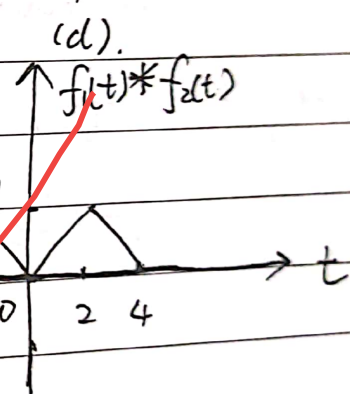
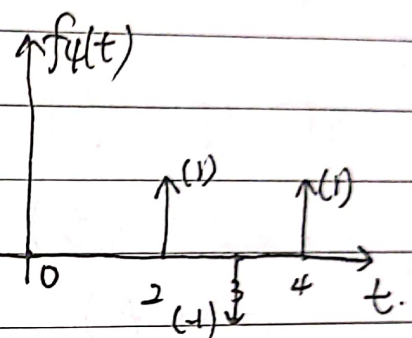
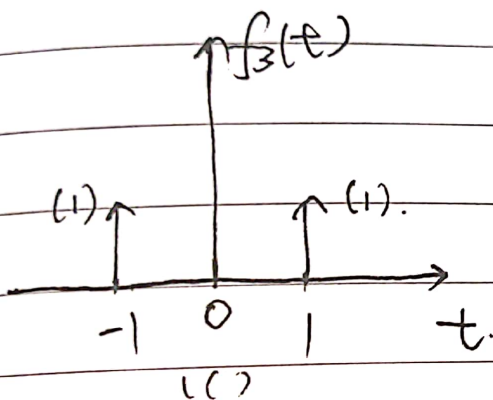
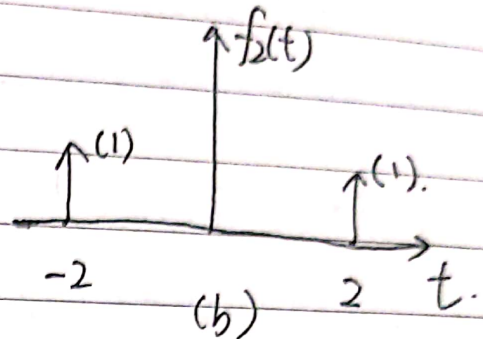
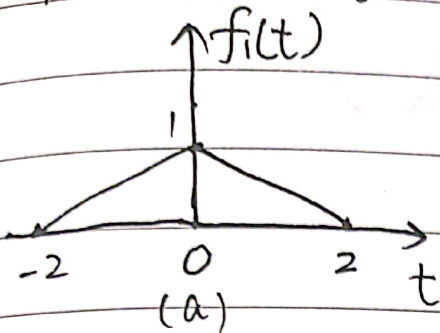
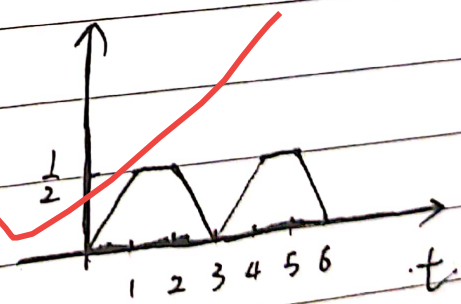


2.16 各函数波形如图，图(b)(c)(d)中均为单位冲激函数，试求下列卷积并画出波形图。



$$\begin{aligned} (1) & f_1(t) * f_2(t) \\ f_2(t) &= \delta(t+2) + \delta(t-2) \\ f_1(t) * f_2(t) &= f_1(t) * \delta(t+2) + f_1(t) * \delta(t-2) \\ &= f_1(t+2) + f_1(t-2) \end{aligned}$$

$$\begin{aligned} (2) & f_1(t) * f_4(t) \\ f_4(t) &= \delta(t-2) - \delta(t-3) + \delta(t-4) \\ f_1(t) * f_4(t) &= f_1(t-2) - f_1(t-3) + f_1(t-4) \end{aligned}$$



2.17 求下列函数的卷积积分  $f_1(t) * f_2(t)$

$$(1) f_1(t) = \varepsilon(t) - \varepsilon(t-4), f_2(t) = \sin(\pi t) \varepsilon(t).$$

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

$$\text{设 } f(t) = \varepsilon(t) * \sin(\pi t) \varepsilon(t)$$

$$= \int_{-\infty}^{\infty} \varepsilon(t-\tau) \sin(\pi \tau) \varepsilon(\tau) d\tau.$$

$$= \int_0^t \sin \pi \tau d\tau \cdot \varepsilon(t)$$

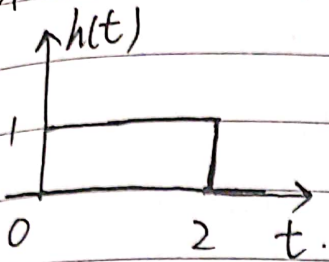
$$= \frac{1}{\pi} \cdot (-\cos \pi \tau) \Big|_0^t \cdot \varepsilon(t)$$

$$= \frac{1}{\pi} (1 - \cos \pi t) \varepsilon(t)$$

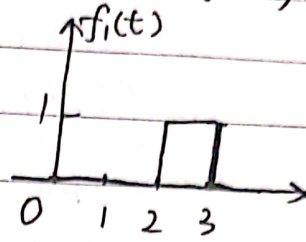
$$\therefore f_1(t) * f_2(t) = f(t) - f(t-4)$$

$$= \frac{1}{\pi} (1 - \cos(\pi t)) (\varepsilon(t) - \varepsilon(t-4))$$

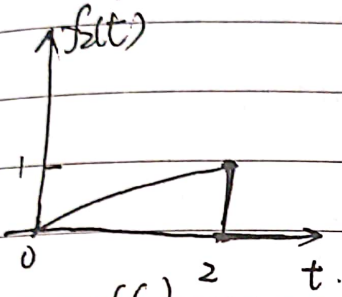
2.18 某 LTI 系统的冲激响应如图 (a)，求输入为下列函数时的零状态响应



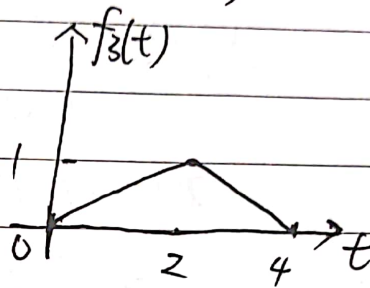
(a)



(b)



(c)



(1) 输入为单位阶跃函数  $\varepsilon(t)$

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

$$y_{zs}(t) = h(t) * \varepsilon(t)$$

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

$$= \int_{-\infty}^{\infty} \varepsilon(t) \cdot \varepsilon(t-\tau) d\tau - \int_{-\infty}^{\infty} \varepsilon(t-2) \cdot \varepsilon(t-\tau-2) d\tau$$

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

(2) 当输入为  $f_1(t)$ ，如图 (b) 所示

$$f_1(t) = \varepsilon(t-2) - \varepsilon(t-3)$$

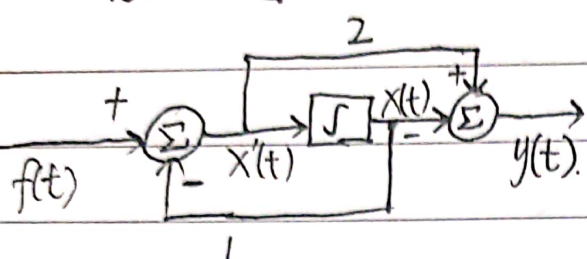
$$y_{zs}(t) = h(t) * f_1(t)$$

$$= [\varepsilon(t) - \varepsilon(t-2)] * [\varepsilon(t-2) - \varepsilon(t-3)]$$

$$= [\varepsilon(t) - \varepsilon(t-2)] * \varepsilon(t-2) - [\varepsilon(t) - \varepsilon(t-2)] * \varepsilon(t-3)$$

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

2.26 试求题图所示系统的冲激响应。



设积分器的输出为  $x(t)$ ，  
由图易得

$$y(t) = 2x(t) - x'(t)$$

$$x'(t) = f(t) - x(t)$$

消  $x(t)$  得  $y(t) = 2f(t) - 3x(t)$

$$\therefore x(t) = \frac{2}{3}f(t) - \frac{1}{3}y(t)$$

$$x'(t) = \frac{2}{3}f'(t) - \frac{1}{3}y'(t)$$

把  $x(t), x'(t)$  代入  $y(t) = 2x(t) - x'(t)$

得  $y(t) + y(t) = 2f'(t) - f(t)$

求冲激响应，设  $f(t) = \delta(t), y(t) = h(t)$ ，

$$h(t) + h(t) = 2\delta'(t) - \delta(t)$$

左端含  $\delta'(t)$ ，令  $h(t) = a\delta'(t) + b\delta(t) + r_0(t)$

$$h(t) = a\delta'(t) + r_1(t)$$

$$\therefore a\delta'(t) + (a+b)\delta(t) + r_1(t) = 2\delta'(t) - \delta(t)$$

$$\therefore a=2, a+b=-1, b=-3$$

$$h(0_+) = b + h(0_-) = -3, \text{ 即 } h'(t) + h(t) = 0$$

解为  $Ce^{-t}, h(0) = -3 = C, \therefore h(t) = 2\delta(t) - 3e^{-t}u(t)$

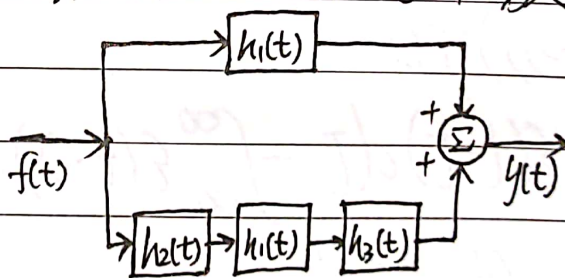
2.30 如图示系统，它由几个子系统所组成，各子系统的冲激响应分别为

$$h_1(t) = \varepsilon(t) \text{ (积分器)}$$

$$h_2(t) = \delta(t-1) \text{ (单位延时)}$$

$$h_3(t) = -\delta(t) \text{ (倒相器)}$$

求复合系统的冲激响应



由图得  $y(t) = f(t) * h_1(t) + f(t) * h_2(t) * h_1(t) * h_3(t)$

$$= f(t) * [h_1(t) + h_2(t) * h_1(t) * h_3(t)]$$

冲激响应，设  $f(t) = \delta(t)$

$$\therefore y(t) = \delta(t) * \varepsilon(t) + \delta(t) * \delta(t-1) * \varepsilon(t) * [-\delta(t)]$$

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

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