶变换有 $(j\omega)\cdot Y(j\omega)+2Y(j\omega)=X(j\omega) \Rightarrow H(j\omega)=\frac{Y(j\omega)}{X(j\omega)}=\frac{1}{2+j\omega}$

(a) $20\lg|H(j\omega)|=10\lg\frac{1}{4+\omega^2}$ $\measuredangle H(j\omega)=-\arctan\frac{\omega}{2}$



$\omega \ll 1$ $20\lg|H(j\omega)|=-20\lg2$ dB

$\omega \gg 1$ $20\lg|H(j\omega)|=-10\lg(4+\omega^2)\approx-20\lg\omega$

(b) $\tau(\omega)=-\frac{d\measuredangle H(j\omega)}{d\omega}=+\frac{1}{2}\cdot\frac{1}{1+\frac{\omega^2}{4}}=\frac{2}{4+\omega^2}$

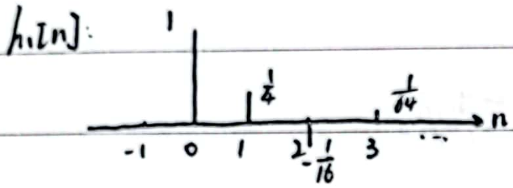
(c) $X(j\omega)=\frac{1}{1+j\omega}$ $Y(j\omega)=X(j\omega)\cdot H(j\omega)=\frac{1}{(1+j\omega)(2+j\omega)}=\frac{1}{1+j\omega}-\frac{1}{2+j\omega}$

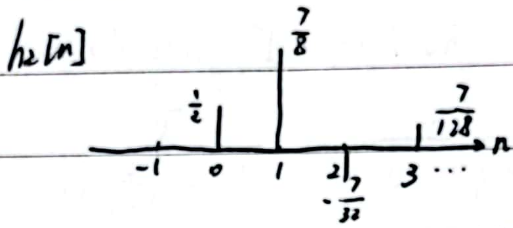
(d) $y(t)=e^{-t}u(t)-e^{-2t}u(t)$

.42

解: (b) $H_1(e^{j\omega}) = \dfrac{1+\frac{1}{2}e^{-j\omega}}{1+\frac{1}{4}e^{-j\omega}} = -\dfrac{1}{1+\frac{1}{4}e^{-j\omega}} + 2$ $\quad h_1[n] = -(-\frac{1}{4})^n u[n] + 2\delta[n]$

$H_2(e^{j\omega}) = \dfrac{\frac{1}{2}+e^{-j\omega}}{1+\frac{1}{4}e^{-j\omega}} = -\dfrac{\frac{7}{2}}{1+\frac{1}{4}e^{-j\omega}} + 4$ $\quad h_2[n] = 4\delta[n] - \frac{7}{2}(-\frac{1}{4})^n u[n]$





(c) $G(e^{j\omega}) = \dfrac{H_2(e^{j\omega})}{H_1(e^{j\omega})} = \dfrac{\frac{1}{2}+e^{-j\omega}}{1+\frac{1}{2}e^{-j\omega}}$ $\quad |G(e^{j\omega})| = \sqrt{\dfrac{\frac{1}{4}+1}{\frac{1}{4}+1}} = 1$

$\because \forall \omega$ 均有 $|G(e^{j\omega})| = 1$ 是全通系统