Question 15.1:

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

10 kHz

10 MHz

1 GHz

1000 GHz

<u>Answer</u>

(b) Answer:

10 MHz

For beyond-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.

Question 15.2:

Frequencies in the UHF range normally propagate by means of:

Ground waves.

Sky waves.

Surface waves.

Space waves.

<u>Answer</u>

Answer:

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.

Question 15.3:

Digital signals

Do not provide a continuous set of values,

Represent values as discrete steps,

Can utilize binary system, and

Can utilize decimal as well as binary systems.

Which of the above statements are true?

(i) and (ii) only

(ii) and (iii) only

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

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

Answer

(c) Answer:

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.

Question 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?

Answer

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, $R = 6.4 \times 10^6$ m

For range, $d = 2Rh$, the service area of the antenna is given by the relation:

$A = \pi d^2$

$= \pi\ (2Rh)$

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

$= 3255.55 \times 10^6\ \text{m}^2$

$= 3255.55$

$\sim 3256\ \text{km}^2$

Question 15.5:

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%?

Answer

Amplitude of the carrier wave, $A_c = 12$ V

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

Amplitude of the modulating wave = A_m

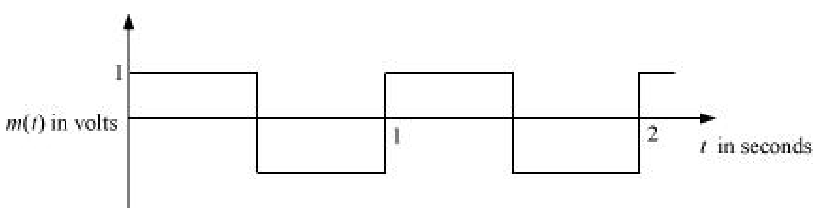
Using the relation for modulation index:

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

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

Question 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.

Sketch the amplitude modulated waveform

What is the modulation index?

Answer

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 $c(t) = 2 \sin(8\pi t)$

$\therefore$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:

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

$$= 2\pi \text{ rad s}^{-1} \qquad \ldots (i)$$

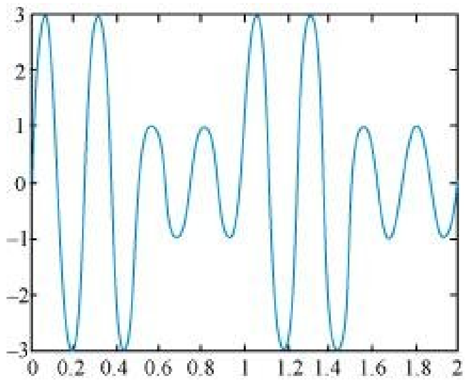
The angular frequency of the carrier signal is calculated as:

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

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

$$\omega_c = 4\omega_m$$

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



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

Question 15.7:

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?

Answer

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 $A_{min} = 0$,

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

Question 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.

Answer

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, $V_{in} = V_c \cos \omega_c t$

$$\therefore V V_{in} = V_1 \cos(\omega_c + \omega_s)t.(V_c \cos \omega_c t)$$
$$= V_1 V_c \left[\cos(\omega_c + \omega_s)t.\ \cos \omega_c t\right]$$

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

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

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

At the receiving station, the low-pass filter allows only high frequency signals to pass through it. It obstructs the low frequency signal ω_s. Thus, at the receiving station, one can record the modulating signal $\frac{V_1 V_c}{2}\cos\omega_s t$, which is the signal frequency.