Q.1: Which of the following frequencies will be suitable for beyond-the horizon communication using sky waves?

(1) 10 kHz

(2) 10 MHz

(3) 1 GHz

(4) 1000 GHz

Soln:

(2) 10 MHz

The signal waves need to travel a large distance for beyond-the-horizon communication.

Due to 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 cannot travel along the trajectory of the ground; also, it cannot get reflected by the ionosphere. The ultrahigh-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 utilise the binary system

(iv) Can utilise 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) (1), (2) and (3), for transferring message signals, the digital signals use the binary (0 and 1) system. Such a system cannot utilise the decimal system. Discontinuous values are represented in digital signals.

Q.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 81 m tall. How much service area can it cover if the receiving antenna is at the ground level?

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 antennae to be at the same height.

Height of the antenna, h = 81 m

Radius of earth, R = 6.4×10^6m

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

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 **= 3256 km²**

Q.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%?

Soln:

Given:

The amplitude of carrier wave, A_c = 12 V

Modulation index, m = 75% = 0.75

The amplitude of the modulating wave = A_m

The modulation index is given by the relation:

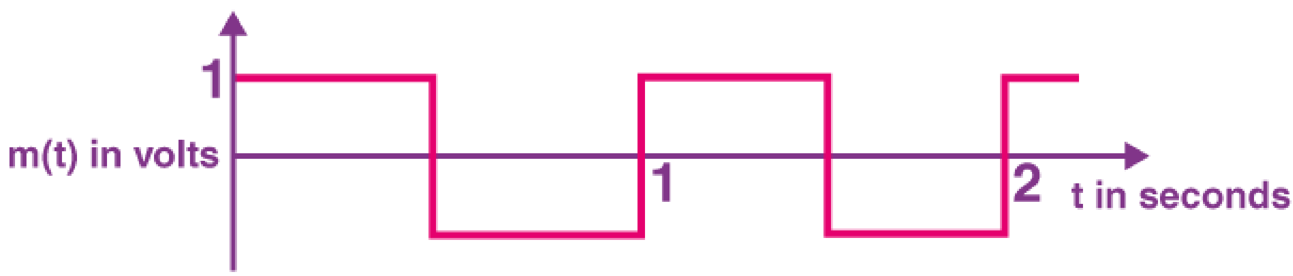
m =

$$\frac{A_m}{A_c}$$

Therefore, $A_m = m.A_c$

= 0.75 x 12 V**= 9 V**

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



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

(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)

The 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,

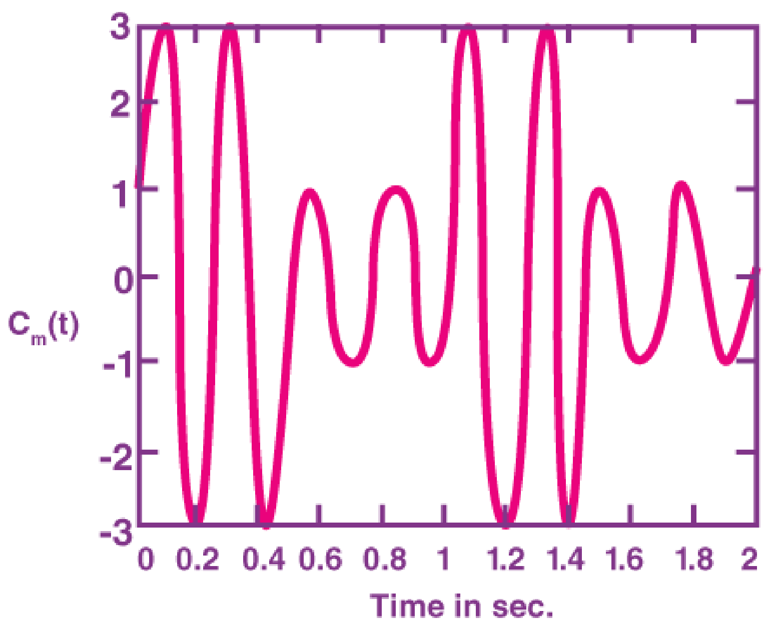
$$\omega_c = 8\pi$$

rad s^{-1} …(2)

From equations (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 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, μ. What would be the value of μ if the minimum amplitude is zero volts?

Soln:

Given,

Maximum Amplitude, $A_{max} = 10$ V

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

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

$\mu = \frac{A_{max} - A_{min}}{A_{max} + A_{min}} = \frac{10-2}{10+2} = \frac{8}{12} = 0.67$

If $A_{min} = 0$,

Then,

$\mu' = \frac{A_{max}}{A_{max}} = 10/10 = 1.$

Q.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, 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_c
t

$V.V_{in} = V_1$cos(

ω_c
+
ω_s
)t. (V_c cos
ω_c
t)

= V_1V_c [cos(

ω_c
+
ω_s
)t . cos
ω_c
t]

=

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

=

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

The low pass filter allows only 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, $\frac{V_1V_C}{2}cos\omega_s t$ which is the signal frequency.

- The transmitter, transmission channel, and receiver are the three basic units of a communication system.
- Low frequencies cannot be transmitted to long distances. Therefore, they are superimposed on a high-frequency carrier signal by a process known as modulation.
- Two important forms of the communication system are Analog and Digital.
- The amplitude-modulated waves can be produced by the application of the message signal and the carrier wave to a non-linear device, followed by a bandpass filter.