CBSE Class 12 physics
Important Questions
Chapter 15
Communication Systems

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1 Mark Questions

1.Name the type of the communication system in which the signal is discrete and binary coded version of message or information?
Ans. Digital communication.

2.What is the purpose of modulating a signal in transmission?
Ans. Modulation is done because low frequency signal cannot be transmitted to a longer distance so in order to increase the range of transmission modulation is done.

3.What is the requirement of transmitting microwaves form one position to another on the earth?
Ans. The transmitting and receiving antenna must be in the line of sight.

4.A T.V. tower has a height of 300m. What is the maximum distance up to which the T.V transmission can be received?
Ans. $d = \sqrt{2Rh} = \sqrt{2 \times 6400 \times 1000 \times 300}$

$d = 62km.$

5.Why ground wave propagation is not suitable for high frequencies?
Ans. Ground waves are not suitable for propagation high frequencies because signals having frequency more than 1500 KHz are greatly absorbed by the surface of the earth and cannot be transmitted.

6.What type of modulation is used for commercial broadcast of voice signal?
Ans. Amplitude Modulation.

2 Mark Questions

1. A signal jumps from one level to another instantaneously. What will be its frequency?

Ans. It means that signal jumps form one level to another in no time so its frequency will be infinite.

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2. Sky has no limit but sky wave propagation has its limit. Explain why?

Ans. Sky wave propagation is due to the reflection of radio waves by the ionosphere but high frequency waves gets absorbed by the ionosphere and cannot be reflected by the ionosphere.

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3. A transmitting antenna has a height of 50m. If radius of the earth is taken as 6250 km. find the area covered by it?

Ans. $d = \sqrt{2rh}$

$d = \sqrt{2 \times 6250 \times 50 \times 10^3}$

$d = 2.5 \times 10^4 m$

Area covered $= \pi d^2 = 3.14 \times (2.5 \times 10^4)^2$

Area covered $= 1963 km^2$

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4. What is the role of F_2 layer in communication?

Ans. F_2 is the topmost layer of ionosphere. Its height is upto 400km and is called as a reflecting layer for high frequency radio wave.

5.A carrier wave of peak voltage 12V is used to transmit a message signal. What should be the peak voltage of the modulating signal in order to have a modulation index of 75%?

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

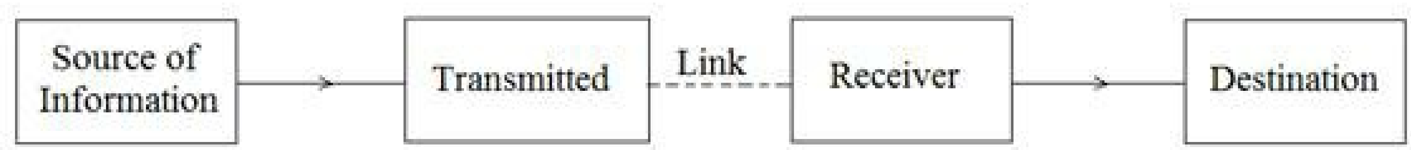
$A_m = \mu \times A_c$

$A_m = \frac{75}{100} \times 12$

$A_m = 9V$

6.Give the set up of a basic communication system?

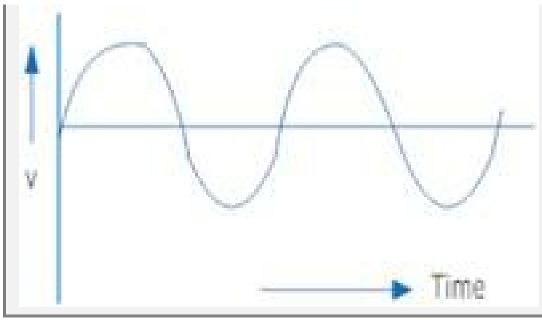
Ans. Basic communication system consist of an information source, a transmitter, a link and a receiver.

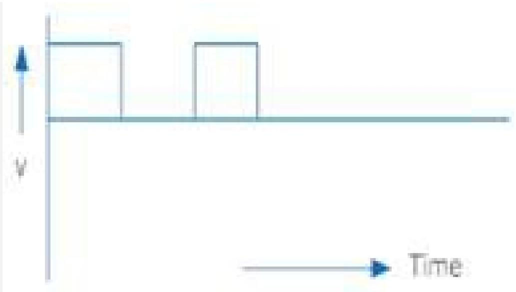


7.Distinguish between analog and digital communication?

Ans.

Analog communication	**Digital communication**
(1) In analog communication analog signal is used which continuous varies with time. (2)	(1) In digital communication digital signal is used which has only two levels i.e. high and low. (2)





8.Which of the following frequencies will be suitable for beyond-the-horizon communication using sky waves?

(a) 10 kHz

(b) 10 MHz

(c) 1 GHz

(d) 1000 GHz

Ans.(b) 10 MHz

Forbeyond-the-horizon communication, it is necessary for the signal waves to travel a large distance. 10 KHz signals cannot be radiated efficiently because of the antenna size. The high energy signal waves (1GHz - 1000 GHz) penetrate the ionosphere. 10 MHz frequencies get reflected easily from the ionosphere. Hence, signal waves of such frequencies are suitable for beyond-the-horizon communication.

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9. Frequencies in the UHF range normally propagate by means of:

(a) Ground waves.

(b) Sky waves.

(c) Surface waves.

(d) Space waves.

Ans.(d) Space waves

Owing to its high frequency, an ultra high frequency (UHF)wave can neither travel along the trajectory of the ground nor can it get reflected by the ionosphere. The signals having UHF are propagated through line-of-sight communication, which is nothing but space wave propagation.

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10. Digital signals

(i) Do not provide a continuous set of values,

(ii) Represent values as discrete steps,

(iii) Can utilize binary system, and

(iv) Can utilize decimal as well as binary systems.

Which of the above statements are true?

(a) (i) and (ii) only

(b) (ii) and (iii) only

(c) (i), (ii) and (iii) but not (iv)

(d) All of (i), (ii), (iii) and (iv).

Ans. (c) A digital signal uses the binary (0 and 1) system for transferring message signals. Such a system cannot utilise the decimal system (which corresponds to analogue signals). Digital signals represent discontinuous values.

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11. Is it necessary for a transmitting antenna to be at the same heightas that of the receiving antenna for line-of-sight communication? A TV transmitting antenna is 81m tall. How much service area can it cover if the receiving antenna is at the ground level?

Ans. Line-of-sight communication means that there is no physical obstruction between the transmitter and the receiver. In such communications it is not necessary for the transmitting and receiving antennas to be at the same height.

Height of the given antenna, h = 81 m

Radius of earth, R = 6.4×10^6 m

For range, $d = (2Rh)\frac{1}{2}$, the service area of the antenna is given by the relation:

$A = \pi d^2$

$= \pi \ (2Rh)$

$= 3.14 \times 2 \times 6.4 \times 10^6 \times 81$

$= 3255.55 \times 10^6 \ m^2$ = 3255.55

$\sim 3256 m^2$

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12. A carrier wave of peak voltage 12 V is used to transmit a message signal. What should be the peak voltage of the modulating signal in order to have a modulation index of 75%?

Ans. Amplitude of the carrier wave, A_c = 12 V

Modulation index, m = 75% = 0.75

Amplitude of the modulating wave = A_m

Using the relation for modulation index:

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

$$A_m = mA_c$$

$$= 0.75 \times 12 = 9V$$

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13. For an amplitude modulated wave, the maximum amplitude is found to be 10 V while the minimum amplitude is found to be 2 V. Determine the modulation index μ . What would be the value of μ if the minimum amplitude is zero volt?

Ans. Maximum amplitude, A_{max} = 10 V

Minimum amplitude, $A_{\min}$ = 2 V

Modulation index μ, is given by the relation:

$$\mu = \frac{A_{\max} - A_{\min}}{A_{\max} + A_{\min}}$$

$$= \frac{10-2}{10+2} = \frac{8}{12} = 0.67$$

If $\mathbf{A_{min}} = 0$

Then $\mu = \frac{A_{\max}}{A_{\max}} = \frac{10}{10} = 1$

3 Mark Questions

1. Define the term modulation index for A.M. wave. What would be the modulation index for an A.M. wave for which the maximum amplitude is 'a' write the minimum amplitude is 'b'?

Ans. Modulation index is the ratio of amplitude E_m of caries wave to the amplitude E_c of carries (original) wave.

i.e. $\mu = \frac{E_m}{E_c}$

Here Maximum Amplitude $a = E_c + E_m$

Minimum Amplitude $b = E_c - E_m$

$$\Rightarrow E_c = \frac{a+b}{2} \text{ and } E_m = \frac{a-b}{2}$$

$$\Rightarrow \mu = \frac{a-b}{a+b}$$

2. A T.V. tower has a height of 80m. By how much the height of tower be increased to triple its coverage?

Ans. Here $h_1 = 80m$

$$d_1 = \sqrt{2h_1R} = \sqrt{2\times80\times R} = \sqrt{160R}$$

$$d_2 = \sqrt{2h_2R} = 3d_1$$

$$\sqrt{2h_2R} = 3\sqrt{160R}$$

$$\Rightarrow h_2 = 720m$$

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3. An audio signal of amplitude one half of the carries amplitude is employed in amplitude modulation. What is the modulation index? Hence define amplitude modulation?

Ans. $E_m = 0.5\ E_c$

$$E_{max} = E_m + 0.5\ E_c = 1.5\ E_c$$

$$E_{min} = E_m - 0.5\ E_c = 0.5\ E_c$$

$$\mu = \frac{E_{\max} - E_{\min}}{E_{\max} + E_{\min}} = \frac{1.5E_c - 0.5E_c}{1.5E_c + 0.5E_c}$$

$$\mu = 0.5$$

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4. An audio signal of 32kHz modulates a carrier of frequency 84MHz and produces a frequency deviation of 96kHz.

Find (a) frequency modulation index

(b) frequency range of the frequency modulated wave?

Ans. $fm = 3.2KHz$

$fc = 34MHz$

$\delta = 96KHz$

(a) Frequency modulated index

$$mf = \frac{\delta}{fm} = \frac{96}{3.2} = 30$$

(b) Frequency range of the modulated wave

$= fc \pm fm$

$= 84 \times 10^3 \pm 3.2KHz$

=83.997MHz to 84.003MHz

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5. Define the following terms

(a) Ground wave propagation

(b) Space wave propagation

(c) Sky wave propagation

Ans.(a) **Ground wave propagation** – Radio travel along the surface of the earth and are called ground waves and the propagation along the surface of the earth is called ground wave propagation. It is limited to a frequency below 1.5 MHz

(b) **Space wave propagation** – The radio waves which are reflected back to the earth by ionosphere are known as sky waves and this mode of propagation of sky waves is known as sky wave propagation.

(c) **Space wave propagation** – High frequency waves which cannot be reflected back to the earth by transmitting antenna to receiving antenna by the mode called line of sight communication. It is also called as space wave propagation.

6. Which two communication methods make use of space wave propagation method? If the sum of the heights of transmitting and receiving antenna is line of sight communication is fixed at h, show that the range is maximum when the two antenna have a height $\frac{h}{2}$ each?

Ans. Satellite communication and line of sight (LOS) communication make use of space waves.

Now $d_1 = \sqrt{2Rh_1}$

$d_2 = \sqrt{2Rh_2}$

For maximum range

$d_m = \sqrt{2Rh_1} + \sqrt{2Rh_2}$

$d_m = d_1 + d_2 = d$

Given $h_1 + h_2 = h$

Let $h_1 = x$ then $h_2 = h - x$

$d_m = \sqrt{2Rx} + \sqrt{2R(h-x)}$

Differentiating wr.t x

$$\frac{dd_m}{d_x} - \sqrt{\frac{R}{2x}} = \sqrt{\frac{R}{2(h-x)}} = 0 i.e. \frac{1}{2x} = \frac{1}{2(h-x)}$$

$$\Rightarrow x = \frac{h}{2} \Rightarrow h_1 = h_2 = \frac{h}{2}$$

7. A frequency modulated wave is represented by an equation.

Find (1) carrier frequency

(2) modulating signal frequency

(3) Power dissipated if load resistor is of 100 Ω ?

Ans. Given e = 10 sin $\left(5\times10^{8}++6\sin 1000t\right)$

Compare if with general equation

e = E sin (w_ct + m_f sin w_mt)

Carries frequency $\nu_c=\frac{w_c}{2\pi}=\frac{5\times10^{8}}{2\times3.14}$

$\nu_c=79.62MHz$

Modulating signal frequency

$$\nu_m=\frac{Wm}{2\pi}=\frac{100}{2\times3.14}=15.92Hz$$

Power dissipated $P=\frac{(Erms)^2}{R}=\frac{\left(\frac{10}{\sqrt{2}}\right)^2}{100}=0.5\ Watts$

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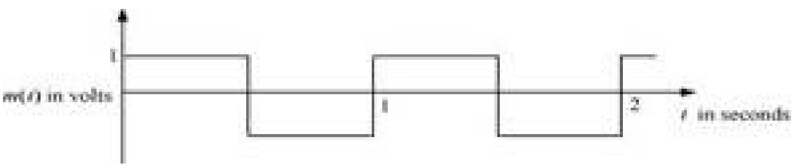
8. A modulating signal is a square wave, as shown in Fig. 15.14.



The carrier wave is given by $c(t)=2\sin(8\Omega t)volts.$

(i) Sketch the amplitude modulated waveform

(ii) What is the modulation index?

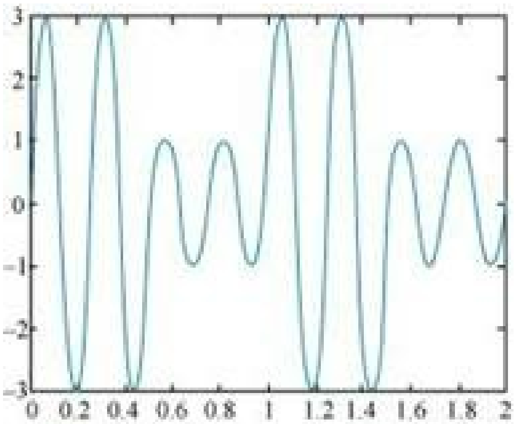
Ans. It can be observed from the given modulating signal that the amplitude of the modulating signal, *A*m= 1 V

It is given that the carrier wave $c(t) = 2\ sin\ (8nt)$

∴Amplitude of the carrier wave, *A*c= 2 V

Time period of the modulating signal *T*m= 1 s

The angular frequency of the modulating signal is calculated as:



$$(t)_m = \frac{2\pi}{T_m}$$

$= 2\pi rad s^{-1}$ ....(i)

The angular frequency of the carrier signal is calculated as:

$(t)_c = 2\pi$ rad s^{-1} ....(ii)

From equations (*i*) and (*ii*), we get:

$(t)_c = 4(t)_m$

The amplitude modulated waveform of the modulating signal is shown in the following figure.

(ii) Modulation index, $m = \frac{A_m}{A_c} = \frac{1}{2} = 0.5$

9.Due to economic reasons, only the upper sideband of an AM wave is transmitted, but at the receiving station, there is a facility for generating the carrier. Show that if a device is available which can multiply two signals, then it is possible to recover the modulating signal at the receiver station.

Ans. Let ω_c and ω_s be the respective frequencies of the carrier and signal waves.

Signal received at the receiving station, $V = V_1 \cos(\omega_c + \omega_s)t$

Instantaneous Voltage of the carrier wave, $V_{in} = V_c \cos \omega_c t$

$$\therefore VV_{in} = V_1 \cos(\omega_c + \omega_s)t.(V_c \cos \omega_c t)$$

$$V_1V_c = [\cos(\omega_c + \omega_s)t.\cos \omega_c t]$$

$$\frac{V_1V_c}{2} = [2\cos(\omega_c + \omega_s)t.\cos \omega_c t]$$

$$\frac{V_1V_c}{2} = [\cos\{(\omega_c + \omega_s)t + \cos \omega_c t\} + \cos\{(\omega_c + \omega_s)t - \omega_c t\}]$$

$$\frac{V_1V_c}{2} = [\cos\{(2\omega_c + \omega_s)t + \cos \omega_s t\}]$$

At the receiving station, the low-pass filter allows only high frequency signals to pass through it. Obstructs the low frequency signal ω_s . Thus, at the receiving station, one can record the modulating signal $\frac{V_1V_c}{2}\cos \omega_s t$, which is the signal frequency.