# Short Answer Questions – II (PYQ)

**Q. 1. Mention the function of any two of the following used in communication system:**

**(i) Transducer,**

**(ii) Repeater**

**(iii) Bandpass Filter [CBSE Delhi 2014, 2012, South 2016]**

**Ans. (i) Transducer:** A device which converts one form of energy into another.

**(ii) Repeater:** It picks up a signal from the transmitter, amplifies it and retransmits it to the receiver.

**(iii) Bandpass filter:** A bandpass filter rejects low and high frequencies and allows a band of frequencies to pass through.

**Q. 2. Draw a block diagram of a generalised communication system. Write the functions of each of the following: [CBSE (AI) 2017]**

**(a) Transmitter**

**(b) Channel**

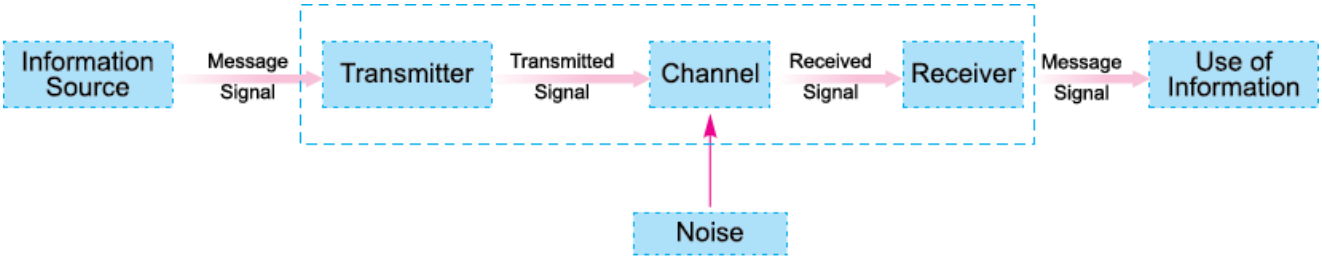
**(c) Receiver**

**Ans.** A communication system consists of three components

**(i)** Transmitter

**(ii)** Transmission channel and

**(iii)** Receiver.




**(a) Transmitter:** A transmitter is an arrangement which processes the incoming message signal so as to make it suitable for transmission through a channel and subsequent reception.

**(b) Channel:** It carries the message signal from a transmitter to a receiver.

**(c) Receiver:** A receiver extracts the desired message signals from the received signals at the channel output.

**Q. 3. Define the term modulation. Draw a block diagram of a simple modulator for obtaining AM signal. [CBSE (F) 2014]**

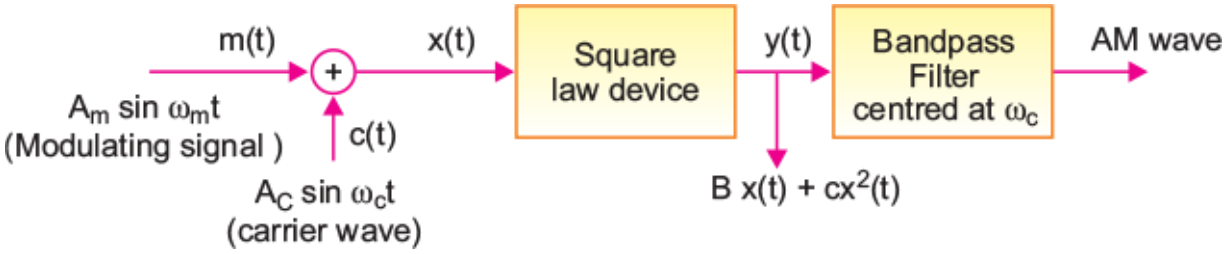
**OR**

**Draw a block diagram of a simple modulator to explain how the AM wave is produced. Can the modulated signal be transmitted as such? Explain. [CBSE Guwahati 2015, Sample Paper 2016]**

**Ans.** Modulation is the process of super imposition of low frequency message signal over a high frequency carrier wave.

**Amplitude Modulation:**

The block diagram is shown in fig.




**Explanation:**

The AM wave has to be fed to power amplifier to provide the necessary power. It is then fed to the antenna for transmission.

**Q. 4. Answer the following questions:**

**(i) How is amplitude modulation achieved?**

**(ii) The frequencies of two side bands in an AM wave are 640 kHz and 660 kHz respectively. Find the frequencies of carrier and modulating signal. What is the bandwidth required for amplitude modulation? [CBSE (AI) 2017]**

**Ans. (i)** In amplitude modulation, the amplitude of the carrier varies in accordance with the information signal. At the input of the transistor as CE, the low frequency modulating signals are superimposed on high frequency carrier wave. The output signal is carrier signal varying in amplitude in accordance with biasing modulation voltage. Thus, AM wave is produced.

For diagram refer to above question.

**(ii)** Frequencies of side bands are:

$$f_c + f_m \text{ and } f_c - f_m$$

$$\therefore \quad f_c + f_m = 660 \text{ kHz} \qquad \ldots (i)$$

$$f_c - f_m = 640 \text{ kHz} \qquad \ldots (ii)$$

Adding equations $(i)$ and $(ii)$, we get

$$2f_c = 660 \text{ kHz} + 640 \text{ kHz}$$

$$\therefore \quad f_c = 650 \text{ kHz}$$

Now, $\quad f_c + f_m = 660 \text{ kHz}$

$$\therefore \quad f_m = 660 \text{ kHz} - 650 \text{ kHz}$$

$$\therefore \quad f_m = 10 \text{ kHz}$$

Band width required for amplitude modulation = Upper side band – Lower side band

$$= (f_c + f_m) - (f_c - f_m) = 2f_m$$

$$= 2 \times 10 \text{ kHz} = 20 \text{ kHz}$$

**Q. 5. Write three important factors which justify the need of modulating a message signal. Show diagrammatically how an amplitude modulated wave is obtained when a modulating signal is superimposed on a carrier wave.**

**Three factors for the need of modulating a message signal:**

**[CBSE Delhi 2013, 2016; Panchkula 2015]**

**Ans. (i)** If λ is the wavelength of the signal then the antenna should have a length at least $\frac{\lambda}{4}$. For an electromagnetic wave of frequency 20 kHz, the wavelength λ is 15 km. Such a long antenna is not possible to construct and operate. So, there is need to modulate the wave in order to reduce the height of antenna to a reasonable height.

**(ii)** The power radiated by a linear antenna (length l) is proportional to $\left(\frac{l}{\lambda}\right)^2$. This shows that power radiated increases with decreasing λ. So, for effective power radiation by antenna, there is need to modulate the wave.

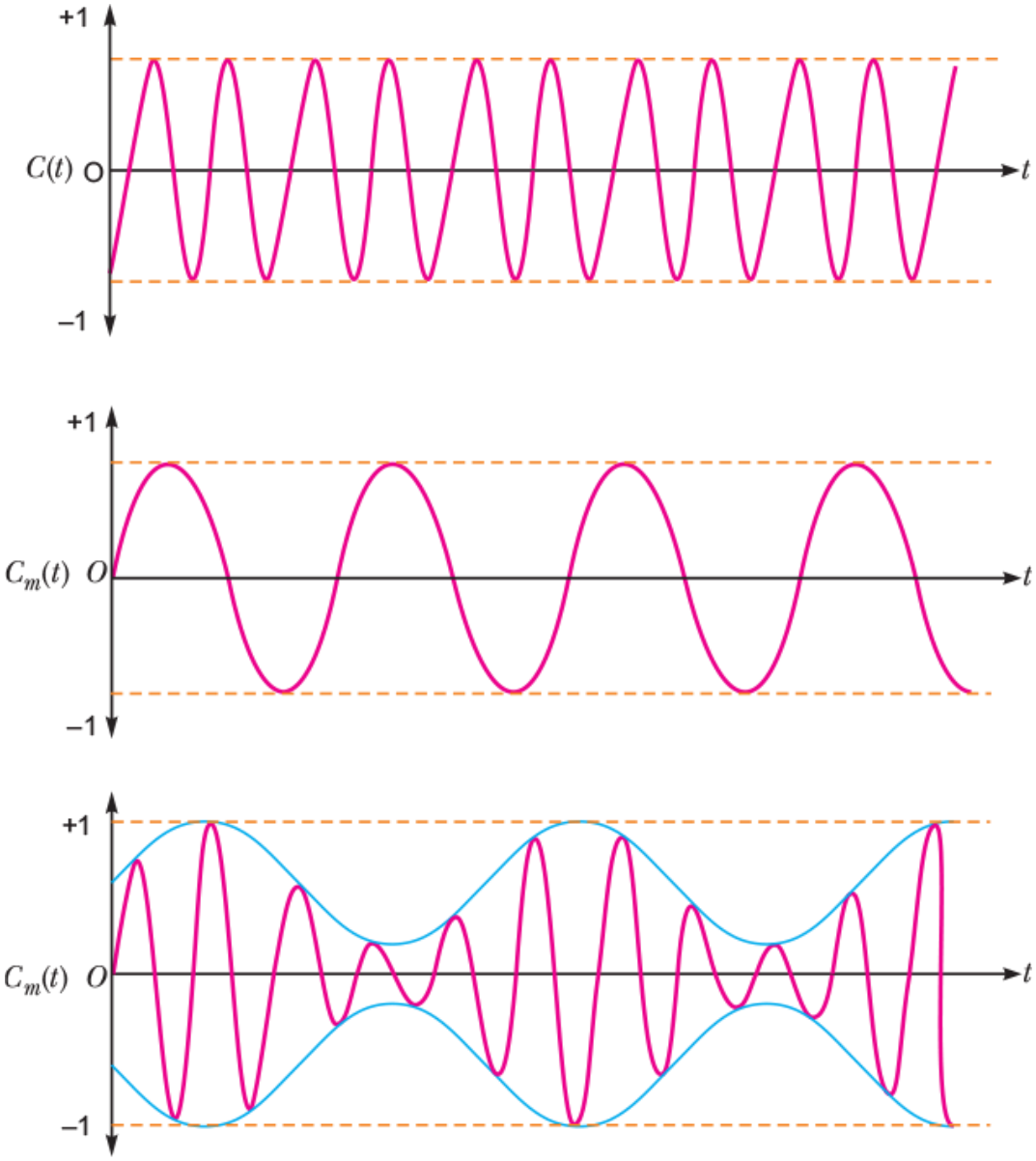
**(iii)** To avoid mixing up of signals from different transmitters.

(a) High frequency

(b) Less noise

(c) Maximum use of transmitted power

**Diagrammatic representation:**



**Q. 6. (a) Define the term 'modulation index,' used in communication system. Why is its value kept less than or equal to one?**

**(b) A message signal of frequency 10 kHz and peak voltage of 10 V is used to modulate a carrier frequency of 1 MHz and peak voltage of 10V. Determine the (i) modulation index, and (ii) side bands produced. [CBSE (F) 2017]**

**OR**

**Define modulation index. Give its physical significance. [CBSE (F) 2012]**

**Ans. Modulation index:** It is the ratio of peak value of modulating signal to the peak value of carrier wave.

$$\mu = \frac{A_m}{A_c}$$

It is kept less than or equal to 1 to avoid distortion.

**Physical significance:** It signifies the level of distortion or noise. A lower value of modulation index indicates a lower distortion in the transmitted signal.

Here, $A_m = 10\ V$, $A_c = 10\ V$

$f_m = 10\,\text{kHz}$, $f_c = 1\ \text{MHz} = 1000\ \text{kHz}$

i. Modulation index, $\mu = \frac{A_m}{A_c} = \frac{10\ V}{10\ V} = 1$

ii. $\text{USB} = f_c + f_m = 1000 + 10 = 1010\ \text{kHz}$

$\text{LSB} = f_c - f_m = 1000 - 10 = 990\ \text{kHz}$

Q. 7. Name the three different modes of propagation of electromagnetic waves. Explain, using a proper diagram the mode of propagation used in the frequency range above 40 MHz. [CBSE Delhi 2012]

**Ans.** Three mode of propagation of electromagnetic waves are:

**(i)** Ground waves

**(ii)** Sky waves

**(iii)** Space waves

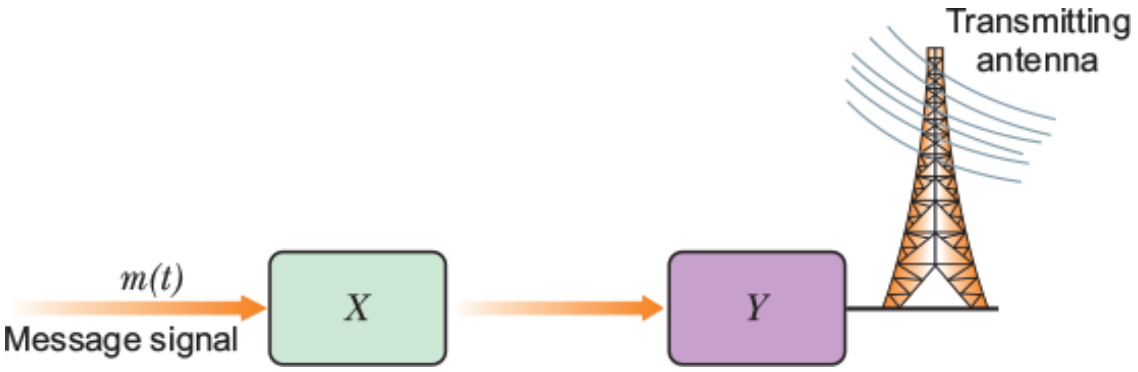
**a.** LOS (Line of Sight) communication

**b.** Satellite communication

For figure refer to Basic Concepts Point 6.

Above 40 MHz, the mode of propagation used is via space waves, a space wave travels in a straight line from the transmitting antenna to the receiving antenna. Space waves are used for the line of sight (LOS) communication as well as satellite communication.

**Q. 8. Figure shows a block diagram of a transmitter. Identify the boxes 'X' and 'Y' and write their functions. [CBSE (F) 2012]**




**Ans.** *X* → Amplitude Modulator

*Y* → Power Amplifier

**Function of *X*:** The original message signal has very small energy and dies out very soon if transmitted directly as such. Hence, these signals are modulated by mixing with very high frequency waves (carrier wave) by modulator power.

**Function of *Y*:** The signal cannot be transmitted as such because they get weaken after travelling long distance. Hence, use of power amplifier provides them necessary power before feeding the signal to the transmitting antenna.

**Q. 9. What is ground wave communication? On what factors does the maximum range of propagation in this mode depend? [CBSE (AI) 2011]**

**OR**

**What is ground wave communication? Explain why this mode cannot be used for long distance communication using high frequencies. [CBSE Patna 2015]**

**Ans.** The mode of wave propagation in which wave glides over the surface of the earth is called ground wave communication.

The maximum range of propagation in this mode depends on

**(i)** Transmitted power and

**(ii)** Frequency (less than a few MHz)

At high frequencies, the rate of energy dissipation of the signal increases and the signal gets attenuated over a short distance.

**Q. 10. What is sky wave propagation? Which frequency range is suitable for sky wave propagation and why? Over which range of frequencies can communication through free space using radio waves takes place? [CBSE (F) 2017]**

**Ans.** A radio wave directed towards the sky and reflected by the ionosphere towards the desired location of the earth is called a sky wave.

The radio waves of frequency range 3 MHz to 30 MHz are suitable for sky wave propagation.

This range of frequencies are reflected by the ionosphere towards the earth. The electromagnetic wave of frequencies higher than 30 MHz penetrates the ionosphere and are not reflected back.

**Q. 11. What is space wave communication? Write the range of frequencies suitable for space wave communication. State the factors which limit its range of propagation. Give two examples of space wave mode of propagation is used. [CBSE Delhi 2013, (AI) 2011, (F) 2014, 2017; North 2016]**

**Ans. Space Wave Propagation:** The mode of propagation in which radio waves travel, along a straight line, from the transmitting to the receiving antenna.

**Frequency Range:** Above 40 Mhz

Space wave propagation is used in:

**(i)** Television broadcast

**(ii)** Microwave link

**(iii)** Satellite communication

**Limiting Factors**

**(i)** Curvature of the earth

**(ii)** Insufficient height of the receiving antenna

**(iii)** LOS distance (> 40 MHz) travel in straight line

**Q. 12. What does the process of detection of amplitude modulated wave mean?**

**The amplitude modulated carrier wave of angular frequency $\omega_c$, $(\omega_c + \omega_m)$ and $(\omega_c - \omega_m)$, where $\omega_m$ is the angular frequency of the modulating signal. Discuss, in brief, with the help of a block diagram the essential details of a simple method used for 'detecting' the modulating signal from this modulated carrier wave.**

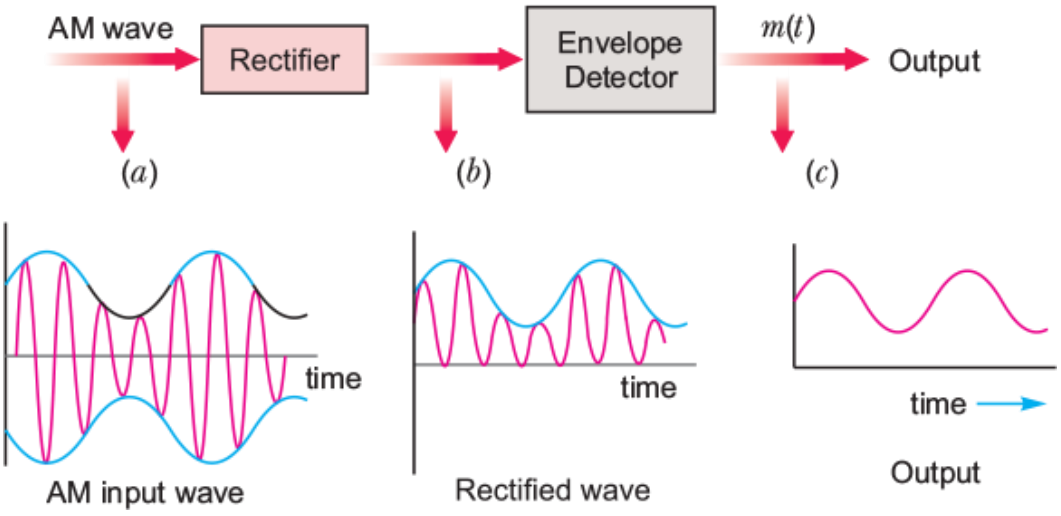
**OR**

**Draw a block diagram of a detector for AM signal and show, using necessary processes and the waveforms, how the original message signal is detected from the input AM wave. [CBSE Delhi 2015]**

**Ans.** Detection is the process of recovery of the modulating signal from the modulated carrier wave.

The amplitude modulated carrier wave contains waves of frequencies $\omega_c$, $\omega_c + \omega_m$ and $\omega_c - \omega_m$.

The block diagram of a simple method is shown below:




In order to obtain the original message signal $m(t)$ of angular frequency $\omega_m$.

The modulated signal [form (*a*)] is passed through a rectifier to produce the output shown in fig. (*b*). The envelope of signal (*b*) is the message signal. This is separated by passing it through envelope detector (which may consist of simple R.C. circuit).

**Q. 13. Answer the following questions:**

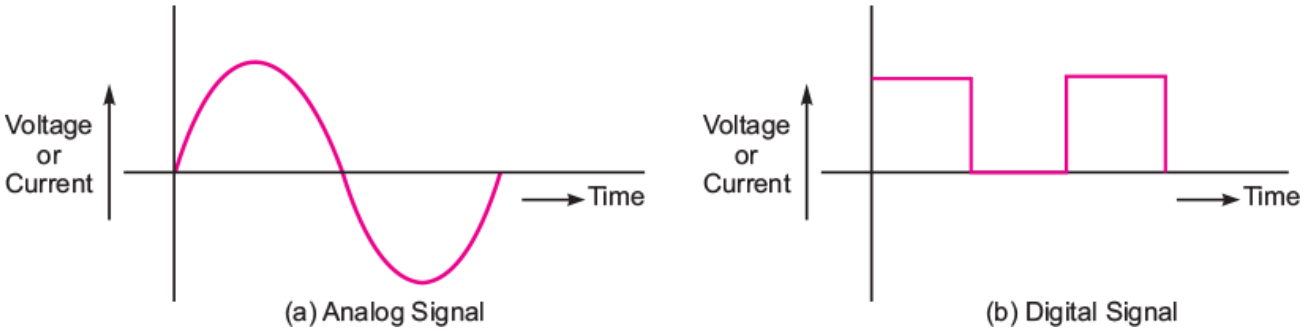
**(i) Distinguish between 'Analog and Digital signals'. [CBSE Delhi 2012, Panchkula 2015]**

**(ii) Explain briefly two commonly used applications of the internet.**

**Ans. (i)** A signal that varies continuously with time (e.g., sine wave form) is called an analog signal.

A signal that is discrete is called a digital signal. The presence of signal is denoted by digit 1 and absence is denoted by digit 0.

These are represented by




**(ii)** Uses of Internet: email, e-banking, e-shopping, e-ticketing, chatting, surfing, file transfer, etc

**Q. 14. By what percentage will the transmission range of a TV tower be affected when the height of the tower is increased by 21%? [CBSE Delhi 2009]**

**Ans.** Transmission range of TV tower

$$d = \sqrt{2hR}$$

If height is increased by 21%, new height

$$h' = h + \frac{21}{100}h = 1.21\,h$$

If $d'$ is the new average range, then $\frac{d'}{d} = \sqrt{\frac{h'}{h}} = 1.1$

$$\%\text{ increase in range } \frac{\Delta d}{d} \times 100\% = \left(\frac{d' - d}{d}\right) \times 100\%$$

$$= \left(\frac{d'}{d} - 1\right) \times 100\%$$

$$= (1.1 - 1) \times 100\% = \mathbf{10\%}$$

**Q. 15. Give reasons for the following:**

**(i) For ground wave transmission, size of antenna should be comparable to the wavelength of the signal, e.g., ~λ/4. [CBSE (F) 2013]**

**(ii) Audio signals converted into electromagnetic waves are not transmitted as such directly.**

**(iii) The amplitude of modulating signal is kept less than that of the carrier wave.**

**Ans. (i)** Ground wave propagation is possible for radio waves of frequency band 540kHz – 1600 kHz (or max. 2 MHz)

If a base band signal of frequency 20 kHz, wavelength of the wave must be λ = 15 km, obviously antenna of size l = 3.75 km is not possible to construct and operate.

If base band signals are translated into high frequency radio wave of frequency v > 1MHz, then antenna of few metre can be constructed and can be used in sending the information along the ground.

Low size of the antenna is required for waves of short wavelength and hence comparable.

**(ii)** Audio signals of large wavelength cannot be sent directly, because large size antenna is required.

**(iii)** Modulation index, μ = $\frac{V_m}{V_C}$, and its value should be less than 1, otherwise distortion will be produced in the wave.

**Q. 16. A carrier wave of frequency 1.5 MHz and amplitude 50 V is modulated by a sinusoidal wave of frequency 10 kHz producing 50% amplitude modulation. Calculate the amplitude of the AM wave and frequencies of the side bands produced.**
**[CBSE Allahabad 2015]**

**Ans.**

$\mu = 50\% = \frac{1}{2}$

Since $\mu = \frac{A_m}{A_c}$

$\frac{1}{2} = \frac{A_m}{50V}$

$A_m = \mathbf{25\ V}$

Frequency of LSB = $\mu_c - \mu_m$

= 1.5 MHz – 10 KHz = 1.5 MHz – 0.01 MHz

= **1.49 MHz**

Frequency of USB = $D_c + v_m$

= 1.5 MHz – 0.01 Mhz = **1.51 MHz**

**Q. 17. A signal of 5 kHz frequency is amplitude modulated on a carrier wave of frequency 2 MHz. What are the frequencies of the side bands produced? [CBSE North 2016]**

**Ans.** $\nu_{sidebands} = \nu_c \pm \nu_m$

Maximum frequency = 5kHz + 2 MHz = $5 \times 10^3 + 2 \times 10^6 = (5 + 2000) \times 10^3$

= $2005 \times 10^3$ Hz = 2005 kHz

Minimum frequency = 2MHz – 5kHz = $2 \times 10^6 - 10^3 = (200 - 5) \times 10^3$

= $1995 \times 10^3$ Hz = 1995 kHz

## Short Answer Questions – II (OIQ)

**Q. 1. What is amplitude modulation? Write its two limitations and two advantages.**

**Ans.** Amplitude modulation is the process in which amplitude of modulated wave (carrier & information signal) varies in accordance with the amplitude of information signal wave.

**Limitations:**

**(i)** Amplitude modulation is noisy.
**(ii)** It cannot be used for high frequency carrier waves *e.g.*, TV broadcasting.

**Advantages:**

**(i)** Production and reception of AM waves is convenient.
**(ii)** It is cheaper.

**Q. 2. We do not choose to transmit an audio signal by just directly converting it to an e.m. wave of the same frequency. Give two reasons for the same.**

**Ans. (i)** Size of Antenna: For efficient transmission and reception of a signal, the height of the antenna must be $\frac{\lambda}{4}$. For example, the height of the antenna of an audio signal of frequency 15 kHz,

$$h = \frac{\lambda}{4} = \frac{1}{4} \times \frac{c}{\nu} = \frac{1}{4} \times \frac{3 \times 10^8}{15 \times 10^3} = 5000\ m$$

Which is impossible.

**(ii)** Simultaneous transmission of signals by different transmitters can overlap, thus causing the disturbance at the receiver end.

**Q. 3. Explain briefly the principle of transmitting signals using a satellite. State two main advantages of using a satellite for transmitting signals.**

**Ans. Principle of transmitting signals using a satellite:** The radio or TV signals are directed to the communication satellite from a point on earth. The transponder receives the signal and reflects it towards the earth which is caught by receiving antenna. Thus, the signal gets transmitted from one place to the other.

(For diagram, refer to Point 6 of Basic Concepts)

**Main advantages of satellite communication**

**(i)** The high frequency signals which are not reflected by ionosphere may be transmitted by satellite.

**(ii)** Satellite communication has a very wide coverage range.

**Q. 4. Answer the following questions:**

**(i) A TV transmitter has a range of 50 km. What is the height of the TV transmission tower? Radius of earth $R_e = 6.4 \times 10^6$ m**

**(ii) A TV tower has a height of 500 m at a given place. If radius of earth is 6400 km, what is it coverage range?**

**Ans. (i)** Here $d$ = 50 km = $50 \times 10^3$m

$$\therefore \text{ Height of TV transmission tower } h = \frac{d^2}{2R_e} = \frac{(50\times10^3)^2}{2\times6.4\times10^6} = 195.3 \text{ m}$$

**(ii)** Coverage range of TV tower

$$d = \sqrt{2R_e h} = \sqrt{2 \times 6400 \times 10^3 \times 500}$$

$$= \sqrt{2 \times 6.4 \times 10^6}\,(\sqrt{32} + \sqrt{50})$$

$$= 80 \times 10^3\text{m} = \mathbf{80km}$$

**Q. 5. An optical communication system is operating at wavelength 800 nm. If only 1% of the optical source frequency is used as channel band width for optical communication; then find the number of channels that can be accommodated for transmitting (i) audio signals requiring a band width of 8 kHz and (ii) Video TV signals requiring a band width of 4.5 MHz.**

**Support your answer with suitable calculations.**

**Ans.**

Optical source frequency, $\nu = \frac{c}{\lambda} = \frac{3\times10^{8}}{800\times10^{-9}} = 3.75 \times 10^{14}\,\text{Hz}$

Bandwidth of channel = 1% of $3.75 \times 10^{14}$ Hz

$$= \frac{1}{100} \times 3.75 \times 10^{14} = 3.75 \times 10^{14} = 3.75 \times 10^{12}\,\text{Hz}$$

i. Number of channels for audio signal $= \frac{3.75\times10^{12}}{8\times10^{3}} = 4.7 \times 10^{8}$

ii. Number of channels for video TV signal $= \frac{3.75\times10^{12}}{4.5\times10^{6}} = 8.3 \times 10^{5}$

Thus, optical communication may transmit a very large number of channels simultaneously.

**Q. 6. What would be the modulation index for an amplitude modulated wave for which the maximum amplitude is 'a' while the minimum amplitude is 'b'? [HOTS]**

**Ans.**

Modulation index, is given by

$$a_m = \frac{E_m}{E_c} \qquad \ldots(i)$$

Maximum amplitude of modulated wave

$$a = E_c + E_m \qquad \ldots(ii)$$

Minimum amplitude of modulated wave

$$b = E_c - E_m \qquad \ldots(iii)$$

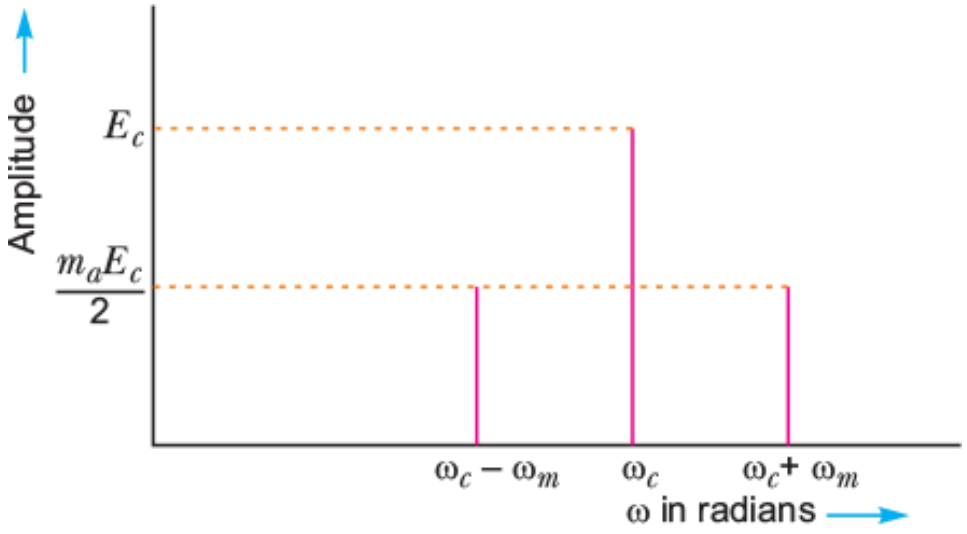
From $(ii)$ and $(iii)$, $E_c = \frac{a+b}{2}$, $E_m = \frac{a-b}{2}$

$\therefore$ From $(i)$, modulation index,

$$a_m = \frac{E_m}{E_c} = \frac{(a-b)/2}{(a+b)/2} = \frac{a-b}{a+b}$$

**Q. 7. Draw a plot of variation of amplitude versus ω for an amplitude modulated wave. Define modulation index. State its importance for effective amplitude modulation.**
**[HOTS]**

**Ans.** Plot of variation of amplitude versus ω for amplitude modulated wave is shown in figure.



Modulation Index: The ratio of amplitude of modulating signal to the amplitude of carrier wave is called modulation index, i.e., ma = $\frac{E_m}{E_c}$

For effective amplitude modulation, the modulation index determines the distortions, so its value is kept ≤ 1 for avoiding distortions.

**Q. 8. A ground receiver station is receiving signals at (i) 5 MHz and (ii) 100 MHz, transmitted from a ground transmitter at a height of 300 m located at a distance of 100 km. Identify whether the signals are coming via space wave or sky wave propagation or satellite transponder. Radius of earth = 6400 km; maximum electron density in ionosphere, $N_{max} = 10^{12} m^{-3}$. [HOTS]**

**Ans.**

Maximum coverage range of transmitting antenna, $d = \sqrt{2R_e h}$

Given, $R_e$ = 6400 km = 6400 $\times 10^3$m, $h$ = 300m

$$\therefore \quad d = \sqrt{2 \times 6400 \times 10^3 \times 300} = 6.2 \times 10^4 m = 62\,\text{km}$$

The receiving station (situated at 100 km) is out of coverage range of transmitting antenna, so space wave communication is not possible, in both cases (*i*) and (*ii*) The critical frequency (or maximum frequency) of ionospheric propagation is $f_c = 9\sqrt{N_{\max}} = 9 \times \sqrt{10^{12}} = 9 \times 10^6\,\text{Hz} = 9\,\text{MHZ}$

Signal (*i*) of 5 MHz (< 9 MHz) is coming via ionosphere mode or sky wave propagation, while signal (*ii*) of 100 MHz is coming via satellite mode.

**Q. 9. A (sinusoidal) carrier wave**

**$C(t) = A_C \sin \omega_c t$**

**Is amplitude modulated by a (sinusoidal) message signal**

**$m(t) = A_m \sin \omega m t$**

**Write the equation of the (amplitude) modulated signal.**

**Use this equation to obtain the values of the frequencies of all the sinusoidal waves present in the modulated signal.**

**Ans.** The equation of the (amplitude) modulated signal is

$$C_m(t) = [(A_c + A_m \sin \omega_m t)] \sin \omega_c t$$

This can be rewritten as

$$C_m(t) = [A_c (1 + \mu \sin \omega_m t)] \sin \omega_c t$$

Where $\mu = \frac{A_m}{A_c}$ = modulation index

$$\therefore \quad C_m(t) = A_c \sin \omega_m t + \frac{\mu A_c}{2} 2 \sin \omega_m t \,.\, \sin \omega_c t$$

$$= A_c \sin \omega_c t + \frac{\mu A_c}{2} [\cos (\omega_c - \omega_m) t - \cos (\omega_c + \omega_m) t]$$

These are the three sinusoidal waves present in the amplitude modulated signal.

The frequencies of these three waves are

$$f_1 = \frac{\omega_c}{2\pi}, \quad f_2 = \frac{\omega_c - \omega_m}{2\pi} \text{ and } f_3 = \frac{\omega_c + \omega_m}{2\pi}$$