

## CBSE NCERT Solutions for Class 12 Physics Chapter 15

### Back of Chapter Questions

15.1. 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

**Solution:** (b) 10 MHz

10 MHz frequencies get reflected from the ionosphere. Hence, signal waves of such frequencies are suitable for beyond-the-horizon communication.

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

- (a) Ground waves.
- (b) Sky waves.
- (c) Surface waves.
- (d) Space waves.

**Solution:** (d) Space waves

An ultra-high frequency (UHF) wave can neither travel along the trajectory of the ground nor can it get reflected by the ionosphere because of its high frequency.

15.3. 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).

**Solution:** (c)

The digital signal uses the binary (0 and 1) system for transferring message. The digital system cannot utilise the decimal system. The digital signals represent in discrete steps.

- 15.4.** Is it necessary for a transmitting antenna to be at the same height as 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?

**Solution:**

In line-of-sight communication, there is no physical obstruction between the transmitter and the receiver. In such communications, the transmitting and receiving antennas are not necessary to be at the same height.

Height of antenna,  $h = 81$  m

The radius of the earth,  $R = 6.4 \times 10^6$  m

For range,  $d = \sqrt{2Rh}$

The service area is given by

$$A = \pi d^2 = \pi (2Rh)$$

$$= 3.14 \times 2 \times 6.4 \times 10^6 \times 81 = 3255.55 \times 10^6 \text{ m}^2 = 3255.55 \sim 3256 \text{ km}^2$$

- 15.5.** 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%?

**Solution:**

The amplitude of the carrier wave,  $A_c = 12$  V

Modulation index,  $m = 75\% = 0.75$

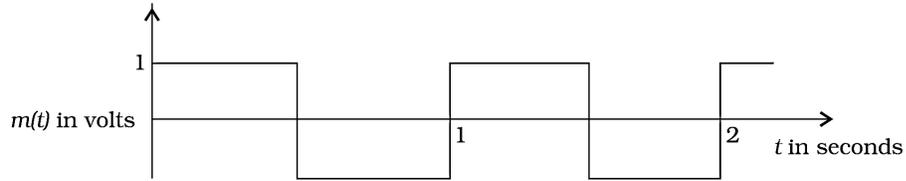
The amplitude of the modulating wave =  $A_m$

Using the relation for modulation index:  $m = \frac{A_m}{A_c}$

Therefore,

$$A_m = m A_c = 0.75 \times 12 = 9 \text{ V}$$

- 15.6.** A modulating signal is a square wave, as shown in Fig. 15.14.



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

- (i) Sketch the amplitude modulated waveform
- (ii) What is the modulation index?

**Solution:**

The amplitude of the modulating signal,  $A_m = 1 V$

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

Therefore, the Amplitude of the carrier wave,  $A_c = 2 V$

The time period of the modulating signal  $T_m = 1 s$

The angular frequency of the modulating wave

$$\omega_m = \frac{2\pi}{T_m} = 2\pi \text{ rad s}^{-1} \quad \dots (i)$$

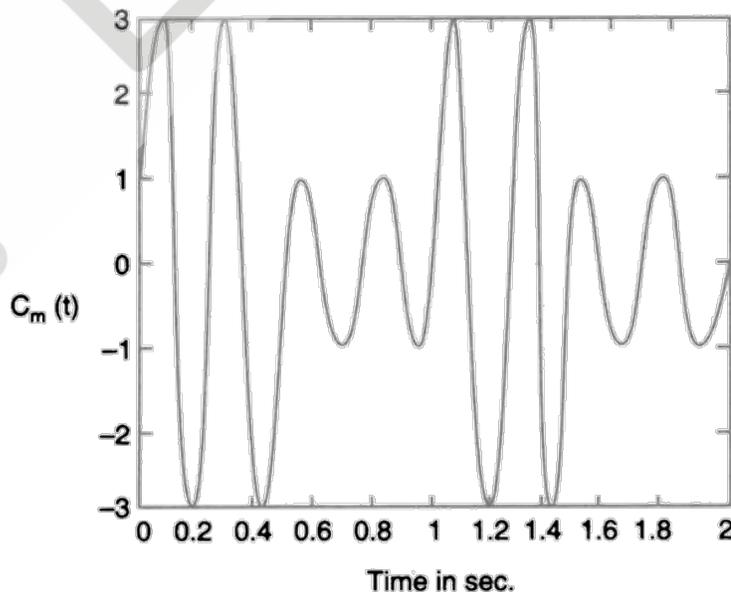
The angular frequency of the carrier wave

$$\omega_c = 8\pi \text{ rad s}^{-1} \quad \dots (ii)$$

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

$$\omega_c = 4\omega_m$$

- (i) The amplitude modulated waveform is shown in the following figure.



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

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

**Solution:**

Maximum amplitude,  $A_{max} = 10 \text{ V}$

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

Modulation index  $\mu$  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  $A_{min} = 0$

Then

$$\mu = \frac{A_{max} - A_{min}}{A_{max} + A_{min}} = \frac{10}{10} = 1$$

- 15.8. 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.

**Solution:**

Let  $\omega_c$  and  $\omega_s$  are the respective frequencies of the carrier and signal waves.

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

The instantaneous voltage of the carrier wave,  $V_{in} = V_c \cos \omega_c t$

$$\therefore V \cdot V_{in} = V_1 \cos(\omega_c + \omega_s)t (V_c \cos \omega_c t)$$

$$= V_1 V_c [\cos(\omega_c + \omega_s)t \cdot \cos \omega_c t]$$

$$= \frac{V_1 V_c}{2} [2 \cos(\omega_c + \omega_s)t \cdot \cos \omega_c t]$$

$$= \frac{V_1 V_c}{2} [\cos(\omega_c + \omega_s + \omega_c)t \cdot \cos(\omega_c + \omega_s - \omega_c)t]$$

$$= \frac{V_1 V_c}{2} [\cos(2\omega_c + \omega_s)t \cdot \cos(\omega_s)t]$$

At the receiving station, the low-pass filter allows only high-frequency signals to pass through it. It obstructs the low-frequency signal  $\omega_s$ .

Thus, at the receiving station, the modulating signal,  $\frac{V_1 V_s}{2} \cos \omega_s t$  can be recorded.

