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

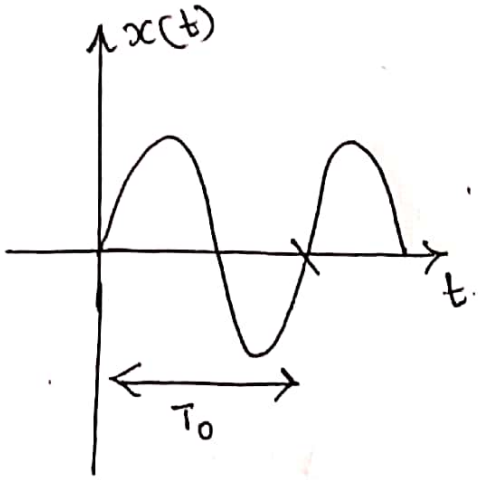
(iii) Energy and power signals

(iv) Deterministic and Random signals.

Periodic Signals :-

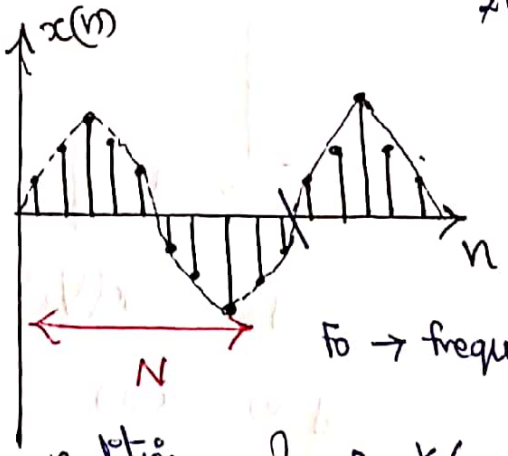
A signal is said to be periodic if it repeats at regular intervals.

CT periodic signal



condition for periodicity $\} x(t) = x(t+T_0) = x(t+2T_0)$

DT periodic signal



$2\pi f_0 N = 2\pi k$

$f_0 = k/N$

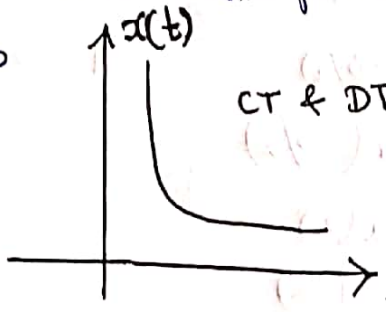
$f_0 \rightarrow$ frequency

condition for periodicity $\} f_0 = k/N$

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

Aperiodic Signal :-

The signals are non-periodic if it donot repeats at regular intervals



CT & DT non-periodic signal

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 $x(t)$ = LCM of T_1 & 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 $x(n)$ = LCM of N_1 & N_2

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

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

$$2\pi f_0 n = \pi n$$

$$f_0 = \frac{1}{2} = \frac{k}{N}$$

$N = 2$ periodic signal ie., ratio of two integers

Fundamental period $N = 2$.

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

$2\pi f_1 n = \frac{2\pi n}{5}$ $\qquad$ $2\pi f_2 n = \frac{2\pi n}{7}$

$f_1 = \frac{1}{5} = \frac{k}{N_1}$ $\qquad$ $f_2 = \frac{1}{7} = \frac{k}{N_2}$

$N_1 = 5$ $\qquad$ $N_2 = 7$

$\frac{N_1}{N_2} = \frac{5}{7}$ The given signal is periodic ie., ratio of two integers.

Fundamental period : LCH of N_1 & N_2

LCH of 5 & 7 is 35

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

$2\pi f_1 n = \frac{n}{8}$ $\qquad$ $2\pi f_2 n = \frac{n\pi}{8}$

$f_1 = \frac{1}{16\pi}$ $\qquad$ $f_2 = \frac{1}{16}$

Non periodic signal $\qquad$ periodic signal

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

4) $x(n) = \cos 3\pi n$ (Periodic signal)

5) $x(n) = \sin 3n$ (Non periodic signal)

6) $x(n) = 5\cos 0.2\pi n$ (periodic signal)

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

$2\pi f_1 n = 2\pi n/3$ $\qquad$ $2\pi f_2 n = 3\pi n/4$

$f_1 = 1/3 = k/N_1$ $\qquad$ $f_2 = 3/8 = k/N_2$ $\qquad$ $\frac{N_1}{N_2} = \frac{3}{8}$

Periodic signal ie., ratio of two integers

Fundamental Period = 24

8) Find the fundamental period :-

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

$2\pi f_1 n = n\pi/2$ $\quad 2\pi f_2 n = n\pi/8$ $\quad 2\pi f_3 n = n\pi/4$

$f_1 = 1/4 = k/N_1$ $\quad f_2 = 1/16 = k/N_2$ $\quad f_3 = 1/8 = k/N_3$

$N_1 = 4$ $\quad N_2 = 16$ $\quad N_3 = 8$

$\therefore \frac{N_1}{N_2} = \frac{4}{16} = 1/4$ $\quad \frac{N_2}{N_3} = 16/8 = 2$

Periodic signal ie., ratio of two integers

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

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

$2\pi f_1 t = 100\pi t$ $\quad 2\pi f_2 t = 50t$

$f_1 = 50$ $\quad f_2 = 25/\pi$

$T_1 = 1/f_1 = 1/50$ $\quad T_2 = 1/f_2 = \pi/25$

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

Non-Periodic ie, not a ratio of two integers.

10) $x(t) = 2\cos t + 3\cos(t/3)$

$2\pi f_1 t = t$ $\quad 2\pi f_2 t = t/3$ $\quad \frac{T_1}{T_2} = \frac{2\pi}{6\pi}$

$f_1 = 1/2\pi$ $\quad f_2 = \frac{1}{6\pi}$ $\quad = 1/3$

$T_1 = \frac{1}{f_1} = 2\pi$ $\quad T_2 = \frac{1}{f_2} = 6\pi$ Periodic signal

ie., ratio of two integers.

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