EXERCISE QUESTIONS

CHAPTER-15 COMMUNICATION SYSTEMS

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

Ans - (b) Higher frequencies, such as 1 GHz and 1000 GHz, will travel through the ionosphere without being reflected, whereas lower frequencies, such as 10 kHz, will need a big radiating antenna.

2. 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 are typically used to propagate frequencies in the UHF region. Although they do not bend with the earth, high frequency space waves are perfect for frequency modulation**.**

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).

Ans - (c) A digital signal transmits message signals using the binary (0 and 1) scheme. The decimal system is inapplicable to such a system (which corresponds to analogue signals). Discontinuous values are represented by digital signals.

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?

Ans - When communication is line-of-sight, there is no physical barrier separating the transmitter and the receiver. It is not necessary for the transmitting and receiving antennas to be at the same height in these communications.

The antenna's height is reported as h = 81 m.

Earth's radius is R = 6.4 x 106 m.

Coverable service area, $A = \pi d^2$

$$= \pi(\sqrt{2 \times h \times R})^2 = \pi \times 2 \times h \times R$$

$$= \frac{22}{7} \times 2 \times 81 \times 6{\cdot}4 \times 10^6 = 3258 \text{ km}^2.$$

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%?

Ans - Carrier wave amplitude, Ac = 12 V

Index of modulation, m = 75% = 0.75

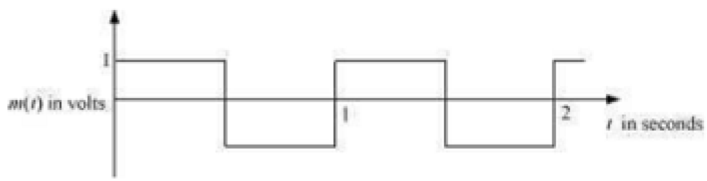
Modulating wave amplitude equals Am

Using the modulation index relation

$$m = 75\% = \frac{3}{4}, \; m = \frac{E_m}{E_c}$$

$$E_m = mE_c = \frac{3}{4} \times 12 = 9 \text{ V}$$

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



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

The carrier wave is given by:

(i) Sketch the amplitude modulated waveform

(ii) What is the modulation index?

Ans - From the provided modulating signal, it can be seen that Am = 1 V, the modulating signal's amplitude,

The carrier wave is defined as c (t) = 2 sin (8t).

The carrier wave's amplitude is Ac = 2 V.

The modulating signal's time duration is 1 second (Tm).

(*i*) Here $E_c = 2$ unit and $E_m = 1$ unit

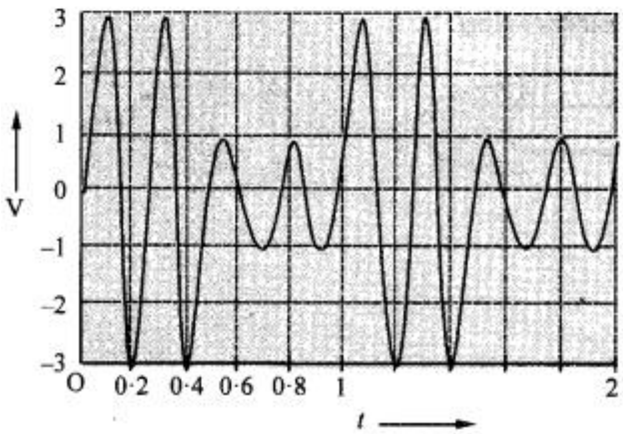
so $(E_e \pm E_m) = 3$ or 1.

And $\omega_c = 8\pi$ *i.e.* $2\pi\nu = 8\pi$

i.e. $\nu = 4$ unit

$$T = \frac{1}{\nu} = \frac{1}{4} = 0{\cdot}25 \text{ s}$$

Accordingly, the amplitude modulated waveform is shown ahead :



(*ii*) Modulation index,

$$m = \frac{E_m}{E_c} = \frac{1}{2} = 0{\cdot}5.$$

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?

Ans - Maximum amplitude, $A_{max} = 10$ V

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

Modulation index μ, is given by the relation:

$$A_{max} = A_c + A_m \quad i.e. \quad 10 = A_c + A_m \qquad \ldots(i)$$

$$A_{min} = A_c - A_m \quad i.e. \quad 2 = A_c - A_m \qquad \ldots(ii)$$

Adding (*i*) and (*ii*), we get

$$12 = 2A_c \quad i.e. \quad A_c = 6\text{ V}$$

so using (*i*), we get $10 = 6 + A_m$

i.e. $A_m = 10 - 6 = 4\text{ V}$

Then, $m = \dfrac{A_m}{A_c} = \dfrac{4}{6} = 0{\cdot}67$

If $A_{min} = 0$ then $0 = A_c - A_m$

i.e. $A_c = A_m$

Then, $m = \dfrac{A_c}{A_m} = \dfrac{A_c}{A_c} = 1.$

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.

Ans - Let's say that two signals are denoted by the expressions Ac cos ct and A0 cos(wc + wm)t, where Ac denotes the amplitude, c denotes the angular frequency of the carrier wave at the receiving end, and A0 denotes the amplitude, (wc+wm) denotes the angular velocity of the modulated wave.

When we multiply these signals, we obtain

$A_c A_0 \cos(\omega_c + \omega_m)t \cos \omega_c t$

Using $\cos(A + B) = \cos A \cos B - \sin A \sin B$

$$= \cos A \cos B - \frac{1}{2}[(\cos A - B) - \cos(A + B)]$$

i.e. $\cos A \cos B$

$$= \frac{1}{2}\cos(A - B) + \frac{1}{2}\cos(A + B)$$

$$= \frac{1}{2}[\cos(A - B) + \cos(A + B)]$$, we get

$A_c A_0 \cos(\omega_c + \omega_m)t \cos \omega_c t$

$$= \frac{1}{2}[(\cos \omega_m t) + \cos(2\omega_c + \omega_m)t]$$

i.e. $\cos(\omega_c + \omega_m)t \cos \omega_c t$

$$= \frac{A_c A_0}{2}\cos \omega_m t + \frac{A_c A_0}{2}\cos(2\omega_c + \omega_m)t$$

The separation of the relationship clearly indicates that the modulating signal $\frac{A_c A_0}{2}\cos \omega_m t$ can be easily recovered at the receiving station.

The device which can be used for this purpose comprises of LC tuned circuits and is called low-pass filter.