

Classification of CT and DT signals :-



It can be classified into four types

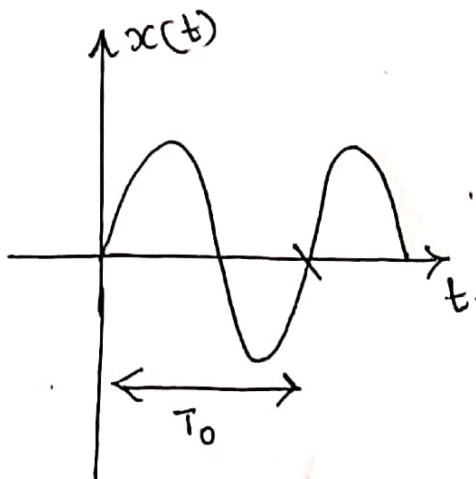


- (i) Periodic and Non periodic [Aperiodic] signals
- (ii) Even and odd signals
- (iii) Energy and power signals
- (iv) Deterministic and Random signals.

Periodic Signals :-

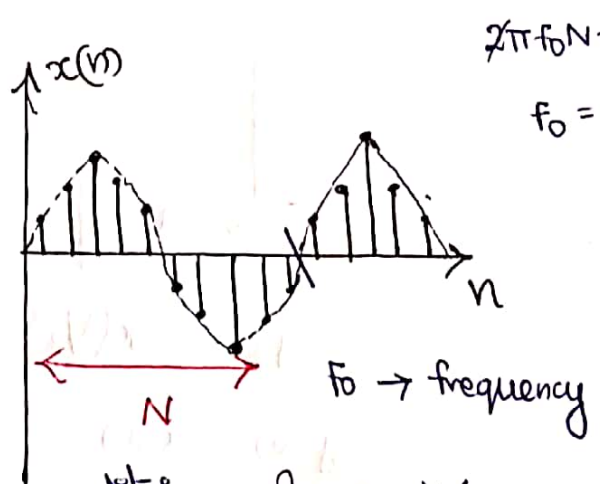
A signal is said to be periodic if it repeats at regular intervals.

CT periodic signal



Condition for periodicity $\left\{ \begin{array}{l} x(t) = x(t+T_0) \\ x(t) = x(t+2T_0) \end{array} \right.$

DT periodic signal

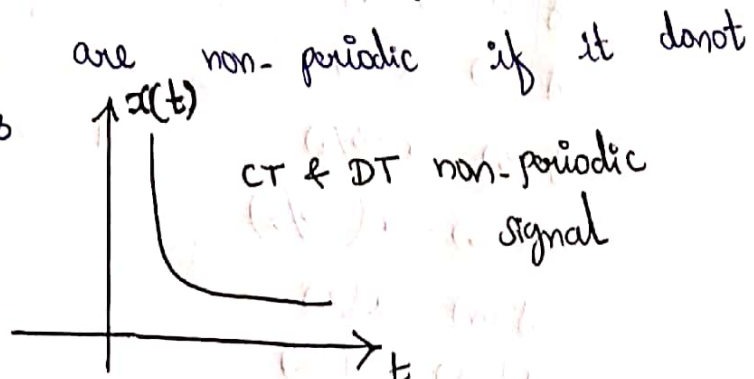


Condition for periodicity $\left\{ \begin{array}{l} f_0 = k/N \end{array} \right.$

$k \rightarrow$ Integer $N \rightarrow$ Time period

Aperiodic Signal :-

The signals are non-periodic if it does not repeat at regular intervals



Condition for periodicity of signal :-

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

$$x_1(t) = x_1(t+T_1) + x_1(t+2T_1)$$

$$x_1(t) = x_1(t+mT_1) \rightarrow (1)$$

$$x_2(t) = x_2(t+T_2) + x_2(t+2T_2)$$

$$x_2(t) = x_2(t+nT_2) \rightarrow (2)$$

m & n are integers. then $x(t) = x_1(t) + x_2(t)$
 $= mT_1 + nT_2 = T_0$

$$\therefore \frac{T_1}{T_2} = \frac{n}{m}$$

ie., ratio of two integers.

Fundamental period of $x(t) = \text{LCM of } T_1 \text{ \& } T_2$

Discrete :-

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

$$\therefore \frac{N_1}{N_2} = \frac{n}{m}$$

ie., ratio of two integers.

Fundamental period of $x(n) = \text{LCM of } N_1 \text{ \& } N_2$

Problems :- check for periodicity & also find the fundamental period :-

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

$$2\pi \text{ fo } \pi = \pi n$$

$$T_0 = \frac{1}{2} = \frac{k}{N}$$

$$\boxed{N=2}$$

periodic signal ie., ratio of two integers

Fundamental period $N=2$

$$(ii) x(n) = \cos \frac{2\pi n}{5} + \cos \frac{2\pi n}{7}$$



$$2\pi f_1 n = \frac{2\pi n}{5}$$

$$2\pi f_2 n = \frac{2\pi n}{7}$$

$$f_1 = \frac{1}{5} = \frac{k}{N_1}$$

$$f_2 = \frac{1}{7} = \frac{k}{N_2}$$

$$\frac{N_1}{N_2} = \frac{5}{7}$$

$$N_1 = 5$$

$$N_2 = 7$$

The given signal is periodic i.e., ratio of two integers.
 Fundamental period : LCM of N_1 & N_2
 LCM of 5 & 7 is 35

$$(3) x(n) = \cos\left(\frac{n}{8}\right) \cdot \cos\left(\frac{n\pi}{8}\right)$$

$$2\pi f_1 n = \frac{n}{8}$$

$$2\pi f_2 n = \frac{n\pi}{8}$$

$$f_1 = \frac{1}{16\pi}$$

$$f_2 = \frac{1}{16}$$

Non periodic signal

Periodic signal

$x(n)$ is non periodic, it is the product of both periodic and non-periodic signal.

$$4) x(n) = \cos 3\pi n \quad (\text{Periodic signal})$$

$$5) x(n) = \sin 3n \quad (\text{Non periodic signal})$$

$$6) x(n) = 5 \cos 0.2\pi n \quad (\text{periodic signal})$$

$$7) x(n) = e^{j2\pi n/3} + e^{j3\pi n/4}$$

$$2\pi f_1 n = \frac{2\pi n}{3}$$

$$2\pi f_2 n = \frac{3\pi n}{4}$$

$$f_1 = \frac{1}{3} = \frac{k}{N_1}$$

$$f_2 = \frac{3}{8} = \frac{k}{N_2}$$

$$\frac{N_1}{N_2} = \frac{3}{8}$$

Periodic signal i.e., ratio of two integers
 fundamental period = 24

8) Find the fundamental period :-



$$x(n) = \cos\left(\frac{n\pi}{2}\right) - \sin\left(\frac{n\pi}{8}\right) + 3\cos\left(\frac{n\pi}{4}\right)$$

$$2\pi f_1 n = \frac{n\pi}{2}$$

$$2\pi f_2 n = \frac{n\pi}{8}$$

$$2\pi f_3 n = \frac{n\pi}{4}$$

$$f_1 = \frac{1}{4} = \frac{k}{N_1}$$

$$f_2 = \frac{1}{16} = \frac{k}{N_2}$$

$$f_3 = \frac{1}{8} = \frac{k}{N_3}$$

$$N_1 = 4$$

$$N_2 = 16$$

$$N_3 = 8$$

$$\therefore \frac{N_1}{N_2} = \frac{4}{16} = \frac{1}{4}$$

$$\frac{N_2}{N_3} = \frac{16}{8} = 2$$

periodic signal i.e., ratio of two integers

fundamental period : LCM of N_1, N_2 & N_3 is 16.

9) $x(t) = 2\cos 100\pi t + 5\sin 50t$

$$2\pi f_1 t = 100\pi t$$

$$2\pi f_2 t = 50t$$

$$f_1 = 50$$

$$f_2 = \frac{25}{\pi}$$

$$T_1 = \frac{1}{f_1} = \frac{1}{50}$$

$$T_2 = \frac{1}{f_2} = \frac{\pi}{25}$$

$$\frac{T_1}{T_2} = \frac{1}{50} \times \frac{25}{\pi} = \frac{25}{50\pi} = \frac{1}{2\pi}$$

Non-Periodic i.e., not a ratio of two integers.

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

$$2\pi f_1 t = t$$

$$2\pi f_2 t = \frac{t}{3}$$

$$\frac{T_1}{T_2} = \frac{2\pi}{6\pi}$$

$$f_1 = \frac{1}{2\pi}$$

$$f_2 = \frac{1}{6\pi}$$

$$= \frac{1}{3}$$

$$T_1 = \frac{1}{f_1} = 2\pi$$

$$T_2 = \frac{1}{f_2} = 6\pi$$

Periodic signal

i.e., ratio of two integers.

11) $x(t) = \cos 2t + \sin 3t \Rightarrow \frac{T_1}{T_2} = \frac{3}{2} \rightarrow$ periodic signal