COMMUNICATION SYSTEMS

EARTH'S ATMOSPHERE AND ELECTROMAGNETIC WAVES

(i) The earth's atmosphere mainly consists of nitrogen 78% and oxygen 21% along with a little portion of argon, carbon-di-oxide, water vapor, hydrocarbons, sulphur compounds and dust particles.

it has been divided into various regions as given below:

(a) Troposphere

Its height of 12 km from earth's surface. The temperature in this region between 298K to 220K. All climatic changes occur in this region.

(b) Stratosphere

Its height between 12 km to 50 km after troposphere. Its temperature increases from 220K to 280K.

(c) Mesosphere

Its height between 50km to 80 km after stratosphere. Its temperature decreases from 280K to 180K.

(d) Ionosphere

Its height from 80 km to 400 km after mesosphere. Its temperature increases from 180K to 700K.

(v) Greenhouse effect

The atmosphere is transparent to visible radiations, but most infrared (heat) radiations are not allowed to pass through. The energy from the sun heats the earth which then starts emitting radiations like any other hot body. However, since the earth is much colder than sun, its radiations are mainly in the infra-red region. These radiations are unable to cross the lower atmosphere and are reflected back. Low lying clouds also reflect back the infra-red radiations. As such, the earth's surface warm at night. This phenomenon is called the Greenhouse effect.

(vi) Propagation of Radio wave

(a) Low frequency waves-the AM band:

Radio waves at frequencies from 10 meters or more wavelengths (frequency less than 30 MHz) is called the formation of the AM band. Lower atmosphere is transparent for these waves, but the ionosphere reflects them back. A signal transmitted from a fixed point to another point can be received in two possible ways - immediately after reflection from the Earth's surface (sky wave) and the ionosphere (sky wave). Waves with a frequency of about 1500 kHz (wavelengths above 200 m) are transmitted primarily through the ground because low-frequency sky waves lose their energy much quicker than sky waves. Therefore, higher frequencies are mainly transmitted through the sky. These two regions of the AM band are called medium wave and short wave band respectively.

(b)High frequency waves-Television transmission

Above the frequency of approximately 40MHz, the ionosphere reflects the earth wave. The television signal is frequency of 100-200 MHz. Thus, TV broadcasting through the sky is not possible — only direct reception through the ground is possible.
Therefore, to have larger coverage, transmission has to be done through very long antennas.

The height of transmitting antenna for TV telecast is given by

$$h = \frac{d^2}{2R_e}$$

Where, d is the radius of the area to be covered for TV telecast and Re is the radius of the Earth.

1.4. TYPE OF MODULATION

It is possible to transmit high frequency signals to long distances by superimposing on a high frequency wave which acts as carrier of the information. This process is known as modulation.

1. **For sinusoidal continuous carrier wave:** The types of modulation are

(A) Amplitude modulation (AM)

(B) Frequency modulation (FM)

(C) Phase modulation

2. **For pulsed carrier waves**: The various modes of modulation are

(A) Pulse amplitude modulation (PAM)

(B) Pulse width modulation (PWM) or pulse duration modulation

(C) Pulse position modulation (PPM)

(D) Pulse code modulation (PCM)

PCM is the preferred modulation scheme for digital communication, while others are more suited to analogy system.

1. CONTINUOUS MODULATION

(A) Amplitude modulation

When the amplitude of high frequency carrier wave is changed in accordance with the intensity of the modulating signal, it is called **amplitude modulation.** The frequency of the modulated wave is equal to carrier frequency.

Modulation Factor

The extent to which the amplitude of carrier wave is changed by the signal is described by modulation factor.

The ratio of change of amplitude of carrier wave to the amplitude of normal carrier wave is called the modulation factor or index of modulation (m)

Modulation factor, $(m) = \frac{\text{Amplitude change of carrier wave}}{\text{Amplitude of normal (unmodulated) carrier wave}}$

(B) Frequency Modulation

When the frequency of carrier wave is changed in accordance with the instantaneous value of the (modulating) signal it is called **frequency modulation**.

The modulation index for FM wave is defined as

$$m_f = \frac{\text{maximum frequency deviatory}}{\text{modulating frequency}}$$

(C) Phase Modulation (PM)

Here the phase angle ϕ of the carrier signal varies in accordance with the modulating voltage. The phase term is an angle like ωt in the equation of sinusoidal wave therefore it will be as a varying frequency.

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COMMUNICATION CHANNELS

Mainly there are two types of communication

(i) Line communication

(ii) Space communication

A new dimension recently added to the space communication is satellite communication.

Line communication: The oldest point to point communication mode is communication through wires as in earlier telephone and telegraph links. The various types of such communication channels are

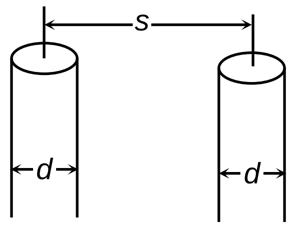
(i) Two wire transmission lines

(ii) Coaxial cables

(iii)Optical fibres

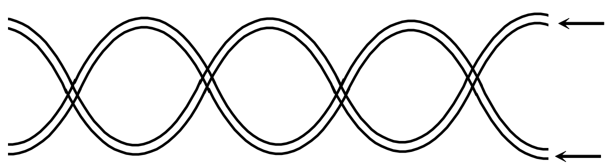
(i) Two wire transmission lines: Commonly used two-wire lines are

(a) Parallel wire lines: The parallel wire line is used where balanced properties are required.



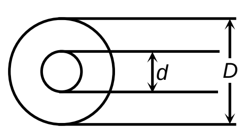
Parallel-wire

(b) Twisted pair wires lines: Twisting helps in minimizing electrical interference they cannot transmit signals over very large distances.



Twisted wire

(c) Co-axial wire lines : These wires are used when un balanced properties are needed often used to interconnect a transmitter and an earthed antenna co-axial line wires can be used for microwaves and ultra-high frequency waves (1 GHz).



Co-axial wire

System of conductors radiates *RF* energy if the conductor separation becomes appreciably approaching a wavelength half that of the operating frequency. It occurs more in the case of parallel wires than in a axial line.

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1.6 OPTICAL COMMUNICATION

There are some inherent advantages of optical communication over the conventional two-wire or cable electronic communication systems. Some of these are

(i) **Wide channel bandwidth and large channel carrying capacity** because of the use of higher frequencies - 10^{14} Hz as compared to the electronic communication links.

(ii) **Low transmission losses**. In optical fibres losses per km are less.

(iii) **Signal security and not accessible to interference**. You will see that the optical signals is confined to the inside of fibre and cannot be tempered easily. So secret information like banking, defence etc. is more secure.

Optical communication is through carrier optical signals. Easily accessible optical frequencies lie in the range 10^{12} to 10^{16} Hz. It is very high as compared to the radio frequencies (10^6 to 10^8 Hz) or microwaves (10^9 to 10^{11} Hz)

The three most important component of an optical communication link are

(i) **Optical source and modulator**: Light sources which can be modulated by our information carrying signal.

(ii) **Optical signal detector or photo detector**: The optical signal reaching the receiving end has to be detected by a detector which converts light in to electrical signal so that the transmitted information may by decoded. Semiconductor based photo detectors are used because they fulfill all the criteria required for the detector of an optical communication system.

(iii) **Cables which can carry optical signal** (light cannot travel along a metallic wire or cable) but can pass through a transparent glass, polymers or dielectric. Therefore, optical transmission line called optical fibre is made from any of these materials. Total internal reflection is the principal behind fibre optics. Light can be transmitted along it with almost no loss because of total internal reflection.

The optical fibre and fibre cables:

An optical fibre consist typically of a transparent core fibre of glass of refractive index n_1 surrounded by a transparent glass sheath or cladding of slightly lower refractive index n_2, with both enclosed in an opaque protective jacket.

or $$\sin\theta_e = \frac{\sqrt{n_1^2 - n_2^2}}{n_0}$$

where, θ_e = entrance angle on the axis of the core,

n_1 = refractive index of core,

n_2 = refractive index of cladding,

n_0 = refractive index of external medium

For air as the external medium ($n_0 = 1$), equation reduces to

$$\sin\theta_e = \sqrt{n_1^2 - n_2^2}$$