Ministry of High Education and Scientifics Research

Al-Farahidi University

College of Technical Engineering

Communications Systems
A. Signal
For students of 2nd class

Lecturer

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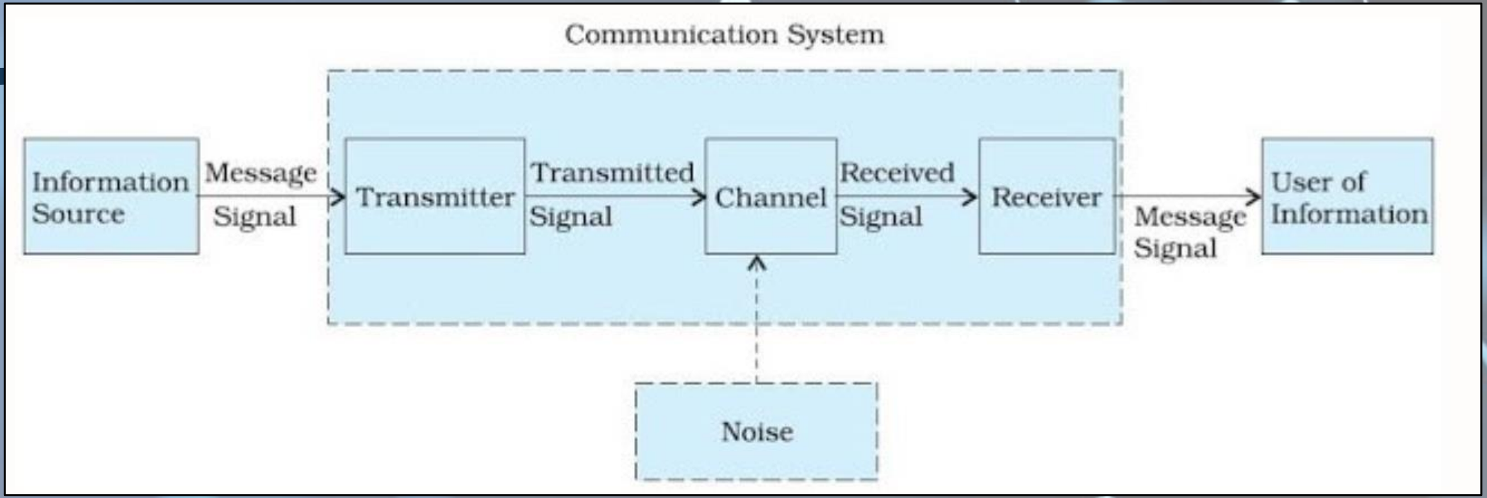
Communication System

Irrespective of the form of communication process being considered, there are three basic elements to every communication system:

1. **Sender or Transmitter (Tx)**: It sends information (located at one point in space). For example, TV transmitting station or radio transmitting stations are senders since they transmit information.

2. **Receiver (Rx)**: Its receivers' information (located at some other point separate form the transmitter). For example, all TV sets and radios are receivers. They get information from transmitter.

3. **Communication Channel**: This is the path through which the signal propagates from transmitter to receiver (connects them).



Communication System

There are two basic modes of communication:

Modes of communication

Broadcasting

which involves the use of a single power transmitter and numerous receivers that are relatively inexpensive to build. Here information bearing signals flow only in one direction.

Point-to-point communication

in which the communication process takes place over a link between a single transmitter and receiver. In this case, there is usually a bidirectional flow of information-bearing signals, which requires the use of transmitter and receiver at each end of the link.

Signals

- A signal may be a function of time, temperature, position, pressure, distance, etc. Some signals in our daily life are music, speech, picture, and video signals. Systematically, we can define a signal as under:

- "A function of one or more independent variables which contains some information is called a signal."

- In an electrical sense, the signal can be voltage or current. The voltage or current is the function of time as an independent variable.

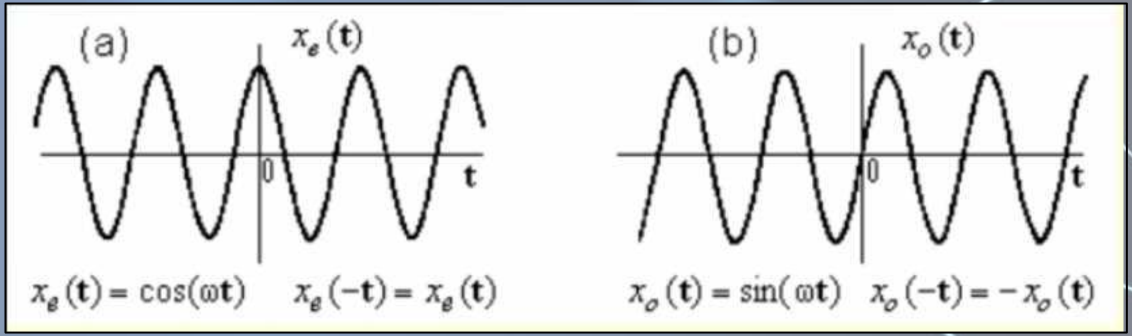
- Audio signals: Our ears are sensitive to sound, which is physically just rapid variations in air pressure. Thus sound can be represented as a function.

Sound*: *Time* → *Pressure

Signals and Symmetry

- Many signals have important symmetry properties. The familiar cosine and sine are good examples.

- Note that both describe the same sinusoidal waveform, except that "sin" lags "cos" by a quarter cycle



- We've called the cosine wave X_e(t) because of its *even* symmetry about the vertical zero−axis.
- We've called the sine wave X_o(t) because of its *odd* symmetry about the same axis.

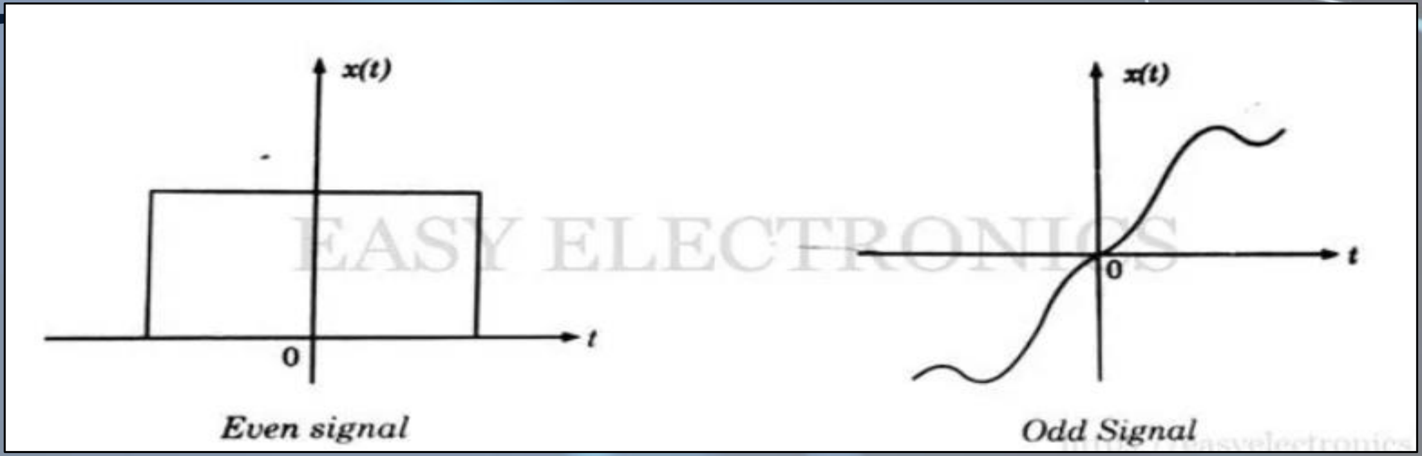
Even and Odd Signals

- An even signal is that type of signal which exhibits symmetry in the time domain. This type of signal is identical to the origin. Mathematically, an even signal, just satisfy the following condition:

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

- Similarly, an odd signal is that type of signal which exhibits anti-symmetry. This type of signal is not identical to the origin.

- Actually, the signal is identical to its negative. Mathematically, an odd signal must satisfy the following condition.



Even and Odd Signals

Some properties of even and odd functions

even and odd functions have the following property:

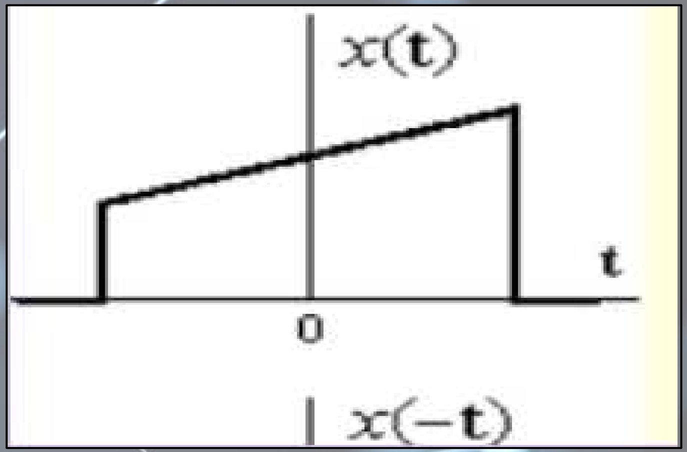
1. even function ´ odd function = odd function

2. odd function´ odd function= even function

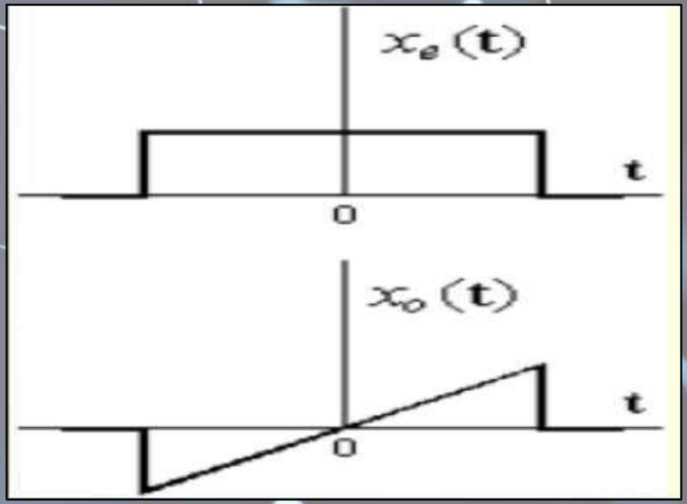
3. even function ´ even function = even function

Even and Odd Signals

A given (real–valued) x(t), such as this one (Fig), might have neither symmetry, but we can routinely decompose it into even and odd parts. Its even part is:



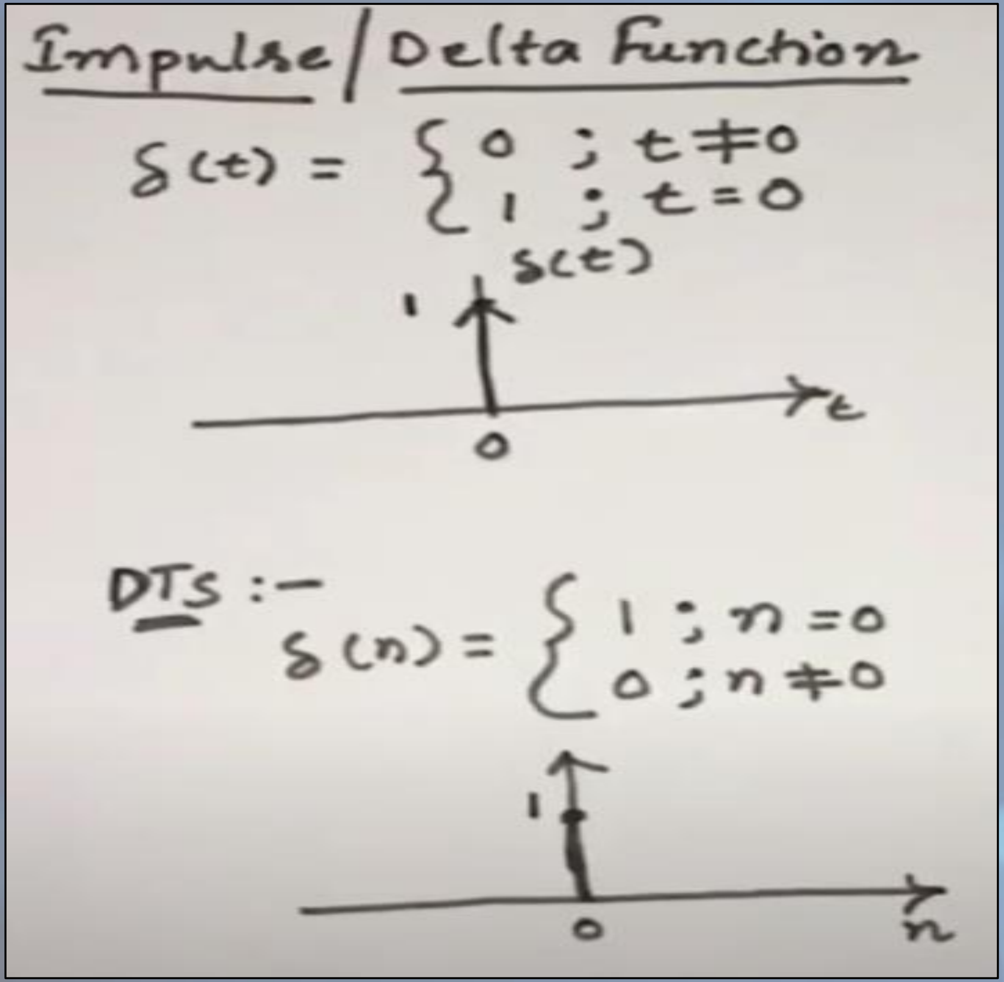
The odd and even part of x(t) is found as:



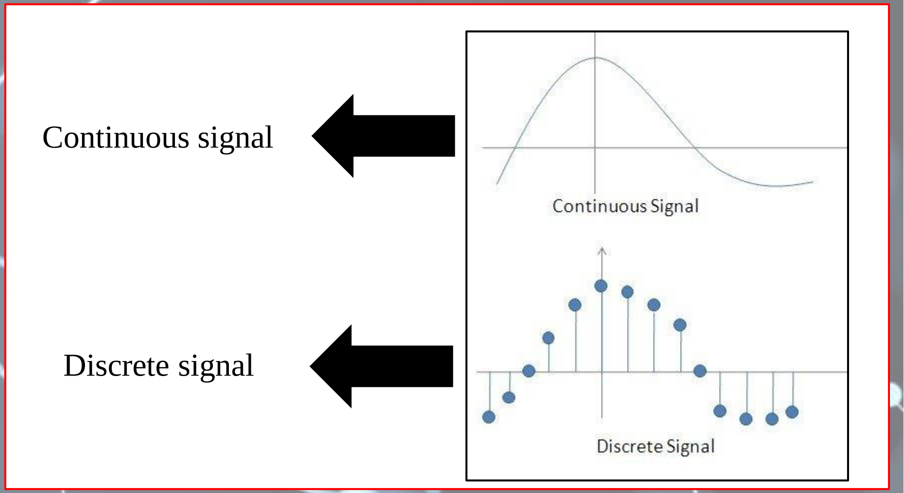
Performance Objectives

1. Unit impulse function :

The unit impulse function, also known as the Dirac delta function, δ(t), is defined by :



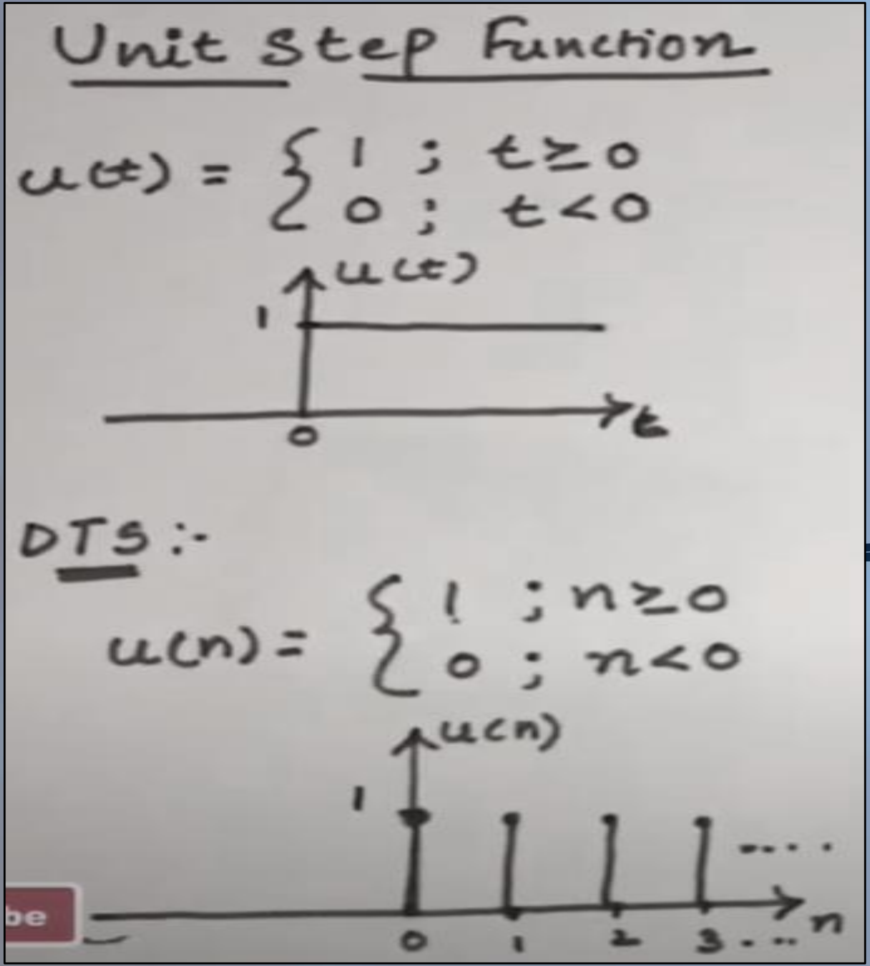
Note



Performance Objectives

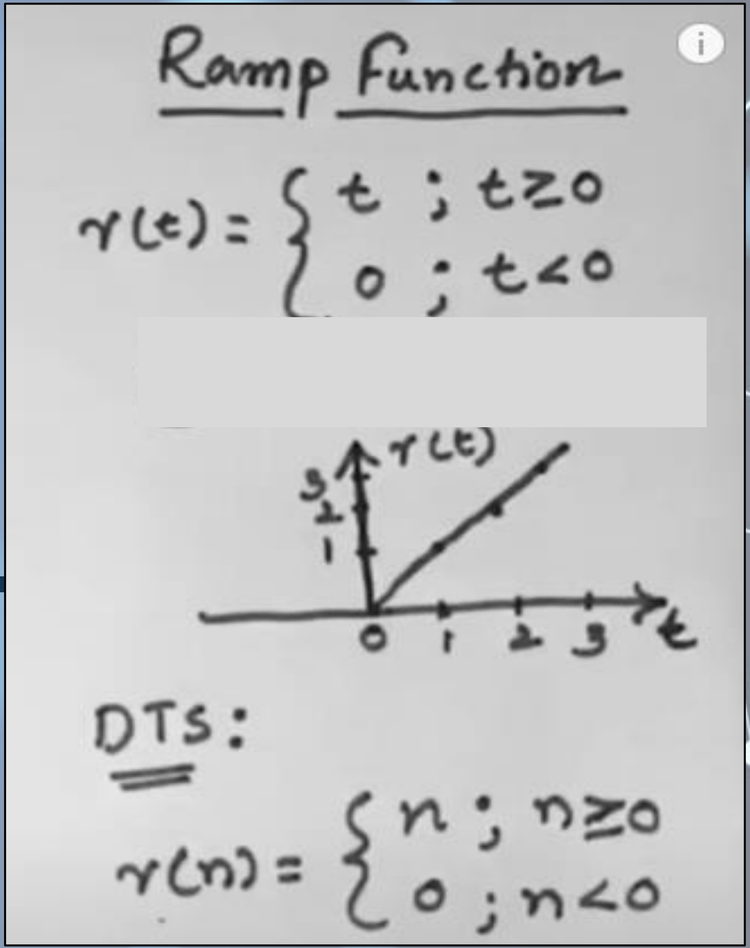
2. Unit step function :

The unit step function u(t) is :



2. Unit ramp function :

The unit ramp function u(t) is :



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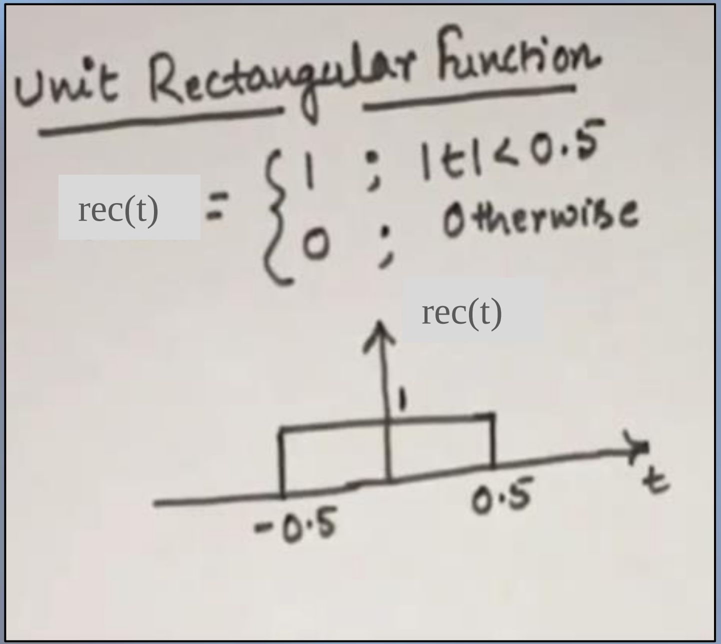
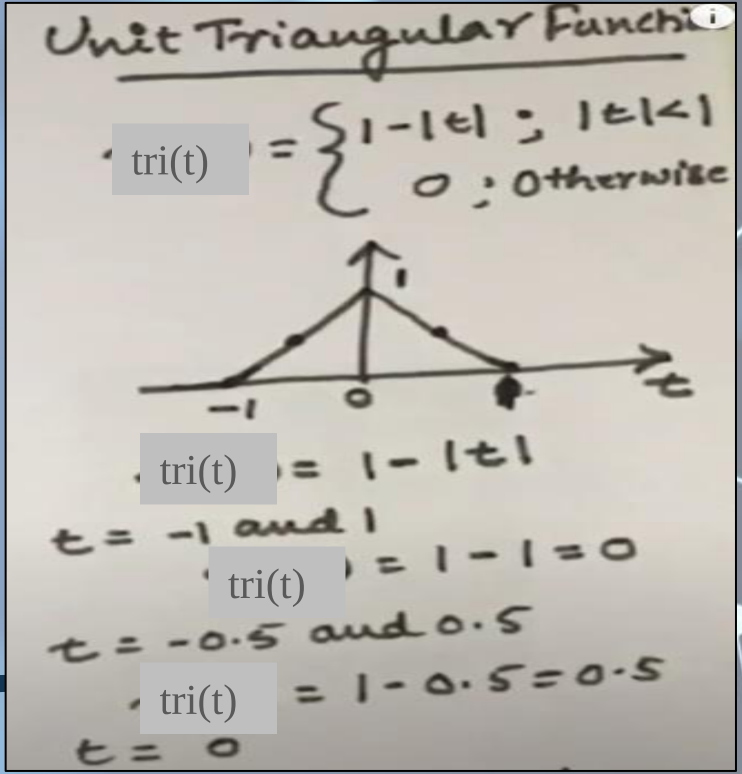
Performance Objectives

3. Unit Rectangular function rec(t)



Draw the rec(n) in Discrete signal:

4. Unit Triangle function is tri(t)



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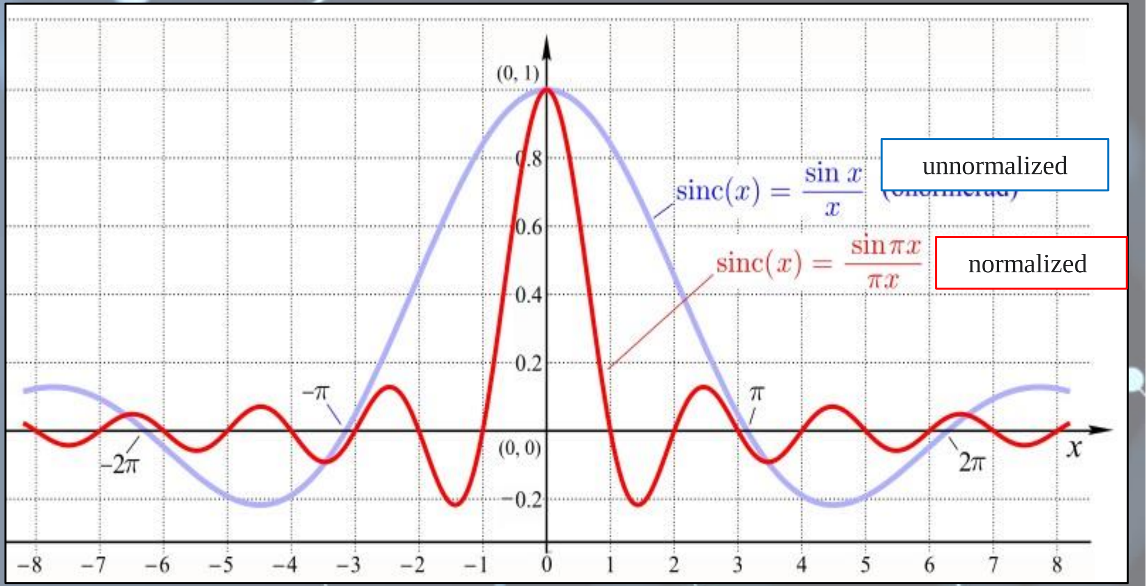
Draw the tir(n) in Discrete signal:

Sinc Function

The sinc function , also called the **"sampling function,"** is a function that arises frequently in signal processing and the theory of Fourier transforms.

$$Sinc\ (X) = \frac{sin(x)}{(x)} \ \ldots\ Sinc\ Eq.\ (\text{unnormalized})$$

$$Sinc\ (X) = \frac{sin\ \Pi x}{\Pi x} \ \ldots\ Sinc\ Eq.\ (\text{normalized})$$

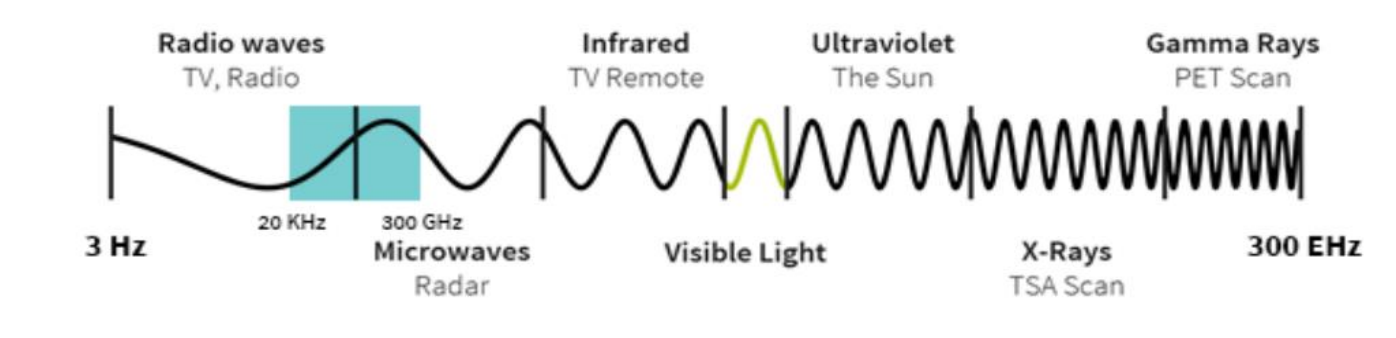


Sinc Properties:

- $Sinc\ (x) = \frac{sin(x)}{(x)} \ \ldots\ (Even)$

Spectrum

- Spectrum refers to the invisible radio frequencies that wireless signals travel over. Those signals are what enable us to make calls from our mobile devices, tag our friends on Instagram, call careem, pull up directions to a destination, and do everything on our mobile devices.
- The frequencies we use for wireless are only a portion of what is called the electromagnetic spectrum.
- Portions of electromagnetic spectrum are grouped in “bands” depending on their wavelengths
- The portion used for wireless communication sits within that space and ranges from about 20 KHz to 300 GHz.



Spectrum wavelengths are classified into different bands within the electromagnetic spectrum range.

Spectrum Frequencies

Spectrum frequencies

Low-band spectrum (under 3 GHz)

- Travels longer distances with minimal signal interruption.

.- Today’s wireless networks are built primarily on low-band spectrum

High-band spectrum (above 24 GHz)

- travels much shorter distance think meters, not miles compared to low-band spectrum

- offers high capacity

- ultra-fast speeds

Mid-band spectrum (between 3 and 24 GHz).

- blends the characteristics of both low- and high-band spectrum.

- providing a mix of coverage and capacity.

Designation of Frequencies (Important)

30-300 Hz	Extremely Low Frequency	(ELF)
300-3 kHz	Voice Frequency	(VF)
3-30 kHz	Very Low Frequency	(VLF)
30-300 kHz	Low Frequency	(LF)
300-3 MHz	Medium Wave Frequency	(MW)
3-30 MHz	Short Wave Frequency	(SW)
30-300 MHz	Very High Frequency	(VHF)
300-3000 MHz	MHz Ultra High Frequency	(UHF)
3-30 GHz	Super High Frequency	(SHF)
30-300 GHz	Extremely High Frequency	(EHF)