Chapter Fifteen

COMMUNICATION SYSTEMS

MCQ I

15.1 Three waves A, B and C of frequencies 1600 kHz, 5 MHz and 60 MHz, respectively are to be transmitted from one place to another. Which of the following is the most appropriate mode of communication:

(a) A is transmitted via space wave while B and C are transmitted via sky wave.

(b) A is transmitted via ground wave, B via sky wave and C via space wave.

(c) B and C are transmitted via ground wave while A is transmitted via sky wave.

(d) B is transmitted via ground wave while A and C are transmitted via space wave.

15.2 A 100m long antenna is mounted on a 500m tall building. The complex can become a transmission tower for waves with λ

(a) ~ 400 m.

(b) ~ 25 m.

(c) ~ 150 m.
(d) ~ 2400 m.

15.3 A 1 KW signal is transmitted using a communication channel which provides attenuation at the rate of – 2dB per km. If the communication channel has a total length of 5 km, the power of the signal received is [gain in dB $= 10 \log \left(\frac{P_0}{P_i}\right)$]

(a) 900 W.
(b) 100 W.
(c) 990 W.
(d) 1010 W.

15.4 A speech signal of 3 kHz is used to modulate a carrier signal of frequency 1 MHz, using amplitude modulation. The frequencies of the side bands will be

(a) 1.003 MHz and 0.997 MHz.
(b) 3001 kHz and 2997 kHz.
(c) 1003 kHz and 1000 kHz.
(d) 1 MHz and 0.997 MHz.

15.5 A message signal of frequency ω_m is superposed on a carrier wave of frequency ω_c to get an amplitude modulated wave (AM). The frequency of the AM wave will be

(a) ω_m.
(b) ω_C.
(c) $\frac{\omega_c + \omega_m}{2}$.
(d) $\frac{\omega_c - \omega_m}{2}$.

15.6 *I-V* characteristics of four devices are shown in Fig. 15.1

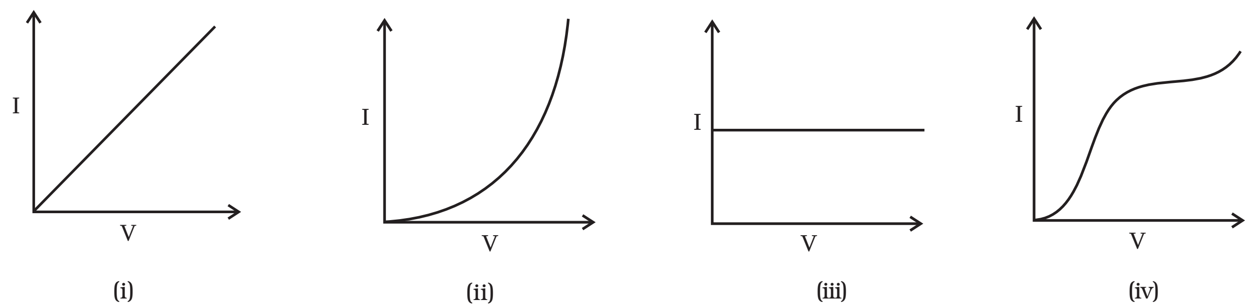

Fig. 15.1

Identify devices that can be used for modulation:

(a) 'i' and 'iii'.
(b) only 'iii'.
(c) 'ii' and some regions of 'iv'.
(d) All the devices can be used.

15.7 A male voice after modulation-transmission sounds like that of a female to the receiver. The problem is due to

(a) poor selection of modulation index (selected $0 < m < 1$)
(b) poor bandwidth selection of amplifiers.
(c) poor selection of carrier frequency
(d) loss of energy in transmission.

15.8 A basic communication system consists of

(A) transmitter.
(B) information source.
(C) user of information.
(D) channel.
(E) receiver.

Choose the correct sequence in which these are arranged in a basic communication system:

(a) ABCDE.
(b) BADEC.
(c) BDACE.
(d) BEADC.

15.9 Identify the mathematical expression for amplitude modulated wave:

(a) $A_c \sin [\{\omega_c + k_1 v_m(t)\}t + \phi]$.
(b) $A_c \sin \{\omega_c t + \phi + k_2 v_m(t)\}$.
(c) $\{A_c + k_2 v_m(t)\} \sin (\omega_c t + \phi)$.
(d) $A_c v_m(t) \sin (\omega_c t + \phi)$.

MCQ II

15.10 An audio signal of 15kHz frequency cannot be transmitted over long distances without modulation because

(a) the size of the required antenna would be at least 5 km which is not convenient.

(b) the audio signal can not be transmitted through sky waves.
(c) the size of the required antenna would be at least 20 km, which is not convenient.
(d) effective power transmitted would be very low, if the size of the antenna is less than 5 km.

15.11 Audio sine waves of 3 kHz frequency are used to amplitude modulate a carrier signal of 1.5 MHz. Which of the following statements are true?

(a) The side band frequencies are 1506 kHz and 1494 kHz.
(b) The bandwidth required for amplitude modulation is 6kHz.
(c) The bandwidth required for amplitude modulation is 3 MHz.
(d) The side band frequencies are 1503 kHz and 1497 kHz.

15.12 A TV trasmission tower has a height of 240 m. Signals broadcast from this tower will be received by LOS communication at a distance of (assume the radius of earth to be 6.4×10^6 m)

(a) 100 km.
(b) 24 km.
(c) 55 km.
(d) 50 km.

15.13 The frequency response curve (Fig. 15.2) for the filter circuit used for production of AM wave should be

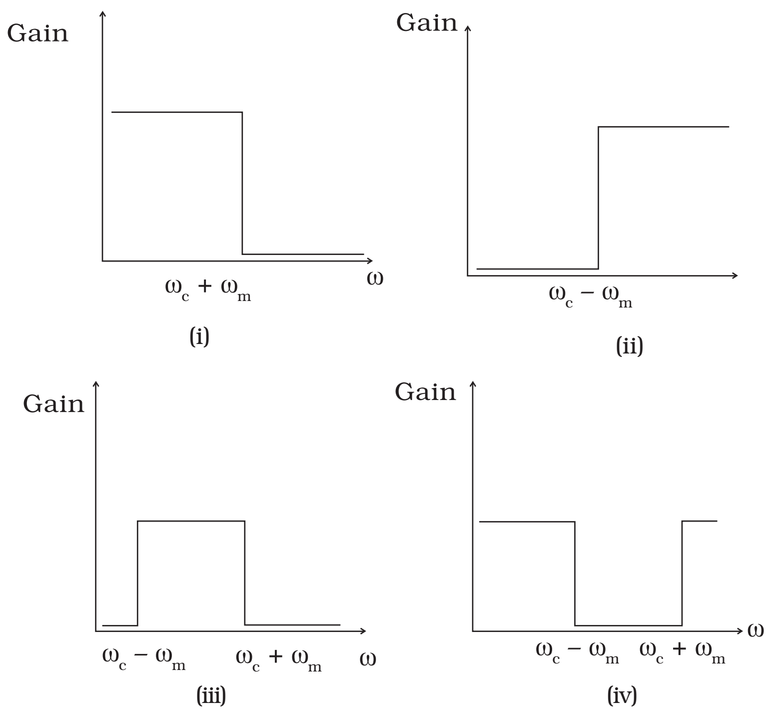

Fig. 15.2

(a) (i) followed by (ii).
(b) (ii) followed by (i).
(c) (iii).
(d) (iv).

15.14 In amplitude modulation, the modulation index m, is kept less than or equal to 1 because

(a) $m > 1$, will result in interference between carrier frequency and message frequency, resulting into distortion.
(b) $m > 1$ will result in overlapping of both side bands resulting into loss of information.
(c) $m > 1$ will result in change in phase between carrier signal and message signal.
(d) $m > 1$ indicates amplitude of message signal greater than amplitude of carrier signal resulting into distortion.

VSA

15.15 Which of the following would produce analog signals and which would produce digital signals?

(i) A vibrating tuning fork.
(ii) Musical sound due to a vibrating sitar string.
(iii) Light pulse.
(iv) Output of NAND gate.

15.16 Would sky waves be suitable for transmission of TV signals of 60 MHz frequency?

15.17 Two waves A and B of frequencies 2 MHz and 3 MHz, respectively are beamed in the same direction for communication via sky wave. Which one of these is likely to travel longer distance in the ionosphere before suffering total internal reflection?

15.18 The maximum amplitude of an A.M. wave is found to be 15 V while its minimum amplitude is found to be 3 V. What is the modulation index?

15.19 Compute the LC product of a tuned amplifier circuit required to generate a carrier wave of 1 MHz for amplitude modulation.

15.20 Why is a AM signal likely to be more noisy than a FM signal upon transmission through a channel?

SA

15.21 Figure 15.3 shows a communication system. What is the output power when input signal is of 1.01mW? (gain in dB = 10 $\log_{10}$ (P_o/P_i)).

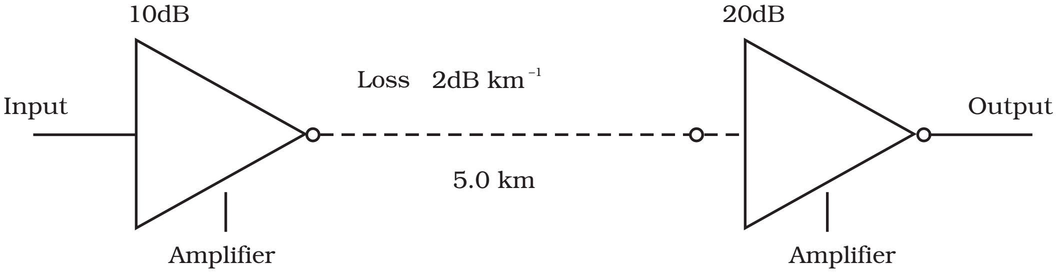

Fig. 15.3

15.22 A TV transmission tower antenna is at a height of 20 m. How much service area can it cover if the receiving antenna is (i) at ground level, (ii) at a height of 25 m? Calculate the percentage increase in area covered in case (ii) relative to case (i).

15.23 If the whole earth is to be connected by LOS communication using space waves (no restriction of antenna size or tower height), what is the minimum number of antennas required? Calculate the tower height of these antennas in terms of earths radius?

15.24 The maximum frequency for reflection of sky waves from a certain layer of the ionosphere is found to be $f_{\max} = 9(N_{max})^{1/2}$, where N_{max} is the maximum electron density at that layer of the ionosphere. On a certain day it is observed that signals of frequencies higher than 5MHz are not received by reflection from the F_1 layer of the ionosphere while signals of frequencies higher than 8MHz are not received by reflection from the F_2 layer of the inonosphere. Estimate the maximum electron densities of the F_1 and F_2 layers on that day.

15.25 On radiating (sending out) an AM modulated signal, the total radiated power is due to energy carried by ω_c, $\omega_c - \omega_m$ & $\omega_c + \omega_m$. Suggest ways to minimise cost of radiation without compromising on information.

LA

15.26 (i) The intensity of a light pulse travelling along a communication channel decreases exponentially with distance x according to the relation $I = I_o e^{-\alpha x}$, where I_o is the intensity at $x = 0$ and α is the attenuation constant.

Show that the intensity reduces by 75 per cent after a distance of $\left(\dfrac{\ln 4}{\alpha}\right)$

(ii) Attenuation of a signal can be expressed in decibel (dB) according to the relation dB $=10 \log_{10}\left(\dfrac{I}{I_o}\right)$. What is the attenuation in dB/km for an optical fibre in which the intensity falls by 50 per cent over a distance of 50 km?

15.27 A 50 MHz sky wave takes 4.04 ms to reach a receiver via re-transmission from a satellite 600 km above earth's surface. Assuming re-transmission time by satellite negligible, find the distance between source and receiver. If communication between the two was to be done by Line of Sight (LOS) method, what should size and placement of receiving and transmitting antenna be?

15.28 An amplitude modulated wave is as shown in Fig. 15.4. Calculate (i) the percentage modulation, (ii) peak carrier voltage and, (iii) peak value of information voltage.

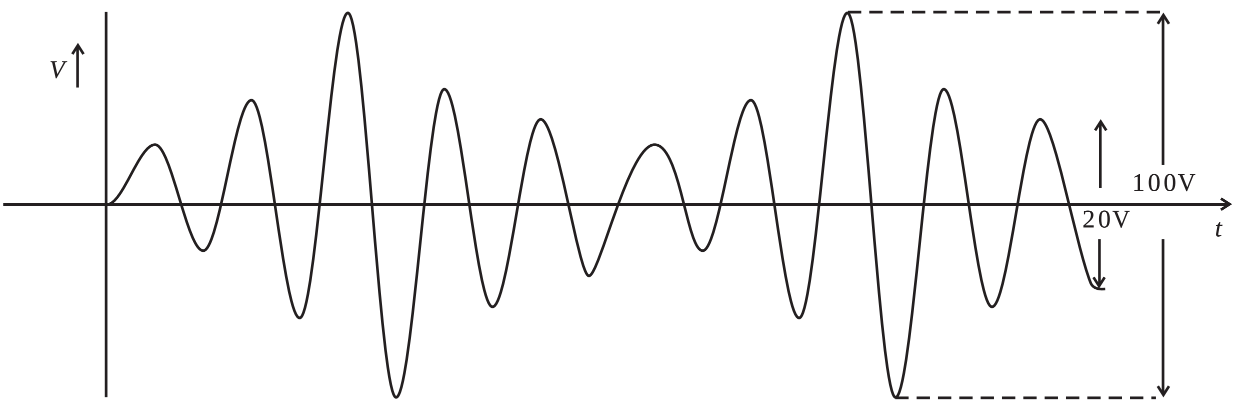

Fig. 15.4

15.29 (i) Draw the plot of amplitude versus 'ω' for an amplitude modulated wave whose carrier wave (ω_c) is carrying two modulating signals, ω_1 and ω_2 ($\omega_2 > \omega_1$). [Hint: Follow derivation from Eq 15.6 of NCERT Textbook of XII]

(ii) Is the plot symmetrical about ω_c? Comment especially about plot in region $\omega < \omega_c$.

(iii) Extrapolate and predict the problems one can expect if more waves are to be modulated.

(iv) Suggest solutions to the above problem. In the process can one understand another advantage of modulation in terms of bandwidth?

15.30 An audio signal is modulated by a carrier wave of 20MHz such that the bandwidth required for modulation is 3kHz. Could this wave be demodulated by a diode detector which has the values of R and C as

(i) $R = 1\ \text{k}\Omega$, $C = 0.01\mu\text{F}$.

(ii) $R = 10\ \text{k}\Omega$, $C = 0.01\mu\text{F}$.

(iii) $R = 10\ \text{k}\Omega$, $C = 0.1\mu\text{F}$.