4.0 COMMUNICATION SYSTEMS (BASICS)

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1. Communication System:

It's a system that involves the transmission of information from one point to another.

2. Basic Elements of a Communication System:

The transmitter is located at one point in space; the receiver is located at some other point separate from the transmitter. The channel is the physical medium that connects the Tx and Rx. The purpose of Tx is to convert the message signal produced by the source of information into a form suitable for transmission over a channel. However, as the transmitted signal propagates along the channel, it's distorted due to channel imperfections. The receiver has the task of operating on the received signal so as to reconstruct a recognizable form of the original message signal.

3. Basic Modes of Communication:

a)Broadcasting: It consists of a single powerful transmitter and numerous receivers that are relatively inexpensive to build. Here, information bearing signals flows only in one direction. E.g. AM, FM broadcasts, TV broadcasts etc.

b) Point to Point Communication: In this mode, communication process takes place over a link between a single TX and a Rx. In this case there's usually a bidirectional flow of information bearing signals which require the use of a TX and a RX at each end of the link.

4. Primary Communication Resources:

In communication system, two primary resources are employed.

i) Transmitted Power: average power of the transmitting signal
ii) Channel Bandwidth: band of frequencies allocated for the transmission of the message signal.

Typically, one resource may be important than the other. i.e. Power limited channel (telephone circuit), Band limited channel (satellite channel).

Depending upon the mode of transmission channel can also be divided into guided propagation (telephone channels, Coaxial cables and fibers) and free Propagation (broadcast, radio channels, satellite channels)

5. Analog and Digital Communication Systems:

Analog communication source produces messages that are defined on continuum. Ex: Microphone – the output voltage describes the information in the sound and it is distributed over a continuous range of values.
Digital communication source produces a finite set of possible messages. Ex: Typewriter – there is a finite number of characters (messages) that can be emitted by this source.
Analog communication system transfers information from an analog source to an intended receiver (sink). Analog communication signals, such as AM & FM signals, are analog signal. They are continuous and vary in amplitude, frequency or phase Ex: AM & FM systems. Analog waveform is a function of time that has a continuous range of values. Ex: sinusoidal waveform.
Digital communication system transfers information from a digital source to an intended receiver (sink). They are discrete, discontinuous pulses that have one of M distinct waveforms. If $M = 2$, this is a binary digital system. Ex: pager & mobile. Digital waveform is a function of time that can have only a discrete set of values. Ex: rectangular pulse.

6. Comparison of Analog and Digital Communication Systems

	ADVANTAGES	**DISADVANTAGES**
ANALOG COMMUNICATION SYSTEM	• Smaller bandwidth. • Synchronization problem is relatively easier.	• Expensive analog components. • No privacy. • Cannot merge data from different sources. • No error correction capability.
DIGITAL COMMUNICATION SYSTEM	• Inexpensive digital circuits. • Privacy preserved (data encryption). • Can merge different data (voice, video and data) and transmit over a common digital transmission system. • Error correction by coding.	• Larger bandwidth • Synchronization problem is relatively difficult.

7. BLOCK DIAGRAM OF A COMMUNICATION SYSTEM

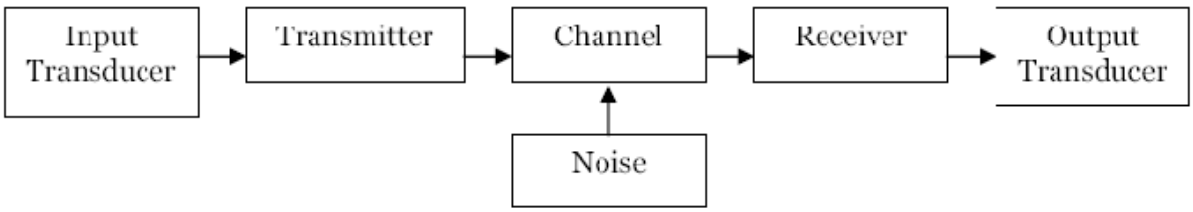

Fig. 1 Block Diagram of a Communication System

Input transducer: Converts the message into electrical signal.
Transmitter: Converts the electrical signal into transmission signal.
Channel: A medium that bridges the distances from transmitter to receiver. Ex. Wire, coaxial cable and fiber optic.
Receiver: Converts the transmission signal to electrical signal.
Output Transducer: Converts electrical signal into its original message.
Noise: Any unwanted signal that can cause distortion to the message signal.

8. RADIO FREQUENCY SPECTRUM

FREQUENCY	***CLASSIFICATION***	***EXAMPLES***
$3-30kHz$	*Very Low Frequencies (VLF)*	*Submarine communication*
$30-300kHz$	*Low Frequencies (LF)*	*AM broadcast*
$300-3000kHz$	*Medium Frequencies (MF)*	*Maritime radio*
$3-30MHz$	*High Frequencies (HF)*	*Communication in mines*
$30-300MHz$	*Very High Frequencies (VHF)*	*Radio navigation (to determine the position of Earth)*

300 – 3000*MHz*	*Ultra High Frequencies (UHF)*	*FM radio broadcast*
3 – 30*GHz*	*Super High Frequencies (SHF)*	*Microwave devices*
30 – 300*GHz*	*Extra High Frequencies (EHF)*	*Radio astronomy and remote sensing*
300 – 3000*GHz*	*Microwave Frequencies*	*Microwave*

9. Modulation:

It's a process of transmitting information over a medium. It can be defined as the process by which some characteristics/parameter (frequency, amplitude, phase) of high frequency carrier is varied with the low frequency message signal. Modulation occurs at the transmitting end of the system.

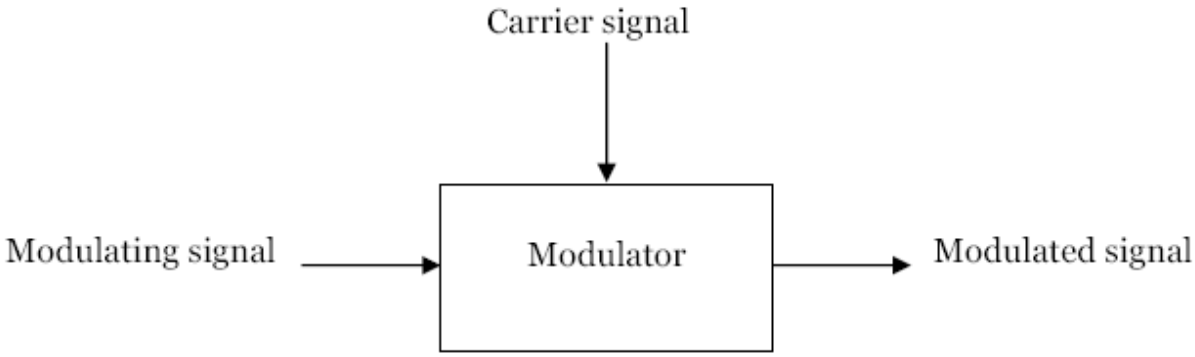

Fig. 2 Block Diagram of a Modulation Process

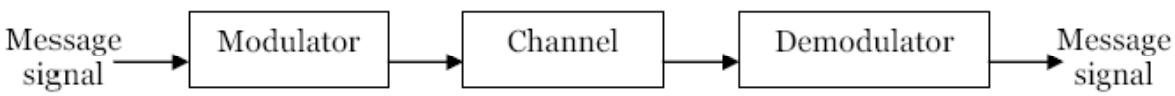

Fig. 3 Block Diagram of Modulation and Demodulation Process

Demodulation is the reverse process of modulation and converts the modulated carrier back to the original information (that is, extracting the message signal from the carrier).

10. Need for Modulation:

There are several strong reasons why the modulation is important in analog communication system.
(a) The frequency of the human voice range from about 20 to 30 kHz. If every one transmitted those frequencies directly as radio waves, interference would cause them to be inefficient. So, we need a higher frequency to carry the baseband frequency)
(b) To overcome hardware limitations because transmitting such lower frequencies require antennas with miles in wavelength.
(c) Modulation is to reduce noise which result in the optimization of signal to noise ratio, SNR
(d) To minimize the effects of interference

11. Types of Modulation

Analog Modulation: (includes AM, FM, PM)

AM: Amplitude of the carrier is varied according to the message signal.

FM: Frequency of the carrier is varied according to the message signal.

PM: Phase of the carrier is varied according to the message signal.

Digital Modulation: (includes ASK, FSK, PSK)

12. Difference between Analog and Digital Modulation

Analog Modulation	Digital Modulation
1. Message Signal as well as carrier signal is analog. 2. Sinusoidal carrier is used. 3. Analog modulation is categorized into AM, FM and PM.	1. Message signal is digital while carrier signal is analog. 2. Pulse signal may also be used as carrier. Sinusoidal wave is also used as carrier. 3. Digital Modulation is categorized into ASK, FSK and PSK.