ADITYA ENGINEERING COLLEGE

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Department of Electronics and Communication Engineering

B.Tech - III Semester (2021-22)

Assignment-1

Course Code : 201EC3T02

Name of the Course : Signals and Systems (AR20)

S.No.	Question	Knowledge Levels	Course Outcomes	Program Outcomes
1	x(t) is unit step signal draw even and odd parts of signal x(t).	K3	CO1	PO1
2	Find even and odd parts of signal x(t)=cost + sint + sintcost	K3	CO1	PO1
3	Examine whether the following signals are periodic or not? If periodic determine fundamental period. a) $x(t)=2\cos(3t+\pi/4)$ b) $x(t)=\cos(\pi/3)t+\sin(\pi/4)t$ c) $x(t)=\cos t+\sin\sqrt{2}t$ d) $x(t)=\left[\sin(t-\frac{\pi}{4})\right]^2$ e) $x(n)=\cos 2\pi n$ f) $x(n)=e^{\left(\frac{j\pi}{4}\right)n}$ g) $x(n)=\cos 4n$ h) $x(n)=\sin\frac{2\pi n}{3}+\cos\frac{2\pi n}{5}$	K4	CO1	PO1 PO2
4	Determine whether the following signals are Energy or Power signals and calculate their Power or Energy a) $X(t)=e^{-2t}u(t)$ b) $x(t)=u(t)$ c) $x(t)=tu(t)$ d) $X(t)=e^{-5t}$ e) $x(n)=(1/3)^n u(n)$ f) $x(n)=\sin\left(\frac{\pi}{3}\right)n$	K4	CO1	PO1 PO2
5	Find which of the following signals are casual or non casual. a) x(t)=cos7t b) x(t)=sin11tu(t) c) x(t)=u(t-2) d) x(t)=u(t+5)-u(t-2) e) x(n)=u(-n) f) x(t)=3sint	K3	CO1	PO1

Questions issue Date: 20.11.2021

Last date for Submission: 27.11.2021

Roll. No : 20A91A0449

Name of the Student : S. Chitti

Year/Sem/Sec : II / I / A

Submission Date : 25-11-2021

Marks Awarded: 05 / 05

Signature of the faculty: A Kard

PRINCIPAL
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SURAMPALEM

Signals and Systems

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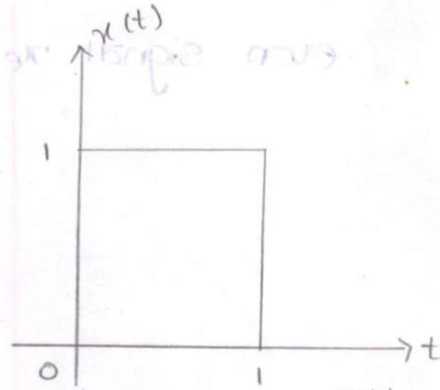
ECE-A

Assignment - 1

1. $x(t)$ is given signal draw even & odd parts of signal $x(t)$

A. even signal $x_e(t) = x(t) + x(-t)/_2$

odd signal $x_o(t) = x(t) - x(-t)/_2$

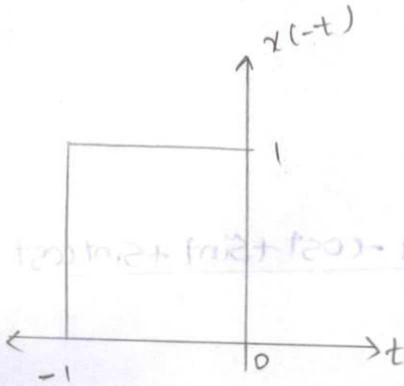


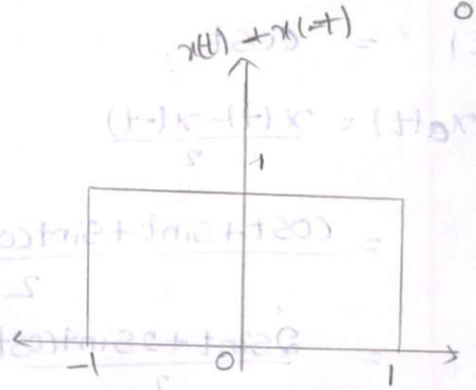
$x_e(t) = x(t) + x(-t)$

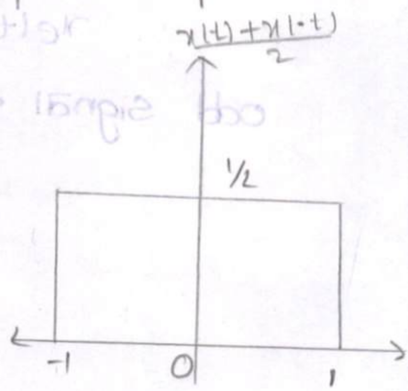
$-1 < t < 0 \Rightarrow 0 + 1 = 1$

$0 < t < 1 \Rightarrow 1 + 0 = 1$

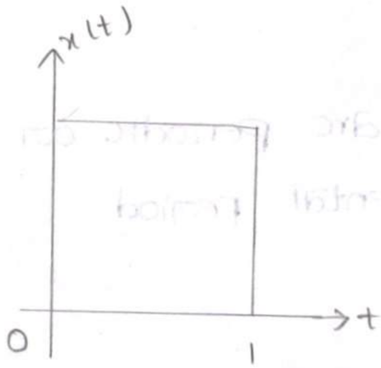
$x_e(t) = 1 + 1 = 2$

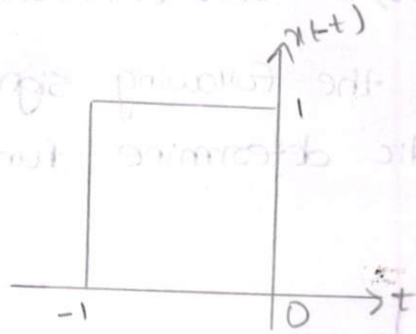






odd signal :

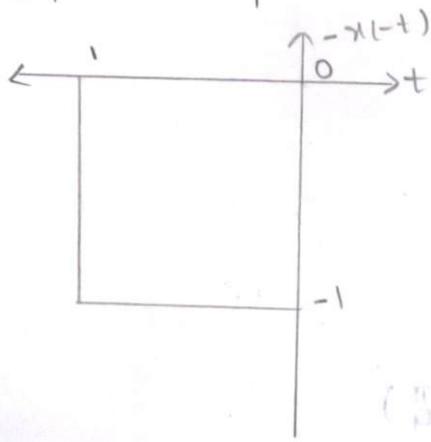


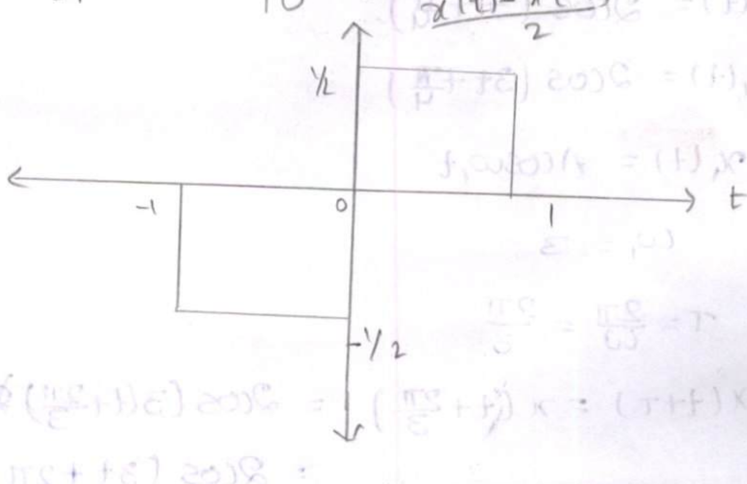


$x(t) - x(-t)$

$-1 < t < 0 \Rightarrow 0 - 1 = -1$

$0 < t < 1 \Rightarrow 1 - 0 = 1$





2. Find the even and odd parts of signal

$$x(t) = \cos t + \sin t + \sin t \cos t$$

A Given $x(t) = \cos t + \sin t + \sin t \cos t$

$x(-t) = \cos(-t) + \sin(-t) + \sin(-t) + \cos(-t)$

$x(-t) = \cos t - \sin t - \sin t \cos t$

even signal $x_e(t) = \dfrac{x(t) + x(-t)}{2}$

$= \dfrac{\cos t + \sin t + \sin t \cos t + \cos t - \sin t - \sin t \cos t}{2}$

$= \dfrac{2\cos t}{2}$

$x_e(t) = \cos t$

odd signal $x_o(t) = \dfrac{x(t) - x(-t)}{2}$

$= \dfrac{\cos t + \sin t + \sin t \cos t - \cos t + \sin t + \sin t \cos t}{2}$

$= \dfrac{2\sin t + 2\sin t \cos t}{2}$

$= \sin t + \sin t \cos t$

$x_o(t) = \sin t\,(1 + \cos t)$

3. Examine whether the following signals are periodic or not ? If periodic determine fundamental period

a) $x(t) = 2\cos\left(3t + \frac{\pi}{4}\right)$

A $x(t) = 2\cos\left(3t + \frac{\pi}{4}\right)$

$x_1(t) = 2\cos\left(3t + \frac{\pi}{4}\right)$

$x_1(t) = A\cos\omega_1 t$

$\omega_1 = 3$

$T = \frac{2\pi}{\omega} = \frac{2\pi}{3}$

$x(t+T) = x\left(t + \frac{2\pi}{3}\right) = 2\cos\left(3\left(t + \frac{2\pi}{3}\right) + \frac{\pi}{4}\right)$

$= 2\cos\left(3t + 2\pi + \frac{\pi}{4}\right)$

$= 2\cos\left(3t + \frac{\pi}{4}\right)$

$x(t) = x(t+T)$ is periodic

b) $x(t) = \cos\frac{\pi}{3}t + \sin\frac{\pi}{4}t$

$x(t) = x_1(t) + x_2(t)$

$x_1(t) = \cos\frac{\pi}{3}t$

$x_1(t) = A\cos\omega_1 t$

$\omega_1 = \pi/3$

$T_1 = \frac{2\pi}{\pi/3} = 6 \text{ sec}$

$x_2(t) = A\sin\omega_2 t$

$\omega_2 = \pi/4$

$T_2 = \frac{2\pi}{\pi/4} = 8 \text{ sec}$

ratio: $\frac{T_1}{T_2} = \frac{6}{8} = 3/4$

ratio of two integers is periodic

$T = \frac{T_1}{T_2} = 3/4$

$T = 4T_1 = 3T_2$

$T = 4T_1 = 4\times 6 = 24 \text{ sec}$

$T = 3T_2 = 3\times 8 = 24 \text{ sec}$

c) $x(t) = \cos t + \sin\sqrt{2}t$

$x(t) = x_1(t) + x_2(t)$

$x_1(t) = A\cos\omega_1 t$

$x_1(t) = \cos t$

$\omega_1 = 1, \ T_1 = \frac{2\pi}{\omega}$

$T_1 = 2\pi$

$x_2(t) = A\sin\omega_2 t$

$\omega_2 = \sqrt{2}, \ T_2 = \frac{2\pi}{\sqrt{2}} = \sqrt{2}\pi$

ratio: $\frac{T_1}{T_2} = \frac{2\pi}{\sqrt{2}\pi} = \sqrt{2}$

ratio is non-integer. so it is aperiodic

d) $x(t) = [\sin(t-\frac{\pi}{4})]^2$

A $x(t) = [\sin(t-\frac{\pi}{4})]^2$

$\sin^2(t-\frac{\pi}{4}) = \frac{1-\cos(t-\pi/4)}{2}$

$x(t) = \frac{1}{2} - \frac{1}{2}\cos(t-\pi/4)$

$x_1(t) = 1/2$ is periodic

$x_2(t) = \frac{1}{2}\cos(t-\pi/4)$

$\omega_1 = 1$

$T = \frac{2\pi}{\omega} = \frac{2\pi}{1} = 2\pi$

$x(t+2\pi) = \frac{1}{2}\cos(t+2\pi-\pi/4)$

$= 1/2 \cos(t-\pi/4)$

$x(t) = x(t+T)$

It is periodic signal

e) $x(n) = \cos 2\pi n$

$x(n) = \cos 2\pi n$

$x(n) = A\cos\omega n$

$\omega = 2\pi$

$T = \frac{2\pi}{2\pi} = 1$

$x(n+T) = \cos(2\pi\{n+1\})$

$= \cos(2\pi n + 2\pi)$

$= \cos 2\pi n$

$x(n) = x(n+T)$

It is periodic

f) $e^{(j\pi/4)n}$

A $x(n) = e^{(j\pi/4)n}$

$x(n+T) = e^{j\pi/4(n+T)}$

$T = \frac{2\pi}{\pi/4} = 8$

$x(n+8) = e^{j\pi/4(n+8)}$

$= e^{j(\pi/4 n + 2\pi)}$

$= e^{j\pi/4 n} \cdot e^{j2\pi}$

$= e^{j\pi/4 n}(\cos 2\pi + j\sin 2\pi)$

$x(n+8) = e^{(j\pi)n} \cdot 1$

$x(n) = x(n+T)$

It is periodic signal

g. $x(n) = \cos 4n$

$x(n) = \cos 4n$

$\omega = 4$,

$T = \frac{2\pi}{4} = \pi/2$

$x(n+\pi/2) = \cos 4(n+\pi/2)$

$= \cos(4n+2\pi)$

$x(n+\pi/2) = \cos 4n$

$x(n) = x(n+T)$

It is periodic signal

h. $\sin \frac{2\pi n}{3} + \cos \frac{2\pi}{5} n$

$x(n) = \sin \frac{2\pi n}{3} + \cos \frac{2\pi}{5} n$

$x(n) = x_1(n) + x_2(n)$

$x_1(n) = \sin \frac{2\pi}{3} n$

$\omega_1 = 2\pi/3$, $T_1 = \frac{2\pi}{2\pi/3} = 3$

$x_2(n) = \cos \frac{2\pi}{5} n$

$\omega_2 = 2\pi/5$

$T_2 = \frac{2\pi}{2\pi/5} = 5$

ratio , $\frac{T_1}{T_2} = 3/5$

The ratio is integer then it is periodic

$T = \frac{T_1}{T_2} = 3/5$

$T = 5T_1 = 3T_2$

$T = 5 \times T_1 = 5 \times 3 = 15$ sec

$T = 3 \times T_2 = 3 \times 5 = 15$ sec

4. Determine whether the following signals are energy or power signals and calculate their power or energy

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

$$E = \lim_{T \to \infty} \int_{-T}^{T} x(t)^2 \, dt$$

$$= \lim_{T \to \infty} \int_{-T}^{T} (e^{-2t}u(t))^2 \, dt$$

$$= \lim_{T \to \infty} \int_{0}^{T} (e^{-2t})^2 \, dt$$

$$= \lim_{T \to \infty} \int_{0}^{T} e^{-4t} \, dt$$

$$= \lim_{T \to \infty} \left[\frac{e^{-4t}}{-4}\right]_0^T$$

$$= \lim_{T \to \infty} \left[\frac{e^{-4T} - e^0}{-4}\right]$$

$$E = \frac{e^{-\infty} - 1}{-4}$$

$$E = 1/4$$

power. $(P) = \lim_{T \to \infty} \frac{1}{2T} \int_{-T}^{T} (e^{-2t}u(t))^2 \, dt$

$$= \lim_{T \to \infty} \frac{1}{2T} \int_{0}^{T} (e^{-2t})^2 \, dt$$

$$= \lim_{T \to \infty} \frac{1}{2T} \int_{0}^{T} e^{-4t} \, dt$$

$$= \lim_{T \to \infty} \frac{1}{2T} \left(\frac{e^{-4t}}{-4}\right)_0^T$$

$$= \lim_{T\to\infty} \frac{1}{2T} \left(\frac{e^{-4T}-1}{-4}\right)$$

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

$$\boxed{P=0}$$

energy is finite and power is zero
Hence signal is energy signal

b) $x(t) = u(t)$

$$E = \lim_{T\to\infty} \int_{-T}^{T} (x(t))^2 \, dt$$

$$= \lim_{T\to\infty} \int_{-T}^{T} (u(t))^2 \, dt$$

$$= \lim_{T\to\infty} \int_{0}^{T} (1) \, dt$$

$$= \lim_{T\to\infty} (t)_0^T$$

$$= \lim_{T\to\infty} (T-0)$$

$$E = \infty$$

$$P = \lim_{T\to\infty} \frac{1}{2T} \int_{-0}^{T} (u(t))^2 dt$$

$$= \lim_{T\to\infty} \frac{1}{2T} \int_{0}^{T} (1) \, dt$$

$$= \lim_{T\to\infty} \frac{1}{2T} (t)_0^T$$

$$= \lim_{T\to\infty} T/2T$$

$$P = 1/2$$

energy is infinite and power is finite
∴ Hence given signal is power signal

c) $x(t) = t\,u(t)$

A $E = \lim_{T\to\infty} \int_{-T}^{T} (x(t))^2\, dt$

$= \lim_{T\to\infty} \int_{-T}^{T} (t\,u(t))^2\, dt$

$= \lim_{T\to\infty} \int_{0}^{T} t^2\, dt$

$= \lim_{T\to\infty} (t^3/3)_0^T$

$= \lim_{T\to\infty} 1/3\,(T^3 - 0)$

$= \frac{\infty^3}{3}$

$E = \infty$

power $= \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} (x(t))^2\, dt$

$= \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} (t\,u(t))^2\, dt$

$= \lim_{T\to\infty} \frac{1}{2T} \int_{0}^{T} t^2\, dt$

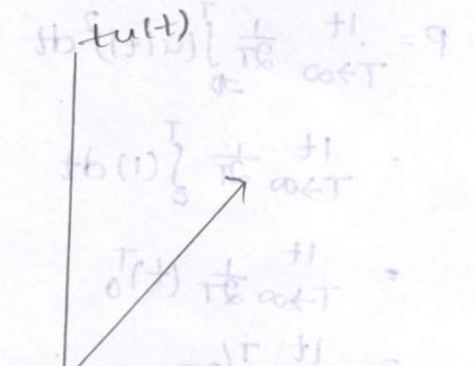
$= \lim_{T\to\infty} \frac{1}{2T} \left(\frac{T^3 - 0}{3}\right)$

$= \lim_{T\to\infty} \frac{T^3}{6T}$

$= \lim_{T\to\infty} \frac{T^2}{6}$

$= \infty^2/6$

$P = \infty$



The signal is neither energy nor signal.

d. $x(t) = e^{-5t}$

$$E = \lim_{T\to\infty} \int_{-T}^{T} (x(t))^2 \, dt$$

$$= \lim_{T\to\infty} \int_{-T}^{T} (e^{-5t})^2 \, dt$$

$$= \lim_{T\to\infty} \int_{-T}^{T} e^{-10t} \, dt$$

$$= \lim_{T\to\infty} \left[\frac{e^{-10t}}{-10}\right]_{-T}^{T}$$

$$= \lim_{T\to\infty} \frac{1}{-10} (e^{-10T} - e^{10T})$$

$$= \frac{e^{-10\infty} - e^{10\infty}}{-10}$$

$$E = \infty$$

$$\text{power} = \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} x(t)^2 \, dt$$

$$= \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} (e^{-5t})^2 dt$$

$$= \lim_{T\to\infty} \frac{1}{2T} \left[\frac{e^{-10t}}{-10}\right]_{-T}^{T}$$

$$= \lim_{T\to\infty} \frac{1}{2T} \left[\frac{e^{-10T} - e^{10T}}{-10}\right]$$

$$P = 0$$

The energy is infinite and power is zero

Hence it is neither power nor energy signal

e. $x(n) = (\frac{1}{3})^n u(n)$

A $$E = \sum_{n=-\infty}^{\infty} (x(n))^2 = \sum_{n=0}^{\infty} |(\tfrac{1}{3})^n u(n)|^2$$

$$u(n) = \begin{cases} 1 & \text{for } n \geq 0 \\ 0 & \text{for } n < 1 \end{cases}$$

$$E = \sum_{n=-\infty}^{-1} 0 + \sum_{n=0}^{\infty} |(\tfrac{1}{3})^n|^2$$

$$E = \sum_{n=0}^{\infty} (\tfrac{1}{9})^{n} = (\tfrac{1}{9})^0 + (\tfrac{1}{9})^1 + (\tfrac{1}{9})^2 + \cdots (\tfrac{1}{9})^n$$

$$= \frac{1}{1-1/9} = \frac{1}{8/9} = 9/8$$

$$E = 9/8$$

$$P = \lim_{N\to\infty} \frac{1}{2N+1}\left[\sum_{n=-N}^{N} |x(n)|^2\right]$$

$$= \lim_{N\to\infty} \frac{1}{2N+1}\left(\sum_{n=-N}^{N} |(\tfrac{1}{3})^n u(n)|^2\right]$$

$$= \lim_{N\to\infty} \frac{1}{2N+1}\left[\sum_{n=0}^{N} |(\tfrac{1}{3})^n|^2\right]$$

$$= \lim_{N\to\infty} \frac{1}{2N+1}\left[\sum_{n=0}^{N} (\tfrac{1}{9})^n\right]$$

$$= \lim_{N\to\infty} \frac{1}{2N+1}\left[(\tfrac{1}{9})^0 + (\tfrac{1}{9})^1 + (\tfrac{1}{9})^2 + \cdots (\tfrac{1}{9})^n\right]$$

$$= \lim_{N\to\infty} \frac{1}{2N+1}\left[\frac{1-(1/9)^{N+1}}{1-1/9}\right] \Rightarrow \lim_{N\to\infty} \frac{1}{2N+1}\left[\frac{1-(1/9)^{N+1}}{8/9}\right]$$

$$= \frac{9}{8} \lim_{N\to\infty} \frac{1}{2N+1}\left[1 - \frac{1}{4^{N+1}}\right]$$

$$P = 9/8(0)$$

$$P = 0$$

energy is finite and power is zero

Hence it is energy signal

f $x(n) = \sin(\pi/3\, n)$

$x(n) = \sin(\pi/3\, n)$

$$E = \sum_{n=-\infty}^{\infty} |x(n)|^2$$

$$= \sum_{n=-\infty}^{\infty} |\sin(\pi/3\, n)|^2$$

$$E = \sum_{n=-\infty}^{\infty} \sin^2 (\pi/3\, n)$$

$$= \sum_{n=-\infty}^{\infty} \frac{1-\cos 2\pi/3\, n}{2}$$

$$= \frac{1}{2}\left[\sum_{n=-\infty}^{\infty} 1 - \cos 2\pi/3\, n\right]$$

$$= \frac{1}{2}\left[\sum_{n=\infty}^{\infty} 1 - \sum_{n=\infty}^{\infty} \cos 2\pi/3\, n\right]$$

$$= \frac{1}{2}\left[\infty - (1 - 1/2 - 1/2 + \cdots)\right]$$

$$= \cancel{\tfrac{1}{2}}\infty$$

$$E = \infty$$

power $(P) = \lim_{N\to\infty} \frac{1}{2N+1} \sum_{n=-N}^{N} |x(n)|^2$

$$= \lim_{N\to\infty} \frac{1}{2N+1} \sum_{n=-N}^{N} |\sin^2 \pi/3\, n|^2$$

$$= \lim_{N\to\infty} \frac{1}{2N+1} \sum_{n=-N}^{N} \frac{1-\cos 2\pi/3\, n}{2}$$

$$= \lim_{N\to\infty} \frac{1}{2N+1} \cdot \frac{1}{2} \cdot \left[\sum_{n=-N}^{N} 1 - \sum_{n=-N}^{N} \cos \frac{2\pi}{3} n\right]$$

$$= \lim_{N\to\infty} \frac{1}{2N+1} \frac{1}{2}\left[\sum_{n=-N}^{N} 1 - 0\right]$$

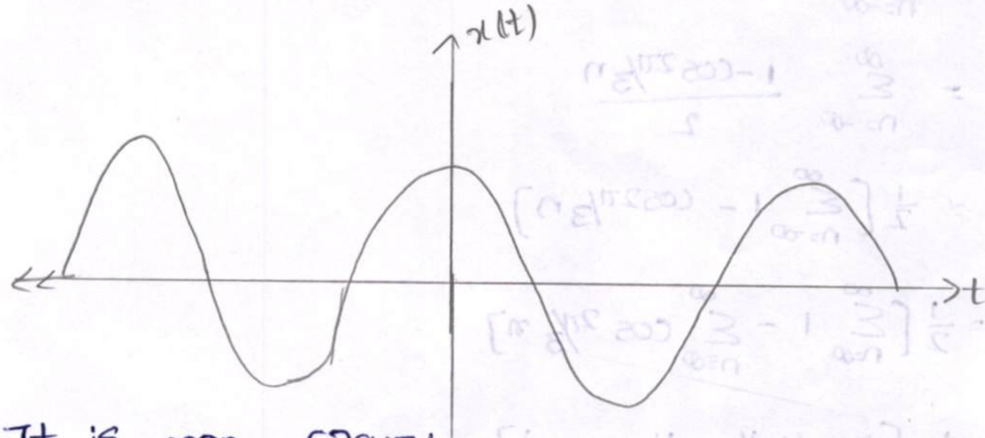
$$= \lim_{N\to\infty} \frac{1}{2N+1} \frac{1}{2} (2N+1)$$

$$P = 1/2$$

energy is infinite and power is finite
Hence the signal is power signal

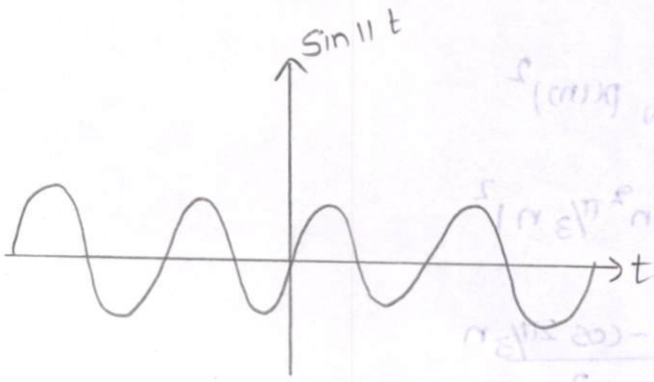
5 Find which of the following signals are casual or non-casual

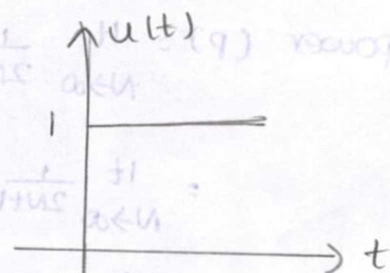
a) $x(t) = \cos 7t$

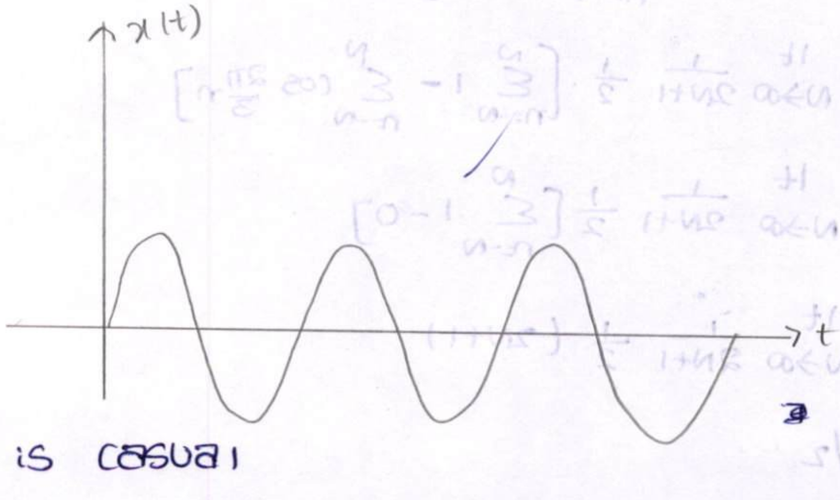


It is non - casual

b) $x(t) = \cancel{\sin t}\ \sin 11t\ u(t)$

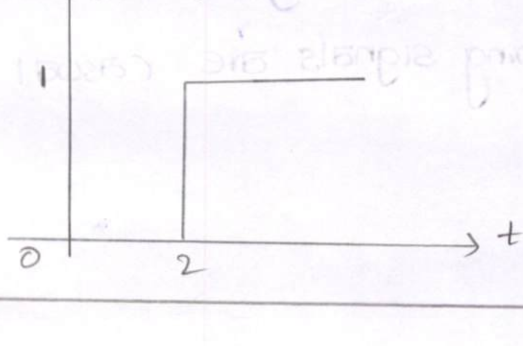






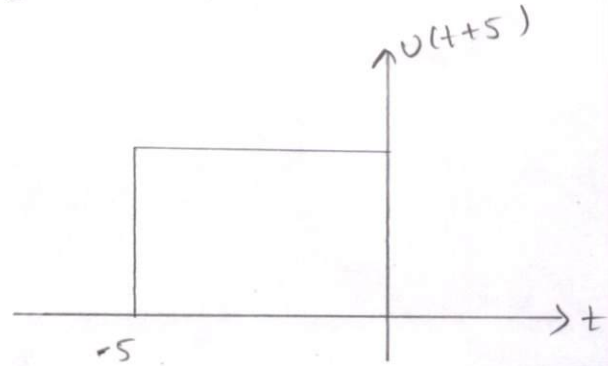
It is casual

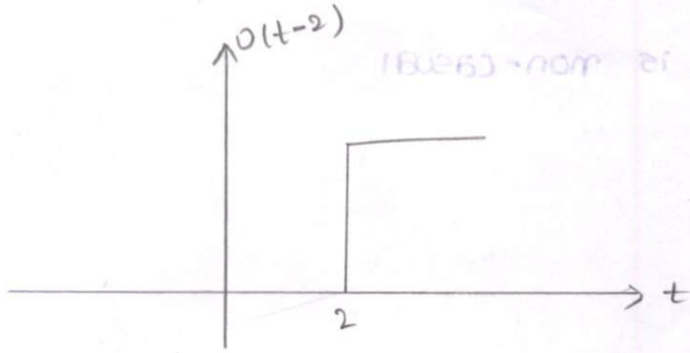
c) $x(t) = u(t-2)$

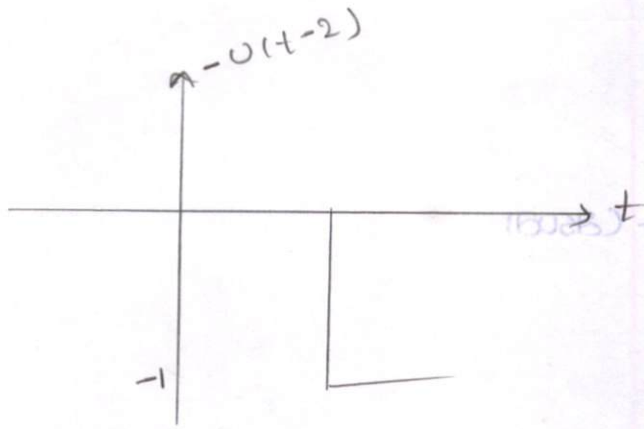


It is casual

d. $x(t) = u(t+5) - u(t-2)$

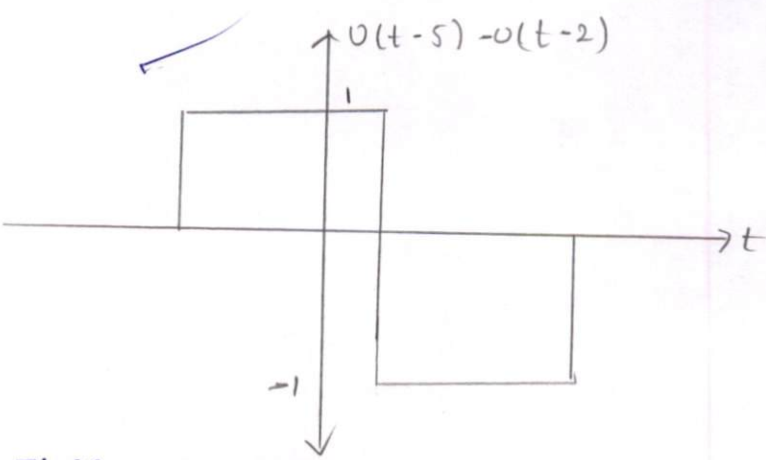






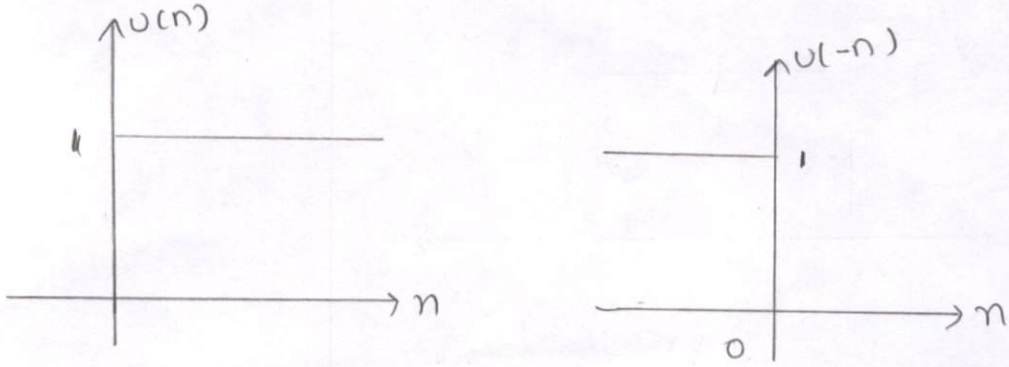
$-5 < t < 2 = 1+0 = 1$

$2 < t < \infty = 0-1 = -1$



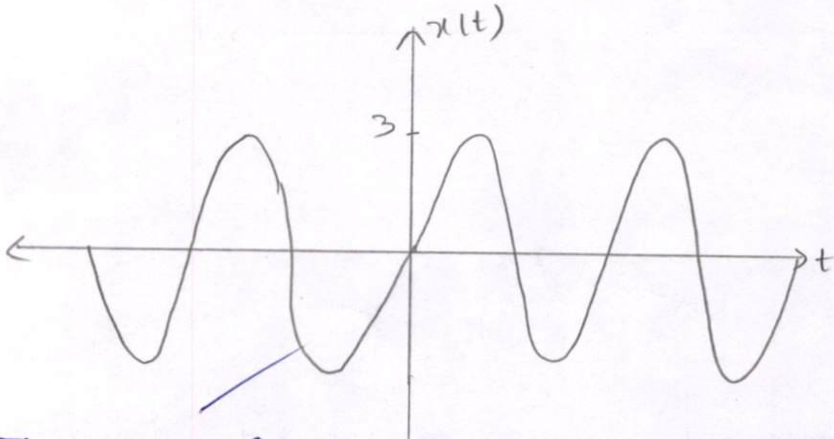
It is non-casoal

e) $x(n) = u(-n)$



It is non-casual

F) $x(t) = 3\sin t$



It is non-casual