JEE Main Physics Previous Year Questions With Solutions on Communication System

The communication system explains the exchange of information between two points. The process of sending and receiving information is called communication. The important elements of a communication system are Transmitter, Medium and the Receiver of information.

Based on the type of signal the communication system can be classified as follows

(i) Analog Communication

In Analog communication the signals are in the form of varying frequency and amplitude.

(ii) Digital Communication

Digital technology stores and transmits the data in the form of 1s and 0s. 1 represents high and 0 represents low.

Elements of Communication System

Information: Video, Music, Picture or any form of data can be the information or input message.

Input Transducer: The transducer is an arrangement or device that converts the input message into electrical energy.

Modulator: Modulation is the process of superimposing a carrier wave to the input signal. The reason for adding a carrier wave to the signal is because these signal waves cannot be transmitted over a large distance.

Transmitter: The transmitter converts the signal to be suitable for transmission through the medium.

Antenna: Antenna is a device used to receive and radiate electromagnetic waves through the air.

Channel: The Channel or medium can be wire, air, etc. The signal is transmitted through this medium.

Receiver: This is the arrangement that extracts the signal from the transmitter at the output end of the medium.

Demodulator: The message signal is separated from the carrier by the process called demodulation.

JEE Main Previous Year Solved Questions on Communication System

Q1: The wavelength of the carrier waves in a modern optical fibre communication network is close to

(a) 600 nm

(b) 2400 nm

(c) 500 nm

(d) 900 nm

Solution

Fibre optics communication is mainly conducted in a wavelength range from 1260 nm to 1625 nm

Answer: (c) 500 nm

Q2: The physical sizes of the transmitter and receiver antenna in a communication system are

(a) inversely proportional to the modulation frequency

(b) proportional to the carrier frequency

(c) independent of both carrier and modulation frequency

(d) inversely proportional to the carrier frequency

Solution

The physical size of the transmitter and receiver antenna is inversely proportional to the carrier frequency.

Answer: (d) inversely proportional to the carrier frequency

Q3: A telephonic communication service is working at a carrier frequency of 10 GHz. Only 10% of it is utilized for transmission. How many telephonic channels can be transmitted simultaneously if each channel requires a bandwidth of 5 kHz?

(a) 2×10^3

(b) 2×10^4

(c) 2×10^5

(d) 2×10^6

Solution

Frequency of carrier wave = 10×10^9 Hz

Available bandwidth 10% of 10×10^9 Hz = 10^9 Hz

Bandwidth for each telephonic channel 5 kHz = 5×10^3 Hz

Number of channels = $10^9/(5 \times 10^3) = 2 \times 10^5$

Answer: (c) 2×10^5

Q4: A TV transmission tower has a height of 140 m and the height of the receiving antenna is 40 m. What is the maximum distance upto which signals can be broadcasted from this tower in LOS (Line of Sight) mode? (Given: radius of earth = 6.4×10^6 m)

(a) 65 km

(b) 48 km

(c) 40 km

(d) 80 km

Solution

Maximum distance upto which signal can be broadcasted is

$$d_{max} = \sqrt{2Rh_T} + \sqrt{2Rh_R}$$

where h_T and h_R are heights of transmitter tower and height of receiver respectively.
Putting all values, we get

$$d_{max} = \sqrt{2 \times 6.4 \times 106}[\sqrt{104} + \sqrt{40}]$$

d_{max} = 65 km

Answer (a) 65 km

Q5: A signal of 5 kHz frequency is amplitude modulated on a carrier wave of frequency 2 MHz. The frequencies of the resultant signal are

(a) 2005 kHz, 2000 kHz and 1995 kHz

(b) 2000 kHz and 1995 kHz

(c) 2 MHz only

(d) 2005 kHz and 1995 kHz

Solution

Given,f_m = 5 kHz, f_c = 2 MHz = 2000 kHz

The frequencies of the resultant signal are $f_c + f_m$ = (2000 + 5) kHz = 2005 kHz c = 2000 kHz and $f_c - f_m$ = (2000 – 5) kHz = 1995 kHz

Answer: (a) 2005 kHz, 2000 kHz and 1995 kHz

Q6: Consider telecommunication through optical fibres. Which of the following statements is not true?

(a) Optical fibres can be of graded refractive index

(b) Optical fibres are subject to electromagnetic interference from outside

(c) Optical fibres have extremely low transmission loss

(d) Optical fibres may have a homogeneous core with a suitable cladding

Answer: (b) Optical fibres are not subject to electromagnetic interference from outside

Q7: The modulation frequency of an AM radio station is 250 kHz, which is 10% of the carrier wave. If another AM station approaches you for a licence, what broadcast frequency will you allot?

(a) 2750 kHz

(b) 2900 kHz

(c) 2250 kHz

(d) 2000 kHz

Solution

10% of f_c = 250 kHz

Hence, range of signal = (2500 ± 250 kHz) = 2250 kHz to 2750 kHz

10% of 2000 kHz = 200 kHz

Range is 1800 kHz to 2200 kHz

Hence, allocated broadcast frequency will be 2000 kHz

Answer: (d) 2000 kHz

Q8: In a communication system operating at wavelength 800 nm, only one percent of source frequency is available as signal bandwidth. The number of channels accommodated for transmitting TV signals of bandwidth 6 MHz is (Take velocity of light c = 3 × 10^8 m/s, h = 6.6 × 10^{-34} J s)

(a) 3.75 × 10^6

(b) 4.87 × 10^5

(c) 6.25 × 10^5

(d) 3.86 × 10^6

Solution

f = C/λ = (3 x 10^8)/(8 x 10^{-7})= 3.75 x 10^{14} Hz

1% of f = 3.75 x 10^{17} Hz = 3. 75 x 10^6 MHz

Number of channels = (3.75 x 10^6)/6

Number of channels = 6.25 x 10^5

Answer: (c) 6.25 × 10^5

Q9: A signal of frequency 20 kHz and peak voltage of 5 volts is used to modulate a carrier wave of frequency 1.2 MHz and peak voltage 25 volts. Choose the correct statement.

(a) Modulation index = 5, side frequency bands are at 1400 kHz and 1000 kHz

(b) Modulation index = 0.2, side frequency bands are at 1220 kHz and 1180 kHz

(c) Modulation index = 0.8, side frequency bands are at 1180 kHz and 1220 kHz

(d) Modulation index = 5, side frequency bands are at 21.2 kHz and 18.8 kHz

Solution

Modulation index, m = (V_m/V_c)=(5/25) = 0.2

Frequency of carrier wave,

f_c = 1.2 × 10^3 kHz = 1200 kHz,

Frequency of modulate wave = 20 kHz

$f_1 = f_c - f_m$ = 1200 – 20 = 1180 kHz

$f_2 = f_c + f_m$ = 1200 + 20 = 1220 kHz

Answer: (b) Modulation index = 0.2, side frequency bands are at 1220 kHz and 1180 kHz

Q10: An audio signal consists of two distinct sounds: one a human speech signal in the frequency band of 200 Hz to 2700 Hz, while the other is a high-frequency music signal in the frequency band of 10200 Hz to 15200 Hz. The ratio of the AM signal bandwidth required to send both the signals together to the AM signal bandwidth required to send just the human speech is

(a) 2

(b) 5

(c) 6

(d) 3

Solution

Band width for both signals = 15200 Hz – 200 Hz = 15000 Hz

Band width for human speed 2700 Hz – 200 Hz = 2500 Hz

The ratio = 15000/2500 = 6

Answer: (c) 6

Q11: In an amplitude modulator circuit, the carrier wave is given by, C(t) = 4 sin(20000π t), while modulating signal is given by, m(t) = 2sin(2000πt). The values of modulation index and lower side band frequency are

(a) 0.4 and 10 kHz

(b) 0.5 and 9 kHz

(c) 0.3 and 9 kHz

(d) 0.5 and 10 kHz

Solution

Given C(t) = 4 sin (20000 πt) ⇒ $A_c = 4$

m(t) = 2 sin (2000πt) ⇒ $A_m = 2$

Now modulation index, $\mu = A_m/A_c = 2/4 = 0.5$

Lower side band frequency, $f = f_c - f_m$ …(1)

Here for carrier wave, $(20000\ \pi t) = 2\pi f_c$

$f_c = 10000$ Hz

For modulating wave, $(2000\ \pi t) = 2\pi f_m$

$f_m = 1000$ Hz

From (i), Lower side band frequency = 10 kHz – 1 kHz = 9 kHz

Answer: (b) 0.5 and 9 kHz