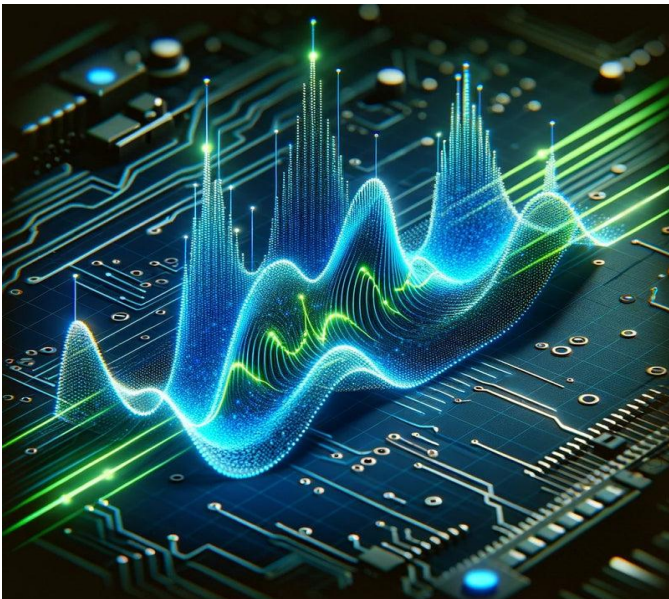


22EE603 – PRINCIPLES OF DIGITAL SIGNAL PROCESSING



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22EE603 – PRINCIPLES OF DIGITAL SIGNAL PROCESSING - CO's

CO1	Illustrate the basics of discrete time signals and systems. [U]
CO2	Interpret the concepts of Discrete and Fast Fourier transform [U]
CO3	Comprehend the architecture of advanced processors. [U]
CO4	Apply the concept of transformation techniques in Discrete Time systems. [AP]
CO5	Design different types of filters using various filter design techniques. [AP]

22EE603 – PRINCIPLES OF DIGITAL SIGNAL PROCESSING - Modules

1	Signals and Systems
2	Discrete Fourier Transform and Fast Fourier Transform
3	FIR Filters, IIR Filters and Digital Signal Processors

MODULE – I : Signals and Systems

1.1	Generation and Representation of Discrete Time signals
1.2	Classification of signals
1.3	Classification of systems
1.4	Sampling of continuous time signals and aliasing effect

1.2 Classifications of signals

Classification of Discrete time signal

1. Deterministic and Random signals
2. Energy and Power signals
3. Even and Odd signals
4. Periodic and Aperiodic signals

Video link:

- This video explains classification of signals

https://drive.google.com/open?id=1kJx6rxEdqNSoxXFIOF03cL5aWIK_4ig

1.2 Classifications of signals

1. Deterministic and Random signals

Deterministic signals

- Signal that can be uniquely described by
 - ✓ an explicit mathematical expression,
 - ✓ a table of data,
 - ✓ a well-defined rule

Eg. $x(n) = A \sin n$, step, ramp, exponential and sinusoidal signals

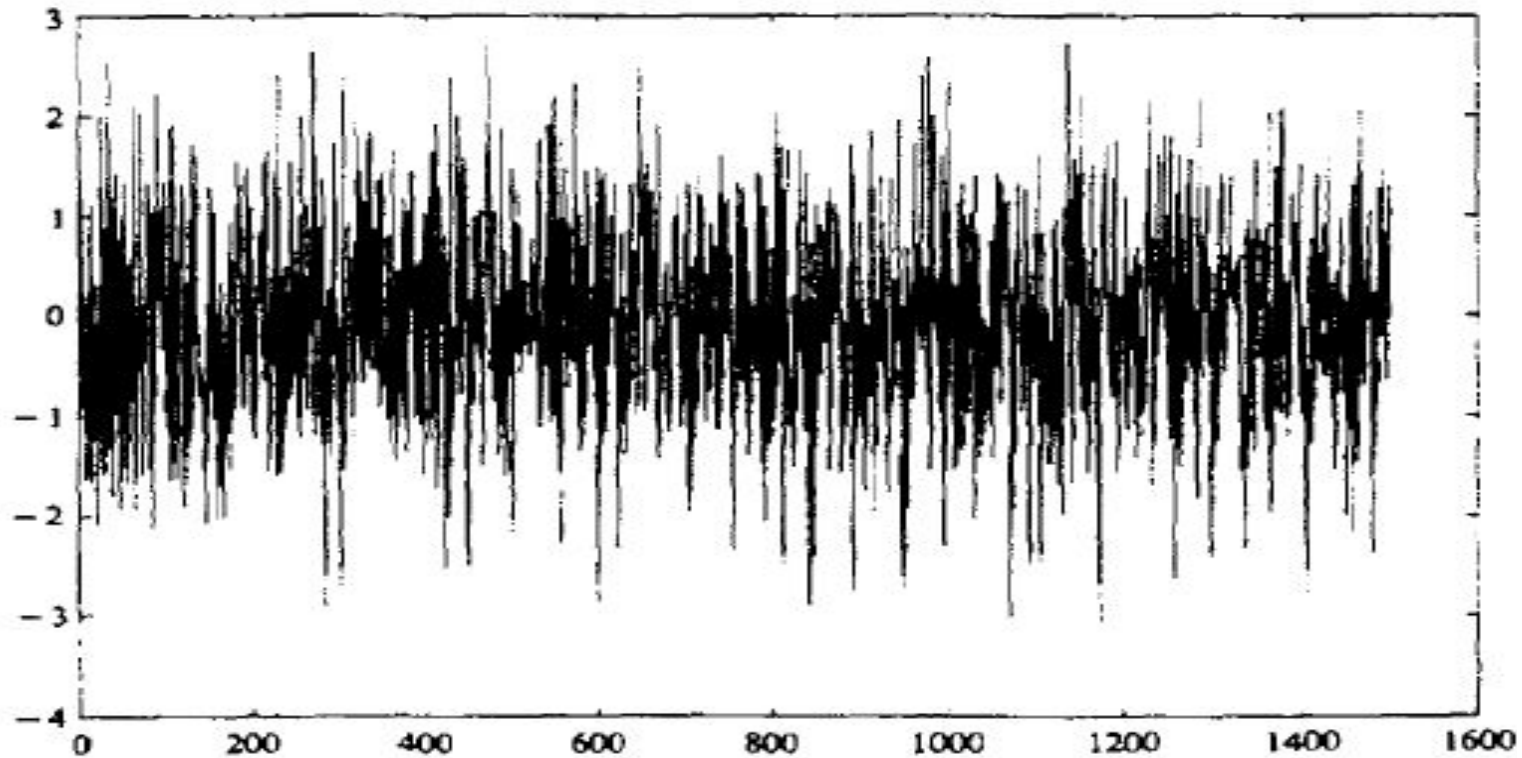
Random signals

- Signals that either cannot be described to any reasonable degree of accuracy by
 - ✓ explicit mathematical formulas,
 - ✓ such a description is too complicated to be of any practical use.

Eg. Noise signal from various sources

1.2 Classifications of signals

Random signals



Example of Random signal

1.2 Classifications of signals

2. Energy and Power signals

Energy signals

A signal is said to be an energy signal if and only if its total energy E is finite, i.e., $0 < E < \infty$.

For an energy signal, the average power $P = 0$. The nonperiodic signals are the examples of energy signals.

- Total energy of the signal is finite and non zero
- Average power is zero

Expression for energy signals

Energy E of a signal $x(n)$ is

$$E_x = \sum_{n=-\infty}^{\infty} |x[n]|^2$$

1.2 Classifications of signals

Power signals

A signal is said to be a power signal if its average power P is finite, i.e., $0 < P < \infty$. For a power signal, the total energy $E = \infty$. The periodic signals are the examples of power signals.

- Average power of the signal is finite and non zero for power signal,
- Energy is infinity

Expression for power signals

Power is

$$P_x = \lim_{N \rightarrow \infty} \frac{1}{2N + 1} \sum_{n=-N}^N |x[n]|^2$$

Video link:

This video explains energy and power signals.

https://drive.google.com/open?id=1RO5aBA7Kg7clxGklr4VNQJs7y_OdlrwYh

1.2 Classifications of signals

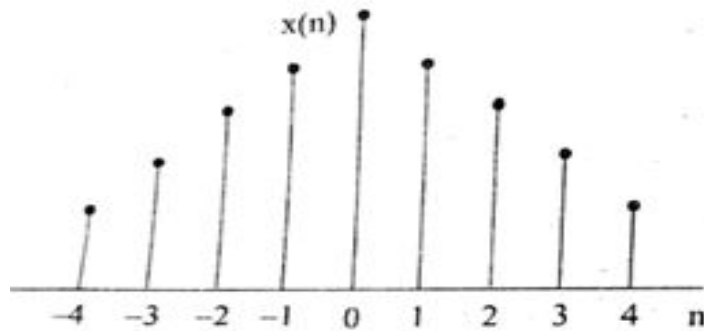
3. Even and Odd signals

Even signals

□ Satisfies the following relationship.

$$x(-n) = x(n) \text{ for all } n$$

□ Also called as Symmetric signals



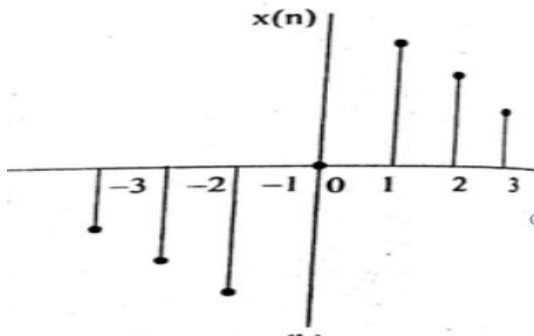
1.2 Classifications of signals

Odd signals

- Satisfies the following relationship.

$$x(-n) = -x(n) \text{ for all } n$$

- Also called as Anti Symmetric signals.



Video link:

- This video explains even and odd signals

<https://drive.google.com/open?id=1kqF4CZzcn41NALyk916yorzAqVvk-4UY>

1.2 Classifications of signals

Arbitrary signal $x(n) = x_o(n) + x_e(n)$

Even part of the signal - $x_e(n)$

Odd part of the signal - $x_o(n)$

$$x_e(n) = \frac{1}{2} [x(n) + x(-n)]$$

$$x_o(n) = \frac{1}{2} [x(n) - x(-n)]$$

Video link:

This video explains even and odd parts of signals

<https://drive.google.com/open?id=1qmLCwoPtj0lnkLP7eG1hC6G-6iY7WtWt>

1.2 Classifications of signals

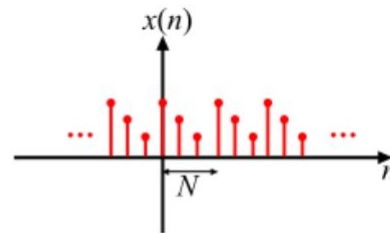
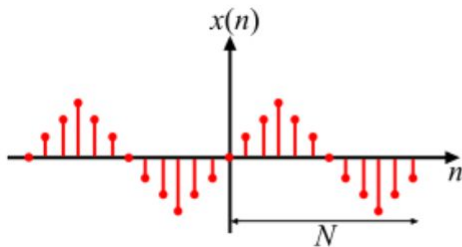
4. Periodic and aperiodic signals

Periodic signals

- A Signal $x(n)$ is periodic with periodicity of N samples (where N is an integer) if and only if

$$\text{Eg. } x(n+N) = x(n) \text{ for all } n$$

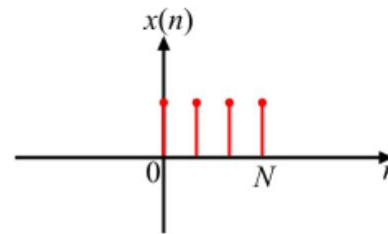
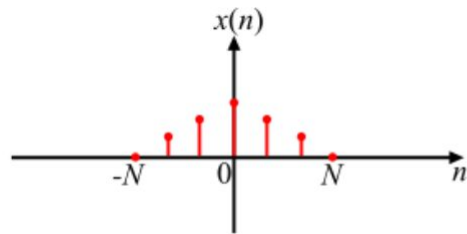
The smallest value of N for which the above equation is true is called fundamental period. If there is no value of N that satisfies the above equation, then it is called aperiodic or nonperiodic signal. When N is the fundamental period, the periodic signals will also satisfy the condition $x(n+kN)=x(n)$, where k is an integer.



1.2 Classifications of signals

Aperiodic signals

- If the condition of periodicity is not satisfied even for one value of n for a discrete time signal $x(n)$, then the discrete time signal is aperiodic or nonperiodic. Signal which is not in regular intervals.



Video link:

1. This video explains periodic signals

<https://drive.google.com/open?id=1wjhjmoksBulrALp698YX5rAqg3VjyTHC>

2. This video explains solved problems in periodic **signals**

<https://drive.google.com/open?id=1VdBeo3lpiXer3QphNJ5NRWXk8BuBWr2z>