

PERIODIC AND NON-PERIODIC SIGNALS

Continuous-Time and Discrete-Time Signals

1. Periodic Signal

Definition: A signal which repeats itself after a fixed time period is called a periodic signal.

Condition of periodicity: A continuous-time signal $x(t)$ is periodic if it satisfies the following condition for a positive time period T :

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

Where: T = time period of $x(t)$.

Important: The smallest positive value of T satisfying the periodicity condition is called the fundamental time period of the signal.

2. Examples of Periodic Signals

Some common examples of periodic signals are:

- Sine wave
- Square wave
- Cosine wave
- Triangular wave
- Sawtooth wave

3. Classification of Periodic Signals

Periodic signals can be classified into two types:

Continuous-Time Periodic Signal	Discrete-Time Periodic Signal
Defined for every value of time t .	Defined at discrete instants n .

4. Discrete-Time Periodic Signal

Condition of periodicity: A discrete-time signal $x(n)$ is periodic if there exists a positive integer N such that:

$$x(n) = x(n + N)$$

Where: N = period of the discrete-time (DT) signal.

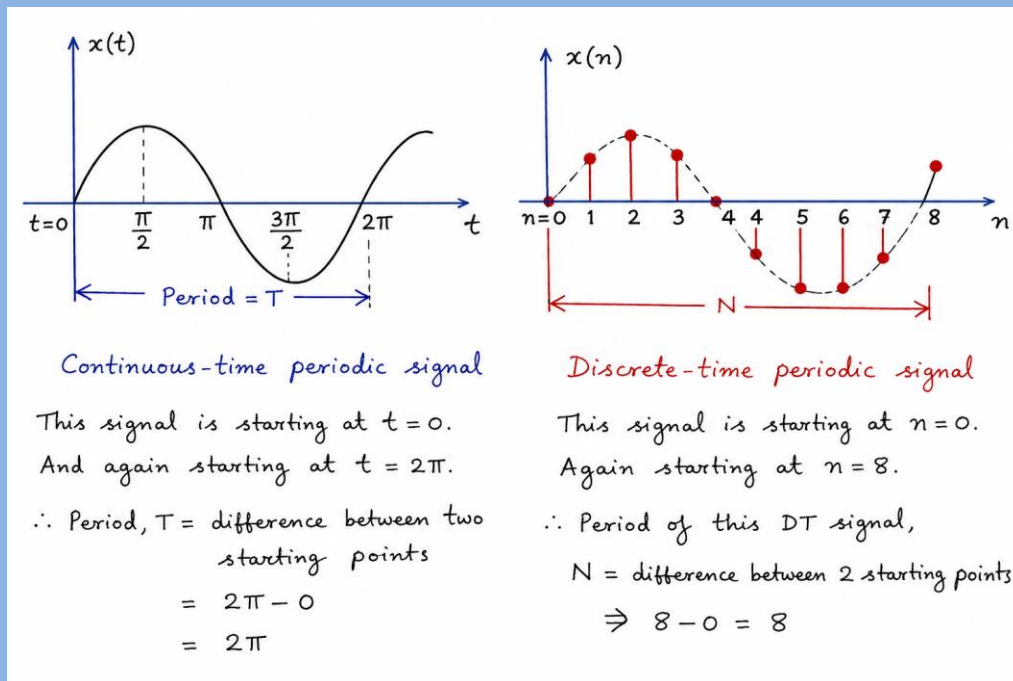


Illustration: Continuous-time and discrete-time periodic signals

5. Periodic Signal – Example and Explanation

Continuous-time example: The signal starts at $t = 0$ and repeats again at $t = 2\pi$. Therefore, the time period is the difference between the two equivalent starting points.

$$T = 2\pi - 0 = 2\pi$$

Discrete-time example: The sequence starts at $n = 0$ and repeats again at $n = 8$. Therefore, the period is the difference between the two equivalent starting points.

$$N = 8 - 0 = 8$$

6. Non-Periodic Signal

Definition: A non-periodic signal is also known as an aperiodic signal. A non-periodic signal does not satisfy the periodicity condition.

$$x(t) \neq x(t + T)$$

Thus, for a non-periodic signal, there is no positive time period T for which the signal repeats itself exactly.

7. Classification of Non-Periodic Signals

Non-periodic signals can be classified into two types:

Continuous-Time Non-Periodic Signal	Discrete-Time Non-Periodic Signal
A non-repeating continuous-time signal.	A non-repeating discrete-time signal.

8. Discrete-Time Non-Periodic Signal

Condition: A discrete-time signal is non-periodic when it does not satisfy:

$$x(n) \neq x(n + N)$$

Here: $x(n)$ = DT signal; n = integer/discrete-time variable; N = period of the DT signal.

9. Examples of Non-Periodic Signals

The following exponential signals illustrate non-periodic behavior:

$$\text{Continuous-time: } x(t) = e^{-t}$$

$$\text{Discrete-time: } x(n) = a^{-n}$$

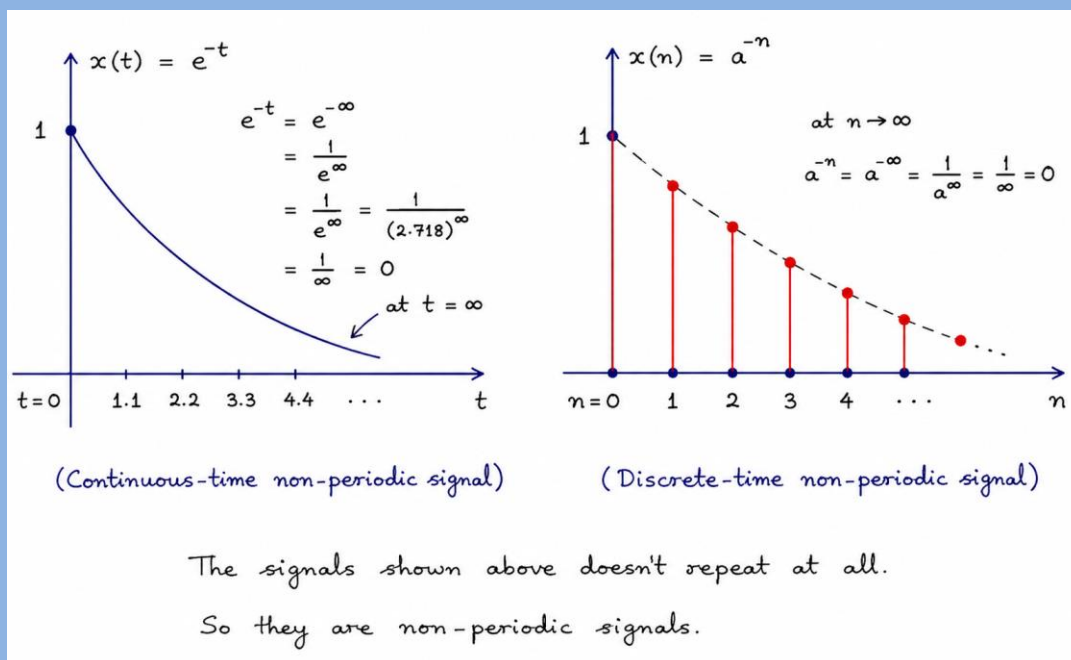


Illustration: Continuous-time and discrete-time non-periodic signals

Observation: The signals shown above do not repeat. Hence, they are non-periodic signals.

10. Quick Revision

Signal Type	Condition	Key Point
CT Periodic	$x(t) = x(t + T)$	Repeats after T
DT Periodic	$x(n) = x(n + N)$	Repeats after N samples
CT Non-Periodic	$x(t) \neq x(t + T)$	Does not repeat
DT Non-Periodic	$x(n) \neq x(n + N)$	Does not repeat

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