NCERT SOLUTIONS
CLASS-XII PHYSICS
CHAPTER-15
COMMUNICATION SYSTEM

Q.1: For beyond – the – horizon communication, which of the following frequencies will be suitable using sky waves?

(1) 10 kHz

(2) 10 MHz

(3) 1 GHz

(4) 1000 GHz
Soln:

(2) 10 MHz

The signal waves needs to travel a large distance for beyond – the – horizon communication.

Because of the antenna size the 10 kHz signals cannot be radiated efficiently.

The 1 GHz – 1000 GHz (high energy) signal waves penetrate the ionosphere.

The 10 MHz frequencies get reflected easily from the ionosphere. Therefore, for beyond – the – horizon communication signal waves of 10 MHz frequencies are suitable.

Q.2: Frequencies in the UHF range normally propagate by means of :

(1) Ground Waves

(2) Sky Waves

(3) Surface Waves

(4) Space Waves

Soln:

(4) Space Waves

Due to its high frequency, an ultra high frequency (UHF) wave can cannot travel along the trajectory of the ground also it cannot get reflected by the ionosphere. The ultra high frequency signals are propagated through line – of – sight communication, which is actually space wave propagation.

Q.3: Digital signals

(i) Do not provide a continuous set of values

(ii) Represent value as discrete steps

(iii) Can utilize binary system

(iv) Can utilize decimal as well as binary systems

State which statement(s) are true ?

(a) (1), (2) and (3)

(b) (1) and (2) only

(c) All statements are true

(d) (2) and (3) only

Soln:

(a) For transferring message signals the digital signals uses the binary (0 and 1) system. Such a system cannot utilise the decimal system. Discontinuous values are represented in digital signals.

Q.4: For line – of – sight communication, is it necessary for the receiving antenna to be at the same height as that of transmitting antenna? A TV transmitting antenna is at a height of 81 m. If the receiving antenna is at ground level, how much of the service area the transmitting antenna can cover?

Soln: In line – of – sight communication, between the transmitter and the receiver there is no physical obstruction. So, there is no need for the transmitting and receiving antenna to be at the same height.

Height of the antenna, h = 81m

Radius of earth, R = 6.4×10^6m

d = 2Rh, for range

The service area of the antenna is given by the relation :

$A = nd^2 = n(2Rh)$

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

$= 3255.55 \times 10^6\ m^2$ = 3255.55 **= 3256 km^2**

Q.5: For transmitting a message signal a carrier wave of peak voltage 12v is used. In order to have a modulation index of 75% what should be the peak voltage of the modulating signal?

Soln:

Given:

Amplitude of carrier wave, A_c = 12v

Modulation index, m = 75% = 0.75

Amplitude of the modulating wave = A_m

Modulation index is given by the relation :

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

Therefore, $A_m = m.A_c$

= 0.75 x 12 **= 9v**

Q.6: A modulating signal is a square wave, as shown in the figure.

The carrier wave is given by

(1) Sketch the amplitude modulated waveform

(2) What is the modulation index.

Soln:

The amplitude of the modulating signal, A_m = 1v can be easily observed from the given modulating signal.

Carrier wave is given by, c(t) = 2 sin(8nt)

Amplitude of the carrier wave, A_c = 2v

Time period, T_m = 1s

The angular frequency of the modulating signal is given by,

$\omega_m = \frac{2\pi}{T_m}$

= 2π rad s^{-1} ...(1)

The angular frequency of carrier signal, $\omega_c = 8\pi$ rad s^{-1} ...(2)

from eqns.(1) and (2),

we get, $\omega_c = 4\omega_m$

The modulating signal having the amplitude modulated waveform is shown in the figure:

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

Q.7: For a wave having amplitude modulation, the minimum amplitude is found to be 2V and maximum aplitude is found to be 10V. Find the modulation index μ. If the minimum amplitude is 0V, what would be the value of μ?

Soln:

Given,

Max. Amplitude, A_{max} = 10v

Min. Amplitude, A_{min} = 2v

For a wave, modulation index μ, is given by :

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

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

If A_{min} = 0,

Then,

μ = $\frac{A_{max}}{A_{min}}$ = 10/10 = 1

Q.8: During the transmission of AM wave, only the upper sideband is transmitted. But, at the receiving station, generation of carrier can be done. 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.

Soln: Let, ω_c be the carrier wave frequency

ω_s be the signal wave frequency

Signal received, V = V_1 cos (ω_c + ω_s)t

Instantaneous voltage of the carrier wave, V_m = V_c cos ω_ct

V.V_{in} = V_1cos(ω_c + ω_s)t. (V_c cos ω_ct)

= V_1V_c [cos(ω_c + ω_s)t . cos ω_ct]

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

The low pass filter allows only the high frequency signals to pass through it. The low frequency signal ω_s is obstructed by it.

Thus, at the receiving station, we can record the modulating signal, $\frac{V_1V_c}{2}[\cos{(2\omega_c+\omega_s)t}+\cos{\omega_s t}]$ which is the signal frequency.