

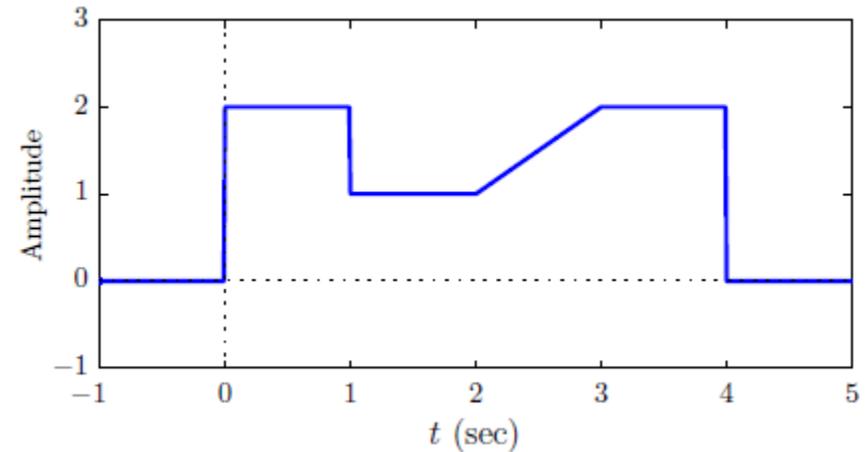
# إشارات ونظم

## جلسة عملي أولى + ثانية

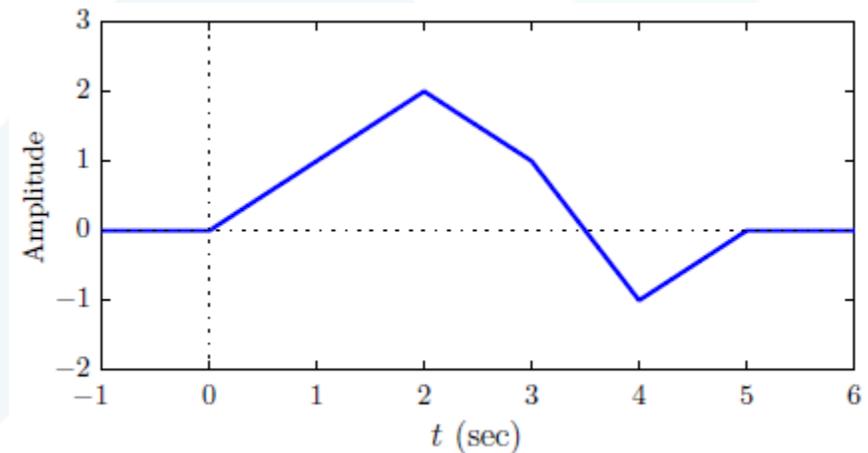
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إشراف: د. رامز قدسية

## 1. Sketch and label each of the signals defined below:

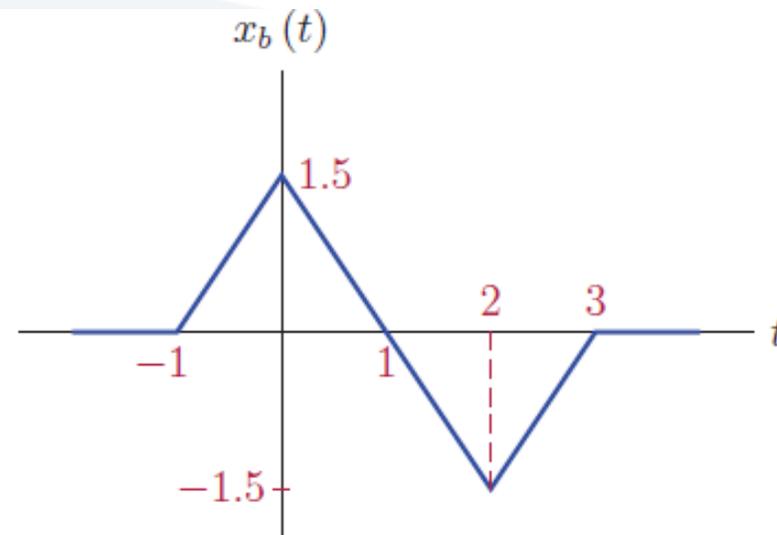
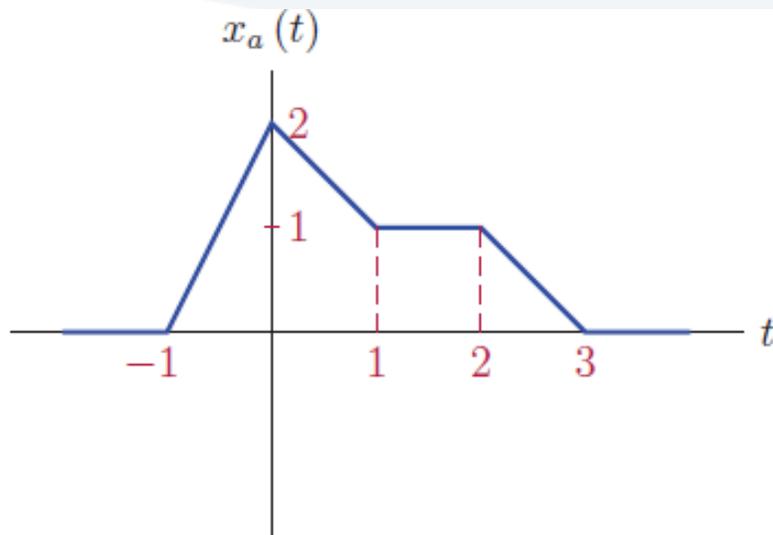
$$x_a(t) = \begin{cases} 0, & t < 0 \text{ or } t > 4 \\ 2, & 0 < t < 1 \\ 1, & 1 < t < 2 \\ t - 1, & 2 < t < 3 \\ 2, & 3 < t < 4 \end{cases}$$



$$x_b(t) = \begin{cases} 0, & t < 0 \text{ or } t > 5 \\ t, & 0 < t < 2 \\ -t + 4, & 2 < t < 3 \\ -2t + 7, & 3 < t < 4 \\ t - 5, & 4 < t < 5 \end{cases}$$



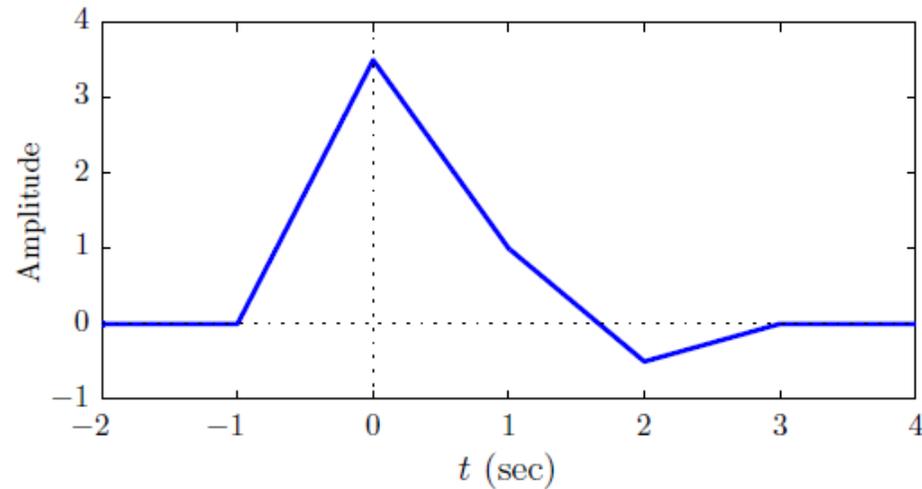
2. Using the two signals  $x_a(t)$  and  $x_b(t)$ , compute and sketch the signals specified below:



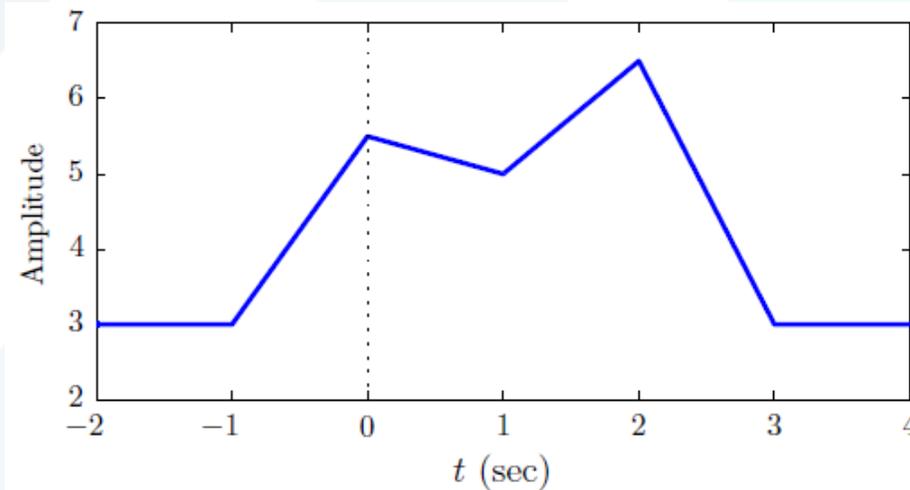
a.  $g_1(t) = x_a(t) + x_b(t)$

b.  $g_2(t) = 2x_a(t) - x_b(t) + 3$

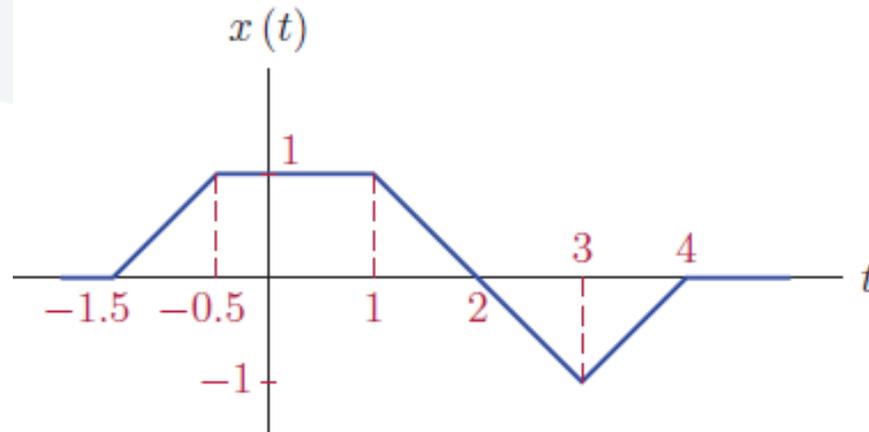
$$g_1(t) = \begin{cases} 0, & t < -1 \text{ or } t > 3 \\ 3.5t + 3.5, & -1 < t < 0 \\ -2.5t + 3.5, & 0 < t < 1 \\ -1.5t + 2.5, & 1 < t < 2 \\ 0.5t - 1.5, & 2 < t < 3 \end{cases}$$



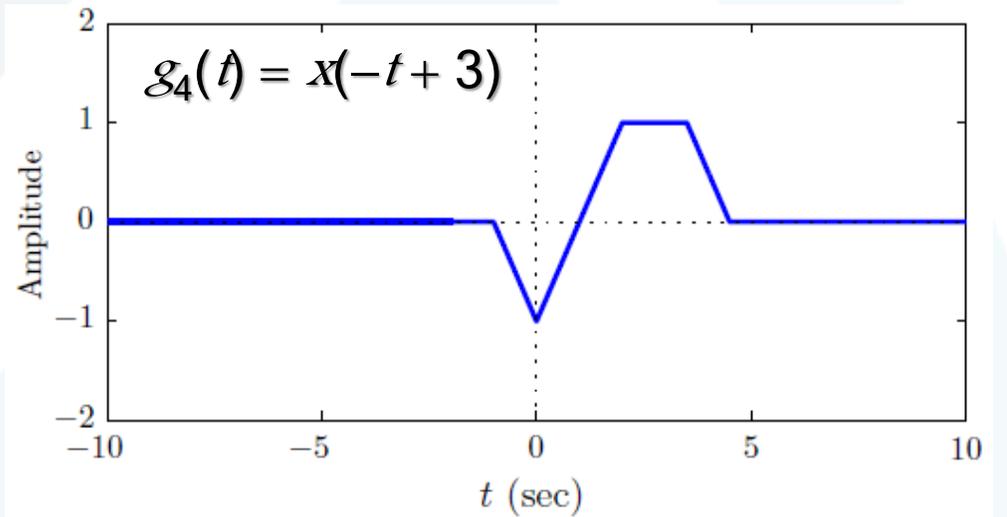
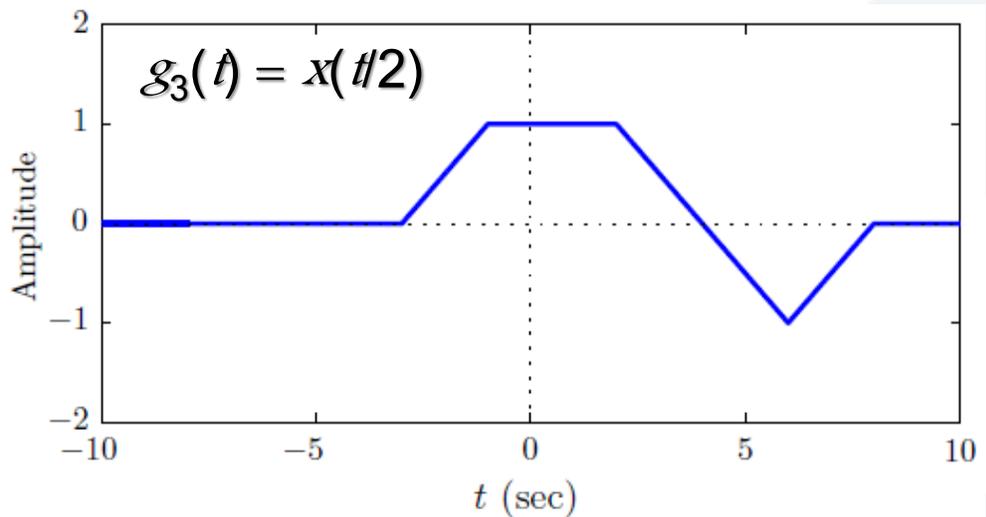
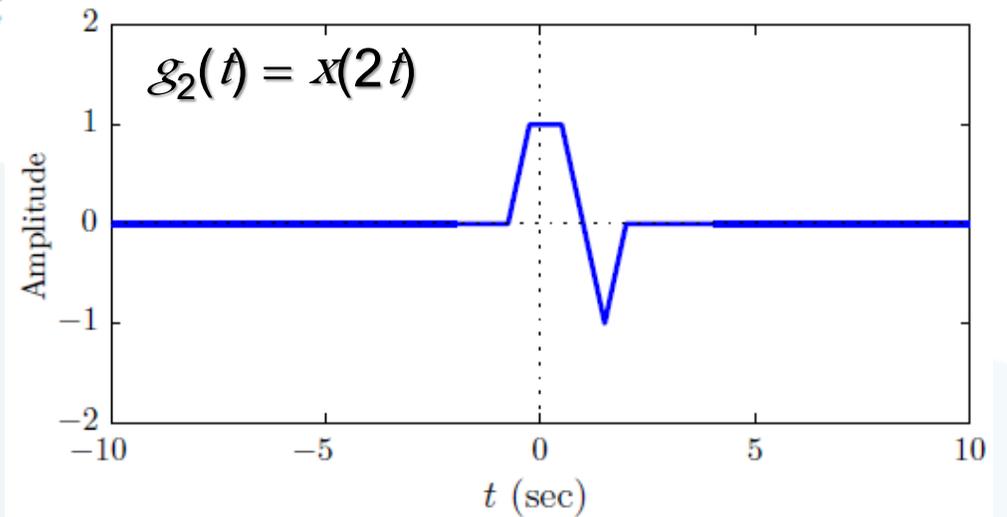
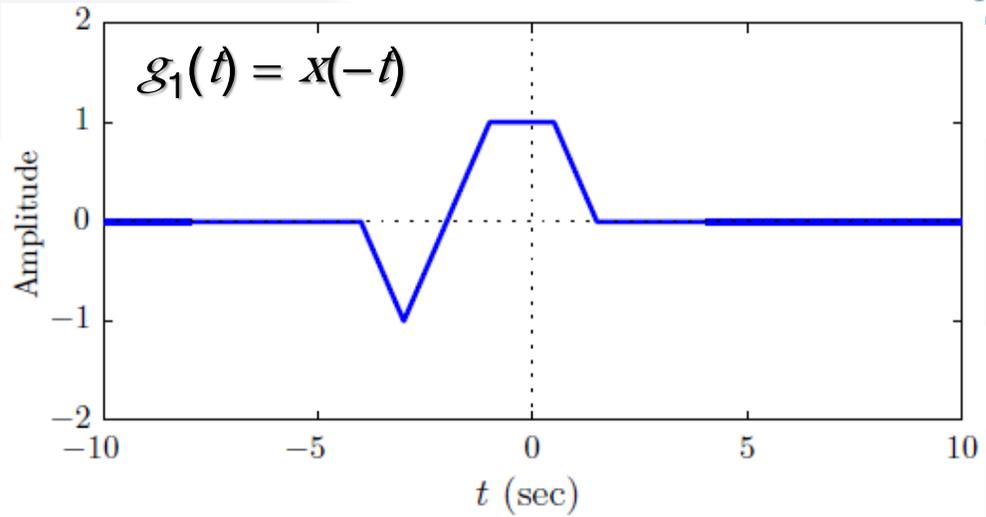
$$g_2(t) = \begin{cases} 3, & t < -1 \text{ or } t > 3 \\ 2.5t + 5.5, & -1 < t < 0 \\ -0.5t + 5.5, & 0 < t < 1 \\ 1.5 + 3.5, & 1 < t < 2 \\ -3.5t + 13.5, & 2 < t < 3 \end{cases}$$



3. For the signal  $x(t)$  shown, compute the following:



- $g_1(t) = x(-t)$
- $g_2(t) = x(2t)$
- $g_3(t) = x(t/2)$
- $g_4(t) = x(-t + 3)$



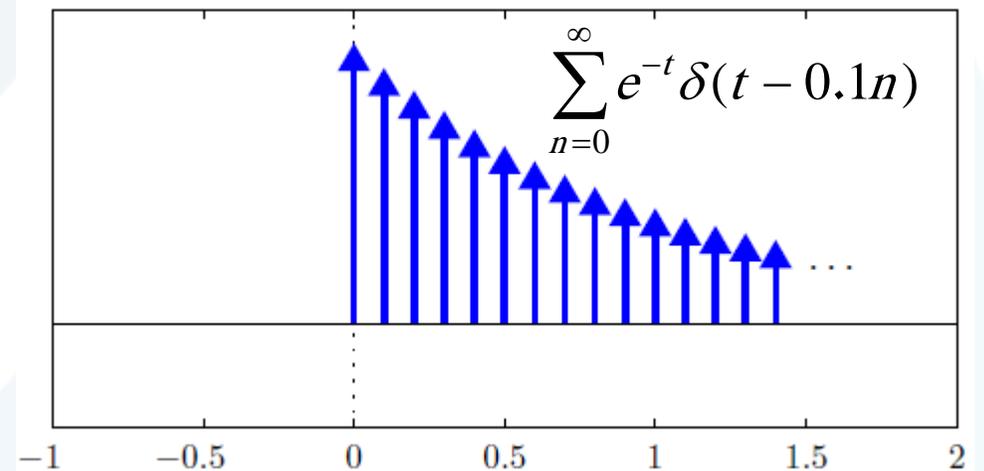
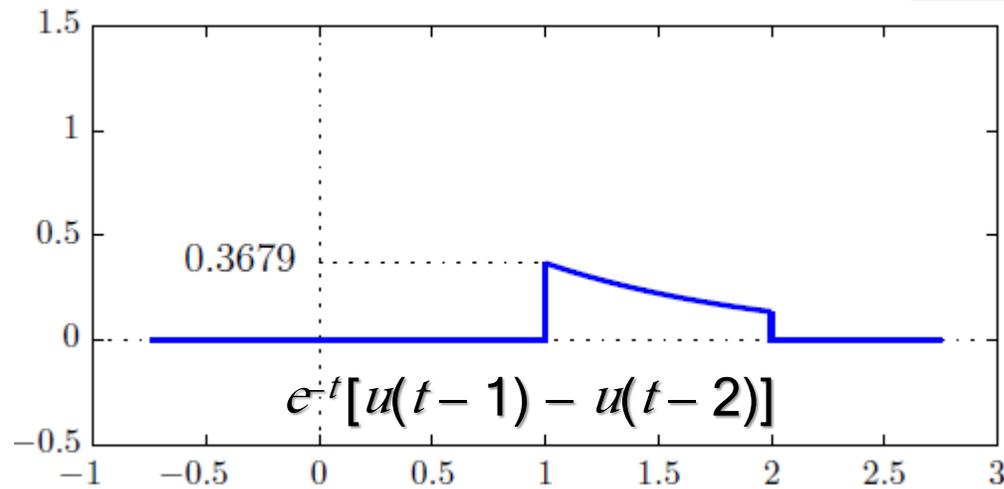
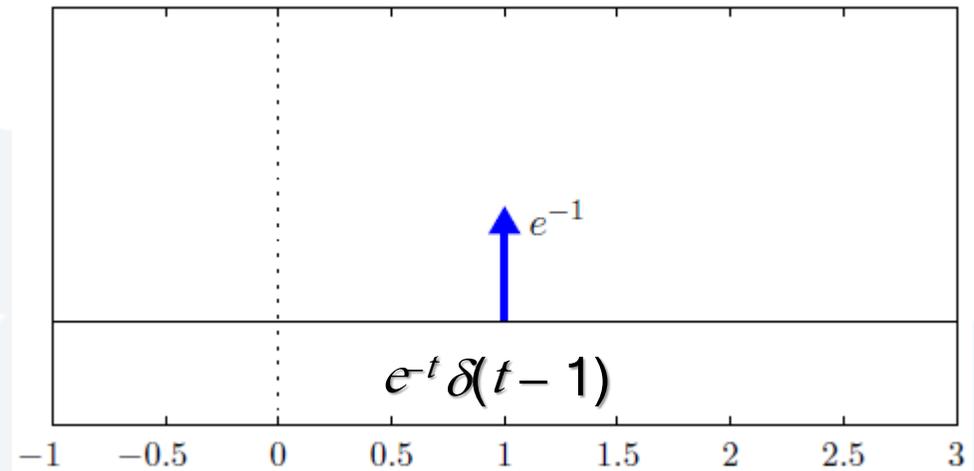
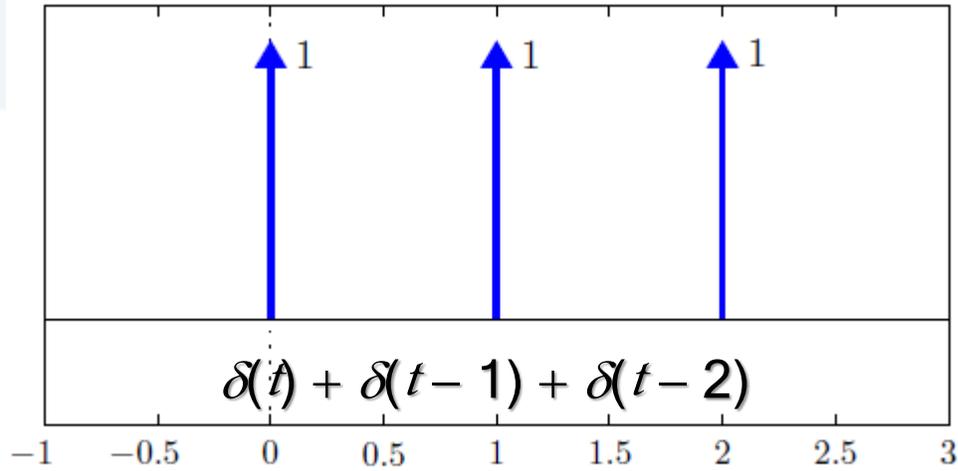
#### 4. Sketch each of the following functions:

a.  $\delta(t) + \delta(t-1) + \delta(t-2)$

b.  $e^{-t} \delta(t-1)$

c.  $e^{-t} [u(t-1) - u(t-2)]$

d.  $\sum_{n=0}^{\infty} e^{-t} \delta(t - 0.1n)$



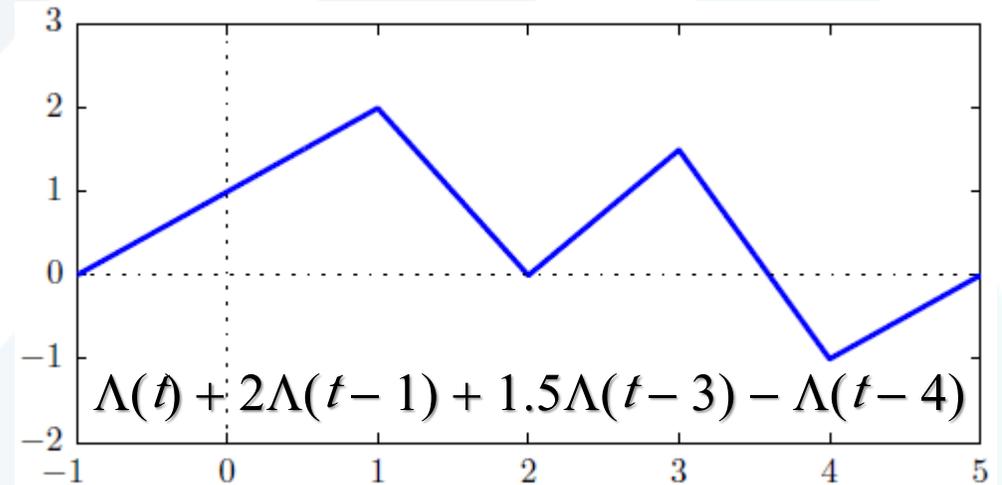
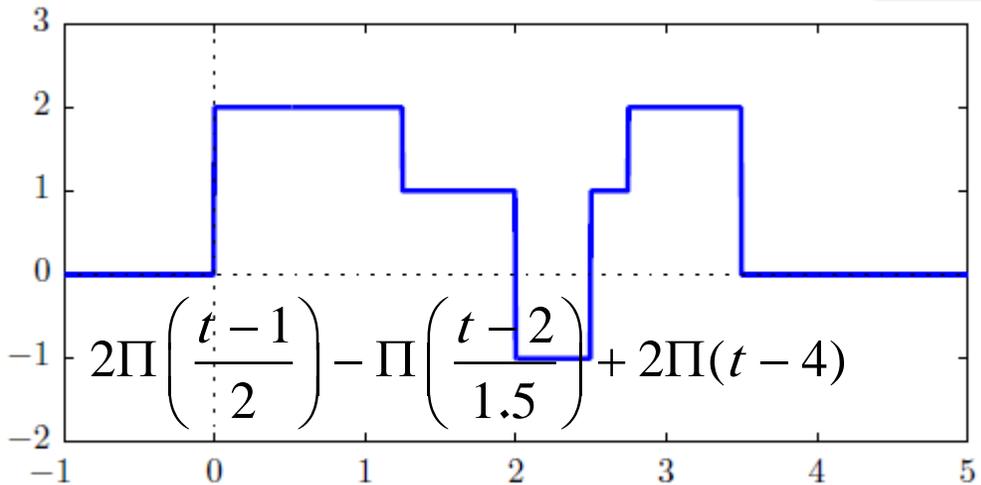
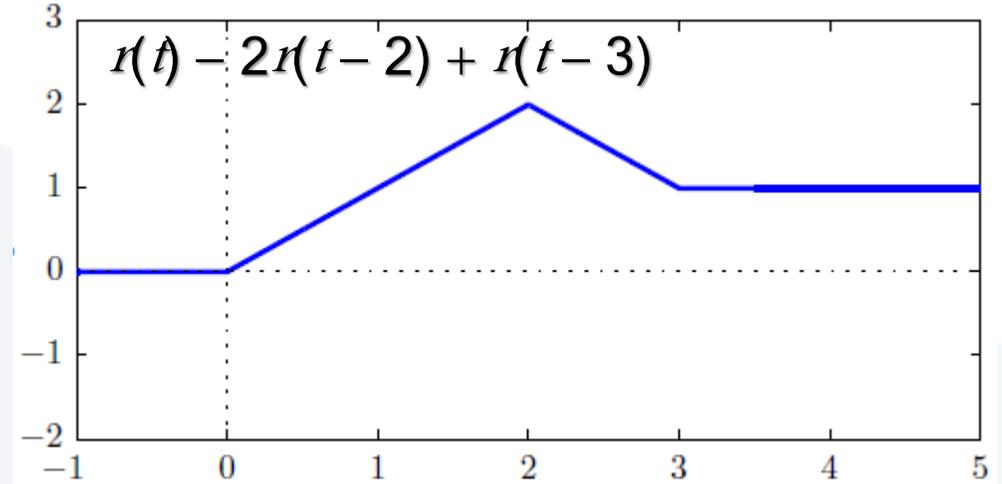
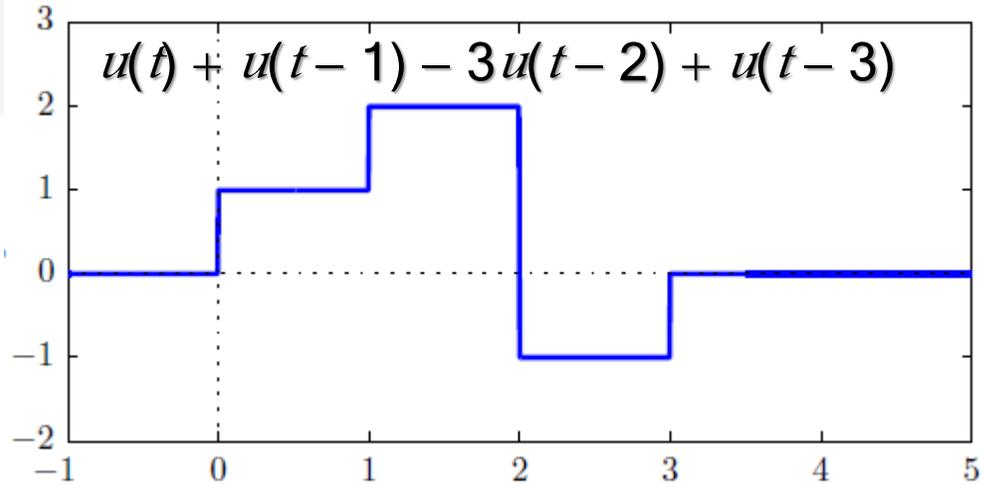
5. Sketch each of the following functions in the time interval  $-1 \leq t \leq 5$ :

a.  $u(t) + u(t-1) - 3u(t-2) + u(t-3)$

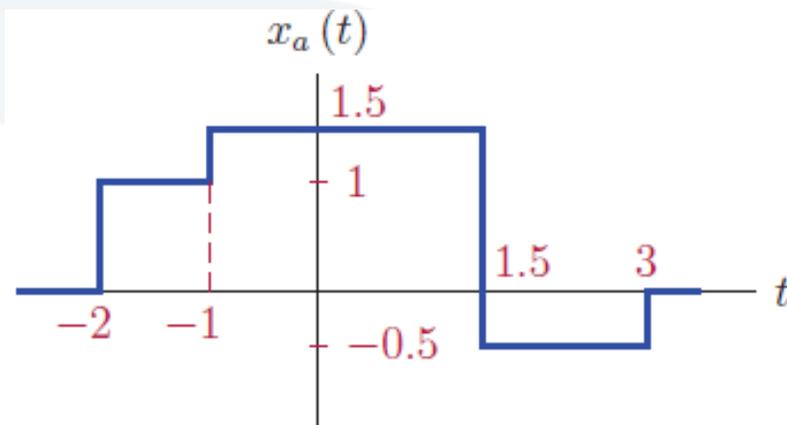
b.  $r(t) - 2r(t-2) + r(t-3)$

c.  $2\Pi\left(\frac{t-1}{2}\right) - \Pi\left(\frac{t-2}{1.5}\right) + 2\Pi(t-4)$

d.  $\Lambda(t) + 2\Lambda(t-1) + 1.5\Lambda(t-3) - \Lambda(t-4)$

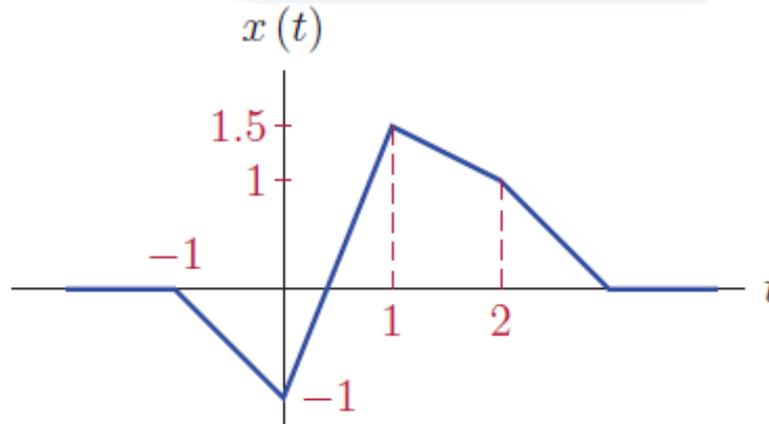


6. Express the signal shown using scaled and time shifted unit step functions:



$$x_a(t) = u(t+2) + 0.5u(t+1) - 2u(t-1.5) + 0.5u(t-3)$$

7. Express the signal shown:
- Unit-ramp functions
  - Unit-triangle functions



$$x(t) = -r(t+1) + 3.5r(t) - 3r(t-1) - 0.5r(t-2) + r(t-3)$$

$$x(t) = -\Lambda(t) + 1.5\Lambda(t-1) + \Lambda(t-2)$$

8. Determine if each signal below is periodic or not. If the signal is periodic, determine the fundamental period and the fundamental frequency.

a.  $x(t) = 2\sin(\sqrt{20}t)$   $2\pi f_0 = \sqrt{20} \Rightarrow f_0 = \sqrt{5}/\pi \text{ Hz}, T_0 = 1/f_0 = \pi/\sqrt{5} \text{ sec}$

b.  $x(t) = \cos^2(3t - \pi/4)$   $2\pi f_0 = 6 \Rightarrow f_0 = 3/\pi \text{ Hz}, T_0 = 1/f_0 = \pi/3 \text{ sec}$

c.  $x(t) = e^{-|t|}\cos(2t)$  **X**

d.  $x(t) = e^{j(2t+\pi/5)}$   $2\pi f_0 = 2 \Rightarrow f_0 = 1/\pi \text{ Hz}, T_0 = 1/f_0 = \pi \text{ sec}$

e.  $x(t) = e^{(-2+j5)t}$  **X**

## 9. Determine the normalized energy of each of the signals

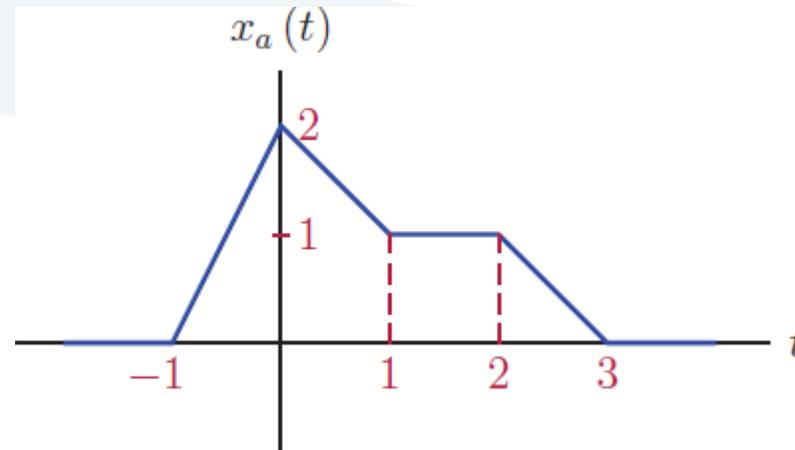
a.  $x(t) = e^{-2|t|}$

b.  $x(t) = e^{-2t} u(t)$

$$a. \quad E_x = \int_{-\infty}^{\infty} |x(t)|^2 dt = \int_{-\infty}^0 e^{-4t} dt + \int_0^{\infty} e^{-4t} dt = \frac{1}{2}$$

$$b. \quad E_x = \int_0^{\infty} e^{-4t} dt = \frac{1}{4}$$

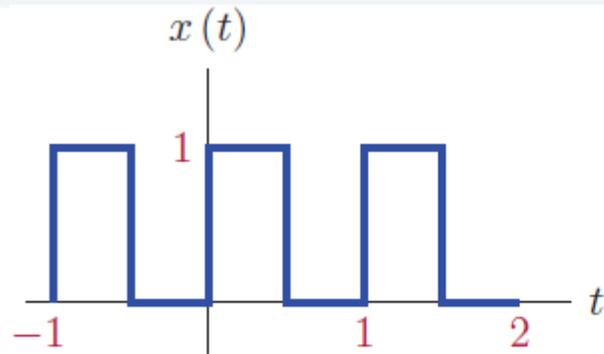
## 10. Determine the normalized energy of the signal below



$$x_a(t) = \begin{cases} 0, & t < -1 \text{ or } t > 3 \\ 2t + 2, & -1 < t < 0 \\ -t + 2, & 0 < t < 1 \\ 1, & 1 < t < 2 \\ -t + 3, & 2 < t < 3 \end{cases}$$

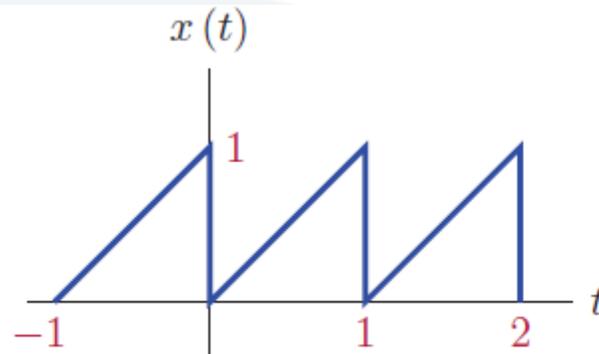
$$E_x = \int_{-1}^0 (2t + 2)^2 dt + \int_0^1 (-t + 2)^2 dt + \int_1^2 (1)^2 dt + \int_2^3 (-t + 3)^2 dt = 5$$

## 11. Determine the normalized average power of the signals below



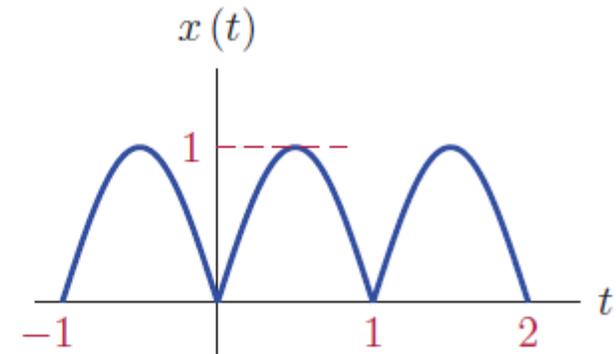
(a)

$$P_x = \int_0^{1/2} (1)^2 dt = \frac{1}{2}$$



(b)

$$P_x = \int_0^1 (t)^2 dt = \frac{1}{3}$$



(c)

$$P_x = \int_0^1 \sin^2(\pi t) dt = \frac{1}{2}$$

12. For each of the signals listed below, find the even and odd components  $x_e(t)$  and  $x_o(t)$ . In each case, sketch the original signal and its two components

a.  $x(t) = e^{-3|t|} \cos(t)$

b.  $x(t) = e^{-3|t|} \sin(t)$

c.  $x(t) = e^{-2|t-1|}$

$$x_e(t) = \frac{1}{2} e^{-3|t|} \cos(t) + \frac{1}{2} e^{-3|-t|} \cos(-t) = e^{-3|t|} \cos(t)$$

$$x_o(t) = \frac{1}{2} e^{-3|t|} \cos(t) - \frac{1}{2} e^{-3|-t|} \cos(-t) = 0$$

$$x_e(t) = \frac{1}{2} e^{-3|t|} \sin(t) + \frac{1}{2} e^{-3|-t|} \sin(-t) = 0$$

$$x_o(t) = \frac{1}{2} e^{-3|t|} \sin(t) - \frac{1}{2} e^{-3|-t|} \sin(-t) = e^{-3|t|} \sin(t)$$

$$x_e(t) = \frac{1}{2} e^{-2|t-1|} + \frac{1}{2} e^{-2|-t-1|}$$

$$x_o(t) = \frac{1}{2} e^{-2|t-1|} - \frac{1}{2} e^{-2|-t-1|}$$

