No: 第二章

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2.1.

解: $x[n]=\delta[n]+2\delta[n-1]-\delta[n-3] \qquad h[n]=2\delta[n+1]+2\delta[n-1]$

(a) $y_1[n]=\sum_{k=-\infty}^{\infty} x[k]\cdot h[n-k]$

$=x[0]\cdot h[n]+x[1]h[n-1]-x[3]h[n-3]$

$=2\delta[n+1]+2\delta[n-1]+2(2\delta[n]+2\delta[n-2])-2\delta[n-2]-2\delta[n-4]$

$=2\delta[n+1]+4\delta[n]+2\delta[n-1]+2\delta[n-2]-2\delta[n-4].$

(b) $x[n+2]=\delta[n+2]+2\delta[n+1]-\delta[n-1].$

$y_2[n]=x[n+2]*h[n] \quad = \sum_{k=-\infty}^{+\infty} x[k+2]\cdot h[n-k]$

$=x[-2]\cdot h[n+2]+x[-1]\cdot h[n+1]-x[1]h[n-1]$

$=2\delta[n+3]+2\delta[n+1]+2(2\delta[n+2]+2\delta[n])-2\delta[n]-2\delta[n-2]$

$=2\delta[n+3]+4\delta[n+2]+2\delta[n+1]+2\delta[n]-2\delta[n-2]$

(c) $h[n+2]=2\delta[n+3]+2\delta[n+1]$

$y_3[n]=x[n]*h[n+2]= \sum_{k=-\infty}^{+\infty} x[k]\cdot h[n+2-k].$

$=x[0]\cdot h[n+2]+x[1]\cdot h[n+1]-x[3]\cdot h[n-1]$

$=2\delta[n+3]+2\delta[n+1]+2(2\delta[n+2]+2\delta[n])-2\delta[n]-2\delta[n-2]$

$=2\delta[n+3]+4\delta[n+2]+2\delta[n+1]+2\delta[n]-2\delta[n-2]$

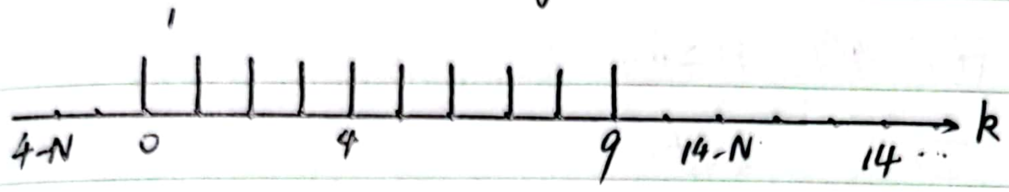
$=y_2[n].$

2.5.

解：$y[n]=x[n]*h[n]=\sum_{k=-\infty}^{+\infty}x[k]\cdot h[n-k]$.

则有 $y[4]=\sum_{k=-\infty}^{+\infty}x[k]h[4-k]$ $\quad y[14]=\sum_{k=-\infty}^{+\infty}x[k]h[14-k]$

作图有



由上知 $4-N$ 在0左侧 即 $4-N\le 0$ $\quad\therefore N\ge 4$ 且 $N<5$

$14-N$ 在9右侧 即 $14-N>9$ $\quad$ 故 $N=4$.

2.21.

解：(a) $y[n]=x[n]*h[n]=\sum_{k=-\infty}^{+\infty}x[k]\cdot h[n-k]$.

$$=\sum_{k=-\infty}^{+\infty}\alpha^k u[k]\cdot\beta^{n-k}\cdot u[n-k]$$

$$=\sum_{k=0}^{n}\alpha^k\beta^{n-k}=\sum_{k=0}^{n}\left(\frac{\alpha}{\beta}\right)^k\cdot\beta^n$$

$$=\beta^n\cdot\frac{1-\left(\frac{\alpha}{\beta}\right)^{n+1}}{1-\frac{\alpha}{\beta}}=\frac{\beta^{n+1}-\alpha^{n+1}}{\beta-\alpha}$$

(c) $y[n]=x[n]*h[n]=\sum_{k=-\infty}^{+\infty}x[k]\cdot h[n-k]$

$$=\sum_{k=-\infty}^{+\infty}\left(-\frac{1}{2}\right)^k u[k-4]\cdot 4^{n-k}u[k+2-n].$$

对前半部分 $\left(-\frac{1}{2}\right)^k u[k-4]$. 当 $k\ge 4$ 时 不为0

对后半部分 $4^{n-k}u[k-(n-2)]$ 当 $k\ge n-2$ 时 不为0

①若 $n-2>4$. 即 $n>6$.

$$y[n]=\sum_{k=n-2}^{+\infty}\left(-\frac{1}{2}\right)^k\cdot 4^{n-k}=\sum_{k=n-2}^{+\infty}4^n\cdot\left(-\frac{1}{8}\right)^k=4^n\cdot\frac{\left(-\frac{1}{8}\right)^{n-2}\left(1-\left(-\frac{1}{8}\right)^{\infty}\right)}{1+\frac{1}{8}}$$

$$=4^n\cdot\frac{512}{9}\left(-\frac{1}{8}\right)^n=\frac{512}{9}\left(-\frac{1}{2}\right)^n$$

②若 $n-2\leq 4$ 即 $n\leq 6$

$$y[n]=\sum_{k=4}^{+\infty}(-\frac{1}{2})^k\cdot 4^{n-k}=\sum_{k=4}^{+\infty}4^n\cdot(-\frac{1}{8})^k=4^n\cdot\frac{(-\frac{1}{8})^4\cdot(1-(-\frac{1}{8})^\infty)}{1+\frac{1}{8}}$$

$$=4^n\cdot\frac{8}{9}\cdot(\frac{1}{8})^4$$

$$\therefore y[n]=\begin{cases}\frac{8}{9}\cdot(\frac{1}{8})^4\cdot 4^n & n\leq 6\\ \frac{512}{9}(-\frac{1}{2})^n & n>6\end{cases}$$

2.11

解：(a) $y(t)=\int_{-\infty}^{+\infty}x(\tau)h(t-\tau)d\tau$

$$=\int_{-\infty}^{+\infty}[u(\tau-3)-u(\tau-5)]\cdot e^{-3(t-\tau)}u(t-\tau)\,d\tau$$

$$=\int_3^5 e^{-3(t-\tau)}u(t-\tau)d\tau$$

$$=\begin{cases}0 & t<3\\ \int_3^t e^{-3(t-\tau)}d\tau & 3<t<5\\ \int_3^5 e^{-3(t-\tau)}d\tau & t>5\end{cases}$$

$$=\begin{cases}0 & t<3\\ \frac{1}{3}[1-e^{-3t}\cdot e^9] & 3\leq t<5\\ \frac{1}{3}e^{-3t}(e^{15}-e^9) & t\geq 5\end{cases}$$

(b) $g(t)=\frac{dx(t)}{dt}*h(t)=y'(t)$

$$=\begin{cases}0 & t<3\\ e^9\cdot e^{-3t} & 3\leq t<5\\ e^{-3t}(e^9-e^{15}) & t\geq 5\end{cases}$$

(c) $g(t)$ 和 $\frac{dy(t)}{dt}$ 相同

2.16.

$x[k]\neq 0$ 求积之和为0

(a) $x[n]*h[n]=\sum_{k=-\infty}^{+\infty}x[k]\cdot h[n-k]$ 当 $k\geq N_1$ 时 $n-k\leq n-N_1<N_2$ 但 $h[n-k]=0$

~~相似的~~ 当 $n-k\geq N_2$ $n-N_2\geq k$ $k<N_1$. $x[k]=0$ 求积之和为0 对

(b) 错 $y[n-1]=x[n-1]*h[n]$ 或 $y[n-1]=x[n]*h[n-1]$

(c) 对 $y(t)=\int_{-\infty}^{+\infty}x(\tau)h(t-\tau)d\tau = x(t)*h(t)$

$y(-t)=\int_{-\infty}^{+\infty}x(\tau)h(-t-\tau)d\tau = x(-t)*h(-t)$

(d) 对 $x(t)*h(t)=\int_{-\infty}^{+\infty}x(\tau)h(t-\tau)d\tau$

$=\int_{T_1}^{\infty}x(\tau)h(t-\tau)d\tau$

$t-T_1>T_2$ 时 $x(\tau)\cdot h(t-\tau)=0$. 即 $t>T_1+T_2$. 故正确.

2.22.

解:(b) $y(t)=x(t)*h(t)$ $h(t)=e^{2t}u(1-t)$

$=[u(t)-2u(t-2)+u(t-5)]*h(t)$

$=u(t)*h(t)-2u(t-2)*h(t)+u(t-5)*h(t)$

由于 $u(t)=\int_{-\infty}^{t}\delta(t)dt$

原式 $=\int_{-\infty}^{t}\delta(t)*h(t)\,dt-\int_{-\infty}^{t}2\delta(t-2)*h(t)\,dt+\int_{-\infty}^{t}\delta(t-5)*h(t)\,dt$

$=\int_{-\infty}^{t}h(t)dt-2\int_{-\infty}^{t}h(t-2)dt+\int_{-\infty}^{t}h(t-5)\,dt$

$=\int_{-\infty}^{t}h(\tau)d\tau-2\int_{-\infty}^{t}h(\tau-2)d\tau+\int_{-\infty}^{t}h(\tau-5)d\tau$

$=\int_{-\infty}^{t}e^{2\tau}u(1-\tau)d\tau-2\int_{-\infty}^{t}e^{2(\tau-2)}u(3-\tau)d\tau+\int_{-\infty}^{t}e^{2(\tau-5)}u(6-\tau)d\tau$

$$= \begin{cases} \frac{1}{2}e^{2t} - e^{2(t-3)} + \frac{1}{2}e^{2(t-5)} & t \le 1 \\ \frac{1}{2}e^{2} - e^{2(t-2)} + \frac{1}{2}e^{2(t-5)} & 1 < t \le 3 \\ -\frac{1}{2}e^{2} + \frac{1}{2}e^{2(t-3)} & 3 < t \le 6 \\ 0 & t > 6 \end{cases}$$

(c) $x(t) = \sin \pi t \quad (0 \le t \le 2)$ $\qquad h(t) = 2u(t-1) - 2u(t-3)$

$y(t) = x(t) * h(t)$

$= (\sin \pi t) * (2u(t-1) - 2u(t-3))$

$= 2\sin \pi t * u(t-1) - 2\sin \pi t * u(t-3)$

$= 2\int_{-\infty}^{t} \sin \pi t * \delta(t-1)dt - 2\int_{-\infty}^{t} \sin \pi t * \delta(t-3)\,dt$

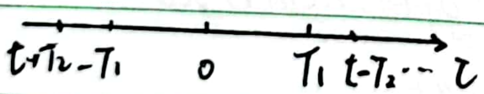
$= 2\int_{-\infty}^{t} \sin \pi(\tau-1)\,d\tau - 2\int_{-\infty}^{t} \sin \pi(t-3)\,d\tau$

$$= \begin{cases} 0 & t < 1 \\ \frac{2}{\pi}[1-\cos \pi(t-1)] & 1 < t < 3 \\ \frac{2}{\pi}[\cos \pi(t-3) - 1] & 3 < t < 5 \\ 0 & t > 5 \end{cases}$$

2.44.

(a) 解: $x(t) * h(t) = \int_{-\infty}^{+\infty} x(\tau) h(t-\tau)\,d\tau$

$= \int_{-T_1}^{T_1} x(\tau) h(t-\tau)\,d\tau$

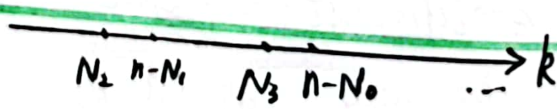


$\because t < -(T_1+T_2)$ 或 $t > (T_1+T_2)$

故 $T_3 = T_1 + T_2$

(b) $y[n] = x[n] * h[n]$

$= \sum_{k=-\infty}^{+\infty} x[k] h[n-k]$



∵不为0的区间: $n-N_1 \geq N_2$ 即 $n \geq N_1+N_2$ $\Rightarrow$ $N_4 = N_1+N_2$

$n-N_0 \leq N_3$ 即 $n \leq N_0+N_3$ $\quad N_5 = N_0+N_3$

ii $M_y = M_x + M_h - 1$ $\quad M_y = N_0+N_3-(N_1+N_2)+1$

$M_x = N_3 - N_2 + 1$ $\quad M_h = N_1 - N_0 + 1$

2.13

解: (a) $h[n] - A h[n-1] = (\frac{1}{5})^n u[n] - (\frac{1}{5})^{n-1} A u[n-1]$

$= \frac{1}{5} \cdot (\frac{1}{5})^{n-1} u[n] - (\frac{1}{5})^{n-1} A u[n-1]$

$\therefore A = \frac{1}{5}$

(b) 由(a)知 $h[n] - \frac{1}{5} h[n-1] = \delta[n]$.

$\therefore h[n] * \delta[n] - h[n] \cdot \frac{1}{5} \delta[n-1] = \delta[n]$.

$\therefore h[n] * (\delta[n] - \frac{1}{5}\delta[n-1]) = \delta[n]$

$\therefore$ 逆系统 S.in $h[n]$为 $\delta[n] - \frac{1}{5}\delta[n-1]$.

2.19

解: (a) $w[n] = \frac{1}{2} w[n-1] + x[n]$ $\quad y[n] = \alpha y[n-1] + \beta w[n]$.

$y[n] = \alpha y[n-1] + \beta (\frac{1}{2} w[n-1] + x[n])$

$= \alpha y[n-1] + \frac{1}{2}\beta w[n-1] + \beta x[n]$

$= \alpha y[n-1] + \frac{1}{2} y[n-1] - \frac{1}{2}\alpha y[n-2] + \beta x[n]$

$\Rightarrow \begin{cases} \beta = 1 \\ \frac{1}{2}\alpha = \frac{1}{8} \end{cases} \Rightarrow \begin{cases} \alpha = \frac{1}{4} \\ \beta = 1 \end{cases}$

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(b) $x[n]=\delta[n]$. $y[n]=-\frac{1}{8}y[n-2]+\frac{3}{4}y[n-1]+\delta[n]$.

$h_1[n]=\frac{1}{2}h_1[n-1]+\delta[n]$ $h_1[-1]=0$

$h_1[0]=\delta[0]=1$ $h_1[1]=\frac{1}{2}h[0]=\frac{1}{2}$ $h_1[2]=(\frac{1}{2})^2$

$\therefore h_1[n]=(\frac{1}{2})^n u[n]$.

$h_2[n]=\frac{1}{4}h_2[n-1]+\delta[n]$ $h_2[-1]=0$

$h_2[0]=u[0]=1$ $h_2[1]=\frac{1}{4}h_2[0]=\frac{1}{4}$

$h_2[2]=\frac{1}{4}h_2[1]=\frac{1}{16}$

$h_2[n]=(\frac{1}{4})^n u[n]$

$\therefore h[n]=\delta[n]*h_1[n]*h_2[n]=h_1[n]*h_2[n]$

$=\sum_{k=-\infty}^{+\infty}(\frac{1}{2})^k u[k]\cdot(\frac{1}{4})^{n-k}u[n-k]$

$=\sum_{k=0}^{n}(\frac{1}{2})^k(\frac{1}{2})^{2(n-k)}=\sum_{k=0}^{n}(\frac{1}{4})^n\cdot(\frac{1}{2})^{-k}=(\frac{1}{4})^n\sum_{k=0}^{n}2^k$

$=(\frac{1}{4})^n\cdot\frac{1-2^{n+1}}{1-2}=(\frac{1}{4})^n[2^{n+1}-1]u[n]$.

2.24

解: (a) $h_2[n]=u[n]-u[n-2]=\delta[n]+\delta[n-1]$

$h_2[n]*h_2[n]=(\delta[n]+\delta[n-1])*(\delta[n]+\delta[n-1])$

$=\delta[n]+2\delta[n-1]+\delta[n-2]$

$\delta[n]*h_1[n]=h_1[n]$.

$h_1[n]*h_2[n]*h_2[n]=h_1[n]*(\delta[n]+2\delta[n-1]+\delta[n-2])$

$=h_1[n]+2h_1[n-1]+h_1[n-2]$.

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故 $h[n]=h_1[n]+2h_1[n-1]+h_1[n-2]$.

当 $n<0$ 时 $h[n]=0$ 知当 $n<0$ 时 $h_1[n]=0$

$h_1[0]=h[0]-0-0=1$

$h_1[1]=h[1]-2h_1[0]-0=3$

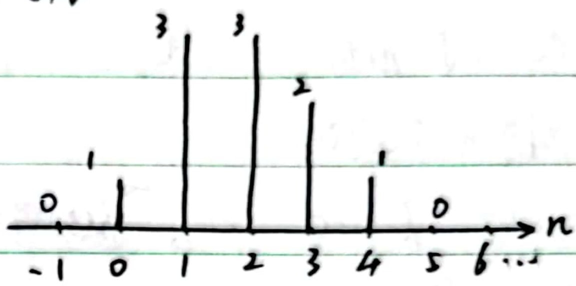
$h_1[2]=h[2]-2h_1[1]-h_1[0]=3$

$h_1[3]=h[3]-2h_1[2]-h_1[1]=2$

$h_1[4]=h[4]-2h_1[3]-h_1[2]=1$

$h_1[5]=h[5]-2h_1[4]-h_1[3]=0$

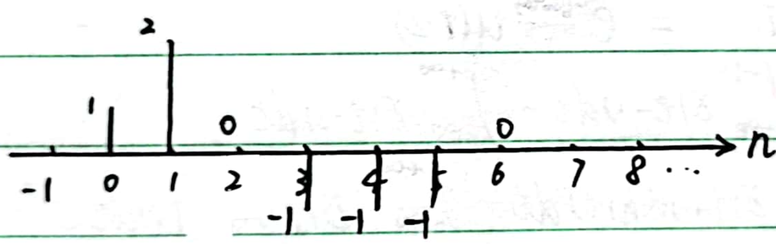
故 $h_1[n]$ 为



(b) $y[n]=x[n]*h[n] = \delta[n]*h[n]-\delta[n-1]*h[n]$

$= h[n]-h[n-1]$

即 $y[n]$ 为



2.28

解 (a). 当 $n<0$ 时 $h[n]=0$ 且 $h[n]$ 绝对可和 $\sum_{n=0}^{\infty}(\frac{1}{5})^n=\frac{1-(\frac{1}{5})^{\infty}}{1-\frac{1}{5}}=\frac{5}{4}$

是因果的 稳定的

(b) 当 $n<0$ 时 $h[n]\neq 0$ $h[n]$ 非绝对可和 $\sum_{n=-\infty}^{0}(\frac{1}{2})^n=\sum_{n=0}^{\infty}2^n=\lim_{n\to\infty}\frac{1-2^n}{1-2}$

$=\lim_{n\to\infty}2^n-1=\infty$

是非因果的非稳定的

(c) 当 $n<0$ 时 $h[n]=0$ 但 $h[n]$ 绝对可和 $\sum_{n=1}^{\infty}n(\frac{1}{3})^n<\frac{3}{4}<\infty$

是因果的 稳定的

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2.29

解: (b) 当 $t<0$ 时 $h(t)\neq 0$ 且 $\int_{-\infty}^{3} e^{-6t}dt = -\frac{1}{6}e^{-6t}\Big|_{-\infty}^{3} = \frac{1}{6}e^{\infty} - \frac{1}{6}e^{-\frac{1}{2}} = \infty$

是非因果的, 不稳定的

(d) 当 $t<0$ 时 $h(t)\neq 0$ 且 $\int_{-\infty}^{-1} e^{2t}dt = \frac{1}{2}e^{2t}\Big|_{-\infty}^{-1} = \frac{1}{2}e^{-2} - 0 = \frac{1}{2e^{2}}$

∴是非因果的 稳定的

(f) 当 $t<0$ 时 $h(t)=0$ $\int_{0}^{+\infty} te^{-t}dt = -te^{-t} - e^{-t}\Big|_{0}^{\infty} = 1 < \infty$

∴是因果的 稳定的

2.40

(a) $y(t) = \int_{-\infty}^{t} e^{-(t-\tau)}x(\tau-2)d\tau$

$h(t) = \int_{-\infty}^{t} e^{-(t-\tau)}\delta(\tau-2)d\tau = e^{-(t-2)}u(t-2)$

(b) $x(t) = u(t+1) - u(t-2) = \int_{-\infty}^{t}\delta(t+1)dt - \int_{-\infty}^{t}\delta(t-2)dt$

$y(t) = x(t)*h(t) = \int_{-\infty}^{t}\delta(t+1)*h(t)dt - \int_{-\infty}^{t}\delta(t-2)*h(t)dt$

$\delta(t+1)*h(t) = h(t+1)$ $\delta(t-2)*h(t) = h(t-2)$

$y(t) = \int_{-\infty}^{t} h(t+1) - \int_{-\infty}^{t} h(t-2)dt$

$= \int_{-\infty}^{t} e^{-(\tau-1)}u(\tau-1)d\tau - \int_{-\infty}^{t} e^{-(\tau-4)}u(\tau-4)d\tau$

$$= \begin{cases} 0 & t<1 \\ \int_{1}^{t} e^{-(\tau-1)}d\tau & 1\le t<4 \\ \int_{1}^{t} e^{-(\tau-1)}d\tau - \int_{4}^{t} e^{-(\tau-4)}d\tau \end{cases} = \begin{cases} 0 & t<1 \\ 1-e^{-(t-1)} & 1\le t<4 \\ e^{-(t-4)} - e^{-(t-1)} & t\ge 4 \end{cases}$$

2.47.

解：(a) $y(t) = 2x_0(t) * h_0(t) = 2y_0(t)$

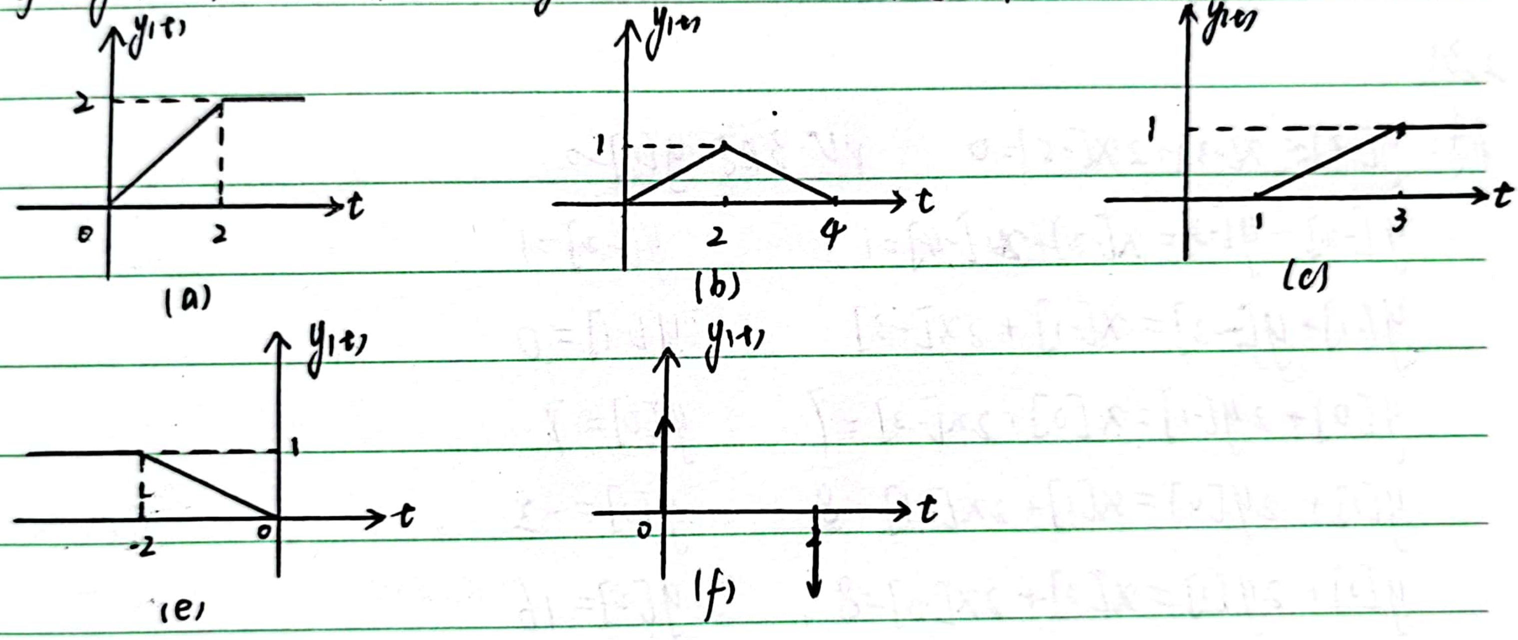
(b) $y(t) = [x_0(t) - x_0(t-2)] * h_0(t) = y_0(t) - y_0(t-2)$

(c) $y(t) = x_0(t-2) * h_0(t+1) = y_0(t-1)$.

(d) 信息不足

(e) $y(t) = x_0(-t) * h_0(-t) = y_0(-t)$

(f) $y(t) = x_0'(t) * h_0'(t) = y_0''(t)$ 图像如下



2.48

(a) 对 $h(t)$ 周期且非0 $\int_{-\infty}^{+\infty} |h(t)| dt = \infty$ 不稳定

(b) 错 例如 $h[n] = \delta[n-k]$ $(k>0)$ 是因果的 但逆系统 $h[n] = \delta[n+k]$ 非因果

(c) 错 若 $|h[n]| = K$ $\sum_{k=-\infty}^{+\infty} |h[k]| = \infty$ 不稳定

(d)

(e) 错 例如 $e^{t}u(t)$ 因果但显然不稳定

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(f). $h(t)=h_1(t)*h_2(t)$ $h_1(t)=\delta(t+1)$ $h_2(t)=\delta(t-1)$

$h(t)=\delta(t)$ 当 $t<0$ 时 $h(t)=0$ 是稳定的

(g) $s(t)=\int_{-\infty}^{t} h(t)dt$

$s(t)$ 绝对可积不能表明 $h(t)$ 绝对可积. 错

(h) $s[n]=\sum_{k=-\infty}^{n} h[k]=\sum_{k=0}^{\infty} h[n-k]$

$n<0$ 时 $s[n]=0$ 则 $n<0$ 时 $h[n]=0$ ∴是因果的

2.31

解: $y[-3]=x[-3]+2x[-5]=0$ $n\le-3$ 时 $y[n]=0$

$y[-2]+y[-3]=x[-2]+2x[-4]=1$ $y[-2]=1$

$y[-1]+2y[-2]=x[-1]+2x[-3]$ $y[-1]=0$

$y[0]+2y[-1]=x[0]+2x[-2]=5$ $y[0]=5$

$y[1]+2y[0]=x[1]+2x[-1]=6$ $y[1]=-4$

$y[2]+2y[1]=x[2]+2x[0]=8$ $y[2]=16$

$y[3]+2y[2]=x[3]+2x[1]=5$ $y[3]=-27$

$y[4]+2y[3]=x[4]+2x[2]=4$ $y[4]=58$

$y[5]+2y[4]=x[5]+2x[3]=2$ $y[5]=-114$

$y[6]+2y[5]=x[6]+2x[4]=0$ $y[6]=(-2)y[5]=228$

$y[7]=(-2)^2y[5]=-4\times114$

$\therefore y[n]=(-2)^{n-5}(-114)$ $n\geq5$