

8. COMMUNICATION

SYNOPSIS

- Communication is the act of transmission of information
- **Space Communication**
Radio waves & microwaves are used in television, radio & other communication system
- (i) **Ground wave**
Height of transmitting & receiving antenna

$$h \propto \frac{\lambda}{4}$$
- (ii) **Sky wave**
 - (a) **Critical Frequency:** Highest frequencies of radio wave which get reflected to earth by the Ionosphere

$$f_c = 9(N_{\max})^{\frac{1}{2}}$$

$$N_{\max} \longrightarrow \text{electron density of the ionosphere.}$$
 - (b) **Skip distance:-** Smallest distance from a transmitter along the earth's surface at which a sky wave of a fixed frequency sent back to earth

$$D_{\text{skip}} = 2h \sqrt{\frac{f^2}{f_c^2} - 1}$$
- (iii) **Space wave**
Television signal propagation:-
Height of transmitting antenna

$$h = \frac{d^2}{2R}$$

$$d \rightarrow \text{distance covered by signal}$$

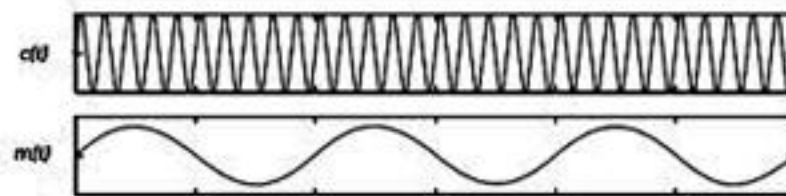
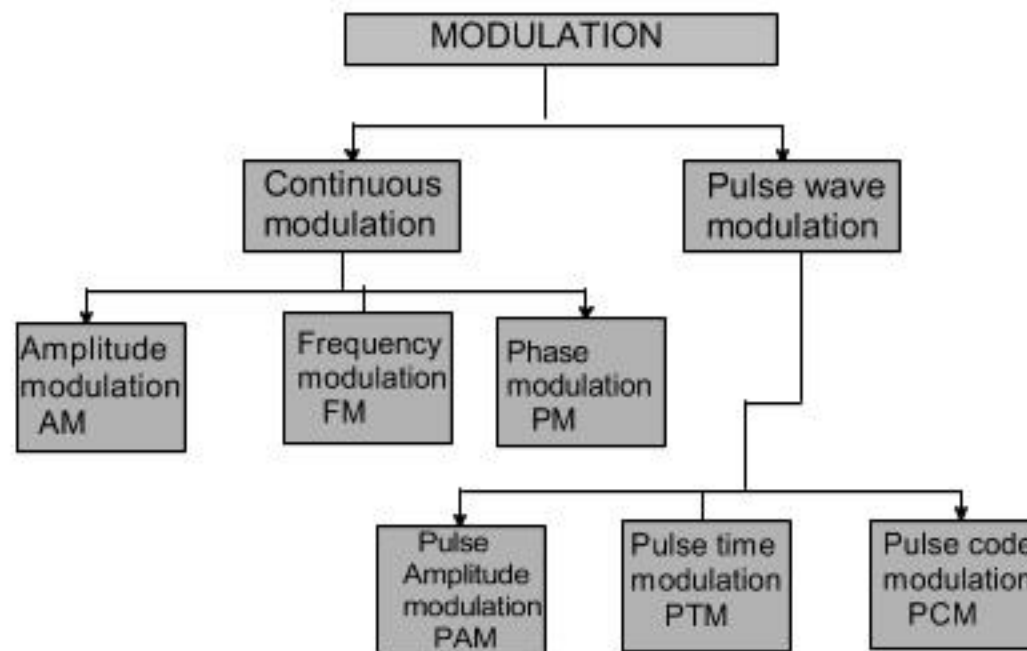
$$R \rightarrow \text{Radius of Earth}$$

$$\text{Area covered (A)} = \pi d^2 = 2\pi R h$$

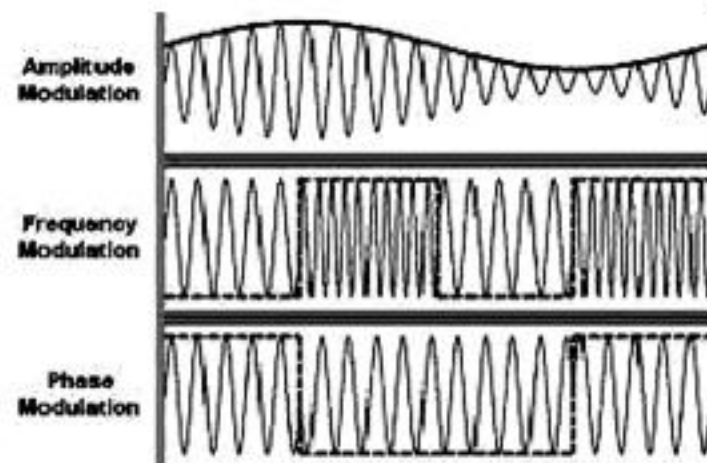
$$\text{Population cover} = \text{population density} \times \text{area covered}$$
- **Modulation :** It is a process of Superimposition of low frequency signal over a high frequency carrier signals.
Effective Power radiated by an antenna.

$$\text{Power} \propto \left(\frac{\ell}{\lambda}\right)^2$$

- Types of modulation



$c(t) \rightarrow$ sinusoidal carrier wave. $m(t) \rightarrow$ modulating signal



SOLVED EXAMPLE

1. Show that the minimum length of antenna required to transmit a radio signal of frequency 10 MHz is 7.5 m.

Sol: Here, $f = 10 \text{ MHz} = 10^7 \text{ Hz}$

$$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{10^7} = 30 \text{ m}$$

$$\text{Minima length of antenna} = \frac{\lambda}{4} = \frac{30}{4} = 7.5 \text{ m}$$

2. What should be the height of transmitting antenna if the T.V. telecast is to cover a radius of 128 km? $R_e = 6.4 \times 10^6 \text{ m}$. If the average population density around the tower is $1000 / \text{km}^2$, how much population is covered?

Sol: Height of transmitting antenna

$$h = \frac{d^2}{2R} = \frac{(128 \times 10^3)^2}{2 \times 6.4 \times 10^6} = 1280 \text{ m}$$

Total population covereds

$$\begin{aligned} &= \pi d^2 \times \text{population density} \\ &= 3.14 \times (128)^2 \times 1000 = 5.14 \times 10^7 \end{aligned}$$

3. For sky wave propagation of a 10 MHz signal, what should be the minimum electron density in ionosphere

Sol: The critical frequency of a sky wave for reflection from a layer of atmosphere is

$$\begin{aligned} f_c &= 9(N_{\max})^{1/2} \\ 10 \times 10^6 &= 9(N_{\max})^{1/2} \\ N_{\max} &= \left(\frac{10 \times 10^6}{9} \right)^2 \\ &= 1.2 \times 10^{12} \text{ m}^{-3} \end{aligned}$$

4. If both the length of an antenna and the wavelength of the signal to be transmitted are doubled, the power radiated by the antenna

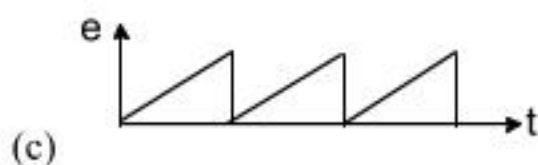
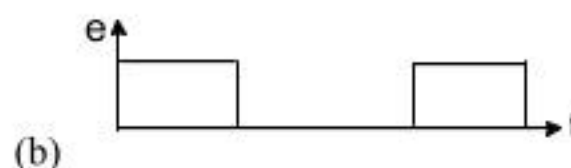
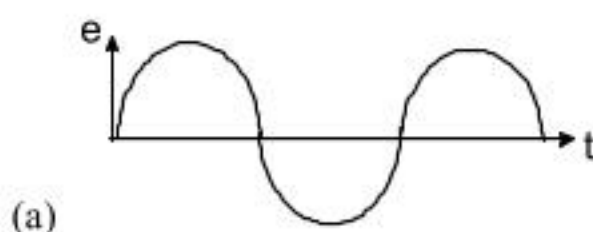
Sol: $P \propto \left(\frac{\ell}{\lambda} \right)^2$

Hence Power will remain constant

EXERCISE

- Which of the following has maximum energy?
(1) Radio waves (2) infrared rays (3) Ultraviolet rays (4) Microwaves
- Frequency of infra red wave is approximately (in hertz)
(1) 10^{16} (2) 10^{19} (3) 10^{14} (4) 10^9
- If a radio receiver amplifies all the signal frequencies equally well, it is said to have high
(1) fidelity (2) distortion (c) sensitivity (4) selectivity
- If a radio receiver is tuned is 885 kHz radio wave, the frequency of local oscillator in kHz is,
(1) 1510 (2) 455 (3) 1310 (4) 885
- For line communication
(1) A two wire transmission line is useful at very high frequency.
(2) A co-axial cable is more useful at very high frequency than optical fibres.
(3) Optical fibre is a good choice because a large number of channels can be transmitted simultaneously by using it
(4) none of these

- The time variation of signals are given as in a, b, and c; point out TRUE statement from the following



- (1) a, b, and c are analogue signals (2) a and c are digital, but b is analogue signal
(3) a and c are digital, but b is analogue signal (4) a and c analogue but b is digital signal
- The maximum line of sight distance d_m two antennas having heights h_r and h above earth is
(1) $\sqrt{R(h_r + h_g)}$ (2) $\sqrt{R / (h_r + h_g)}$ (3) $\sqrt{2Rh_r} + \sqrt{2Rh_g}$ (4) $\sqrt{2Rh_r} + \sqrt{2Rh_r}$
- What fraction of the surface area of Earth can be covered to establish communication by one geostationary satellite?
(1) $\frac{1}{2}$ (2) $\frac{1}{3}$ (3) $\frac{1}{4}$ (4) $\frac{1}{8}$
- AT.V. tower has a height 150 m. What is the total population covered by the T.V. tower, if the population density around the T.V. tower is 10^3 km^{-2} ? Radius of the earth is $6.4 \times 10^6 \text{ m}$
(1) 60.288 lakhs (2) 40.192 lakhs (3) 100 lakhs (d) 20.228 lakhs

WINDOW TO JEE MAIN

1. Consider telecommunication through optical fibers. Which of the following statements is not true? **[AIEEE 2003]**
 - (1) Optical fibers can be of graded refractive
 - (2) Optical fibers are subjected to electromagnetic interference from outside.
 - (3) Optical fibers have extremely low transmission loss.
 - (4) Optical fibres may have homogenous core with a suitable cladding.

2. This question has Statement -1 and Statement-2 of the four choices given after the statements, choose the one that best describes the two statement. **[AIEEE-2011]**

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

 - (1) Statement-1 is true, Statement-2 is false
 - (2) Statement-1 is true, Statement-2 is true and Statement-2 is the correct explanation of Statement-1
 - (3) Statement-1 is true, Statement-2 is true and Statement-2 is **not** the correct explanation of Statement-1.
 - (4) Statement-1 is false, Statement-2 is true.

3. Which of the following four alternatives is not correct? We need modulation **[AIEEE-2011]**
 - (1) to reduce the time lag between transmission and reception of the information signal
 - (2) to reduce size of antenna
 - (3) to reduce the fractional band width, that is, the ratio of the signal band width to the centre frequency
 - (4) to increase the selectivity

4. A radar has 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- **[AIEEE-2012]**
 - (1) 16 km
 - (2) 40 km
 - (3) 64 km
 - (4) 80 km

5. If a carrier wave $c(t) = A \sin \omega_c t$, were to be amplitude modulated by a modulating signal $m(t) = A \sin \omega_m t$, the equation representing the modulated signal $[C_m(t)]$, and its modulation index, would be respectively : **[JEE MAIN ONLINE 2013]**
 - (1) $C_m(t) = A(1 + \sin \omega_c t) \sin \omega_m t$ and 1
 - (2) $C_m(t) = A(1 + \sin \omega_c t) \sin \omega_m t$ and 2
 - (3) $C_m(t) = A(1 + \sin \omega_m t) \sin \omega_c t$ and 2
 - (4) $C_m(t) = A(1 + \sin \omega_m t) \sin \omega_c t$ and 1

6. Which of the following modulated signal has the best noise-tolerance? **[JEE MAIN ONLINE 2013]**
 - (1) long-wave
 - (2) short-wave
 - (3) medium-wave
 - (4) amplitude-modulated

7. A transmitting antenna at the top of a tower has a height 32 m and the height of the receiving antenna is 50 m. What is the maximum distance between them for satisfactory communication in line of sight (LOS) mode ? **[JEE MAIN ONLINE 2014]**
 - (1) 55.4 km
 - (2) 45.5 km
 - (3) 54.5 km
 - (4) 455 km

8. Long range radio transmission is possible when the radiowaves are reflected from the ionosphere. For this to happen the frequency of the radiowaves must be in the range :

[JEE MAIN ONLINE 2014]

(1) 80 - 150 MHz (2) 8 - 25 MHz (3) 1 - 3 MHz (4) 150 - 500 kHz
9. For sky wave propagation, the radio waves must have a frequency range in between :

[JEE MAIN ONLINE 2014]

(1) 1 MHz to 2 MHz (2) 5 MHz to 25 MHz
 (3) 35 MHz to 40 MHz (4) 45 MHz to 50 MHz
10. 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

[JEE MAIN ONLINE 2015]

(1) 2 MHzs only (2) 2005 kHz and 1995 kHz
 (3) 2005 kHz, 2000 kHz and 1995 kHz (4) 2000 kHz and 1995 kHz

ANSWER KEY

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|----|-----|----|-----|----|-----|----|-----|----|-----|
| 1. | (3) | 2. | (3) | 3. | (3) | 4. | (4) | 5. | (3) |
| 6. | (4) | 7. | (4) | 8. | (2) | 9. | (1) | | |

WINDOW TO JEE MAIN

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|----|-----|----|-----|----|-----|----|-----|-----|-----|
| 1. | (1) | 2. | (4) | 3. | (1) | 4. | (4) | 5. | (4) |
| 6. | (2) | 7. | (2) | 8. | (2) | 9. | (2) | 10. | (3) |