Analog and Digital Communication EC223

Introduction

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Introduction

- Communication can be defined as the process of exchange of information through means such as words ,signs, etc., between two or more individuals.
- Parts of Communication are Sender, Channel, Receiver.

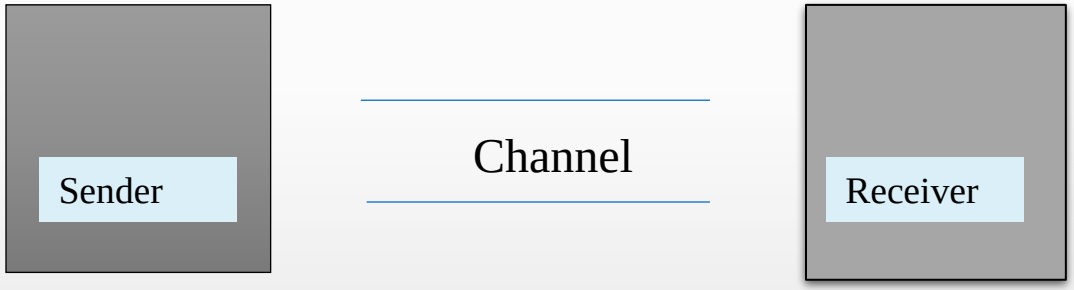
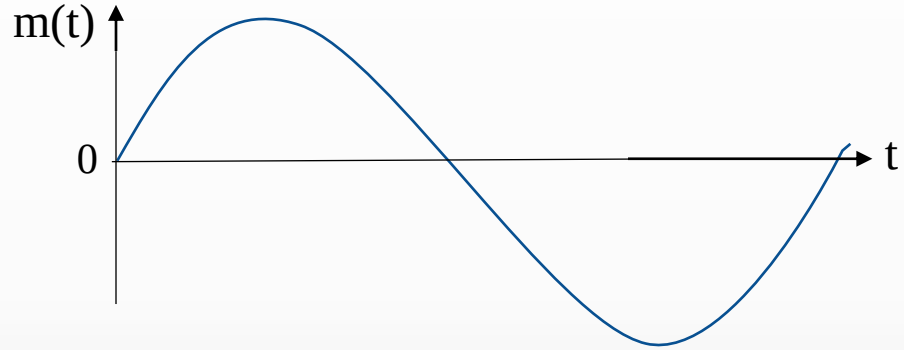


Fig 1: Communication system

- Classified into two types:
  - Analog Communication
  - Digital Communication

- Analog Communication: This uses signals that can be represented by sine waves. The message signal is in analog form i.e., continuous time signal.



m(t) is Amplitude of the signal

Fig 2: Analog Signal

- Digital Communication: Digital communication uses signals that can be represented by square waves. Usually digital data i.e., discrete time signals containing information is transmitted.

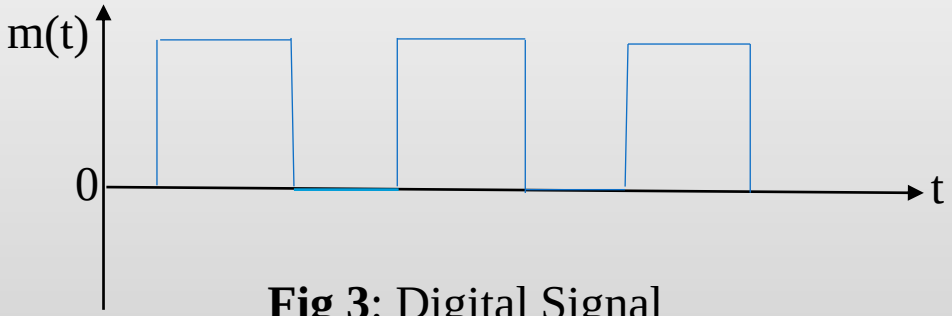
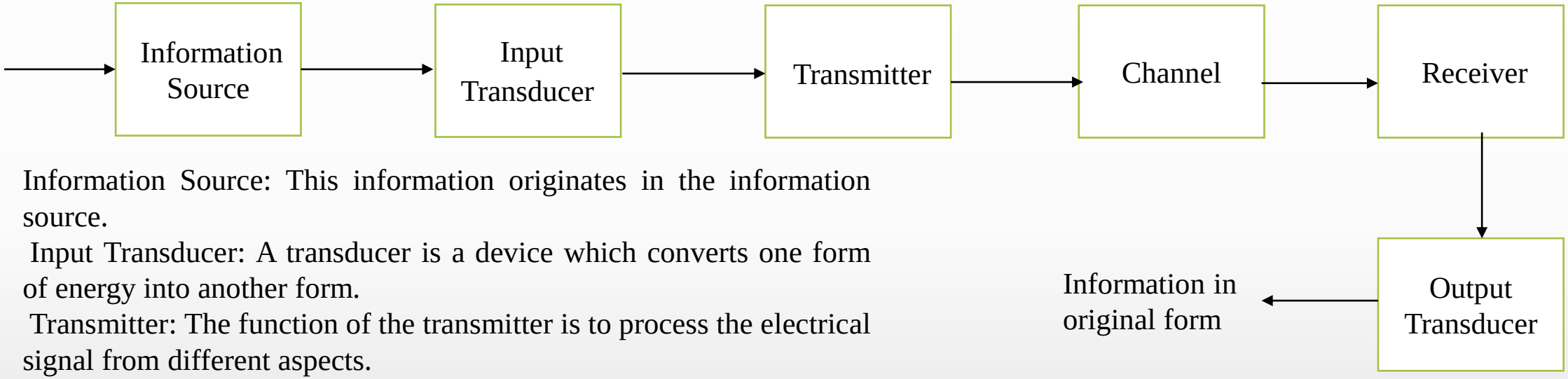


Fig 3: Digital Signal

- Basic Blocks of Communication System:



- Information Source: This information originates in the information source.
- Input Transducer: A transducer is a device which converts one form of energy into another form.
- Transmitter: The function of the transmitter is to process the electrical signal from different aspects.
- Channel: Medium through which the message travels from the transmitter to the receiver.
- Receiver: Receiver is to reproduce the message signal in electrical form from the distorted received signal
- Output Transducer: Destination is the final stage which is used to convert an electrical message signal into its original form.

Fig 4: Basic Blocks of Communication System

Baseband and Passband Signals

- **Baseband Signals**: The term "baseband" is used to designate the band of frequencies representing the original signal as delivered by a source of information.
- Baseband, as the name suggests, refers to the original transmission signal with no modulation of high frequency carrier.

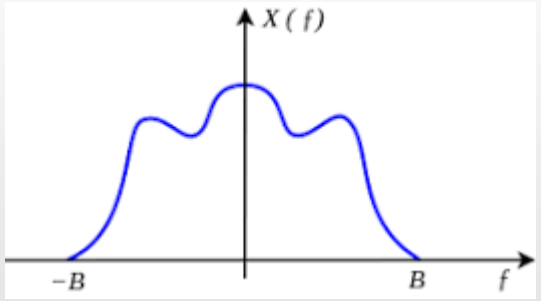


Fig 5: Baseband Signal

- **Passband Signal:** Passband signal refers to filtered signal or modulated signal in which the frequency or phase of the carrier signal is modulated to transmit the bits.
- If a modulated signal is transmitted over the channel, it is called Passband transmission.

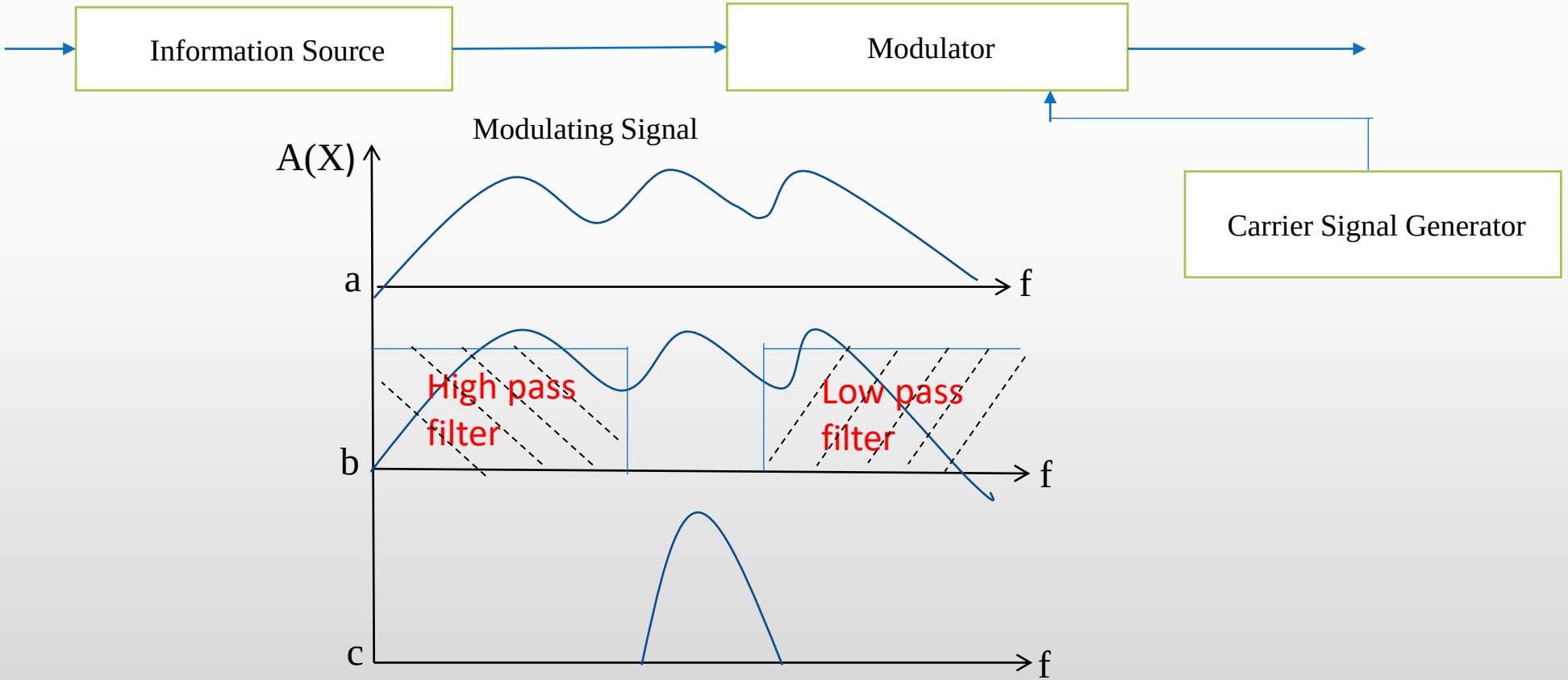


Fig 6: Passband Signal

Modulation and Demodulation

- **Modulation:** The process of shifting the baseband signal to passband range for transmission is known as MODULATION
- It improves the strength of the signal without disturbing the parameters of the original signal.
- **Need For Modulation:** Baseband signals are incompatible for direct transmission. For such a signal, to travel longer distances, its strength has to be increased by modulating with a high frequency carrier wave, which doesn't affect the parameters of the modulating signal.
- In modulation, one characteristic or more of a signal (generally a sinusoidal wave) known as the carrier is changed based on the information signal that we wish to transmit.
- The characteristics of the carrier signal that can be changed are the amplitude, phase, or frequency, which result in Amplitude modulation, Phase modulation, or Frequency modulation.

$$\text{carrier signal } C(t) = A_c \sin \omega_c t$$

- The process of shifting the passband signal to baseband frequency range at the receiver is known as DEMODULATION

- **Amplitude Modulation:** The amplitude of the carrier signal varies in accordance with the instantaneous amplitude of the modulating signal." Which means, the amplitude of the carrier signal containing no information varies as per the amplitude of the signal containing information, at each instant. This can be well explained by the following figures.

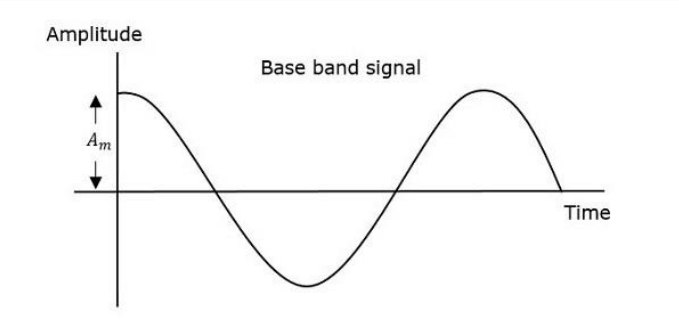


Fig 7a

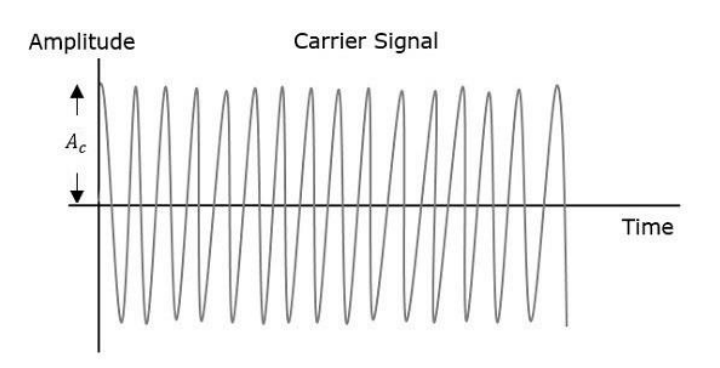


Fig 7b

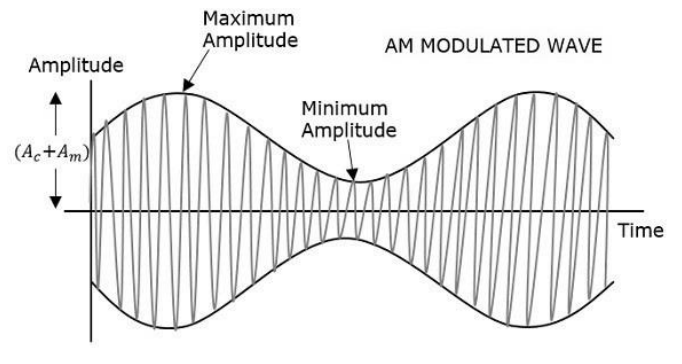


Fig 7c

- The figure 7a shows the modulating wave, which is the message signal. The fig 7b is the carrier wave, which is a high frequency signal and contains no information. While, the fig 7c is the resultant modulated wave.
- It can be observed that the positive and negative peaks of the carrier wave, are interconnected with an imaginary line.
- This line helps recreating the exact shape of the modulating signal. This imaginary line on the carrier wave is called as Envelope. It is the same as that of the message signal.
- Following are the mathematical expressions for these waves.
- Time-domain Representation of the Waves Let the modulating signal be,

$$m(t)=Am\cos(2\pi fmt)$$

and the carrier signal be, $c(t)=Ac\cos(2\pi fct)$

- Am and Ac are the amplitude of the modulating signal and the carrier signal respectively.
- fm and fc are the frequency of the modulating signal and the carrier signal respectively.

- Then, the equation of Amplitude Modulated wave will be

$$s(t)=[Ac+Amcos(2\pi fmt)]cos(2\pi fct) \quad \text{---------- (Eq. 1)}$$

- **Modulation Index of AM**

A carrier wave, after being modulated, if the modulated level is calculated, then such an attempt is called as Modulation Index or Modulation Depth.

It states the level of modulation that a carrier wave undergoes.

Rearrange the Eq.1 then

$$s(t)=Ac[1+(Am/Ac)cos(2\pi fmt)]cos(2\pi fct)$$

$$s(t)=Ac[1+\mu cos(2\pi fmt)]cos(2\pi fct) \quad \text{---------- (Eq. 2)}$$

Where, **μ** is Modulation index or Modulation Depth and it is equal to the ratio of Am and Ac.

we can write it as $\boldsymbol{\mu=Am/Ac}$ ---------- (Eq. 3)

By Using the Eq.3 we can calculate the Modulation Index when the amplitude of modulation and carrier signals are known.

References:

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Thank You