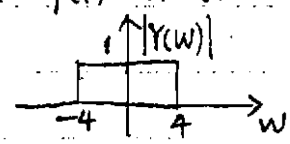
西南交通大学2002年硕士研究生信号与系统入学考试试题参考答案 432#

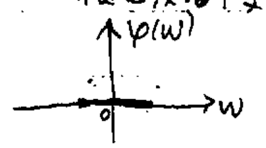
一、选择题

1. A 2. C 3. B 4. D 5. C

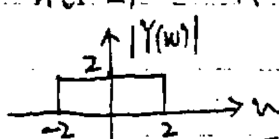
二、画图题

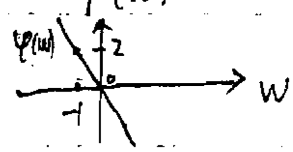
(1) $y(t)=x(2t)\xrightarrow{FT}\frac{1}{2}X(\frac{w}{2})$ 　　相位频谱不变仍为 $\varphi(w)=0$



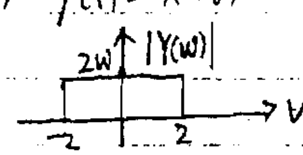


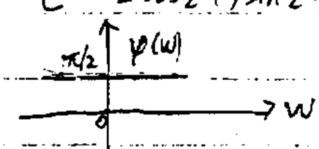
(2) $x(t-2)\xrightarrow{FT}X(w)e^{-j2w}$ 　　$\varphi(w)=-2w$



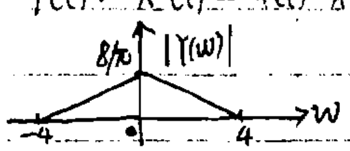


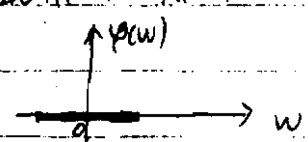
(3) $y(t)=x'(t)\xrightarrow{FT}jwX(w)$ 　　$e^{j\frac{\pi}{2}}=\cos\frac{\pi}{2}+j\sin\frac{\pi}{2}=j$ 故 $\varphi(w)=\frac{\pi}{2}$





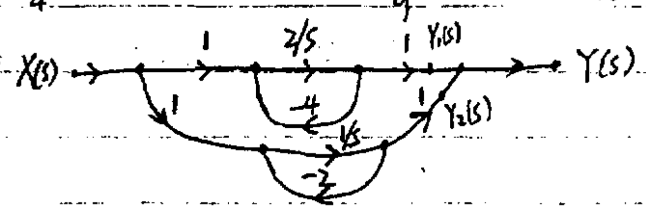
(4) $y(t)=x^2(t)=x(t)\cdot x(t)\xrightarrow{FT}\frac{1}{2\pi}X(w)*X(w)$ 　　$\varphi(w)=0$





三、

(1) 信号流图：

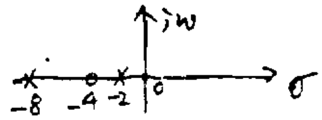


(2) $Y_1(s)=[X(s)-4Y_1(s)]\frac{2}{s}$ 　$\Rightarrow$ 　$Y_1(s)=\frac{2}{s+8}X(s)$

$Y_2(s)=[X(s)-2Y_2(s)]\frac{1}{s}$ 　$\Rightarrow$ 　$Y_2(s)=\frac{1}{s+2}X(s)$

$\therefore\ H(s)=\frac{Y(s)}{X(s)}=\frac{Y_1(s)+Y_2(s)}{X(s)}=\frac{2}{s+8}+\frac{1}{s+2}=\frac{3s+12}{(s+8)(s+2)}$ 　　$\sigma>-2$

零点 -4，极点 $-8,-2$



零、极点图

$\because$ H(s)的极点全部都在jw轴的左平面

$\therefore$ 该系统渐近稳定

(3) $H(s)=\frac{3s+12}{(s+8)(s+2)}=\frac{3s+12}{s^2+10s+16}=\frac{Y(s)}{X(s)}$

$$(s^2+10s+16)Y(s)=(3s+12)X(s)$$

∴该系统的微分方程为：$y''(t)+10y'(t)+16y(t)=3x'(t)+12x(t)$

(4) 零状态响应 $Y(s)=H(s)\cdot X(s)=\frac{3s+12}{(s+8)(s+2)(s+3)}=\frac{A}{s+8}+\frac{B}{s+2}+\frac{C}{s+3}$

其中：$A=Y(s)\cdot(s+8)\big|_{s=-8}=-2/5$ $\quad B=Y(s)(s+2)\big|_{s=-2}=1$

$C=Y(s)(s+3)\big|_{s=-3}=-3/5$

故：$Y(s)=-\frac{2}{5}\frac{1}{s+8}+\frac{1}{s+2}-\frac{3}{5}\frac{1}{s+3}$ $\quad \sigma>-2$

$y_f(t)=(-\frac{2}{5}e^{-8t}+e^{-2t}-\frac{3}{5}e^{-3t})u(t)$

其中：自由响应分量为：$(-\frac{2}{5}e^{-8t}+e^{-2t})u(t)$ 受迫响应分量为：$-\frac{3}{5}e^{-3t}u(t)$

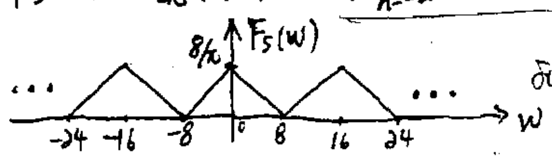
暂态响应分量为：$(-2/5e^{-8t}+e^{-2t}-3/5e^{-3t})u(t)$ 稳态响应分量为：0

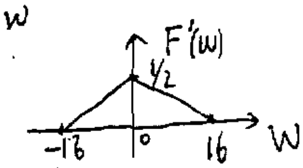
四.(1) $w_s\geq 2w_m=16$ $\quad f_s\geq\frac{w_s}{2\pi}=\frac{8}{\pi}$ $\quad T_s\leq\frac{2\pi}{w_s}=\frac{1}{f_s}=\frac{\pi}{8}$

(2) $f_s(t)=f(t)\cdot\delta_T(t)=f(t)\cdot\sum_{n=-\infty}^{+\infty}\delta(t-nT_s)$ 时域相乘 频域卷积

$F_s(w)=\frac{1}{2\pi}F(w)*w_s\sum_{n=-\infty}^{+\infty}\delta(w-nw_s)=\frac{1}{T_s}\sum_{n=-\infty}^{+\infty}F(w-nw_s)$

$\delta(t)$的傅里叶 $\quad =\frac{8}{\pi}\sum_{n=-\infty}^{+\infty}F(w-16n)$

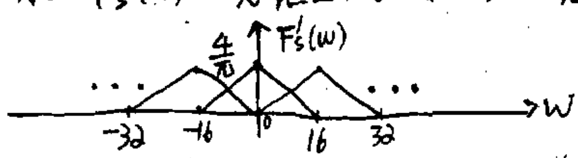




(3)

$f'(t)=f(2t)\xrightarrow{FT}\frac{1}{2}F(\frac{w}{2})$

同理有：$F_s'(w)=\frac{8}{\pi}\sum_{n=-\infty}^{+\infty}F'(w-16n)=\frac{4}{\pi}\sum_{n=-\infty}^{+\infty}F[\frac{1}{2}(w-16n)]$

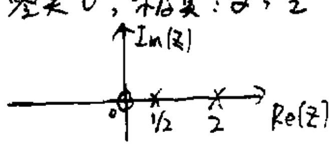


五.(1) $y(n-1)-5/2y(n)+y(n+1)=x(n)$ —(差分方程)

对两边作Z变换：$z^{-1}Y(z)-\frac{5}{2}Y(z)+zY(z)=X(z)$

$H(z)=\frac{Y(z)}{X(z)}=\frac{1}{z^{-1}-\frac{5}{2}+z}=\frac{2z}{2z^2-5z+2}=\frac{z}{(z-2)(z-\frac{1}{2})}$ $\quad |z|>2$

(2) 零点 0，极点：2，$\frac{1}{2}$



∵该系统为因果系统，$|z|>2$，收敛域没有包含单位圆

∴该系统不稳定

(3) $x(n)=(1/3)^n u(n)\xrightarrow{ZT}\frac{z}{z-1/3}$

$Y(z)=H(z)X(z)=\frac{z^2}{(z-2)(z-1/2)(z-1/3)}$

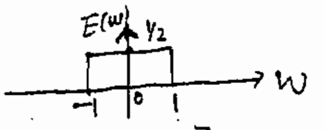
$$\frac{Y(z)}{z}=\frac{z}{(z-2)(z-1/2)(z-1/3)}=\frac{A}{z-2}+\frac{B}{z-1/2}+\frac{C}{z-1/3}$$

其中: $A=\frac{Y(z)}{z}\cdot(z-2)\Big|_{z=2}=4/5$ $\quad B=\frac{Y(z)}{z}(z-\frac{1}{2})\Big|_{z=\frac{1}{2}}=2$ $\quad C=\frac{Y(z)}{z}(z-1/3)\Big|_{z=\frac{1}{3}}=6/5$

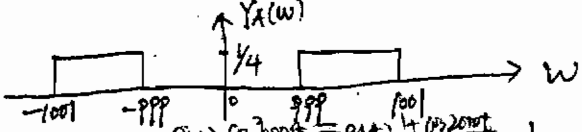
$$\therefore Y(z)=\frac{4}{5}\frac{z}{z-2}-2\frac{z}{z-1/2}+\frac{6}{5}\frac{z}{z-1/3}$$

$$y(n)=[\tfrac{4}{5}(2)^n-2(\tfrac{1}{2})^n+\tfrac{6}{5}(1/3)^n]\,u(n)$$

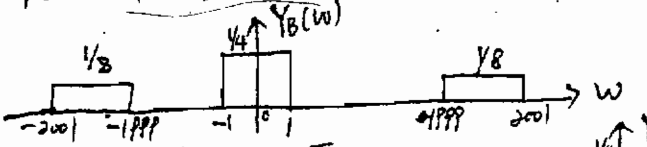
六、(1) $e(t)=\frac{\sin t}{2\pi t}\xrightarrow{FT}\frac{1}{2}G_2(w)$



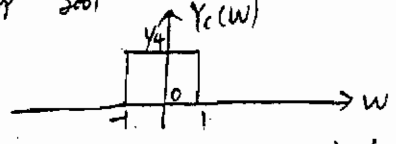
A点: $y_A(t)=e(t)\cdot s(t)\xrightarrow{FT}\frac{1}{2}[E(w-1000)+E(w+1000)]$



B点: $y_B(t)=y_A(t)\cdot s(t)$ $e(t)\cdot\cos^2 1000t=e(t)\cdot\frac{1+\cos 2000t}{2}$ $\xrightarrow{FT}\frac{1}{2}E(w)+\frac{1}{4}E(w-2000)+\frac{1}{4}E(w+2000)$



C点: $y_C(t)\xrightarrow{FT}\frac{1}{2}E(w)$



(2) $R(w)=Y_C(w)=\frac{1}{2}E(w)=\frac{1}{4}G_2(w)$ $\quad\therefore r(t)=\frac{\sin t}{4\pi t}$

一、选择题

1 c，2 b，3 d，4 a，5 d，6 a，7 b，8 a，9 a，10 c.

二、$y(t)=y_x(t)+y_f(t)$

零输入响应：$r^2+3r+2=0 \quad r_1=-1, r_2=-2$

$y_x(t)=(C_1e^{-2t}+C_2e^{-t})u(t) \quad y(0)=3,\ y'(0)=4$

$$\begin{cases}C_1+C_2=3\\-2C_1-C_2=4\end{cases} \Rightarrow \begin{cases}C_1=-7\\C_2=10\end{cases} \quad y_x(t)=(-7e^{-2t}+10e^{-t})u(t)$$

零状态响应：$s^2Y(s)+3sY(s)+2Y(s)=X(s) \quad =\frac{4}{s+2}$

$$H(s)=\frac{Y(s)}{X(s)}=\frac{4}{(s+1)(s+2)^2}=4\left[\frac{A}{s+1}+\frac{B}{(s+2)^2}+\frac{C}{(s+2)}\right]$$

其中：$4A=H(s)\cdot(s+1)\big|_{s=-1}=4$. $\quad 4B=H(s)(s+2)^2\big|_{s=-2}=-4$

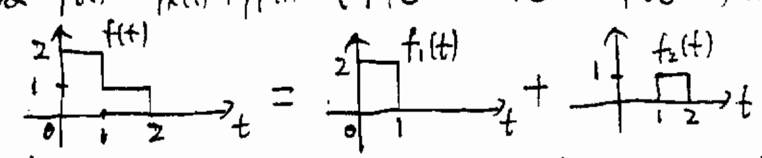
$4C=[H(s)\cdot(s+2)^2]'\big|_{s=-2}=-4$

$$\therefore H(s)=\frac{4}{s+1}-\frac{4}{(s+2)^2}-\frac{4}{s+2}$$

$$y_f(t)=(4e^{-t}-4e^{-2t}-4te^{-2t})u(t)$$

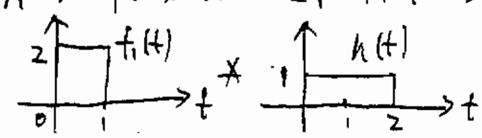
故 $y(t)=y_x(t)+y_f(t)=(14e^{-t}-11e^{-2t}-4te^{-2t})u(t)$

三、



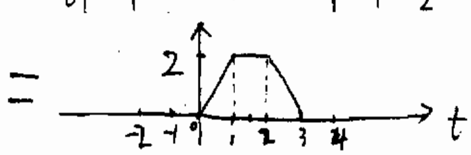
$y_f(t)=f(t)*h(t)=[f_1(t)+f_2(t)]*h(t)=f_1(t)*h(t)+f_2(t)*h(t)$

其中：



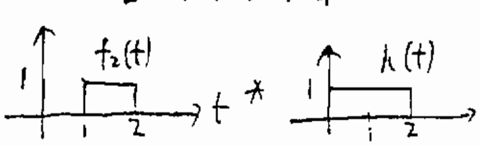
中心点：$f_1(t)$为0.5，$h(t)$为1 故 $1+0.5=1.5$

上底宽度：$|1-2|=1$



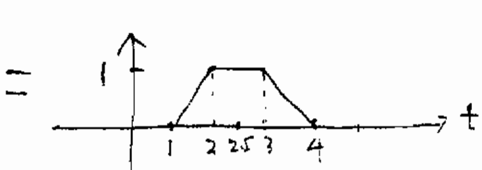
下底宽度：$1+2=3$

高度：$f_1(t)$高2，$h(t)$高1，$f_1(t)$较窄为1. 故 $2\times1\times1=2$



中心点：$1.5+1=2.5$

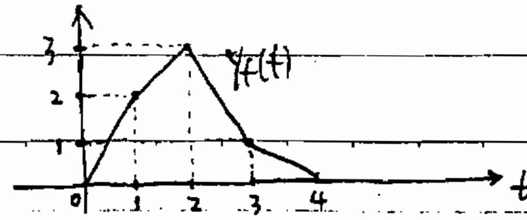
上底宽度：$|1-2|=1$



下底宽度：$1+2=3$

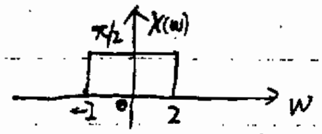
高度：$1\times1\times1=1$

三、$y_f(t)$的图为：

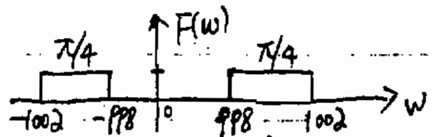


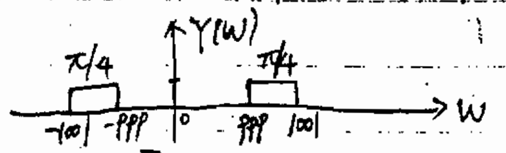
四 $x(t)=Sa(2t)$

$X(w)=\frac{\pi}{2}G_4(w)$



$F(w)=X(w)*\frac{1}{2\pi}[\pi\delta(w-1000)+\pi\delta(w+1000)]=\frac{\pi}{4}[G_4(w-1000)+G_4(w+1000)]$





$Y(w)=\frac{\pi}{4}[G_2(w-1000)+G_2(w+1000)]$

五 (1) $H(s)=\frac{H_1(s)}{1-H_1(s)G(s)}=\frac{1/s+3}{1-k/s+3}=\frac{1}{s+3-k}$

(2) 系统稳定则极点必须在jw轴左边，故 $3-k>0$ 得：$k<3$

(3) $k=1$ $H(s)=\frac{1}{s+2}$ $h(t)=e^{-2t}u(t)$

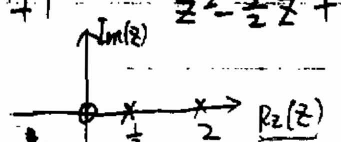
(4) $H(s)=\frac{1}{s+2}$ $H(jw)=\frac{1}{2(1+\frac{jw}{2})}$

六 (1) $y(n-2)-\frac{5}{2}y(n-1)+y(n)=-\frac{3}{2}x(n-1)$

$z^{-2}Y(z)-\frac{5}{2}z^{-1}Y(z)+Y(z)=-\frac{3}{2}z^{-1}X(z)$

$H(z)=\frac{Y(z)}{X(z)}=\frac{-3/2\,z^{-1}}{z^{-2}-5/2\,z^{-1}+1}=\frac{-3/2\,z}{z^2-\frac{5}{2}z+1}=\frac{-3/2\,z}{(z-2)(z-1/2)}$ $|z|>2$

零点0，极点2，1/2.



(2) $H(z)=z\left(\frac{-\frac{3}{2}A}{z-2}+\frac{-\frac{3}{2}B}{z-1/2}\right)$

其中 $A=\frac{1}{z-1/2}\Big|_{z=2}=\frac{2}{3}$ $B=\frac{1}{z-2}\Big|_{z=1/2}=-\frac{2}{5}$ $\times -\frac{2}{3}$

☆ 故 $H(z)=\frac{-z}{z-2}+\frac{\cancel{3/5}\,z}{z-1/2}$ $h(t)=-(2)^n u(n)+(\frac{1}{2})^n u(n)$

单位样响应

(3) ∵ $|z|>2$ 不包含单位圆，故该系统不稳定。

当 $\frac{1}{2}<|z|<2$ 时，收敛域包含单位圆，此时系统稳定。

$h(t)=\underbrace{\frac{3}{5}(\frac{1}{2})^n u(n)}_{|z|>\frac{1}{2}}+\underbrace{(2)^n u(-n-1)}_{收敛域|z|<2}$ 有误

13

七、(1) $sY_c(s) + Y_c(s) = X_c(s)$

$$H_1(s) = \frac{Y_c(s)}{X_c(s)} = \frac{1}{s+1}$$

(2) $Y_c(s) = H_1(s)X_c(s) = \frac{1}{s+1}$ 故 $y_c(t) = e^{-t}u(t)$

(3) $$y(n) = y_c(t) \cdot \sum_{n=-\infty}^{+\infty} \delta(t-nT)$$
$$= e^{-t}u(t) \cdot \sum_{n=-\infty}^{+\infty} \delta(t-nT)$$
$$= e^{-nT}u(n) \quad n \geq 0.$$

(4) $$y_0(n) = y(n) * h_2(n) = e^{-nT}u(n) * [\delta(n) - e^{-T}\delta(n-1)]$$
$$= e^{-nT}u(n) - e^{-T}e^{-(n-1)T}u(n-1)$$
$$= e^{-nT}u(n) - e^{-nT}u(n-1) = e^{-nT}\delta(n)$$
$$= \delta(n)$$

$Y_0(s) = Y(s) \cdot h_2(s)$

$h_2(s) \cdot Y(s) = h_2(n) * y(n)$.

频域相乘　　时域卷积

西南交通大学 2004年硕士研究生 信号与系统 入学考试试题参考答案 452册

一、选择题

1b，2b，3a，4b，5a，6b，7d，8c，9b，10a

二、(1) $y''(t)+4y'(t)+3y(t)=x(t)$

$s^2Y(s)+4sY(s)+3Y(s)=X(s)$

$H(s)=\frac{Y(s)}{X(s)}=\frac{1}{s^2+4s+3}=\frac{1}{(s+1)(s+3)}=\frac{1/2}{s+1}-\frac{1/2}{s+3}$

$h(t)=(\frac{1}{2}e^{-t}-\frac{1}{2}e^{-3t})u(t)$

(2) 零输入响应：$r^2+4r+3=0$ $\quad r_1=-1, r_2=-3$

$y_{zi}(t)=C_1e^{-t}u(t)+C_2e^{-3t}u(t)$ 代入 $y(0^-)=1$ $y'(0^-)=1$

$\begin{cases}C_1+C_2=1\\-C_1-3C_2=1\end{cases} \Rightarrow \begin{cases}C_1=2\\C_2=-1\end{cases}$ 故：$y_{zi}(t)=2e^{-t}u(t)-e^{-3t}u(t)$

零状态响应：$Y_{zs}(s)=H(s)\cdot X(s)=\frac{1}{(s+1)(s+2)(s+3)}=\frac{1/2}{s+1}+\frac{-1}{s+2}+\frac{1/2}{s+3}$

故：$y_{zs}(t)=\frac{1}{2}e^{-t}u(t)-e^{-2t}u(t)+\frac{1}{2}e^{-3t}u(t)$

$y(t)=y_{zi}(t)+y_{zs}(t)=\frac{5}{2}e^{-t}u(t)-e^{-2t}u(t)-\frac{1}{2}e^{-3t}u(t)$

三、(1) $H(s)=H_0\frac{(s-z_1)}{(s-z_2)(s-z_3)}$ $\quad H_0=1$，零点无，极点 $-1, 2$.

故 $H(s)=\frac{1}{(s+1)(s-2)}=\frac{-1/3}{s+1}+\frac{1/3}{s-2}$.

(2) $h(t)=-\frac{1}{3}e^{-t}u(t)+\frac{1}{3}e^{2t}u(t)$

(3) ∵极点2位于jω轴右边. 故该系统不稳定.

(4) $H(s)=\frac{Y(s)}{X(s)}=\frac{1}{s^2-s-2}$

$(s^2-s-2)Y(s)=X(s)$

微分方程：$y''(t)-y'(t)-2y(t)=x(t)$

四、(1) 据图可得，$y(n)=x(n)+\frac{3}{4}y(n-1)-\frac{1}{8}y(n-2)$

∴ $y(n)-\frac{3}{4}y(n-1)+\frac{1}{8}y(n-2)=x(n)$

(2) $Y(z)-\frac{3}{4}z^{-1}Y(z)+\frac{1}{8}z^{-2}Y(z)=X(z)$

$H(z)=\frac{Y(z)}{X(z)}=\frac{1}{1-\frac{3}{4}z^{-1}+\frac{1}{8}z^{-2}}=\frac{z^2}{z^2-\frac{3}{4}z+\frac{1}{8}}=\frac{z^2}{(z-\frac{1}{2})(z-\frac{1}{4})}$ $\quad |z|>\frac{1}{2}$

(3) $H(z)=z[\frac{A}{z-1/2}+\frac{B}{z-1/4}]=\frac{2z}{z-1/2}-\frac{z}{z-1/4}$ $\quad |z|>1/2$

$h(n)=2(\frac{1}{2})^n u(n)-(\frac{1}{4})^n u(n)$

4) $Y(z)=H(z)X(z)=\dfrac{z^3}{(z-\frac{1}{2})^2(z-\frac{1}{4})}=z\left[\dfrac{A}{(z-\frac{1}{2})^2}+\dfrac{B}{(z-\frac{1}{2})}+\dfrac{C}{z-\frac{1}{4}}\right]$

其中：$A=\dfrac{z^2}{z-\frac{1}{4}}\Big|_{z=\frac{1}{2}}=2$ $\quad C=\dfrac{z^2}{(z-\frac{1}{2})^2}\Big|_{z=\frac{1}{4}}=4$

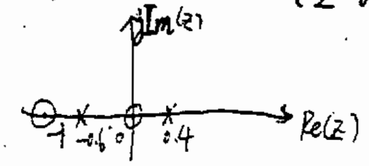
$B=\left(\dfrac{z^2}{z-\frac{1}{4}}\right)'\Big|_{z=\frac{1}{2}}=-4$

$\therefore y(n)=2n\left(\frac{1}{2}\right)^{n-1}u(n)-4\left(\frac{1}{2}\right)^n u(n)+4\left(\frac{1}{4}\right)^n u(n)$

五.(1) $Y(z)+0.2z^{-1}Y(z)-0.24z^{-2}Y(z)=X(z)+z^{-1}X(z)$

$H(z)=\dfrac{Y(z)}{X(z)}=\dfrac{1+z^{-1}}{1+0.2z^{-1}-0.24z^{-2}}=\dfrac{z^2+z}{z^2+0.2z-0.24}=\dfrac{z(z+1)}{(z-0.4)(z+0.6)}$ $\quad |z|>0.6$

零点：0，-1． 极点：0.4，-0.6



(2) $H(z)=z\left[\dfrac{A}{z-0.4}+\dfrac{B}{z+0.6}\right]$

其中 $A=\dfrac{z+1}{z+0.6}\Big|_{z=0.4}=1.4$ $\quad B=\dfrac{z+1}{z-0.4}\Big|_{z=-0.6}=-0.4$

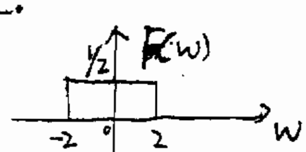
$H(z)=\dfrac{1.4z}{z-0.4}-\dfrac{0.4z}{z+0.6}$

$h(n)=1.4(0.4)^n u(n)-0.4(-0.6)^n u(n)$

(3) $|z|>0.6$ 包含单位圆，故该系统稳定。

六.(1) $f(t)=\dfrac{\sin 2t}{2\pi t}=\dfrac{1}{\pi}Sa(2t)$

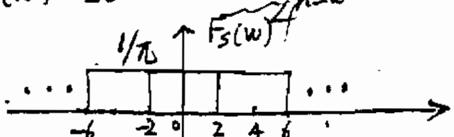
$F(w)=\frac{1}{2}G_4(w)$



(2) $w_m=2$ $\quad W_s=4$ $\quad f_s=\frac{2}{\pi}$ $\quad T_s=\frac{\pi}{2}$

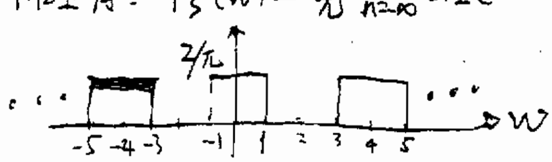
(3) $f_s=f(t)\cdot\delta_T(t)=f(t)\cdot\sum\limits_{n=-\infty}^{+\infty}\delta(t-nT_s)$

$F_s(w)=\frac{1}{2\pi}F(w)*W_s\sum\limits_{n=-\infty}^{+\infty}\delta(w-nW_s)=\frac{2}{\pi}\sum\limits_{n=-\infty}^{+\infty}F(w-4n)=\frac{1}{\pi}\sum\limits_{n=-\infty}^{+\infty}G_4(w-4n)$



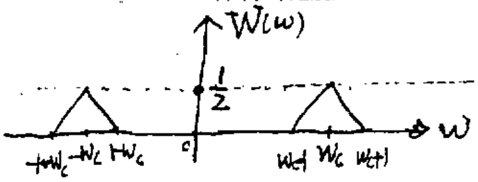
(4) $f(t/2)\xrightarrow{FT}2F(2w)=G_2(w)$ $\quad F_s'(w)=\frac{1}{2\pi}G_2(w)*4\sum\limits_{n=-\infty}^{\infty}\delta(w-4n)$

同理有：$F_s'(w)=\frac{2}{\pi}\sum\limits_{n=-\infty}^{+\infty}G_2(w-4n)$ $\quad =\frac{2}{\pi}G_2(w-4n)$



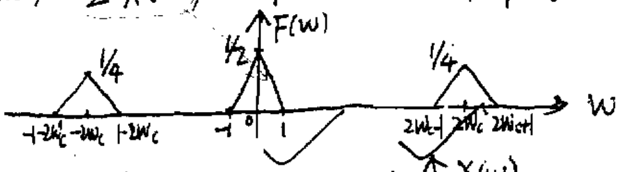
七 (1) $W(t)=X(t)\cdot\cos W_c t$

$$W(w)=\frac{1}{2}[X(w-W_c)+X(w+W_c)]$$



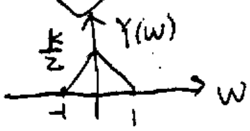
(2) $f(t)=W(t)\cdot\cos W_c t$

$$F(w)=\frac{1}{2}X(w)+\frac{1}{4}X(w-2W_c)+\frac{1}{4}X(w+2W_c)$$



(3) $Y(w)=\frac{1}{2}X(w)$

$=\frac{K}{2}X(w)=X(w)$



(4) 据(3)可知, $K=2$, $1\le W_c\le 2W_c-1$

西南交通大学2005年硕士研究生信号与系统试题参考答案　452#

一、选择题

1b，2a，3b，4c，5a，6a，7a，8c，9d，10b

二、(1) $y(n-1)-\frac{26}{5}y(n)+y(n+1)=x(n)$

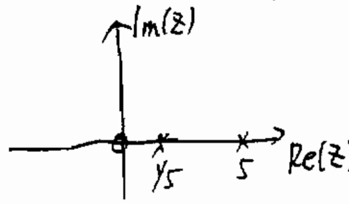
$z^{-1}Y(z)-\frac{26}{5}Y(z)+zY(z)=X(z)$

$$H(z)=\frac{Y(z)}{X(z)}=\frac{1}{z^{-1}-\frac{26}{5}+z}=\frac{5z}{5z^2-26z+5}$$

(2) $H(z)=\frac{5z}{(5z-1)(z-5)}$　$5>|z|>\frac{1}{5}$

零点：0

极点：$\frac{1}{5}$，5.



(3) ∵收敛域 $\frac{1}{5}<|z|<5$ 为双边序列.

∴该系统不是因果系统. 因果的信号是右边序列

(4) $H(z)=\frac{5z}{(5z-1)(z-5)}=-\frac{5}{24}\frac{z}{z-1/5}+\frac{5}{24}\frac{z}{z-5}$

$h(n)=-\frac{5}{24}(\frac{1}{5})^n u(n)-\frac{5}{24}(5)^n u(-n-1)$　03年六大题与此题类似.

三 (1). 由图可知：1 零点；-2，-1 极点.

$H(s)=k\cdot\frac{(s-1)}{(s+1)(s+2)}$

∵ $h(0^+)=2$. 由 $\boxed{\text{初值定理}}$ 得：

$$\lim_{s\to\infty}sH(s)=\lim_{s\to\infty}\frac{ks(s-1)}{(s+1)(s+2)}=k=2$$

故：$H(s)=\frac{2(s-1)}{(s+1)(s+2)}$

(2) $H(s)=\frac{-4}{s+1}+\frac{6}{s+2}$

$h(t)=(-4e^{-t}+6e^{-2t})u(t)$

(3) ∵系统而极点都在 jw 轴左边. 故该系统为渐近稳定系统。

(4) $H(s)=\frac{2(s-1)}{(s+1)(s+2)}=\frac{Y(s)}{X(s)}$

$(s^2+3s+2)Y(s)=(2s-2)X(s)$

微分方程：$y''(t)+3y'(t)+2y(t)=2x'(t)-2x(t)$

四(1) 由图可得：$y(n)=x(n)-0.1y(n-1)+0.12y(n-2)$

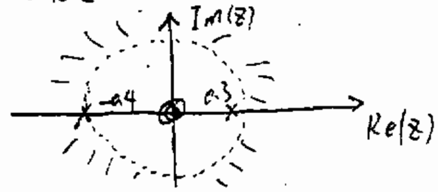
$$y(n)+0.1y(n-1)-0.12y(n-2)=x(n)$$

(2) $Y(z)+0.1z^{-1}Y(z)-0.12z^{-2}Y(z)=X(z)$

$$H(z)=\frac{Y(z)}{X(z)}=\frac{1}{1+0.1z^{-1}-0.12z^{-2}}=\frac{z^2}{z^2+0.1z-0.12}=\frac{z^2}{(z-0.3)(z+0.4)} \quad |z|>0.4$$

0：二阶零点

0.3，-0.4 一阶极点



(3) $H(z)=\frac{z^2}{(z-0.3)(z+0.4)}=\frac{3}{7}\frac{z}{z-0.3}+\frac{4}{7}\frac{z}{z+0.4}$

$$h(n)=\left[\frac{3}{7}(0.3)^n+\frac{4}{7}(-0.4)^n\right]u(n)$$

(4) 收敛域 $|z|>0.4$ 包括了单位圆，故系统渐近稳定.

五.(1) $H(s)=\frac{G(s)}{1-G(s)E(s)}=\frac{3s}{s^2+2s-3}=\frac{3s}{(s+3)(s-1)}$

(2) ∵极点1位于 $j\omega$ 轴右边，故该系统不稳定.

(3) $Y(s)=F(s)H(s)$

$$=\frac{3s}{(s+2)(s+3)(s-1)}=\frac{2}{s+2}+\frac{-\frac{9}{4}}{s+3}+\frac{\frac{1}{4}}{s-1}$$

$$y_{zs}(t)=\left(2e^{-2t}-\frac{9}{4}e^{-3t}+\frac{1}{4}e^{t}\right)u(t)$$

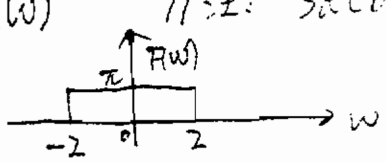
(4) $H(s)=\frac{3s}{s^2+2s-3}$ $\quad r^2+2r-3=0.$ $\quad r_1=-3,\ r_2=1$

$$\begin{cases} c_1+c_2=1 \\ -3c_1+c_2=2 \end{cases} \Rightarrow \begin{cases} c_1=-1/4 \\ c_2=5/4 \end{cases}$$

$$y_{zi}(t)=\left(-\frac{1}{4}e^{-3t}+\frac{5}{4}e^{t}\right)u(t)$$

六(1) $f(t)=\frac{\sin 2t}{t}=2\frac{\sin 2t}{2t}=2Sa(2t)$

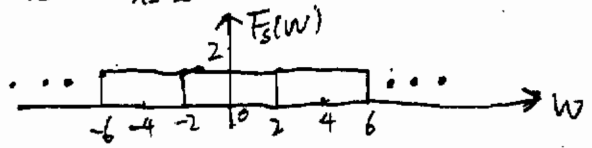
$F(\omega)=\pi G_4(\omega)$ $\quad$ //注：$Sa(bt)\xrightarrow{FT}\frac{\pi}{b}G_{2b}(\omega)$



2) $f_s(t)=f(t)\cdot\delta_T(t)$ $\quad W_m=2$ $\quad W_s=4$ $\quad T_s\le\frac{2\pi}{W_s}=\frac{\pi}{2}$

3) $F_s(w)=\frac{1}{2\pi}F(w)*W_s\sum\limits_{n=-\infty}^{+\infty}\delta(w-nW_s)$

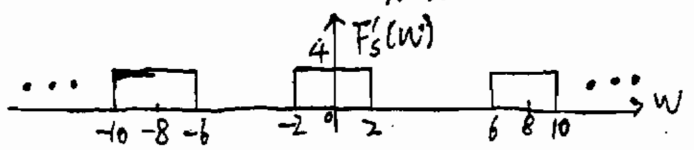
$$=\frac{2}{\pi}\cdot\sum_{n=-\infty}^{+\infty}F(w-4n)=\cancel{2\sum_{n=-\infty}^{+\infty}F(w-4n)}=2\sum_{n=-\infty}^{+\infty}G_4(w-4n)$$



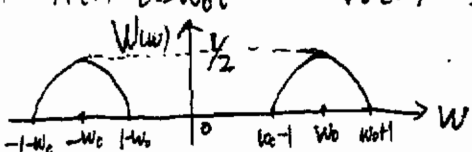
(4) 以$\frac{T_s}{2}$抽样 即 $T_s'=\frac{\pi}{4}$ $\quad W_s'=8$ $\quad F_s'(w)=\frac{1}{2\pi}F(w)*W_s'\sum\delta(w-nW_s')$

同理有: $F_s'(w)=4\sum\limits_{n=-\infty}^{+\infty}G_4(w-8n)$ $\quad =\frac{1}{2\pi}\cdot\pi G_4(w)*8\sum\delta(w-8n)$

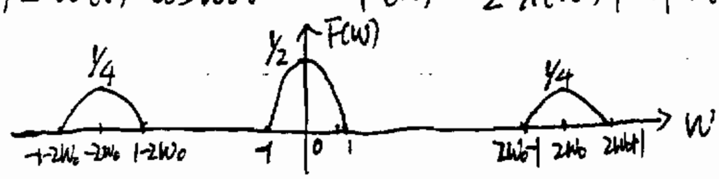
$=4\sum G_4(w-8n)$



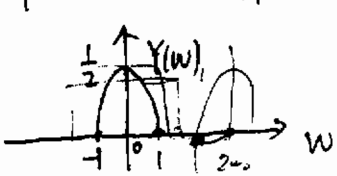
t.(1) $w(t)=x(t)\cdot\cos W_0t$ $\quad W(w)=\frac{1}{2}[X(w-W_0)+X(w+W_0)]$



(2) $f(t)=w(t)\cdot\cos W_0t$ $\quad F(w)=\frac{1}{2}X(w)+\frac{1}{4}X(w-2W_0)+\frac{1}{4}X(w+2W_0)$



(3) $Y(w)=\frac{1}{2}X(w)$



(4) 由(3)可知, $\quad 1\le W_c\le 2W_0-1$

甲

西南交通大学2006年硕士研究生信号与系统试题参考答案 452#

一、选择题

1 b，2 b，3 c，4 d，5 d，6 a，7 b，8 a，9 a，10 d

二.(1) $y''(t)+5y'(t)+6y(t)=x'(t)$

$(s^2+5s+6)Y(s)=sX(s)$

$H(s)=\dfrac{Y(s)}{X(s)}=\dfrac{s}{s^2+5s+6}=\dfrac{-2}{s+2}+\dfrac{3}{s+3}\qquad \sigma>-2$

$h(t)=-2e^{-2t}u(t)+3e^{-3t}u(t)$

(2) $y_{zi}(t)=C_1e^{-2t}u(t)+C_2e^{-3t}u(t)$

代入 $y(0^-)=1\quad y'(0^-)=2$

$\begin{cases}C_1+C_2=1\\-2C_1-3C_2=2\end{cases}\Rightarrow\begin{cases}C_1=5\\C_2=-4\end{cases}$

$y_{zi}(t)=5e^{-2t}u(t)-4e^{-3t}u(t)$

$Y_{zs}(s)=H(s)\cdot X(s)=\dfrac{s}{(s+1)(s+2)(s+3)}=\dfrac{-\frac{1}{2}}{s+1}+\dfrac{2}{s+2}+\dfrac{-\frac{3}{2}}{s+3}$

$y_{zs}(t)=-\frac{1}{2}e^{-t}u(t)+2e^{-2t}u(t)-\frac{3}{2}e^{-3t}u(t)$

$y(t)=y_{zi}(t)+y_{zs}(t)$

$\quad=-\frac{1}{2}e^{-t}u(t)+7e^{-2t}u(t)-\frac{11}{2}e^{-3t}u(t)$

(3) 受迫响应分量：$-\frac{1}{2}e^{-t}u(t)$

自然响应分量：$7e^{-2t}u(t)-\frac{11}{2}e^{-3t}u(t)$

三.(1) 令 $H(z)=k\cdot\dfrac{z^2}{(z-\frac{1}{3})(z-\frac{1}{2})}$

$h(0)=\lim\limits_{z\to\infty}H(z)=k\qquad$ 故 $k=1$

$H(z)=\dfrac{z^2}{(z-\frac{1}{3})(z-\frac{1}{2})}\qquad |z|>\frac{1}{2}$

(2) $H(z)=z\cdot\left[\dfrac{z}{(z-\frac{1}{3})(z-\frac{1}{2})}\right]=\dfrac{-2z}{z-\frac{1}{3}}+\dfrac{3z}{z-\frac{1}{2}}$

$h(n) = -2\left(\frac{1}{3}\right)^n u(n) + 3\left(\frac{1}{2}\right)^n u(n)$

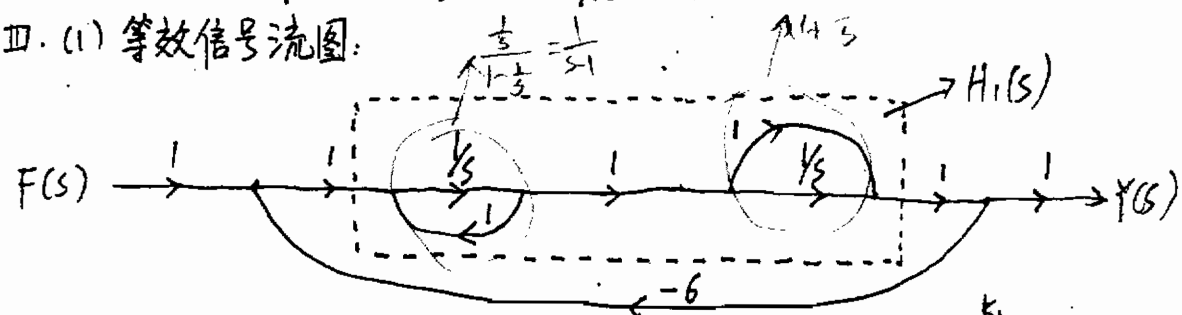
(3) 收敛域 $|z| > \frac{1}{2}$ 包含单位圆，故该系统稳定。

(4) $H(z) = \frac{Y(z)}{X(z)} = \frac{z^2}{(z-\frac{1}{3})(z-\frac{1}{2})}$

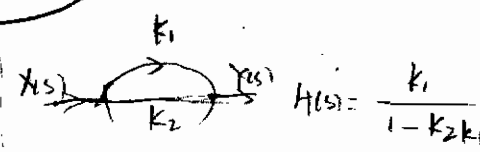
$\left(z^2 - \frac{5}{6}z + \frac{1}{6}\right)Y(z) = z^2 X(z)$

$y(n+2) - \frac{5}{6}y(n+1) + \frac{1}{6}y(n) = x(n+2)$

四. (1) 等效信号流图:

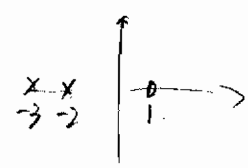


令虚线框内的传递函数为 $H_1(s)$



$H_1(s) = \frac{1}{s-1} \cdot \left[1 + \frac{1}{s}\right] = \frac{s+1}{s(s-1)}$

$H(s) = \frac{H_1(s)}{1+6H_1(s)} = \frac{s+1}{(s+2)(s+3)}$ $\sigma > -2$



(2) $H(s) = Y(s)/F(s)$

$(s^2+5s+6)Y(s) = (s+1)F(s)$

$y''(t) + 5y'(t) + 6y(t) = f'(t) + f(t)$

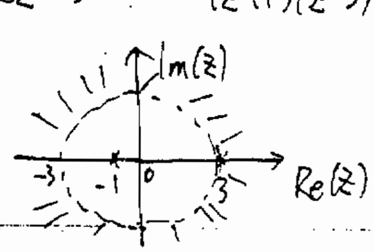
(3) 收敛域 $\sigma > -2$，包含jω轴，故该系统稳定。?

五 (1) $y(n+2) - 2y(n+1) - 3y(n) = x(n)$

$(z^2 - 2z - 3)Y(z) = X(z)$

$H(z) = \frac{Y(z)}{X(z)} = \frac{1}{z^2-2z-3} = \frac{1}{(z+1)(z-3)}$

收敛域: $|z| > 3$



(2) 令 $y_{zi}(n)=C_1(-1)^n u(n)+C_2(3)^n u(n)$

代入：$y(0)=y(1)=2$ 得

$$\begin{cases} C_1+C_2=2 \\ -C_1+3C_2=2 \end{cases} \Rightarrow \begin{cases} C_1=1 \\ C_2=1 \end{cases}$$

$\therefore y_{zi}(n)=(-1)^n u(n)+(3)^n u(n)$

$$Y_{zs}(z)=H(z)\cdot X(z)$$

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

$$=z\left(\frac{1/12}{z+1}+\frac{1/4}{z-3}+\frac{-1/3}{z-2}\right)$$

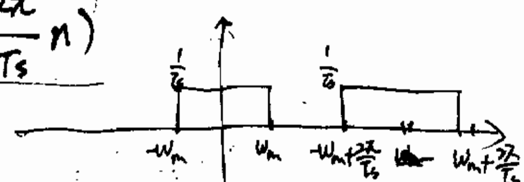
$\therefore y_{zs}(n)=\frac{1}{12}(-1)^n u(n)+\frac{1}{4}(3)^n u(n)-\frac{1}{3}(2)^n u(n)$

(3) 因为收敛域 $|z|>3$ 不包含单位圆，故该系统不稳定。

六. (1) $f_s(t)=\underset{Sa}{\underline{f(t)}}\cdot\delta_{T_s}(t)$

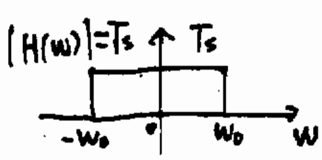
$$F_s(w)=\frac{1}{2\pi}F(w)*\frac{2\pi}{T_s}\sum_{n=-\infty}^{+\infty}\delta\left(w-\frac{2\pi}{T_s}n\right)$$

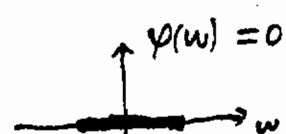
$$=\frac{1}{T_s}\sum_{n=-\infty}^{+\infty}F\left(w-\frac{2\pi}{T_s}n\right)$$



(2) 需要一个低通滤波器来无失真的恢复 $f(t)$

$$|H(w)|=\begin{cases} T_s & W_m<|W|\le\frac{2\pi}{T_s}-W_m \\ 0 & 其它 \end{cases} \qquad \varphi(w)=0$$





(3) 满足(2)中条件必须满足奈奎斯特抽样定理： $f_s\ge 2f_m$

我们取 $f_s=2f_m$ 有

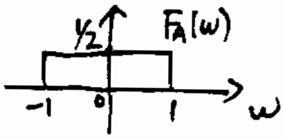
$$|H(w)|=\begin{cases} \frac{\pi}{W_m} & |W|\le W_m \\ 0 & 其它 \end{cases} \qquad \varphi(w)=0$$

t. (1) $X(t)=\frac{\sin t}{2\pi t}=\frac{1}{2\pi}\cdot\frac{\sin t}{t}=\frac{1}{2\pi}Sa(t)$

由 $Sa(Bt)\xrightarrow{FT}\frac{\pi}{B}G_{2B}(w)$ 得：

$F(w)=\frac{1}{2\pi}\cdot\pi G_2(w)$

$\quad=\frac{1}{2}G_2(w)$

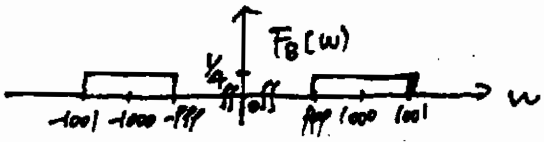


A点：$F_A(w)=F(w)=\frac{1}{2}G_2(w)$

B点：$f_B(t)=X(t)\cdot\cos1000t$ $F_B(w)=\frac{1}{2}[F(w-1000)+F(w+1000)]=\frac{1}{4}[G_2(w-1000)+G_2(w+1000)]$

$F_B(w)=\frac{1}{2\pi}F(w)*[\pi\delta(w-1000)+\pi\delta(w+1000)]$

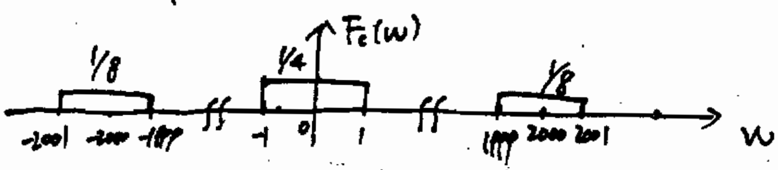
$\quad=\frac{1}{4}[G_2(w-1000)+G_2(w+1000)]$



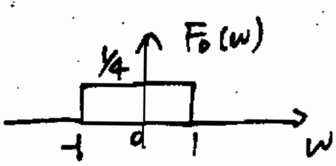
C点：$f_C(t)=f_B(t)\cdot\cos1000t$

$F_C(w)=\frac{1}{2\pi}F_B(w)*[\pi\delta(w-1000)+\pi\delta(w+1000)]$

$\quad=\frac{1}{4}G_2(w)+\frac{1}{8}[G_2(w-2000)+G_2(w+2000)]$



D点：$F_D(w)=\frac{1}{4}G_2(w)$



(2) $y(t)=\frac{\sin t}{4\pi t}=\frac{1}{2}X(t)$

西南交通大学2007年硕士研究生信号与系统试题参考答案 924#

一. 选择题

1c, 2b, 3b, 4b, 5d, 6A, 7b, 8a, 9d, 10b

二. $f(t)$ 全响应 $\longrightarrow y_1(t)=y_{x_1}(t)+y_{f_1}(t)=(2e^{-t}+\cos 2t)u(t)$ ①

$2f(t)$ 全响应 $\longrightarrow y_2(t)=y_{x_2}(t)+y_{f_2}(t)=(e^{-t}+2\cos 2t)u(t)$ ②

因为系统没有变，故有 $y_{x_1}(t)=y_{x_2}(t)$，$y_{f_2}(t)=2y_{f_1}(t)$ 由输入信号引起的响应（由于是线性系统，当输入信号成比例，则输出信号也成比例）

②式－①式得：$f(t)$ 的零状态响应 $y_f(t)=(\cos 2t-e^{-t})u(t)$ ③

把③代入①中得：$f(t)$ 的零输入响应 $y_x(t)=3e^{-t}u(t)$

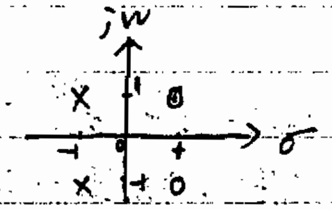
故 $3f(t)$ 全响应 $\longrightarrow y(t)=y_x(t)+3y_f(t)$

$$=3\cos 2t\,u(t)$$

三. (1) $h(t)=\delta(t)-4e^{-t}\cos t\,u(t)+4e^{-t}\sin t\,u(t)$

$$H(s)=1-4\frac{s+1}{(s+1)^2+1}+4\frac{1}{(s+1)^2+1}$$

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



零点：$s=1\pm i$，极点 $s=-1\pm i$

(2) $H(jw)=H(s)\big|_{s=jw}=\dfrac{2-w^2-2jw}{2-w^2+2jw}$

$$=\frac{w^4+4-8w^2-(8w-4w^3)j}{w^4+4}$$

令：$a=\dfrac{w^4+4-8w^2}{w^4+4}$　　$b=\dfrac{-(8w-4w^3)}{w^4+4}$　　$H(jw)=a+bj$

故 $|H(jw)|=\sqrt{a^2+b^2}=1$

$\tan\varphi(jw)=\dfrac{b}{a}$

故 $\varphi(jw)=\arctan\dfrac{b}{a}$

(3) 因为两个极点：$s_1=-1+i$ 和 $s_2=-1-i$ 都在 jw 左边，该系统又为线性因果系统，故收敛域 $\sigma>-1$，包含 jw 轴，故该系统为稳定系统。

四.(1) $y''(t)+11y'(t)+30y(t)=x'(t)$

两边作拉氏变换：$(s^2+11s+30)Y(s)=sX(s)$

$$H(s)=\frac{Y(s)}{X(s)}=\frac{s}{s^2+11s+30}=\frac{-5}{s+5}+\frac{6}{s+6}\qquad \sigma>-5$$

$$h(t)=-5e^{-5t}u(t)+6e^{-6t}u(t)$$

(2) $y_{zi}(t)=C_1e^{-5t}u(t)+C_2e^{-6t}u(t)$

代入 $y(0^-)=1$ $y'(0^-)=2$ 得

$$\begin{cases}C_1+C_2=1\\-5C_1-6C_2=2\end{cases}\Rightarrow\begin{cases}C_1=8\\C_2=-7\end{cases}$$

故 $y_{zi}(t)=8e^{-5t}u(t)-7e^{-6t}u(t)$

$$Y_{zs}(s)=H(s)\cdot X(s)=\frac{s}{(s+5)(s+6)(s+2)}$$
$$=\frac{5/3}{s+5}+\frac{-3/2}{s+6}+\frac{-1/6}{s+2}$$

$$y_{zs}(t)=(-\tfrac{1}{6}e^{-2t}+\tfrac{5}{3}e^{-5t}-\tfrac{3}{2}e^{-6t})\cdot u(t)$$

$$y(t)=y_{zi}(t)+y_{zs}(t)$$
$$=(-\tfrac{1}{6}e^{-2t}+\tfrac{29}{3}e^{-5t}-\tfrac{17}{2}e^{-6t})u(t)$$

(3) 受迫响应分量：$-\tfrac{1}{6}e^{-2t}u(t)$

自然响应分量：$(\tfrac{29}{3}e^{-5t}-\tfrac{17}{2}e^{-6t})u(t)$

五.(1) 由系统框图可知：

$$y(n)=x(n)+\tfrac{3}{4}y(n-1)-\tfrac{1}{8}y(n-2)$$

故差分方程为：$y(n)-\tfrac{3}{4}y(n-1)+\tfrac{1}{8}y(n-2)=x(n)$ ①

(2) 对①式两端作z变换：

$$(1-\tfrac{3}{4}z^{-1}+\tfrac{1}{8}z^{-2})Y(z)=X(z)$$

$$H(z)=\frac{Y(z)}{X(z)}=\frac{z^2}{z^2-\frac{3}{4}z+\frac{1}{8}}=\frac{2z}{z-\frac{1}{2}}+\frac{-z}{z-\frac{1}{4}}\qquad |z|>\tfrac{1}{2}$$

$$\therefore h(n)=2(\tfrac{1}{2})^n u(n)-(\tfrac{1}{4})^n u(n)$$

(3) $Y(z)=H(z)\cdot X(z)$

$$=\left[\frac{z^3}{(z-\frac{1}{2})^2(z-\frac{1}{4})}\right]$$

$$=z\left[\frac{A_1}{z-1/4}+\frac{A_2}{(z-\frac{1}{2})^2}+\frac{A_3}{(z-\frac{1}{2})}\right]$$

其中：$A_1=\left.\frac{z^2}{(z-1/2)^2}\right|_{z=\frac{1}{4}}=1$ $\quad A_2=\left.\frac{z^2}{z-\frac{1}{4}}\right|_{z=\frac{1}{2}}=1$

$$A_3=\left.\left(\frac{z^2}{z-\frac{1}{4}}\right)'\right|_{z=\frac{1}{2}}=0$$

故 $Y(z)=\frac{z}{z-\frac{1}{4}}+\frac{z}{(z-\frac{1}{2})^2}$

$$y(n)=(\tfrac{1}{4})^n u(n)+n(\tfrac{1}{2})^{n-1}u(n)$$

六 (1) 令 $H(z)=K\cdot\frac{1}{(z+2)(z-1)}$

$$\lim_{n\to\infty}h(n)=\lim_{z\to 1}\left(\frac{z-1}{\cancel{z}}\right)H(z)$$? 终值定理

$$=\lim_{z\to 1}\frac{K}{z+2}=3$$

故：$K=9$

$$H(z)=\frac{9}{(z+2)(z-1)}$$ $|z|>2$

(2) $Y(z)=H(z)\cdot X(z)$

$(z^2+z-2)Y(z)=9X(z)$

差分方程：$y(n+2)+y(n+1)-2y(n)=9x(n)$

(3) 因为该系统为因果系统，故 $|z|>2$，收敛域不包含单位圆，故该系统不稳定。 (说明)

(4) 令：$y_{zi}(n)=C_1(-2)^n u(n)+C_2 u(n)$，代入 $y(0)=1$，$y(1)=1$ 得

$$\begin{cases}C_1+C_2=1\\-2C_1+C_2=1\end{cases}\Rightarrow\begin{cases}C_1=0\\C_2=1\end{cases}$$

故 $y_{zi}(n) = u(n)$

$Y(z) = H(z) \cdot X(z)$

$= \frac{9}{(z+2)(z-1)} \cdot \frac{z}{(z-\frac{1}{2})}$

$= z\left(\frac{-36/5}{z-\frac{1}{2}} + \frac{6/5}{z+2} + \frac{6}{z-1}\right)$

故 $y_{zs}(n) = -36/5\,(\frac{1}{2})^n u(n) + 6/5\,(-2)^n u(n) + 6u(n)$

$y_n(n) = y_{zi}(n) + y_{zs}(n)$

$= -36/5 \cdot (\frac{1}{2})^n u(n) + 6/5\,(-2)^n u(n) + 7u(n)$

七. (1) $x(t) = \left(\frac{\sin 30t}{\pi t}\right)^2 = \left(\frac{\sin 30t}{30t} \cdot \frac{30}{\pi}\right)^2 = \frac{900}{\pi^2} Sa^2 30t$

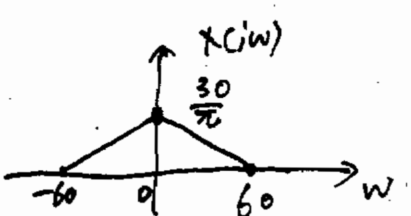
由: $Sa\,Bt \xrightarrow{FT} \frac{\pi}{B} G_{2B}(w)$ 得:

$G_{60}(w) * G_{60}(w) = \begin{cases} -w+60 & w \in [-60, 0] \\ w+60 & w \in [0, 60] \end{cases}$

$Sa\,30t \xrightarrow{FT} \frac{\pi}{30} G_{60}(w)$

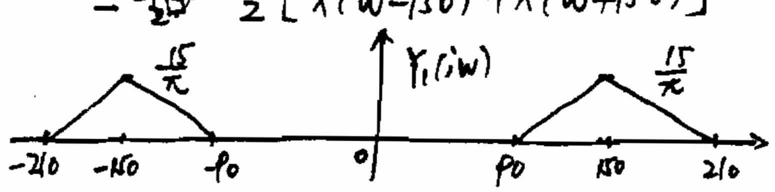
$X(jw) = \frac{1}{2\pi} \cdot \frac{900}{\pi^2}\left[\frac{\pi}{30} G_{60}(w) * \frac{\pi}{30} G_{60}(w)\right]$

$= \begin{cases} \frac{1}{2\pi} w + \frac{30}{\pi} & -60 \le w < 0 \\ -\frac{1}{2\pi} w + \frac{30}{\pi} & 0 \le w \le 60 \end{cases}$



(2) $Y_1(jw) = \frac{1}{2\pi} X(jw) * [\pi\delta(w-150) + \pi\delta(w+150)]$

$= \frac{1}{2}[X(w-150) + X(w+150)]$



$Y_2(jw)$ 是 $Y_1(jw)$ 通过带通滤波器后得到的频谱为: