

Solution : DTS

1.(D) $d = \sqrt{2hR}$

2.(D) Optical source frequency $v = \frac{c}{\lambda}$ Or $v = \frac{3 \times 10^8 \text{ ms}^{-1}}{1200 \times 10^{-9} \text{ m}} = 2.5 \times 10^{14} \text{ Hz}$

Band width of channel (2% of the source frequency)

$$= 5 \times 10^{12} \text{ Hz}$$

$$\text{Number of channels} = \frac{\text{Total band width}}{\text{Band width needed per channel}} = \frac{5 \times 10^{12} \text{ Hz}}{5 \times 10^6 \text{ Hz}} = 10^6 = 1 \text{ million}$$

3.(C) $MI\% = \frac{E_M}{E_C} \times 100 = \frac{10}{20} \times 100 = 50\%$

4.(B) FACT 5.(C) $\lambda / 4$

6.(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.

7.(C) Modulation.

8.(B) Series impedance for transmission line per unit length

$$Z = R + j\omega L$$

And shunt admittance / unit length = $Y = \epsilon_1 + j\omega C$ \therefore Propagation constant = \sqrt{ZY}

9.(D) 50,000 cycles/sec carrier frequency > audio frequency

10.(D) An oscillator circuit is used to generate radio-waves of constant amplitude using capacitor in filter circuit.

11.(A) Modulation increases bandwidth from $(f_c - f_m)$ to $(f_c + f_m)$. So option (A) is not true.

12.(D) For satellite communication $f_{\text{uplink}} \equiv f_{\text{downlink}}$ and geo-stationary orbit must lie in equatorial plane at 0° for no. signal loss.

13.(A) Sky wave propagation is useful in range of 2 MHz to 30 MHz.

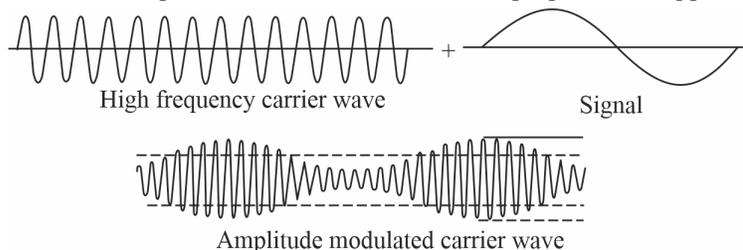
14.(C) Maximum frequency that can be reflected from ionosphere

$$f_c = 9\sqrt{N_{\text{max}}} \Rightarrow N_{\text{max}} = \frac{144 \times 10^{12}}{81} \approx 1.78 \times 10^{12} / \text{m}^3$$

15.(C) Sampling results in highest communication speed by selecting appropriate signals.

Solution : JEE Main (Archive)

- 1.(B)** Optical fibres are subject to electromagnetic interference from outside.
- 2.(A)** Sky waves are used for long distance radio communication. They are less stable because state of ionosphere varies.
- 3.(C)** FACT **4.(B)** FACT **5.(B)** FACT **6.(C)** FACT
- 7.(B)** Max. distance = $\sqrt{2Rh_T} + \sqrt{2Rh_R}$
 $= \sqrt{2R} (\sqrt{h_T} + \sqrt{h_R})$
 $= \sqrt{2 \times 6400} \left(\sqrt{\frac{32}{1000}} + \sqrt{\frac{50}{1000}} \right) = 45.5 \text{ km}$
- 8.(B)** Infrared waves → To treat muscular strain
 Radio wave → For broadcasting
 X-ray → To detect feature of bones
 Ultraviolet waves → Absorbed by the ozone layer of the atmosphere
- 9.(D)** (i) Vibration of atoms and molecules → Infrared Ray → 700 nm to 1 mm
 (ii) Inner shell electrons movement → UV rays → 1 nm to 400 nm.
 (iii) Radioactive Decay of nucleus → Gamma Ray → $< 10^{-3} \text{ nm}$
 (iv) Magnetron valve → Micro wave → 1 mm to 0.1 m
- 10.(D)** In amplitude modulation amplitude of carrier wave varies in proportion to applied signal.



11.(D) No of telephonic channels that can be transmitted simultaneously = $\frac{0.1 \times 10 \times 10^9}{5 \times 10^3} = 2 \times 10^5$

12.(A) $\lambda = 800 \text{ nm}$

$$f = \frac{3 \times 10^8}{800 \times 10^{-9}} = \frac{3000}{800} \times 10^{14} \text{ Hz}$$

$$\text{Now } 1\% = \frac{3000}{800} \times 10^{14} \times \frac{1}{100} \text{ Hz}$$

$$\text{Number of channels} = \frac{\frac{3}{8} \times 10^{13}}{6 \times 10^6} = \frac{3}{48} \times 10^7 = \frac{300}{48} \times 10^5 = 6.25 \times 10^5$$

13.(A) Range = 2250 kHz to 2750 kHz

$$2500 \pm 250$$

For 2900 kHz range is 2650 kHz – 3150 kHz which falls in the given range

2250 kHz & 2750 kHz also fall within the given range

Only 2000 kHz is permissible as range for it is 1750 kHz – 2250 kHz

$$\begin{aligned}
 \mathbf{14.(A)} \quad \sqrt{2 \times 6.4 \times 10^6 \times 140} + \sqrt{2 \times 6.4 \times 10^6 \times 40} &= \sqrt{28 \times 64 \times 10^6} + \sqrt{8 \times 64 \times 10^6} \\
 &= (\sqrt{28} + \sqrt{8}) \times 8 \times 10^3 = (5.3 + 2.8) \times 8 \text{ km} \\
 &= 8.1 \times 8 \text{ km} = 64.8 \text{ km} \approx 65 \text{ km}
 \end{aligned}$$

$$\begin{aligned}
 \mathbf{15.(A)} \quad C_m(t) &= (A_C + A_m \sin \omega_m t) \sin \omega_c t \\
 A_C + A_m &= 10 \text{ V} \\
 A_C - A_m &= 8 \text{ V} \quad \therefore A_C = 9 \text{ V} \\
 \omega_c &= \frac{2\pi}{8 \times 10^{-6}} = 2.5 \times 10^5 \pi \\
 \omega_m &= \frac{2\pi}{100 \times 10^{-6}} = 2 \times 10^4 \pi.
 \end{aligned}$$

16.(B) The standard equation of AM wave is:

$$y(t) = [1 + m \cos(\omega_m t + \phi)] A \sin(\omega_c t)$$

Where ω_m : Angular freq. of mod. wave

ω_c : Angular freq. of carrier wave.

If the above equation is expanded as follows:

$$y(t) = A \sin(\omega_c t) + \frac{1}{2} Am \sin((\omega_c + \omega_m)t + \phi) + \frac{1}{2} Am \sin((\omega_c - \omega_m)t)$$

The first term is the original carrier wave, and the other two are known as sidebands.

Comparing the given equation with above equation, sideband frequencies are:

$$\mathbf{(i)} \quad f_c - f_m = \frac{(55 - 2.2)}{2\pi} \times 10^4 \cong 84.1 \text{ KHz} \quad \mathbf{(ii)} \quad f_c + f_m = \frac{(55 + 2.2)}{2\pi} \times 10^4 \cong 91 \text{ KHz.}$$

Closest option is (89.25, 85.75)

17.(B) The height should be multiplied by 4 times

$$\begin{aligned}
 \mathbf{18.(A)} \quad A_{\text{carrier wave}} &= 100 \\
 A_C + A_m &= 160 \\
 A_C - A_m &= 40 \\
 \Rightarrow A_m &= 60 \\
 \mu = \frac{A_m}{A_C} &= 0.6
 \end{aligned}$$

19.(C) Refer NCERT

$$\begin{aligned}
 \mathbf{20.(D)} \quad d &= \sqrt{2Rh_T} + \sqrt{2Rh_R} \\
 50 \times 10^3 &= \sqrt{2 \times 6.4 \times 10^6 \times h_T} + \sqrt{2 \times 6.4 \times 10^6 \times 70} \quad \Rightarrow \quad h_T = 32 \text{ m}
 \end{aligned}$$

21.(A) Theoretical

22.(B) The physical size of antenna of receiver and transmitter both inversely proportional to carrier frequency.

23.(B) In fiber optics, we use wavelength in range 1.3 – 1.6 μm (Infrared)

Radar stands for Radio detection and ranging so, it uses radio waves.

Sonar uses high energy (high frequencies) sound waves for under-water research.

Mobile phones uses microwaves of wavelength of order of few meters.

$$24.(B) \text{ Modulating index } = m = \frac{\text{Amplitude of message signal}}{\text{Amplitude of Carrier signal}} = \frac{100}{400} = 0.25$$

Three frequency are obtained, $(f_{carrier} - f_{message}), f_{carrier}, (f_{carrier} + f_{message})$

So, difference between two side band frequencies = $2f_{message} = 200 \text{ MHz}$

$$25.(D) \text{ L.S.B } = \omega_c - \omega_m = (20000 - 2000)\pi = 18000\pi \text{ rad/s}$$

So, lower side band frequency = $\frac{18000\pi}{2\pi} = 9000\text{Hz}$

$$\text{Modulation index} = \frac{A_m}{A_c} = 0.5$$

$$26.(C) Y = 5(1 + 0.6 \cos 6280t) \sin(211 \times 10^4 t)$$

$$A_{\max} = 5 \times 1.6 = 8V$$

$$A_{\min} = 5(1 - 0.6) = 2V$$

Best choice (3)