SIGNALS & SYSTEMS

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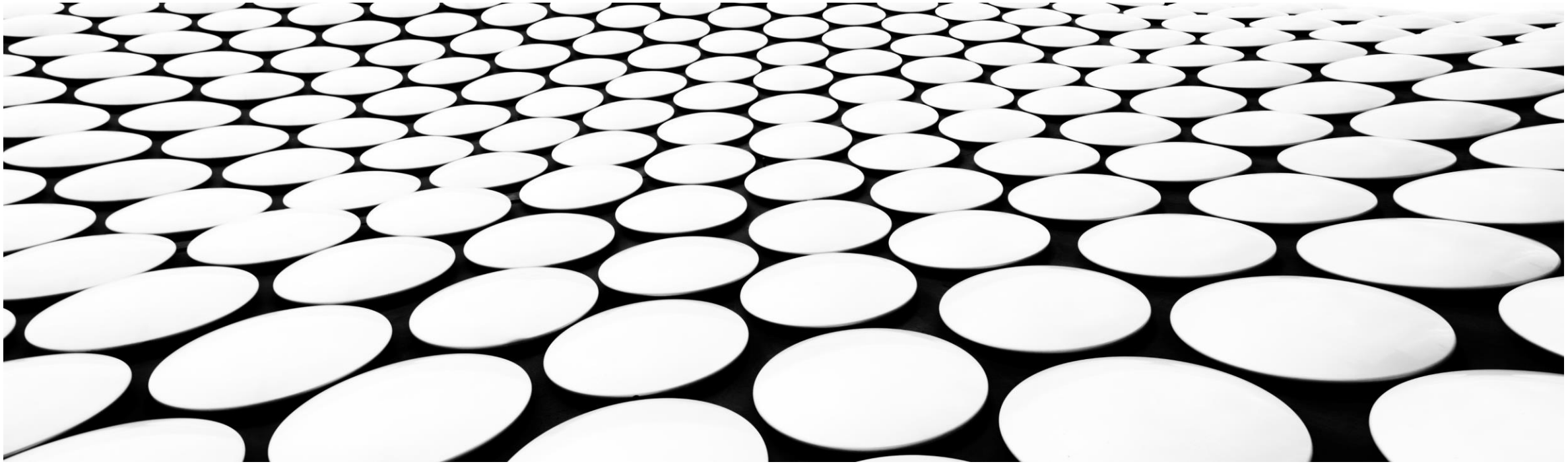


Q1) Sketch the following signals:-

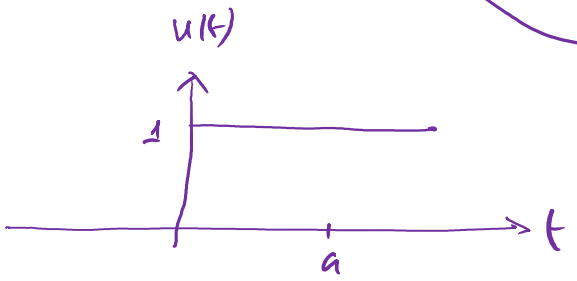
$x(t) = A[u(t+a) - u(t-a)]$: for $a>0$. Also determine whether the given signal is a power signal or an energy signal or neither.

Soln:-

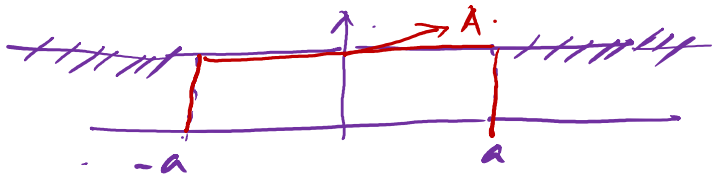
$x(t) = A[u(t+a) - u(t-a)]$

$u(t)$ → unit step signal $\quad u(t) = \begin{cases} 1, & t \geq 0 \\ 0, & t<0 \end{cases}$

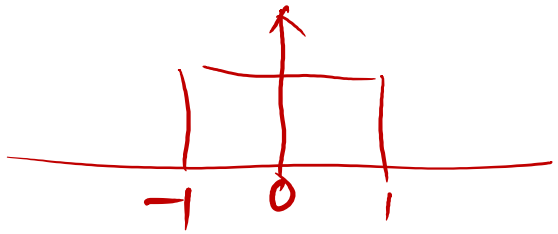
$t+a=0 \Rightarrow t=-a$

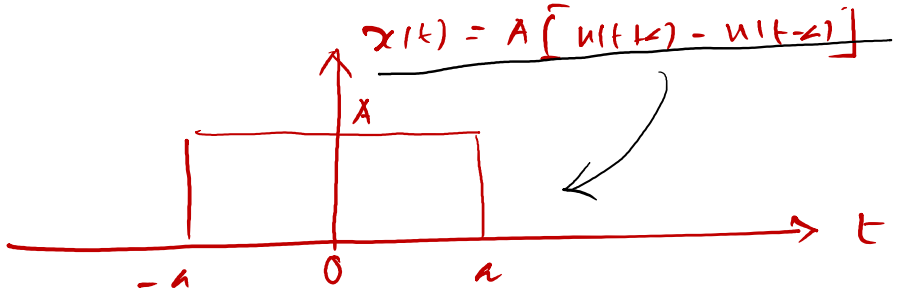


$x(t) = A \quad$ for $\quad -a<t<a$



$u(t+1) - u(t-1)$ → Gate function





$|x(t)|$ → Amplitude of a signal within the range

Energy signal:-

$$E = \int_{-\infty}^{\infty} |x(t)|^2 dt = \int_{-a}^{a} |A|^2 dt = 2aA^2 \times$$

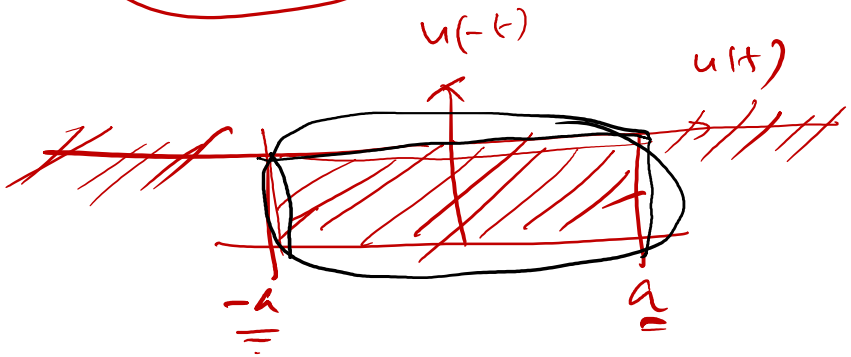
due to the symmetry

$$= 2\int_{0}^{a} x^2 dt$$

$u(t+a)$

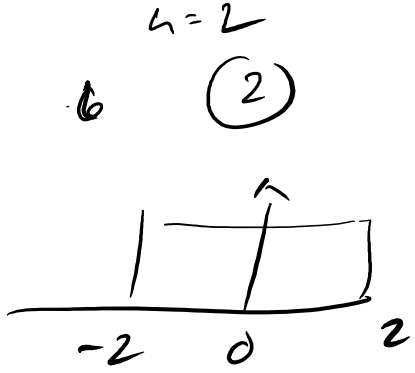
$t = -a$

$u(-t+a) - u(t-a)$

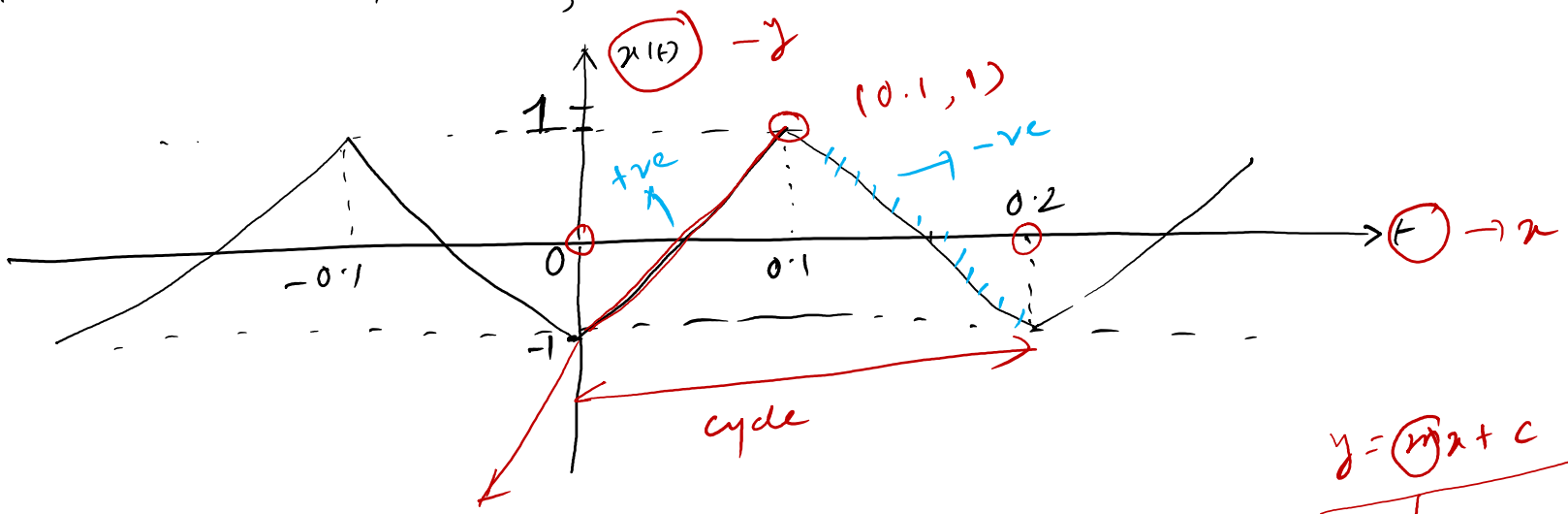


$$= 2A^2[t]_0^a$$

$$= 2aA^2$$



2) Calculate the Av. power of the triangular wave shown in the fig. below:-



$$P = \frac{1}{T}\int_0^T |x(t)|^2\, dt$$

(x, y)

(0, -1)

$y = mx + c$

nature of slope ? → +ve, 0 → constant, → negative

Define $x(t)$

$$x(t) = \begin{cases} 20t - 0.1 & \leftarrow \text{in b/w } 0 \text{ to } 0.1 \\ -20t + 0.3 & \leftarrow \text{in b/w } 0.1 \text{ to } 0.2 \end{cases}$$

The eqn of a st. line passing through two points $\begin{cases} x_1, y_1 \rightarrow (0, -1) \\ x_2, y_2 \rightarrow (0.1, 1) \end{cases}$

$y = mx + c$

$M = mx$

$$y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$$

$$\Rightarrow \frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1} \Rightarrow \frac{y - (-1)}{1 - (-1)} = \frac{x - 0}{0.1 - 0} \Rightarrow \frac{y+1}{2} = \frac{x}{0.1}$$

$$\Rightarrow 2x = 0.1(y+1)$$

$$\Rightarrow 2x = 0.1y + 0.1$$

$$\Rightarrow 0.1y = 2x - 0.1$$

$$x(t) = \begin{cases} 20t - 1 & \leftarrow \text{for } 0 \leq t \leq 0.1 \\ -20t + 3 & \leftarrow \text{for } 0.1 \leq t \leq 0.2 \end{cases}$$

$$0.1x(t) = 2t - 0.1$$

$$\Rightarrow \boxed{x(t) = 20t - 1}$$

$$P = \frac{1}{T}\int_0^T |x(t)|^2\,dt = \frac{1}{0.2}\int_0^{0.1}(20t-1)^2\,dt + \frac{1}{0.2}\int_{0.1}^{0.2}(-20t+3)^2\,dt$$

$$\int_0^{0.1}(400t^2-40t+1)\,dt + \int_{0.1}^{0.2}(400t+9-120t)\,dt$$

$$\int x^n\,dx = \frac{x^{n+1}}{n+1}$$

$\Rightarrow P = 0.33$ or 1.33

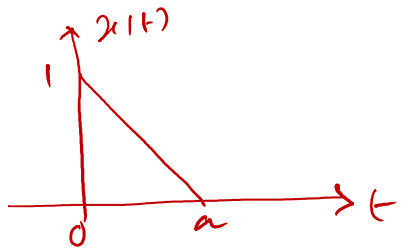
11.32 ✓
4.33 ✓

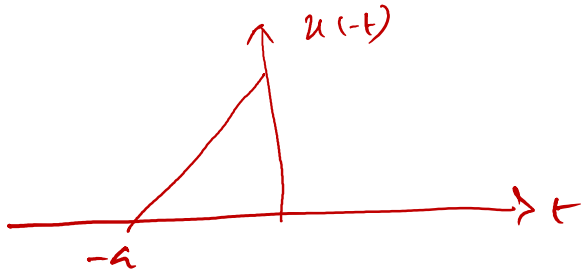
0.16

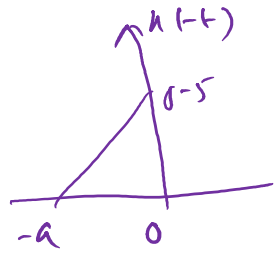
+ 0.60 ✓
16
1.76

0.76

Q.5 Search the even and odd part of the signal:-

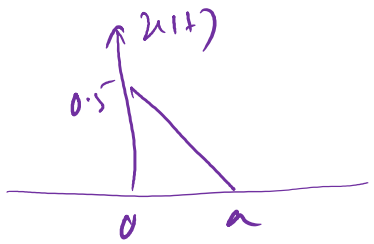


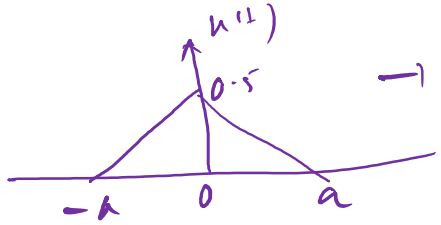




even part : $\frac{1}{2}\left[x(t) + x(-t)\right] = \frac{1}{2}x(t) + \frac{1}{2}x(-t)$

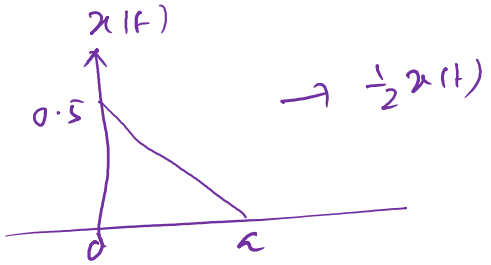
odd part = $\frac{1}{2}\left[x(t) - x(-t)\right] = \frac{1}{2}x(t) - \frac{1}{2}x(-t)$





→ even part-

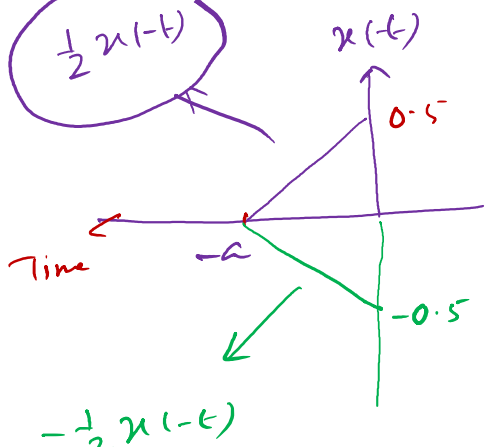
odd part of the signal:-



$\rightarrow \frac{1}{2}x(t)$

$\frac{1}{2}x(t) - \frac{1}{2}x(-t)$

$\frac{1}{2}x(-t)$



$0.5 \times -1 = -0.5$

$0 \times -1 = 0$

$\left[\frac{1}{2}x(t) - \frac{1}{2}(x(-t)\right]$