CHAPTER

20 Communication Systems

1. A telephonic communication service is working at 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 *(2018)*

2. The number of amplitude modulated broadcast stations that can be accommodated in a 300 kHz band width for the highest modulating frequency 15 kHz will be
(a) 20 (b) 10
(c) 8 (d) 15 *(Online 2018)*

3. The carrier frequency of a transmitter is provided by a tank circuit of a coil of inductance 49 μH and a capacitance of 2.5 nF. It is modulated by an audio signal of 12 kHz. The frequency range occupied by the side bands is
(a) 18 kHz – 30 kHz (b) 13482 kHz – 13494 kHz
(c) 63 kHz – 75 kHz (d) 442 kHz – 466 kHz
(Online 2018)

4. A carrier wave of peak voltage 14 V is used for transmitting a message signal. The peak voltage of modulating signal given to achieve a modulation index of 80% will be
(a) 22.4 V (b) 11.2 V
(c) 7 V (d) 28 V *(Online 2018)*

5. In amplitude modulation, sinusoidal carrier frequency used is denoted by ω_c and the signal frequency is denoted by ω_m. The bandwidth $(\Delta\omega_m)$ of the signal is such that $\Delta\omega_m << \omega_c$. Which of the following frequencies is not contained in the modulated wave?
(a) ω_m (b) ω_c
(c) $\omega_m + \omega_c$ (d) $\omega_c - \omega_m$ *(2017)*

6. 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
(Online 2017)

7. A signal is to be transmitted through a wave of wavelength λ, using a linear antenna. The length l of the antenna and effective power radiated P_{eff} will be given respectively as (K is a constant of proportionality)
(a) $\frac{\lambda}{5}, P_{\text{eff}} = K\left(\frac{l}{\lambda}\right)^{1/2}$ (b) $\lambda, P_{\text{eff}} = K\left(\frac{l}{\lambda}\right)^{2}$
(c) $\frac{\lambda}{16}, P_{\text{eff}} = K\left(\frac{l}{\lambda}\right)^{3}$ (d) $\frac{\lambda}{8}, P_{\text{eff}} = K\left(\frac{l}{\lambda}\right)$
(Online 2017)

8. Choose the correct statement :
(a) In amplitude modulation the amplitude of the high frequency carrier wave is made to vary in proportion to the amplitude of the audio signal.
(b) In amplitude modulation the frequency of the high frequency carrier wave is made to vary in proportion to the amplitude of the audio signal.
(c) In frequency modulation the amplitude of the high frequency carrier wave is made to vary in proportion to the amplitude of the audio signal.
(d) In frequency modulation the amplitude of the high frequency carrier wave is made to vary in proportion to the frequency of the audio signal.
(2016)

9. 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 *(Online 2016)*

10. A modulated signal $C_m(t)$ has the form
$C_m(t) = 30 \sin 300\pi t + 10 (\cos 200\pi t - \cos 400\pi t)$. The carrier frequency f_c, the modulating frequency (message frequency) f_ω, and the modulation index μ are respectively given by
(a) $f_c = 200$ Hz; $f_\omega = 50$ Hz; $\mu = \frac{1}{2}$
(b) $f_c = 150$ Hz; $f_\omega = 50$ Hz; $\mu = \frac{2}{3}$
(c) $f_c = 150$ Hz; $f_\omega = 30$ Hz; $\mu = \frac{1}{3}$
(d) $f_c = 200$ Hz; $f_\omega = 30$ Hz; $\mu = \frac{1}{2}$ *(Online 2016)*

11. A signal of 5 kHz frequency is amplitude modulated on a carrier wave of frequency 2 MHz. The frequencies of the resultant signal is/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 *(2015)*

12. A radar has a power of 1 kW and is operating at a frequency of 10 GHz. It is located on a mountain top of height 500 m. The maximum distance upto which it can detect object located on the surface of the earth (Radius of earth = 6.4×10^6 m) is

(a) 16 km (b) 40 km
(c) 64 km (d) 80 km *(2012)*

13. This question has Statement-1 and Statement-2. Of the four choices given after the statements, choose the one that best describes the two statements.

Statement-1 : Sky wave signals are used for long distance radio communication. These signals are in general, less stable than ground wave signals.

Statement-2 : The state of ionosphere varies from hour to hour, day to day and season to season.

(a) Statement-1 is true, statement-2 is false.
(b) Statement-1 is true, Statement-2 is true, Statement-2 is the correct explanation of Statement-1.
(c) Statement-1 is true, Statement-2 is true, Statement-2 is not the correct explanation of Statement-1.
(d) Statement-1 is false, Statement-2 is true. *(2011)*

14. 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 homogeneous core with a suitable cladding. *(2003)*

ANSWER KEY

1. (c) **2.** (b) **3.** (d) **4.** (b) **5.** (a) **6.** (b) **7.** (b) **8.** (a) **9.** (c) **10.** (b) **11.** (a) **12.** (d)
13. (b) **14.** (b)

Explanations

1. (c) : 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

$\therefore$ Number of channels = $\dfrac{10^9}{5\times10^3} = 2\times10^5$

2. (b) : If modulating frequency is 15 kHz then bandwidth of one channel = 30 kHz

Number of channels accommodate = $\dfrac{300\,\text{kHz}}{30\,\text{kHz}} = 10$

3. (d) : Carrier frequency, $\upsilon_c = \dfrac{1}{2\pi\sqrt{LC}}$

$$= \frac{1}{6.28\times\sqrt{49\times10^{-6}\times2.5\times10^{-9}}} = \frac{10^8}{6.28\times7\times5}\ \text{Hz} = 454\ \text{kHz}$$

Side bands are $\upsilon_c \pm \upsilon_m$ = (454 ± 12) Hz
i.e. 442 kHz - 466 kHz is occupied by side bands.

4. (b) : As modulation index is given by

$m = \dfrac{A_m}{A_c}$ or $A_m = mA_c$
Also, m = 80% = 0.8 $\therefore A_m = 0.8 \times 14 = 11.2$ V

5. (a) : Let $x(t) = A_c \sin\omega_c t$ represents carrier wave.
$y(t) = A_m \sin\omega_m t$ represents the modulating signal.
The modulated signal $x_m(t)$ can be written as

$x_m(t) = (A_c + A_m \sin\omega_m t)\sin\omega_c t = A_c\left(1+\dfrac{A_m}{A_c}\sin\omega_m t\right)\sin\omega_c t$

$x_m(t) = A_c\sin\omega_c t + \mu A_c\sin\omega_m t\sin\omega_c t$

Here $\mu = \dfrac{A_m}{A_c}$ is the modulation index.

Also, $x_m(t) = A_c\sin\omega_c t + \mu A_c \dfrac{1}{2}[\cos(\omega_c-\omega_m)t - \cos(\omega_c+\omega_m)t]$
[Using $2\sin A\sin B = \cos(A - B) - \cos(A + B)$]

$\Rightarrow x_m(t) = A_c\sin\omega_c t + \dfrac{\mu A_c}{2}\cos(\omega_c-\omega_m)t - \dfrac{\mu A_c}{2}\cdot\cos(\omega_c+\omega_m)\,t$

Amplitude modulated wave contains the frequencies ω_c, $\omega_c - \omega_m$ and $\omega_c + \omega_m$. So, the frequency ω_m is not contained in the amplitude modulated wave.

6. (b) : Modulation index, $m = \dfrac{V_m}{V_c} = \dfrac{5}{25} = 0.2$
Frequency of carrier wave,
$\upsilon_c = 1.2 \times 10^3$ kHz = 1200 kHz,
Frequency of modulate wave = 20 kHz
$\upsilon_1 = \upsilon_c - \upsilon_m = 1200 - 20 = 1180$ kHz
$\upsilon_2 = \upsilon_c + \upsilon_m = 1200 + 20 = 1220$ kHz

7. (b) : For transmitting a signal, the size of antenna should be comparable to the wavelength of the signal (λ).
A linear antenna of length (l) radiates power which is proportional to $\left(\dfrac{l}{\lambda}\right)^2$ *i.e.* $P_{eff} = K\left(\dfrac{l}{\lambda}\right)^2$.

8. (a) : Carrier wave : $y_c = A_c \sin\omega_c t$
Message signal : $y_m = A_m \sin\omega_m t$
Amplitude modulated carrier wave :
$y = (A_c + A_m \sin\omega_m t)\sin\omega_c t$

9. (c)

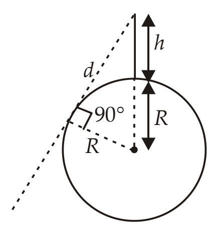
10. (b) : Here,
$C_m(t) = 30\sin(300\pi t) + 10(\cos(200\pi t) - \cos(400\pi t))$
Compare this equation with standard equation of amplitude modulated wave,

$C_m(t) = A_c\sin\omega_c t - \dfrac{\mu A_c}{2}\cos(\omega_c+\omega_m)t + \dfrac{\mu A_c}{2}\cos(\omega_c-\omega_m)t$

$A_c = 30$ V, $\omega_c = 300\pi \Rightarrow 2\pi f_c = 300\pi \Rightarrow f_c = 150$ Hz
$\omega_c - \omega_m = 200\pi \Rightarrow f_c - f_\omega = 100$ Hz
$\therefore f_\omega = 150 - 100 = 50$ Hz
$\dfrac{\mu A_c}{2} = 10, A_c = 30 \therefore \mu = \dfrac{10}{15} = \dfrac{2}{3}$

11. (a) : Given, $\upsilon_m = 5$ kHz, $\upsilon_c = 2$ MHz = 2000 kHz
The frequencies of the resultant signal are
$\upsilon_c + \upsilon_m$ = (2000 + 5) kHz = 2005 kHz
υ_c = 2000 kHz and
$\upsilon_c - \upsilon_m$ = (2000 – 5) kHz = 1995 kHz

12. (d) : Maximum distance on earth where object can be detected is d, then



$(h + R)^2 = d^2 + R^2$
$d^2 = h^2 + 2Rh$
$\because h << R$
$\therefore d = \sqrt{2Rh}$
$d = \sqrt{2\times6.4\times10^6\times500} = 8\times10^4\ \text{m} = 80\ \text{km}$

13. (b)

14. (b) : Optical fibres are subject to electromagnetic intereference from outside.