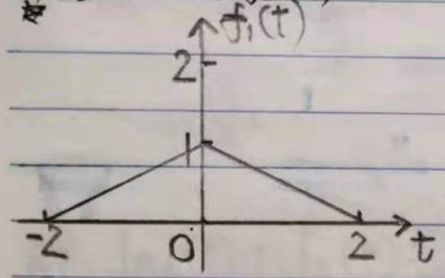
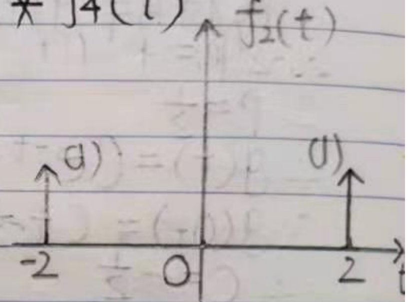
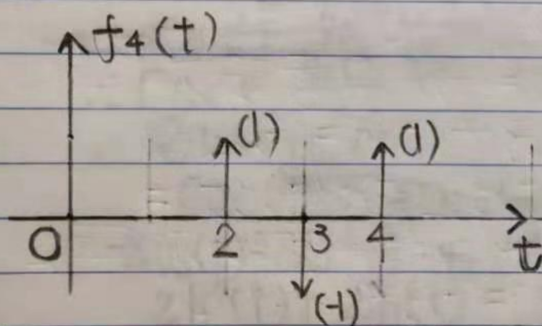
2.16 各函数波形如图所示，图b,c,d为单位冲激函数，试求下列卷积，并画出波形图。

(1) $f_1(t)*f_2(t)$　　(3) $f_1(t)*f_4(t)$

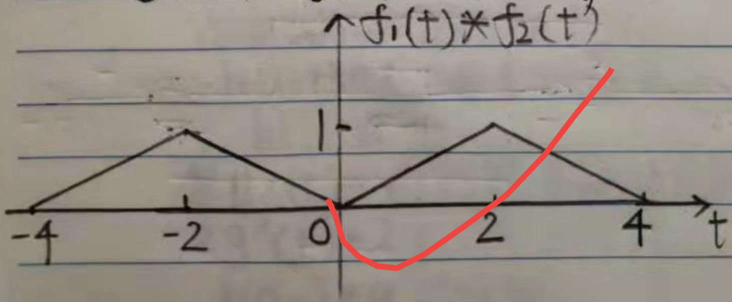






(1)解：$\because f_2(t)=\delta(t+2)+\delta(t-2)$

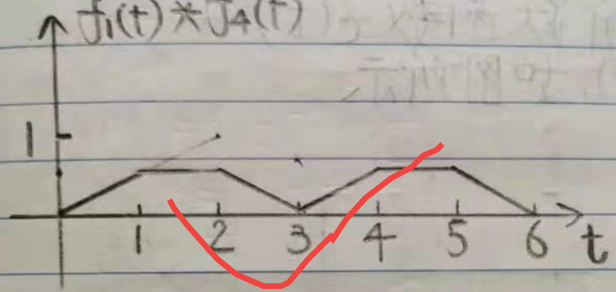
$\therefore f_1(t)*f_2(t)=f_1(t)*[\delta(t+2)+\delta(t-2)]=f_1(t)*\delta(t+2)+f_2(t)*\delta(t-2)=f(t+2)+f(t-2)$



(3) 解：$\because f_4(t)=\delta(t-2)-\delta(t-3)+\delta(t-4)$

$\therefore f_1(t)*f_4(t)=f_1(t)*[\delta(t-2)-\delta(t-3)+\delta(t-4)]$

$=f(t-2)-f(t-3)+f(t-4)$



2.17 求下列函数的卷积积分 $f_1(t)*f_2(t)$

(7) $f_1(t)=\varepsilon(t)-\varepsilon(t-4)$, $f_2(t)=\sin(\pi t)\varepsilon(t)$

解 $f_1(t)*f_2(t)=f_2(t)*[\varepsilon(t)-\varepsilon(t-4)]=$

$f_2(t)*\varepsilon(t)-f_2(t)*\varepsilon(t-4)$

当 $t>0$, $f_2(t)*\varepsilon(t)=\int_{-\infty}^{\infty}\sin\pi\tau\,\varepsilon(\tau)\varepsilon(t-\tau)d\tau$

$=\int_0^t\sin\pi\tau d\tau\,\varepsilon(t)=\frac{1}{\pi}(1-\cos\pi t)\varepsilon(t)$

当 $t>4$, $f_2(t)*\varepsilon(t-4)=\int_{-\infty}^{\infty}\sin\pi\tau\,\varepsilon(\tau)\varepsilon(t-4-\tau)d\tau$

$=\int_0^{t-4}\sin\pi\tau d\tau\,\varepsilon(t)=\frac{1}{\pi}[1-\cos(t-4)\pi]\varepsilon(t)=\frac{1}{\pi}(1-\cos\pi t)\varepsilon(t)$

$\therefore$ 当 $t<0$, $f_2(t)*0-f_2(t)*0=0$;

当 $t>4$, $f_2(t)*\varepsilon(t)-f_2(t)*\varepsilon(t-4)=\frac{1}{\pi}(1-\cos\pi t)-\frac{1}{\pi}(1-\cos\pi t)=0$

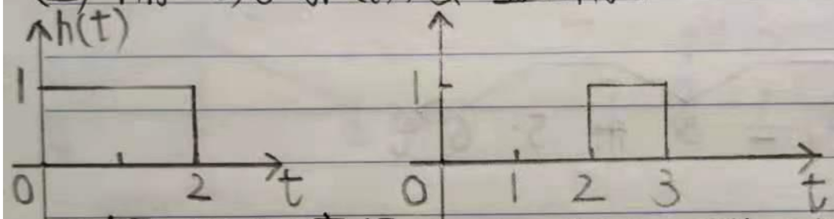
当 $0<t<4$, $f_2(t)*\varepsilon(t)-f_2(t)*\varepsilon(t-4)=\frac{1}{\pi}(1-\cos\pi t)$

$\therefore f_1(t)*f_2(t)=\begin{cases}\frac{1}{\pi}(1-\cos\pi t), & 0<t<4\\ 0, & t<0 \text{ 或 } t>4\end{cases}$

2.18 某LTI系统的冲激响应如图所示，求输入为下列函数时的零状态响应，或画出波形图)

(1) 输入为单位阶跃函数 $\varepsilon(t)$

(2) 输入为 $f_1(t)$，如图所示



(1) 解：依题意得：$h(t)=\varepsilon(t)-\varepsilon(t-2)$

$\therefore y_{zs}(t)=h(t)*\varepsilon(t)=[\varepsilon(t)-\varepsilon(t-2)]*\varepsilon(t)=$

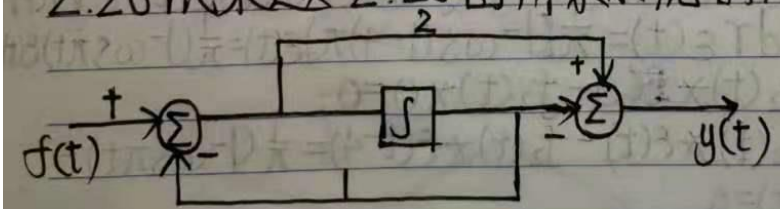
$=t\varepsilon(t)+(t-2)\varepsilon(t-2)$

(2) 解：依题意得：$h(t)=\varepsilon(t)-\varepsilon(t-2)$，$f_1(t)=\varepsilon(t-2)-\varepsilon$

$\therefore y_{zs}(t)=h(t)*\varepsilon(t)=[\varepsilon(t)-\varepsilon(t-2)]*[\varepsilon(t-2)-\varepsilon(t-3)$

$=(t-2)\varepsilon(t-2)-(t-3)\varepsilon(t-3)-(t-4)\varepsilon(t-4)+(t-5)\varepsilon(t-)$

2.26 试求题 2.26 图所示系统的冲激响应



2.26

解 设~~左力~~积分器输出为 $x(t)$

$\therefore$ 左边加法器输出：$x'(t)=f(t)-x(t)$，

右加加法器输出：$2x'(t)-x(t)=y(t)$

$$\therefore \begin{cases} x'(t)+x(t)=f(t) \\ 2x'(t)-x(t)=y(t) \end{cases}$$

$\therefore 2f'(t)-f(t)=y'(t)+y(t)$

设冲激响应为 $h(t)$

$$\therefore \begin{cases} 2h_1'(t)-h_1(t)=h(t) \\ h'(0_-)=h(0_-)=0 \end{cases}$$

$\because \lambda=-1$

$\therefore h_1(t)=Ce^{-t}\varepsilon(t)$

$\because h_1'(t)+h(t)=\delta(t)$

$\therefore h_1(0_+)-h_1(0_-)=1$

$\therefore h_1(0_+)=1$

$\therefore C=1$

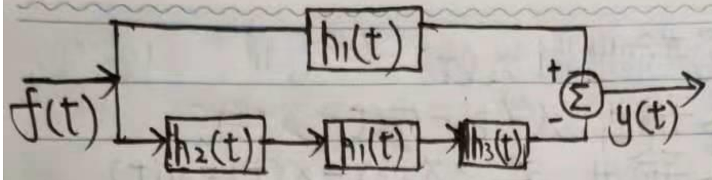
$\therefore h_1(t)=e^{-t}\varepsilon(t)$

$\therefore h(t)=2\delta(t)-3e^{-t}\varepsilon(t)$

2.30 如题 2.30 图所示的系统，它由几个子系统所组成，各子系统的冲激响应为

$$h_1(t)=\varepsilon(t)$$
$$h_2(t)=\delta(t-1)$$
$$h_3(t)=-\delta(t)$$

求复合系统的冲激响应



解: $y(t)=f(t)*h_1(t)-f(t)*h_2(t)*h_1(t)*h_3(t)$

$=\delta(t)*\varepsilon(t)+\delta(t)*\varepsilon(t)*\delta(t-1)*\cancel{\varepsilon}\,\delta(t)$

$=\varepsilon(t)+\varepsilon(t-1)$