

Communication System

SUMMARY and ASSIGNMENT

1. **Communication system** – System to transmit information from one point to another. A communication system primarily consists of (i) **transmitter**, (ii) **communication channel** and (iii) **receiver**.
2. **Transmitter** – A set up that transmits the message to the receiving end through a communication channel. The basic functions of the set up are to transform the message signal into a form suitable for transmission over the channel to the receiver and transmit it.
The basic components of a transmitter are:
 - (a) A message signal generator
 - (b) Modulator or encoder
 - (c) Antenna
3. **Message signal** – It is a single valued function of time that conveys the information. Signals can be *analog or digital*.
Analog signal – A signal that is a continuous function of time, with the amplitude (Instantaneous value of the signal) being continuous.
Discrete signal – A discontinuous signal that is defined only at discrete times.
Bandwidth – The range over which the frequencies in a signal vary.
4. **Modulating/encoding** – Modification of the message signal suitable for transmission. In order to transmit information, a variation of the characteristics of wave called the *carrier wave* is carried out in some manner.
The modulation of a carrier wave is carried out in two ways. (1) The amplitude of the carrier wave is varied about a mean value, linearly with the baseband signal, the angular frequency remaining constant. This mode of modulation is called the *amplitude modulation*. (2) The phase angle, θ , of the carrier wave is varied according to the baseband signal. This method of modulation is called the *angle modulation*. There are two forms of angular modulation-*phase modulation* and *frequency modulation*.
Pulse modulation – Sampling of the information signal at periodic intervals and transmitting a very short pulse radio-frequency carrier for each sample with the pulse characteristics being varied in some manner proportional to the signal amplitude at the sampling instant.
Three modulation techniques are employed for transforming digital into analog signals.
5. **Antenna** – A length of conductor that acts as a conversion device. The first conversion takes place at the transmitter where electrical energy is converted into electromagnetic waves. The second conversion takes place at the receiver, where electromagnetic waves are transformed into electrical signal. In communication, we come across several types of antenna. A dipole antenna is omni-directional, whereas the dish antenna is highly directional.
6. **Communication channel** – The communication channel or the transmission medium is the physical path between transmitter and the receiver. The transmission media can

be (a) guided and (b) unguided. Twisted pair, coaxial cable and optical fibre provide examples of guided media. Free space provided an example of an unguided medium. The characteristics and quality of transmission are determined both by the nature of the signal and the nature of the medium. In case of guided media, the medium itself is more important in determining limitations of transmission. For unguided media, the spectrum or frequency band of the signal produced by transmitting antenna is more important than the medium in determining transmission characteristics. Depending on the nature of the communication channel, communication is classified under three broad categories, (a) line communication, (b) optical communication and (c) space communication.

- 7. Receiver**– The receiver reconstructs the original message or data after its propagation through the communication channel. The process consists of decoupling of the carrier wave and the modulating signal is broadly termed as demodulation.
- 8. Fax** – A facsimile/exact reproduction of a document (picture, letter, maps etc.) at the receiving end. The document to be transmitted is first converted into digital data form. A process called *scanning*, carried out by optical means, does this. The device, which does scanning, is called a *scanner*. The digital data representing the document is transmitted to the destination by using a suitable medium. At the receiving end the digital data is used to reconstruct the original picture or the document.
- 9. Modem – modulator/demodulator** – A device, which converts a series of binary pulses into an analog signal by encoding the digital data into a *carrier frequency*. The resulting signal occupies a certain spectrum of frequency centred about the carrier and may cross a medium suitable for that carrier. At the end of the line, the modem demodulates the signal to recover the original data.
- 10. Space communication** – The communication process utilizing the physical space as communication medium.
In space communication, a signal is emitted from the antenna of a transmitter and received by another antenna of the receiver. This can be done in two ways. The waves can travel directly following the surface of earth, known as *surface wave (ground wave)*, or can reach after being bounced back from the ionosphere, known as *sky wave*.
In surface wave propagation the reception is possible only when the receiver antenna directly intercepts the signal. This mode of communication is used for medium wave band and for television broadcasting.
In sky wave propagation, the carrier wave is reflected back from different layers of the ionosphere.
Skip distance – a distance from the transmitter, measured along the surface of the earth, to point where the sky wave returns to earth after reflection from ionosphere. Using multiple hops in which the wave is reflected between ionosphere and earth's surface several times or beaming at different angles can increase the propagation range.
- 11. Satellite communication** – communication through satellite. A communication satellite is placed in an orbit around the earth, which carries on board microwave

receiver and transmitting equipment. It is essentially a microwave link repeater. It receives signals beamed up by the earth stations, amplifies and returns to earth at a different frequency to avoid interference between the up link and down link. This mode of communication permits transmission of data at high rate.

- 12. Remote sensing** – the science and art of obtaining information about an object, area, or phenomenon, acquired by a sensor that is not in direct contact with the target of investigation.

A satellite equipped with appropriate sensors to acquire data is placed in an orbit around the earth at any height having a period of revolution. It takes photographs or collects any other information desired and transmits back to an earth station. This is known as remote sensing.

- 13. Line communication** – A communication system involving point to point contact between the transmitter and the receiver. This mode of communication requires use of a guided medium such as twisted pair or coaxial cable.

Twisted pair – Two insulated copper wires arranged in a spiral pattern. Normally a number of such pairs are bundled together into a thick cable. Copper conductor wires in the twisted pair provide a very low cost medium. Such a system is commonly used for transmitting, both analog/digital information.

Coaxial cable – It consists of a hollow outer cylindrical conductor, which surrounds a co-axial single inner conductor. The inner conductor is made up of a copper wire and the outer conductor can be either a solid or a braided mesh of fine wires. The inner conductor is held in the centre by a solid dielectric (insulating) material all around. The outer conductor is normally connected to ground and thus provides an electrical shield to the signals carried by the central conductor. Co-axial cables are normally used for long distance high frequency transmission. local area computer networks for high speed transmission as input/output channels for the computer systems.

- 14. Optical communication** – A communication mode employing an optical communication link optical. A light wave of a very high frequency is transmitted in the form of light pulses, and this method has two distinct advantages: (a) it can be used as a high bandwidth carrier and (b) it can carry large amount of information.

Optical fibre – A thin wire of glass having a diameter of about 0.1 mm. The propagation of light in an optical fibre is governed by laws of optics and propagates by multiple total internal reflections. Light can be guided in such a wire by launching it at one end, using an intense and focussed source, and allowing it to bounce down to the other end by a series of reflections (*total internal reflections*) from the sides. An actual optical fibre used in optical fibre cables consists of an inner cylinder of glass, known as the **core**, having a refractive index ' n_1 ', and an outer cylinder of a different glass, called the **'cladding layer'** having a refractive index ' n_2 '. The refractive indices of the two regions are arranged in such a way so that $n_1 > n_2$.

Photonic devices – semiconductor devices used for the generation and detection of photons.

Light emitting diode (LED) – A light emitting diode (LED) works by the process of

spontaneous emission. When a p-n junction is forward biased, the potential barrier is reduced and the depletion zone is narrowed until the holes and electrons are free to cross the barrier. Electrons injected into the *p*- region encounters holes and recombine, similarly the holes injected into the *n*-region encounter electrons and recombine. When each electro-hole pair recombines a single photon is released. The wavelength and frequency of the light emitted is determined by the band gap energy. The intensity of light emitted is proportional to the forward current conducted by the junction.

Laser – is a acronym and stands for *light amplification by stimulated emission of radiation*. It is a source highly directional, monochromatic, and coherent light. Laser action has been obtained using many different materials, including gases, such as neon, carbon dioxide, and solids such as ruby, and semiconductors.

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ASSIGNMENT

1. What is communication system? Describe briefly the major constituents of a communication system.
2. What is an analog signal? Explain the term bandwidth and base band.
3. What is a discrete signal? Explain briefly how an analog signal can be converted into a digital signal. Enumerate some of the advantages of digital communication.
4. What is the frequency band used in satellite communication. Why are different frequencies used to uplink and downlink signals in satellite communication?
5. Explain the term modulation. State at least 3 advantages of using modulation.
6. Why should transmitters broadcasting programmes use different carrier frequencies?
7. What is a carrier wave? Why high frequency carrier waves are employed for transmission?
8. A radio broadcast is transmitted using *amplitude modulation at a carrier frequency of 680 KHz*. Explain the meaning of each of the italicized words.
9. What is amplitude modulation? Discuss the advantages and disadvantages.
10. What is frequency modulation?
11. Why is an FM signal less susceptible to noise than an AM signal?
12. What mode of communication is employed for the transmission of TV signals? Explain why TV transmission towers are usually made very high.
13. Explain the term pulse modulation.
14. A message signal of frequency 10kHz and peak value of 10V is used to modulate a carrier of frequency 1MHz and peak voltage of 20V. Determine a) modulation index b) the side bands of the frequency spectrum.
15. What is an antenna? What role does it play in communication system? What should be the length of a dipole antenna?
16. Explain the term demodulation.
17. Explain the term FAX. Distinguish between FAX and e-mail.
18. What is a communication channel? Discuss briefly the various communication channels employed in communication.
19. A message signal has a bandwidth of 5 MHz. Which part of the atmosphere will be used for its transmission.
20. What are different modes of propagation of Radio waves?
21. Why ground wave propagation not suitable for high frequencies?
22. What is ionosphere? Explain its importance in communication.
23. Long distance radio broadcasts use short-wave bands. Why?
24. It is necessary to use satellites for long distance TV transmission. Why?
25. Attenuation can be expressed in decibels (dB) according to the equation (I/I_0) . Work out the attenuation in dB per km for a fibre in which the intensity falls by 50% over a distance of 50 km.