Ordinary Thinking

Objective Questions

Communication

1. In short wave communication waves of which of the following frequencies will be reflected back by the ionospheric layer, having electron density $10^{}$ per m [AIIMS 2003]

(a) 2 MHz (b) 10 MHz

(c) 12 MHz (d) 18 MHz

2. In an amplitude modulated wave for audio frequency of 500 $cycle/second$, the appropriate carrier frequency will be [AMU 1996]

(a) 50 $cycles/sec$ (b) 100 $cycles/sec$

(c) 500 $cycles/sec$ (d) 50,000 $cycles/sec$

3. AM is used for broadcasting because

(a) It is more noise immune than other modulation systems

(b) It requires less transmitting power compared with other systems

(c) Its use avoids receiver complexity

(d) No other modulation system can provide the necessary bandwidth faithful transmission

4. Range of frequencies allotted for commercial FM radio broadcast is

(a) 88 to 108 MHz (b) 88 to 108 kHz

(c) 8 to 88 MHz (d) 88 to 108 GHz

5. The velocity factor of a transmission line x. If dielectric constant of the medium is 2.6, the value of x is [AFMC 1995]

(a) 0.26 (b) 0.62

(c) 2.6 (d) 6.2

6. The process of superimposing signal frequency (*i.e.* audio wave) on the carrier wave is known as [AIIMS 1987]

(a) Transmission (b) Reception

(c) Modulation (d) Detection

7. Long distance short-wave radio broadcasting uses [AFMC 1996]

(a) Ground wave (b) Ionospheric wave

(c) Direct wave (d) Sky wave

8. A step index fibre has a relative refractive index of 0.88%. What is the critical angle at the corecladding interface [Manipal 2003]

(a) 60° (b) 75°

(c) 45° (d) None of these

9. The characteristic impedance of a coaxial cable is of the order of

(a) 50 Ω (b) 200 Ω

(c) 270 Ω (d) None of these

10. In which frequency range, space waves are normally propagated

(a) HF (b) VHF

(c) UHF (d) SHF

11. If μ_1 and μ_2 are the refractive indices of the materials of core and cladding of an optical fibre, then the loss of light due to its leakage can be minimised by having [BVP 2003]

(a) $\mu_1 > \mu_2$ (b) $\mu_1 < \mu_2$

(c) $\mu_1 = \mu_2$ (d) None of these

12. Through which mode of propagation, the radio waves can be sent from one place to another [JIPMER 2003]

(a) Ground wave propagation

(b) Sky wave propagation

(c) Space wave propagation

(d) All of them

13. A laser beam of pulse power $10^{}$ $watt$ is focussed on an object are $10^{}$ cm. The energy flux in $watt/cm$ at the point of focus is

(a) $10^{}$ (b) $10^{}$

(c) $10^{}$ (d) $10^{}$

14. The carrier frequency generated by a tank circuit containing 1 nF capacitor and 10 μH inductor is [AFMC 2003]

(a) 1592 Hz (b) 1592 MHz

(c) 1592 kHz (d) 159.2 Hz

15. Broadcasting antennas are generally [AFMC 2003]

(a) Omnidirectional type (b) Vertical type

(c) Horizontal type (d) None of these

16. For television broadcasting, the frequency employed is normally

(a) 30-300 MHz (b) 30-300 GHz

(c) 30-300 KHz (d) 30-300 Hz

17. The radio waves of frequency 300 MHz to 3000 MHz belong to [MNR 1997]

(a) High frequency band

(b) Very high frequency band

(c) Ultra high frequency band

(d) Super high frequency band

18. An antenna behaves as resonant circuit only when its length is

(a) $\frac{\lambda}{2}$

(b) $\frac{\lambda}{4}$

(c) λ

(d) $\frac{\lambda}{2}$ or integral multiple of $\frac{\lambda}{2}$

19. Maximum useable frequency (MUF) in F-region layer is x, when the critical frequency is 60 MHz and the angle of incidence is 70°. Then x is [Himachal PMT 2003]

(a) 150 MHz (b) 170 MHz

(c) 175 MHz (d) 190 MHz

20. The electromagnetic waves of frequency 2 MHz to 30 MHz are

(a) In ground wave propagation

(b) In sky wave propagation

(c) In microwave propagation

(d) In satellite communication [CPMT 2003]

21. A laser is a coherent source because it contains [JIPMER 2003]

(a) Many wavelengths [EAMCET 2002]

(b) Uncoordinated wave of a particular wavelength

(c) Coordinated wave of many wavelengths

(d) Coordinated waves of a particular wavelength

22. The attenuation in optical fibre is mainly due to [AFMC 2003]

(a) Absorption

(b) Scattering

(c) Neither absorption nor scattering

(d) Both (a) and (b)

23. The maximum distance upto which TV transmission from a TV tower of height h can be received is proportional to [AIIMS 2003]

(a) h (b) h

(c) h (d) h

24. A laser beam is used for carrying out surgery because it [AIIMS 2003]

(a) Is highly monochromatic (b) Is highly coherent

(c) Is highly directional (d) Can be sharply focussed

25. Laser beams are used to measure long distances because [DCE 2002, 03]

(a) They are monochromatic

(b) They are highly polarised

(c) They are coherent

(d) They have high degree of parallelism

26. An oscillator is producing FM waves of frequency 2 *kHz* with a variation of 10 *kHz*. What is the modulating index [DCE 2004]

(a) 0.20 (b) 5.0

(c) 0.67 (d) 1.5

27. The maximum peak to peak voltage of an AM wire is 24 *mV* and the minimum peak to peak voltage is 8 *mV*. The modulation factor is

(a) 10% (b) 20%

(c) 25% (d) 50%

28. Sinusoidal carrier voltage of frequency 1.5 *MHz* and amplitude 50 *V* is amplitude modulated by sinusoidal voltage of frequency 10 *kHz* producing 50% modulation. The lower and upper side-band frequencies in *kHz* are

(a) 1490, 1510 (b) 1510, 1490

(c) $\frac{1}{1490}, \frac{1}{1510}$ (d) $\frac{1}{1510}, \frac{1}{1490}$

29. What is the modulation index of an over modulated wave

(a) 1 (b) Zero

(c) < 1 (d) > 1

30. Basically, the product modulator is

(a) An amplifier (b) A mixer

(c) A frequency separator (d) A phase separator

31. If f and f represent the carrier wave frequencies for amplitude and frequency modulations respectively, then

(a) $f_a > f_f$ (b) $f_a < f_f$

(c) $f_a \approx f_f$ (d) $f_a \geq f_f$

32. Which of the following is the disadvantage of FM over AM

(a) Larger band width requirement

(b) Larger noise

(c) Higher modulation power

(d) Low efficiency

33. If a number of sine waves with modulation indices n, n, n ..... modulate a carrier wave, then total modulation index (n) of the wave is

(a) $n + n$ .... $+ 2(n + n$.....)

(b) $\sqrt{n_1 - n_2 + n_3 .....}$

(c) $\sqrt{n_1^2 + n_2^2 + n_3^2 .....}$

(d) None of these

34. An AM wave has 1800 *watt* of total power content, For 100% modulation the carrier should have power content equal to

(a) 1000 *watt* (b) 1200 *watt*

(c) 1500 *watt* (d) 1600 *watt*

35. The frequency of a FM transmitter without signal input is called

(a) Lower side band frequency

(b) Upper side band frequency

(c) Resting frequency

(d) None of these

36. What type of modulation is employed in India for radio transmission

(a) Amplitude modulation (b) Frequency modulation

(c) Pulse modulation (d) None of these

37. When the modulating frequency is doubled, the modulation index is halved and the modulating voltage remains constant, the modulation system is

(a) Amplitude modulation (b) Phase modulation

(c) Frequency modulation (d) All of the above

38. An antenna is a device

(a) That converts electromagnetic energy into radio frequency signal

(b) That converts radio frequency signal into electromagnetic energy

(c) That converts guided electromagnetic waves into free space electromagnetic waves and vice-versa

(d) None of these

39. While tuning in a certain broadcast station with a receiver, we are actually

(a) Varying the local oscillator frequency

(b) Varying the frequency of the radio signal to be picked up

(c) Tuning the antenna

(d) None of these

40. Indicate which one of the following system is digital

(a) Pulse position modulation

(b) Pulse code modulation

(c) Pulse width modulation

(d) Pulse amplitude modulation

41. In a communication system, noise is most likely to affect the signal

(a) At the transmitter

(b) In the channel or in the transmission line

(c) In the information source

(d) At the receiver

42. The waves used in telecommunication are

(a) IR (b) UV

(c) Microwave (d) Cosmic rays

43. In an FM system a 7 *kHz* signal modulates 108 *MHz* carrier so that frequency deviation is 50 *kHz*. The carrier swing is

(a) 7.143 (b) 8

(c) 0.71 (d) 350

44. Consider telecommunication through optical fibres. Which of the following statements is not true **[AIEEE 2003]**

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

(b) Optical fibres can be of graded refractive index

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

(d) Optical fibres have extremely low transmission loss

45. The phenomenon by which light travels in an optical fibres is

(a) Reflection (b) Refraction

(c) Total internal reflection (d) Transmission

46. Television signals on earth cannot be received at distances greater than 100 *km* from the transmission station. The reason behind this is that **[DCE 1995]**

(a) The receiver antenna is unable to detect the signal at a distance greater than 100 *km*

(b) The TV programme consists of both audio and video signals

(c) The TV signals are less powerful than radio signals

(d) The surface of earth is curved like a sphere

47. Advantage of optical fibre **[DCE 2005]**

(a) High bandwidth and EM interference

(b) Low bandwidth and EM interference

(c) High band width, low transmission capacity and no EM interference

(d) High bandwidth, high data transmission capacity and no EM interference

48. In frequency modulation **[Kerala PMT 2005]**

(a) The amplitude of modulated wave varies as frequency of carrier wave

(b) The frequency of modulated wave varies as amplitude of modulating wave

(c) The amplitude of modulated wave varies as amplitude of carrier wave

(d) The frequency of modulated wave varies as frequency of modulating wave

(e) The frequency of modulated wave varies as frequency of carrier wave

49. Audio signal cannot be transmitted because **[Kerala PMT 2005]**

(a) The signal has more noise

(b) The signal cannot be amplified for distance communication

(c) The transmitting antenna length is very small to design

(d) The transmitting antenna length is very large and impracticable

(e) The signal is not a radio signal

50. In which of the following remote sensing technique is not used

(a) Forest density (b) Pollution

(c) Wetland mapping (d) Medical treatment

51. For sky wave propagation of a 10 *MHz* signal, what should be the minimum electron density in ionosphere **[AIIMS 2005]**

(a) $\sim 1.2 \times 10^{} \; m^{}$ (b) $\sim 10^{} \; m^{}$

(c) $\sim 10^{} \; m^{}$ (d) $\sim 10^{} \; m^{}$

52. What should be the maximum acceptance angle at the aircore interface of an optical fibre if n_1 and n_2 are the refractive indices of the core and the cladding, respectively **[AIIMS 2005]**

(a) $\sin^{-1}(n_2 / n_1)$ (b) $\sin^{-1}\sqrt{n_1^2 - n_2^2}$

(c) $\left[\tan^{-1}\frac{n_2}{n_1}\right]$ (d) $\left[\tan^{-1}\frac{n_1}{n_2}\right]$

[DCE 2001]

Critical Thinking

Objective Questions

1. A sky wave with a frequency 55 *MHz* is incident on *D*-region of earth's atmosphere at 45°. The angle of refraction is (electron density for *D*-region is 400 *electron*/*cm*) **[Haryana PMT 2003]**

(a) 60° (b) 45°

(c) 30° (d) 15°

2. In a diode AM-detector, the output circuit consist of $R = 1k\Omega$ and $C = 10$ *pF*. A carrier signal of 100 *kHz* is to be detected. Is it good

(a) Yes

(b) No

(c) Information is not sufficient

(d) None of these

3. Consider an optical communication system operating at λ~800 *nm*. Suppose, only 1% of the optical source frequency is the available channel bandwidth for optical communication. How many channels can be accommodated for transmitting audio signals requiring a bandwidth of 8 *kHz*

(a) $4.8 \times 10^{}$ (b) 48

(c) $6.2 \times 10^{}$ (d) $4.8 \times 10^{}$

4. A photodetector is made from a semiconductor $In_{x}Ga_{1-x}As$ with $E_g = 0.73$ *eV*. What is the maximum wavelength, which it can detect

(a) 1000 *nm* (b) 1703 *nm*

(c) 500 *nm* (d) 173 *nm*

5. A transmitter supplies 9 *kW* to the aerial when unmodulated. The power radiated when modulated to 40% is

(a) 5 *kW* (b) 9.72 *kW*

(c) 10 *kW* (d) 12 *kW*

6. The antenna current of an AM transmitter is 8 *A* when only carrier is sent but increases to 8.96 *A* when the carrier is sinusoidally modulated. The percentage modulation is

(a) 50% (b) 60%

(c) 65% (d) 71%

7. The total power content of an AM wave is 1500 *W*. For 100% modulation, the power transmitted by the carrier is

(a) 500 *W* (b) 700 *W*

(c) 750 *W* (d) 1000 *W*

8. The total power content of an AM wave is 900 *W*. For 100% modulation, the power transmitted by each side band is

(a) 50 *W* (b) 100 *W*

(c) 150 *W* (d) 200 *W*

9. The modulation index of an FM carrier having a carrier swing of 200 *kHz* and a modulating signal 10 *kHz* is

(a) 5 (b) 10

(c) 20 (d) 25

10. A 500 *Hz* modulating voltage fed into an FM generator produces a frequency deviation of 2.25 *kHz*. If amplitude of the voltage is kept constant but frequency is raised to 6 *kHz* then the new deviation will be

(a) 4.5 *kHz* (b) 54 *kHz*

(c) 27 *kHz* (d) 15 *kHz*

11. The audio signal used to modulate 60 sin $(2\pi \times 10^{3} t)$ is $15\sin 300\pi t$. The depth of modulation is

(a) 50% (b) 40%

(c) 25% (d) 15%

12. The bit rate for a signal, which has a sampling rate of 8 *kHz* and where 16 quantisation levels have been used is

(a) 32000 *bits/sec* (b) 16000 *bits/sec*

(c) 64000 *bits/sec* (d) 72000 *bits/sec*

13. An amplitude modulated wave is modulated to 50%. What is the saving in power if carrier as well as one of the side bands are suppressed

(a) 70% (b) 65.4%

(c) 94.4% (d) 25.5%

14. In AM, the centpercent modulation is achieved when

(a) Carrier amplitude = signal amplitude

(b) Carrier amplitude ≠ signal amplitude

(c) Carrier frequency = signal frequency

(d) Carrier frequency ≠ signal frequency

A R Assertion & Reason

For AIIMS Aspirants

Read the assertion and reason carefully to mark the correct option out of the options given below:

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.
(c) If assertion is true but reason is false.
(d) If the assertion and reason both are false.
(e) If assertion is false but reason is true.

1. Assertion : Diode lasers are used as optical sources in optical communication.

Reason : Diode lasers consume less energy.

[AIIMS 2005]

2. Assertion : Television signals are received through sky-wave propagation.

Reason : The ionosphere reflects electromagnetic waves of frequencies greater than a certain critical frequency. **[AIIMS 2005]**

3. Assertion : In high latitude one sees colourful curtains of light hanging down from high altitudes.

Reason : The high energy charged particles from the sun are deflected to polar regions by the magnetic field of the earth. **[AIIMS 2003]**

4. Assertion : Short wave bands are used for transmission of radio waves to a large distance.

Reason : Short waves are reflected by ionosphere

[AIIMS 1994]

5. Assertion : The electrical conductivity of earth's atmosphere decreases with altitude.

Reason : The high energy particles (*i.e.* γ-rays and cosmic rays) coming from outer space and entering our earth's atmosphere cause ionisation of the atoms of the gases present there and the pressure of gases decreases with increase in altitude.

6. Assertion : The electromagnetic waves of shorter wavelength can travel longer distances on earth's surface than those of longer wavelengths.

Reason : Shorter the wavelength, the larger is the velocity of wave propagation.

7. Assertion : The surface wave propagation is used for medium wave band and for television broadcasting.

Reason : The surface waves travel directly from transmitting antenna to receiver antenna through atmosphere.

8. Assertion : The television broadcasting becomes weaker with increasing distance.

Reason : The power transmitted from TV transmitter varies inversely as the distance of the receiver

9. Assertion : Microwave propagation is better than the sky wave propagation.

Reason : Microwaves have frequencies 100 to 300 *GHz*, which have very good directional properties.

10. Assertion : Satellite is an ideal platform for remote sensing.

Reason : Satellite in polar orbit can provide global coverage or continuous coverage of the fixed area in geostationary configuration.

11. Assertion : Fax is a modulating and demodulating device.

Reason : It is necessary for exact reproduction of a document.

12. Assertion : A dish antenna is highly directional.

Reason : This is because a dipole antenna is omni directional.

Answers

Communication

1	a	2	d	3	c	4	a	5	b
6	c	7	c	8	d	9	c	10	c
11	a	12	d	13	b	14	c	15	b
16	a	17	c	18	d	19	c	20	b
21	d	22	d	23	a	24	d	25	d
26	b	27	d	28	a	29	d	30	b
31	b	32	a	33	c	34	b	35	c
36	a	37	c	38	c	39	a	40	b
41	b	42	c	43	a	44	c	45	c
46	d	47	d	48	b	49	d	50	d
51	a	52	b						

Critical Thinking Questions

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

Assertion and Reason

1	b	2	d	3	a	4	a	5	e
6	c	7	a	8	c	9	a	10	a
11	e	12	b						

Answers and Solutions

Communication

1. (a) By using $f_c \approx 9(N_{max})^{1/2} \Rightarrow f_c \approx 2\ MHz$

2. (d) Carrier frequency > audio frequency

3. (c)

4. (a) A maximum frequency deviation of 75 *kHz* is permitted for commercial FM broadcast stations in the 88 to 108 *MHz VHF* band.

5. (b) $v.f. = \frac{1}{\sqrt{k}} = \frac{1}{\sqrt{2.6}} = 0.62$

6. (c) Carrier + signal $\rightarrow$ modulation.

7. (c)

8. (d) Here $\frac{n_1 - n_2}{n_1} = \frac{0.88}{100} \Rightarrow \frac{n_2}{n_1} = 0.9912$

$\therefore$ Critical angle $\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right) = \sin^{-1}(0.9912) = 84°24'$

9. (c)

10. (c)

11. (a)

12. (d) Radio waves can be transmitted from one place to another as grand wave or sky wave or space wave propagation.

13. (b) The energy flux $\phi = \frac{\text{Pulsepower}}{\text{Area}} = \frac{10^{12}}{10^{-4}} = 10^{16}\ \frac{W}{cm^2}$

14. (c) $\nu = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2 \times 3.14\sqrt{10 \times 10^{-6} \times 1 \times 10^{-9}}} = 1592\ kHz$

15. (b)

16. (a) VHF (Very High Frequency) band having frequency range 30 *MHz* to 300 *MHz* is typically used for TV and radar transmission.

17. (c)

18. (d)

19. (c) $MUF = \frac{f_c}{\cos\theta} = \frac{60}{\cos 70°} = 175\ MHz$

20. (b)

21. (d)

22. (d) A very small part of light energy is lost from an optical fibre due to absorption or due to light leaving the fibre as a result of scattering of light sideways by impurities in the glass fibre.

23. (a) $d = \sqrt{2hR} \Rightarrow d \propto h^{1/2}$

24. (d) Surgery needs sharply focused beam of light and laser can be sharply focused.

25. (d) Laser beams are perfectly parallel. So that they are very narrow and can travel a long distance without spreading. This is the feature of laser while they are monochromatic and coherent these are characteristics only.

26. (b) The formula for modulating index is given by

$$m_f = \frac{\delta}{\nu_m} = \frac{\text{Frequency variation}}{\text{Modulatingfrequency}} = \frac{10 \times 10^3}{2 \times 10^3} = 5$$

27. (d) Here, $V_{max} = \frac{24}{2} = 12\ mV$ and $V_{min} = \frac{8}{2} = 2\ mV$

Now, $m = \frac{V_{max} - V_{min}}{V_{max} + V_{min}} = \frac{12-4}{12+4} = \frac{8}{16} = \frac{1}{2} = 0.5 = 50\%$

28. (a) Here, $f_c = 1.5\ MHz = 1500\ kHz,\ f_m = 10\ kHz$

$\therefore$ Low side band frequency

$= f_c - f_m = 1500\ kHz - 10\ kHz = 1490\ kHz$

Upper side band frequency

$= f_c + f_m = 1500\ kHz + 10\ kHz = 1510\ kHz$

29. (d) When m > 1 then carrier is said to be over modulated.

30. (b) It mix weak signals with carrier signals.

31. (b)

32. (a) Frequency modulation requires much wider channel (7 to 15 times) as compared to AM.

33. (c)

34. (b) $P_t = P_c\left(1 + \frac{m_a^2}{2}\right)$; Here m = 1

$\Rightarrow 1800 = P_c\left(1 + \frac{(1)^2}{2}\right) \Rightarrow P_c = 1200W$

35. (c)

36. (a)

37. (c)

38. (c) An antenna is a metallic structure used to radiate or receive EM waves.

39. (a)

40. (b) Pulse code modulation is a digital system.

41. (b)

42. (c) In telecommunication, microwaves are used.

43. (a) Carrier swing $= \frac{\text{Frequency deviation}}{\text{Modulating frequency}} = \frac{50}{7} = 7.143$

44. (c) Optical fibres are not subjected to electromagnetic interference from outside.

45. (c) In optical fibre, light travels inside it, due to total internal reflection.

46. (d)

47. (d) Few advantages of optical fibres are that the number of signals carried by optical fibres is much more than that carried by the *Cu* wire or radio waves. Optical fibres are practically free from electromagnetic interference and problem of cross talks whereas ordinary cables and microwave links suffer a lot from it.

48. (b) The process of changing the frequency of a carrier wave (modulated wave) in accordance with the audio frequency signal (modulating wave) is known as frequency modulation (FM).

49. (d) Following are the problems which are faced while transmitting audio signals directly.

(i) These signals are relatively of short range.

(ii) If every body started transmitting these low frequency signals directly, mutual interference will render all of them ineffective.

(iii) Size of antenna required for their efficient radiation would be larger *i.e.* about 75 *km*.

50. (d) Remote sensing is the technique to collect information about an object in respect of its size, colour, nature, location, temperature *etc.* without physically touching it. There are some areas or location which are inaccessible. So to explore these areas or locations, a technique known as remote sensing is used. Remote sensing is done through a satellite.

51. (a) The critical frequency of a sky wave for reflection from a layer of atmosphere is given by $f_c = 9(N_{\max})^{1/2}$

$\Rightarrow 10\times10^6 = 9(N_{\max})^{1/2}$

$\Rightarrow N_{\max} = \left(\frac{10\times10^6}{9}\right)^2 \simeq 1.2\times10^{12} m^{-3}$

52. (b) Core of acceptance angle $\theta = \sin^{-1}\sqrt{n_1^2 - n_2^2}$

Critical Thinking Questions

1. (b) $n_{eff} = n_0\sqrt{1-\left(\frac{80.5\,N}{\nu^2}\right)} = 1\sqrt{1-\frac{80.5\times(400\times10^6)}{(55\times10^6)^2}} \approx 1$

Also $n_{eff} = \frac{\sin i}{\sin r} \Rightarrow \sin r = \sin i \Rightarrow r = i = 45°$

2. (b) For demodulation $\frac{1}{f_c} << RC$

$\frac{1}{f_c} = \frac{1}{100\times10^3} = 10^{-5}\,s$

$RC = 10^3\times10\times10^{-12}\,s = 10^{-8}\,s$

We see that $\frac{1}{f_c}$ here is not less than RC as required by the above condition. Hence, this is not good.

3. (a) Optical source frequency $f = \frac{c}{\lambda}$

$= 3\times10^8/(800\times10^{-9}) = 3.8\times10^{14}\,Hz$

Bandwidth of channel (1% of above) $= 3.8\times10^{12}\,Hz$

Number of channels =(Total bandwidth of channel)/(Bandwidth needed per channel)

(a) Number of channels for audio signal

$= (3.8\times10^{12})/(8\times10^3) \sim 4.8\times10^8$

4. (b) Limiting value of $h\nu$ is E_g such that $h\nu = \frac{hc}{\lambda} = E_g$

or $\lambda = \frac{hc}{E_g} = \frac{6.63\times10^{-34}\,J\text{-}s\times3\times10^8\,ms^{-1}}{0.73\times1.6\times10^{-19}\,J}$

$= 1703\,nm$

5. (b) $P_t = P_c\left[1+\frac{m^2}{2}\right] = 9\left[1+\frac{(0.4)^2}{2}\right]$

$= 9\left[1+\frac{0.16}{2}\right]$ ($\because$ m = 40% = 0.4)

$= 9\,(1.08) = 9.72\,kW$

6. (d) We know that $\left(\frac{I_t}{I_c}\right)^2 = 1+\frac{m^2}{2}$

Here, $I_t = 8.96A$ and $I_c = 8A$

$\therefore \left(\frac{8.96}{8}\right)^2 = 1+\frac{m^2}{2}$ or $1.254 = 1+\frac{m^2}{2}$

or $\frac{m^2}{2} = 0.254$ or $m^2 = 0.508$

or m = 0.71 = 71%

7. (d) $\frac{P_t}{P_c} = 1+\frac{m^2}{2}$ or $P_c = P_t\left[\frac{2}{2+m^2}\right]$

$\therefore P_c = 1500\left[\frac{2}{2+1}\right]$ $\because$ m = 100% = 1

$= 1000\,W$

8. (c) $P_c = P_t\left[\frac{2}{2+m^2}\right] = 900\left[\frac{2}{2+1}\right] = 600W$

Now, $P_{LSB} = \frac{m^2}{4}\times P_c = \frac{1}{4}\times600 = 150\,W$

9. (b) CS = 2 × Δf or Δf = $CS/2$

$\therefore \Delta f = \frac{200}{2} = 100\,kHz$

Now $m_f = \frac{\Delta f}{f_m} = \frac{100}{10} = 10$

10. (b) $m_f = \frac{\delta}{f_m} = \frac{2250}{500} = 4.5$

$\therefore$ New deviation $= 2(m_f\ f_m) = 2 \times 4.5 \times 6 = 54\ kHz.$

11. (c) $m_a = \frac{E_m}{E_c} = \frac{15}{60} \times 100 = 25\%$

12. (a) If n is the number of bits per sample, then number of quantisation level = 2^n

Since the number of quantisation level is 16

$\Rightarrow 2^n = 16 \Rightarrow n = 4$

$\therefore$ bit rate = sampling rate × no. of bits per sample

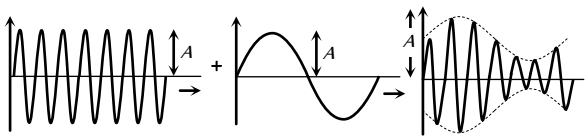
= 8000 × 4 = 32,000 *bits/sec.*

13. (c) $P_{sb} = P_c\left(\frac{m_a}{2}\right)^2 = P_c\frac{(0.5)^2}{4} = 0.0625\,P_c$

Also $P = P_c\left(1 + \frac{m_a^2}{2}\right) = P_c\left(1 + \frac{(0.5)^2}{2}\right) = 1.125P_c$

$\therefore$ % saving $= \frac{(1.125P_c - 0.0625P_c)}{1.125P_c} \times 100 = 94.4\%.$

14. (a) When signal amplitude is equal to the carrier amplitude, the amplitude of carrier wave varies between 2*A* and zero.



$m_a = \frac{\text{Amplitude change of carrier}}{\text{Amplitude of normal carrier}} = \frac{2A - A}{A} \times 100 = 100\%$

Assertion and Reason

1. (b) In optical communication, diode laser is used to generate analog signals or digital pulses for transmission or digital pulses for transmission trough optical fibres. The advantage of diode lasers are their small size and low power input.

2. (d) TV signals (frequency greater than 30 *MHz*) cannot be propagated through sky wave propagation.

Above critical frequency, an electromagnetic wave penetratates the ionosphere and is not reflected by it.

3. (a) Microwave communication is preferred over optical communication because microwaves provide large number of channels and wider band width compared to optical signals as information carrying capacity is directly proportional to band width. So, wider the band width, greater the information carrying capacity.

4. (a) Having the range of wavelength from 30 *km* to 30 *cm* are known as short wave. These waves are used for radio transmission and for general communication purpose to a longer distance from ionosphere. Ionosphere is the outermost region of atmosphere extending from height of 80 *km* to 400 *km* approximately, above the surface of earth. Therefore, both the assertion and reason are true and reason is the correct explanation of assertion.

5. (e) The electrical conductivity of earth's atmosphere increases with height so assertion is false.

When high energy particles enters in earth's atmosphere. They ionises the gases present in atmosphere. Also as we go up, the air thins out gradually and air pressure decreases.

6. (c) The electromagnetic waves of shorter wavelength do not suffer much diffraction from the obstacles of earth's atmosphere so they can travel long distance.

Also, shorter the wavelength, shorter is the velocity of wave propagation.

7. (a) Both assertion and reason are true and reason is the correct explanation of assertion. (For more detail, refer theory).

8. (c) As the distance increases, TV signals becomes weaker. So assertion is true. The power transmitted from TV transmitter is inversely proportional to the square of the distance of the receiver. That's why reason is false.

9. (a) Microwaves have got good directional properties. Due to it, the microwaves can be directed as beam signals in a particular direction, much better than radio waves, because microwaves do not bend around the corners of any obstacle coming in their way.

10. (a) The remote sensing is done through a satellite. A remote sensing satellite files in a polar orbit at an altitude of 918 *km*, around the earth, in such away that it passes over a given location on the earth at the same local time.

11. (e) The electronic reproduction of a document at a distance plane is known as FAX modulation and demodulation is done by modem.

12. (b) A dish antenna is a directional antenna because it can transmit or sec.

Communication

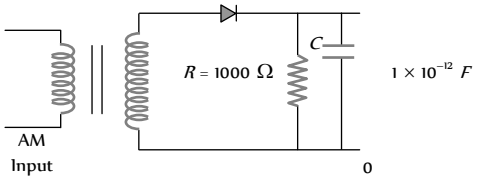
SET Self Evaluation Test - 28

1. A ground receiver station is receiving a signal at (i) 5 *MHz* and transmitted from a ground transmitter at a height of 300 *m*, located at a distance of 100 *km* from the receiver station. The signal is coming via. Radius of earth = 6.4×10^{6} *m*. N_0 of isosphere = 10^{6} *m*

(a) Space wave (b) Sky wave propagation

(c) Satellite transponder (d) All of these

2. In the given detector circuit, the suitable value of carrier frequency is



(a) $<< 10^{6}$ *Hz* (b) $<< 10^{6}$ *Hz*

(c) $>> 10^{6}$ *Hz* (d) None of these

3. The impedance of coaxial cable, when its inductance is 0.40 μH and capacitance is 1×10^{-11} *F*, can be

(a) $2 \times 10^{6}\ \Omega$ (b) 100 Ω

(c) $3 \times 10^{6}\ \Omega$ (d) $3 \times 10^{-6}\ \Omega$

4. A wave is represented as

$$e = 10\sin(10^{8}t + 6\sin 1250t)$$

then the modulating index is

(a) 10 (b) 1250

(c) 10^{6} (d) 6

5. An optical fibre communication system works on a wavelength of 1.3 μm. The number of subscribers it can feed if a channel requires 20 *kHz* are

(a) 2.3×10^{6} (b) 1.15×10^{6}

(c) 1×10^{6} (d) None of these

6. In an FM system a 7 *kHz* signal modulates 108 *MHz* carrier so that frequency deviation is 50 *kHz*. The carrier swing is

(a) 7.143 (b) 8

(c) 0.71 (d) 350

7. In a radio receiver, the short wave and medium wave stations are tuned by using the same capacitor but coils of different inductance L_1 and L_2 respectively then

(a) $L_1 > L_2$ (b) $L_1 < L_2$

(c) $L_1 = L_2$ (d) None of these

8. The electron density of *E*, *F*, F_1 layers of ionosphere is 2×10^{6}, 5×10^{6} and 8×10^{6} m^{-3} respectively. What is the ratio of critical frequency for reflection of radiowaves

(a) 2 : 4 : 3 (b) 4 : 3 : 2

(c) 2 : 3 : 4 (d) 3 : 2 : 4

9. A carrier is simultaneously modulated by two sine waves with modulation indices of 0.4 and 0.3. The resultant modulation index will be

(a) 1.0 (b) 0.7

(c) 0.5 (d) 0.35

10. Mean optical power launched into an 8 *km* fibre is 120 μW and mean output power is 4 μW, then the overall attenuation is (Given log 30 = 1.477)

(a) 14.77 *dB* (b) 16.77 *dB*

(c) 3.01 *dB* (d) None of these

11. A antenna current of an AM broadcast transmitter modulated by 50% is 11 *A*. The carrier current is

(a) 10.35 *A* (b) 9.25 *A*

(c) 10 *A* (d) 5.5 *A*

12. Because of tilting which waves finally disappear

(a) Microwaves (b) Surface waves

(c) Sky waves (d) Space waves

13. A transmitter transmits a power of 10 *kW* when modulation is 50%. Power of carrier wave is

(a) 5 *kW* (b) 8.89 *kW*

(c) 14 *kW* (d) 5.7 *kW*

14. A telephone link operating at a central frequency of 10 *GHz* is established. If 1% of this is available then how many telephone channel can be simultaneously given when each telephone covering a band width of 5 *kHz*

(a) 2×10^{6} (b) 2×10^{6}

(c) 5×10^{6} (d) 5×10^{6}

AS Answers and Solutions

1. (b) Maximum distance covered by space wave communication $\sqrt{2Rh} = 62\,km$

Critical frequency = $f_c = 9(N_{\max})^{1/2} \simeq 9\ MHz$

5 *MHz* < *f*, sky wave propagation (ionospheric propagation)

2. (a) Using $\frac{1}{f_{carrier}} << RC$

We get time constant, $RC = 1000 \times 10^{-12} = 10^{-9}\,s$

Now $\nu = \frac{1}{T} = \frac{1}{10^{-9}} = 10^9\,Hz$

Thus the value of carrier frequency should be much less than $10^9\,Hz$, say 100 *kHz*.

3. (a) Using $Z = \sqrt{\frac{L}{C}}$ we get $Z = \sqrt{\frac{0.40 \times 10^{-6}}{10^{-11}}} = 2 \times 10^2\,\Omega$

4. (d) Comparing with standard equation.

5. (b) Optical source frequency $f = \frac{c}{\lambda} = \frac{3 \times 10^8}{1.3 \times 10^{-6}} = 2.3 \times 10^{14}\,Hz$

$\therefore$ Number of channels or subscribers $= \frac{2.3 \times 10^{14}}{20 \times 10^3}$

= 1.15 × 10^{-}

6. (a) Carrier swing $= \frac{\text{Frequency deviation}}{\text{Modulatingfrequency}} = \frac{50}{7} = 7.143$

7. (b) As $\nu = \frac{c}{\lambda} \Rightarrow \nu_m = \frac{c}{\lambda_m}$ and $\nu_s = \frac{c}{\lambda_s}$

$\because\ \lambda_m > \lambda_s \Rightarrow \nu_m < \nu_s$

Also $\nu_m = \frac{1}{2\pi\sqrt{L_m C}}$ and $\nu_s = \frac{1}{2\pi\sqrt{L_s C}}$

$\Rightarrow \frac{\nu_m}{\nu_s} = \sqrt{\frac{L_s}{L_m}} \Rightarrow L < L.$

8. (c) $f_c \propto (N)^{1/2} \Rightarrow (f_c)_E : (f_c)_{F_1} : (f_c)_{F_2}$

$= (2 \times 10^{11})^{1/2} : (5 \times 10^{11})^{1/2} : (8 \times 10^{11})^{1/2}$ = 2 : 3 : 4

9. (c) $m = \sqrt{m_1^2 + m_2^2} = \sqrt{(0.16) + (0.09)} = 0.5$

10. (a) Attenuation $= 10 \log \frac{120}{4} = 10 \log 30$

$= 10 \times 1.4771 = 14.77\,dB.$

11. (a) $I_{Carrier} = \frac{I_{rms}}{\sqrt{1 + \frac{m_a^2}{2}}} = \frac{11}{\sqrt{1 + \frac{(0.5)^2}{2}}} = 10.35\,A$

12. (b)

13. (b) $P_c = \frac{P}{\left(1 + \frac{m_a^2}{2}\right)} = \frac{10000}{\left(1 + \frac{(0.5)^2}{2}\right)} = \frac{10000}{1.125} = 8.89\,kW$

14. (a) 1% of 10 *GHz* = $10 \times 10^9 \times \frac{1}{100} = 10^8\,Hz$

Number of channels $= \frac{10^8}{5 \times 10^3} = 2 \times 10^4$