SIGNALS & SYSTEMS

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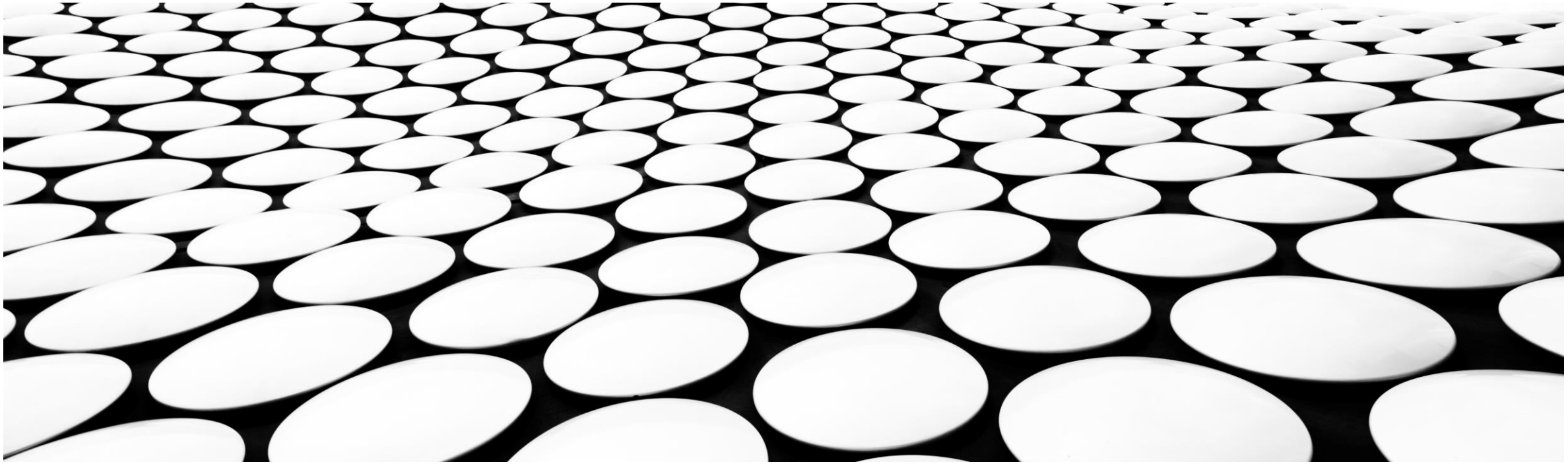


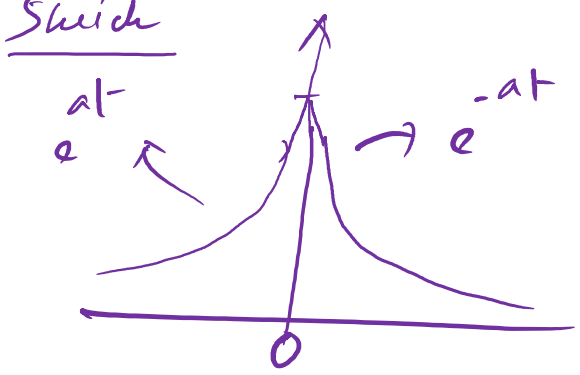
Sketch the given signal $x(t) = e^{-a|t|}$ for $a > 0$. Also determine whether the signal is a power signal or energy signal or neither.

The signal is given by $x(t) = e^{-a|t|}$, for $a > 0$

$$\therefore x(t) = \begin{cases} e^{-at}, & t \geq 0 \\ e^{-a(-t)}, & t < 0 \Rightarrow e^{at} \end{cases}$$

For $t = 0 \Rightarrow x(t) = 1$

Sketch



To determine the energy use the formula

$$E = \int_{-\infty}^{\infty} |x(t)|^2 dt = \int_{-\infty}^{0} (e^{at})^2 dt + \int_{0}^{\infty} (e^{-at})^2 dt$$

$$= \int_{-\infty}^{0} e^{2at}\,dt + \int_{0}^{\infty} e^{-2at}\,dt$$

$$= \int_{0}^{\infty} e^{-2at}\,dt + \int_{0}^{\infty} e^{-2at}\,dt$$

$$= 2\int_{0}^{\infty} e^{-2at}\,dt$$

$$= 2\cdot\left[\frac{e^{-2at}}{-2a}\right]_{0}^{\infty}$$

Change of limit

from $-\infty$ to $0 \rightarrow 0$ to ∞

since symmetrical.

$$= \cancel{2}x - \frac{1}{\cancel{2}a}\left[e^{-2at}\right]_0^\infty$$

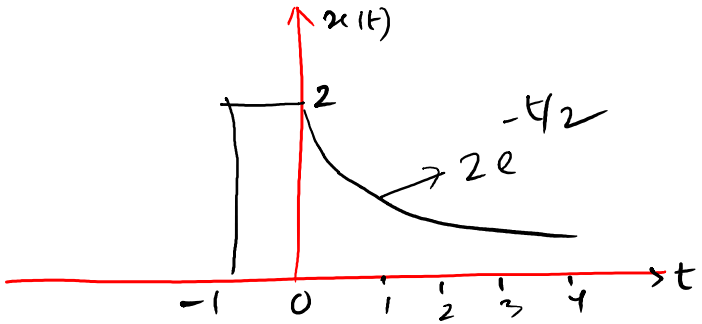
$$= -\frac{1}{a}\left[\frac{1}{e^{2at}}\right]_0^\infty$$

$$= -\frac{1}{a}\left[\frac{1}{\cancel{e^{2a\cdot\infty}}}^{0} - \frac{1}{e^{2a\cdot 0}}\right]$$

$$= -\frac{1}{a}[-1] = \boxed{\frac{1}{a}} \text{ Joule}$$

Note:- This is non-periodic signal so without solving we can say it is an energy signal.

Q. Determine the signal shown in fig below is either power or energy or <u>neither</u> i.e. neither power nor energy.



<u>Sol^{n}</u>:- Whenever fig is given we must get a function out of it.

From the figure —

$$x(t) = \begin{cases} 2, & -1 \le t \le 0 \\ 2e^{-t/2}, & t > 0 \end{cases}$$

For energy, $E = \int_{-\infty}^{\infty} |x(t)|^2 \, dt$

$$= \int_{-1}^{0} (2)^2 \, dt + \int_{0}^{\infty} \left(2e^{-t/2}\right)^2 dt$$

$$= \int_{-1}^{0} 4 \, dt + \int_{0}^{\infty} 4.e^{-t} \, dt$$

$$= 4[0+1] + 4\left[\frac{e^{-t}}{-1}\right]_0^{\infty}$$

$$= 4 + 4(-1)\cdot\left[\frac{1}{e^t}\right]_0^{\infty} = 4 - 4\left[\frac{1}{e^{\infty}} - \frac{1}{e^0}\right] = 4 - 4(-1)$$

$$= 8 \text{ Joule.}$$

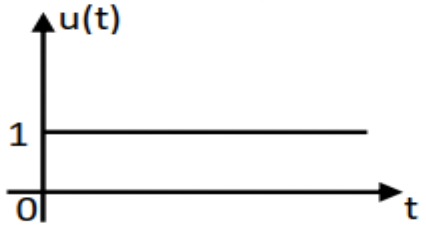
[Since $E = 8$ Joule
hence this is an energy signal]

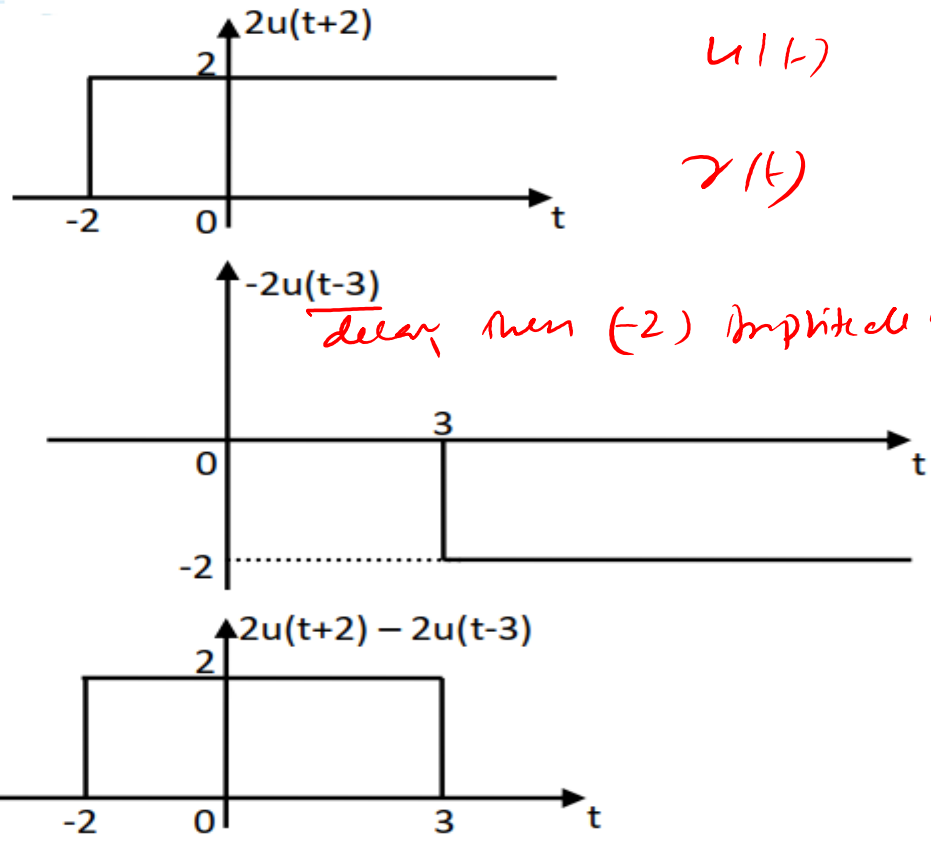
Sketch the following signals

(a) $x(t) = 2u(t+2) - 2u(t-3)$ (b) $x(t) = u(t+4)\,u(-t+4)$ (c) $x(t) = r(-t)\,u(t+2)$

(c) $x(t) = r(t) - r(t-1) - r(t-3) + r(t-4)$

- Consider the elementary signal u(t).
- The signal 2u(t+2) is obtained by shifting u(t) to the left by 2 units and multiplying by 2
- The signal -2u(t-3) is obtained by shifting u(t) to the right by 3 units and multiplying by -2
- The signal x(t) is obtained by adding 2u(t+2) and – 2u(t-3)
- The sketch of all the signals are shown in Fig. (a).





· Waveforms for Example (a)