JEE Main Physics

Short Notes

Communication System

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Communication System is an important topic from JEE Main / JEE Advanced Exam Point of view. Every year there are 1-2 questions asked from this topic. This short notes on Communication System will help you in revising the topic before the JEE Main & IIT JEE Advanced Exam. You can also download notes in PDF format at end of the post.

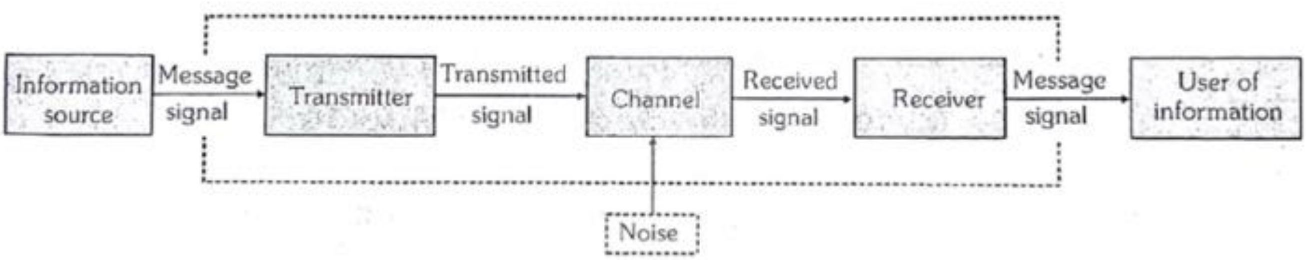
Communication System

The transmission of information is known as communication. For transmission of information from one place to other, there are three essential elements.

Transmitter- Transmitter is used to transmit the input signal from the information source.

Channel- Channel is defined as the medium through which the signal is sent from transmitter to receiver.

Receiver- Receiver is used to extract the desired message signal from the received signal at the channel output.



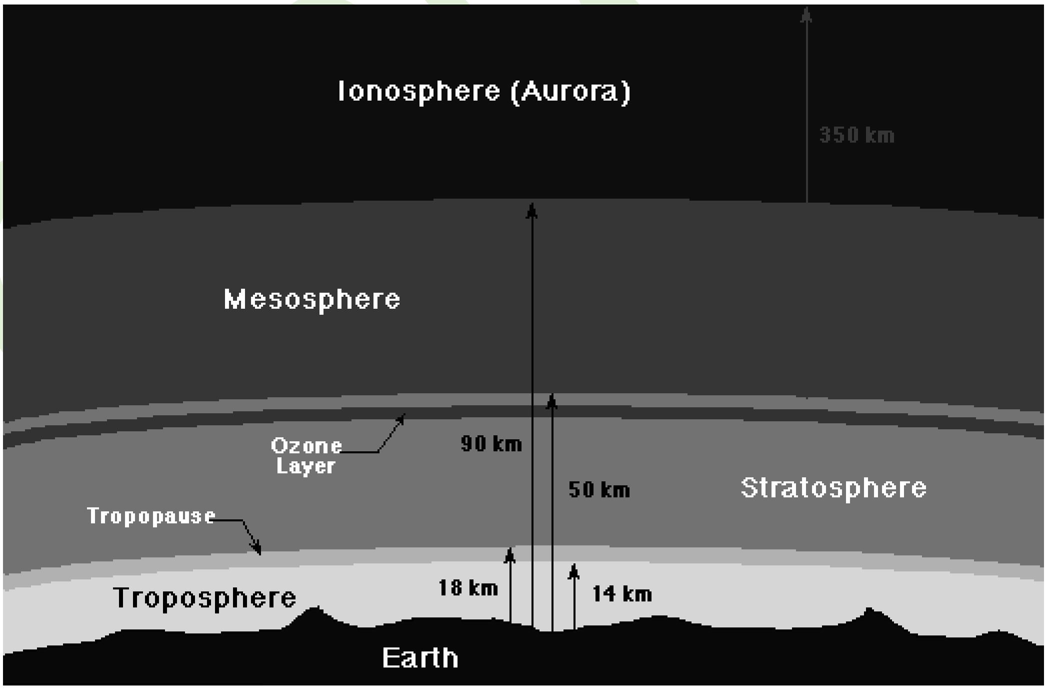
Bandwidth of signal – The difference between the maximum and minimum frequency of a signal is known as the bandwidth of that signal.

The frequency band of some important wireless communications

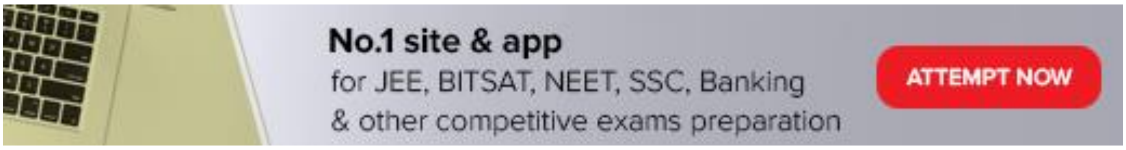
Service	Frequency bands
Standard AM broad cast	540 – 1600 KHz
FM broadcast	88 – 108 MHz
Television (VHF) TV VMF TV	54 – 72 MHz 76 – 88 MHz 174 – 216 MHz 420 – 890 MHz
Cellular Mobile Radio	896 – 901 MHz 840 – 935 MHz
Satellite Communication	5.925 – 6.425 MHz 3.7 – 4.2 GHz

Propagation of Electromagnetic Waves

In the case of radio waves communication, an antenna at the transmitter radiates the electromagnetic waves (EM waves). The EM waves travel through space and reach the receiving antenna at the other end. As the EM wave travels away from the transmitter, their strength keeps on decreasing. Many factors influence the propagation of EM waves including the path they follow. The composition of the earth's atmosphere also plays a vital role in the propagation of EM waves, as summarised below.



Layers of atmosphere and their interaction with the propagating EM waves.



Ground wave Propagation

The radio waves which travel through atmosphere following the surface of the earth are known as ground waves or surface waves and their propagation is called ground wave propagation or surface wave propagation.

Points to remember

(1) The ground wave transmission becomes weaker with the increase in frequency because more absorption of ground waves takes place at a higher frequency during propagation through the atmosphere.

(2) The ground wave propagation is suitable for low and medium frequency i.e. upto 2 or 3 MHz only.

(3) The ground wave propagation is generally used for local band broadcasting.

Sky wave Propagation

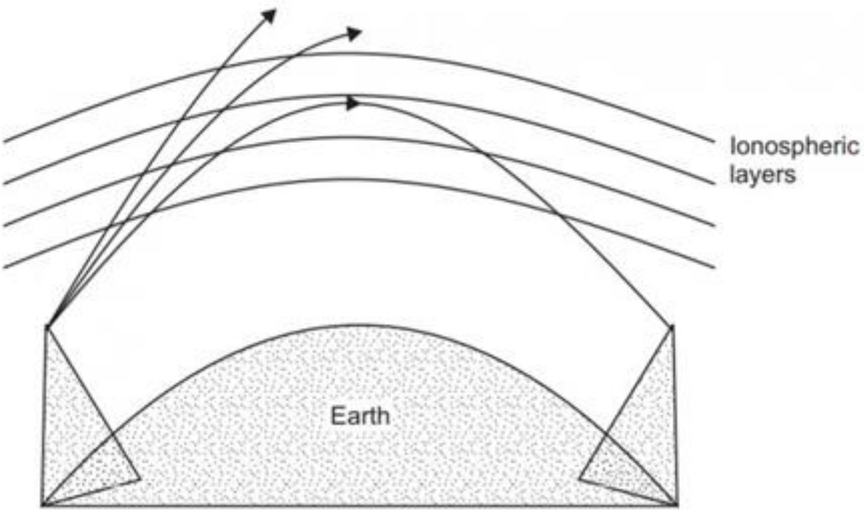
The sky waves are the radio waves of frequency between 2 MHz to 30 MHz.

Points to remember

(1) The ionospheric layer acts as a reflector for a certain range of frequencies (3 to 30 MHz). Electromagnetic waves of frequencies higher than 30 MHz penetrate the ionosphere and escape.

(2) The highest frequency of radio waves which when sent straight (normally) towards the layer of ionosphere gets reflected from the ionosphere and returns to the earth is called critical frequency.

$f_c = 9\,(N_{max})^{1/2}$, where N is the number density of electron/m^3.



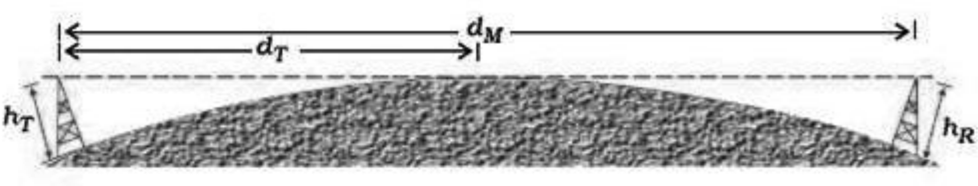
Space wave propagation

The space waves are the high-frequency radio waves. These waves can travel through the atmosphere from the transmitter antenna to receiver antenna either directly or after reflection from the ground in the earth's troposphere region. Therefore the space wave propagation is also called as tropospheric propagation or line of sight propagation.

Points to remember

(1) The range of communication of space wave propagation can be increased by increasing the heights of transmitting and receiving antenna.

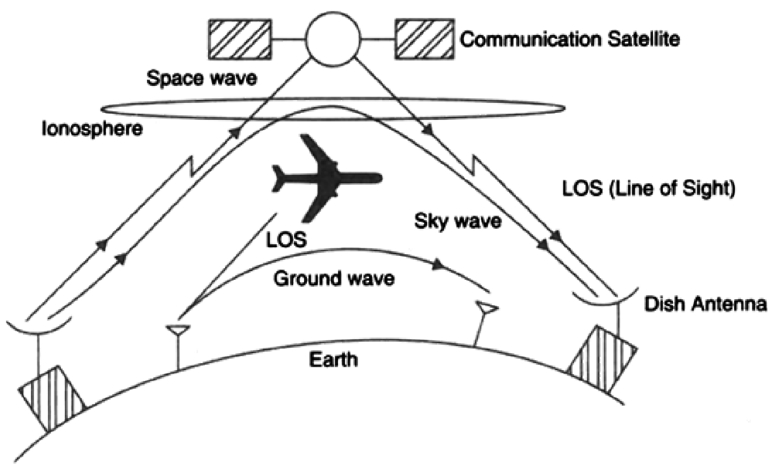
(2) If the transmitting antenna is at a height h_T, the distance to the horizontal d_T is given as
$d_T = \sqrt{2Rh_T}$, where R is the radius of the earth (approximately 6400 km).



d_T is also called the radio maximum line-of-sight distance d_m between the two antennas having heights h_T and h_R above the earth is given by:

$$d_M = \sqrt{2Rh_T} + \sqrt{2Rh_R}$$

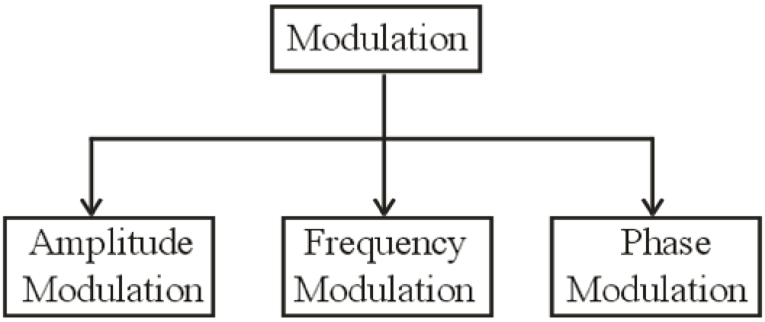
where h_R is the height of receiving antenna.



Modulation

Modulation is a process by which the input signal or modulating the signal, is mounted onto another signal of a high frequency which is known as the carrier signal. The signal which results from this process is known as the modulated signal.

Types of Modulation



Amplitude Modulation

In amplitude modulation, the amplitude of the carrier is varied in accordance with the information signals.

Let $c(t) = A_C \sin\omega_C t$ represent carrier wave and

$m(t) = A_m \sin \omega_m t$ represent the message or the modulating signal where $\omega_m = 2\pi f_m$ is the angular frequency of the message signal.

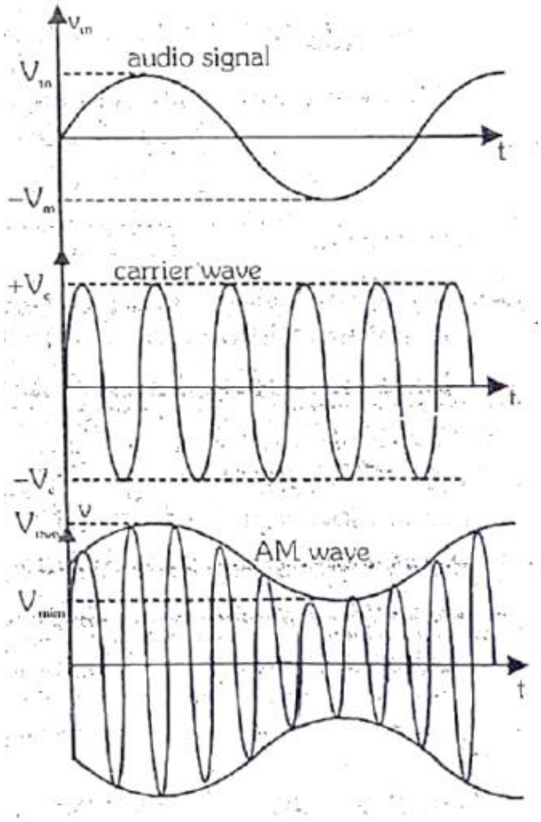
The modulated signal $c_m(t)$ can be written as

$$c_m(t) = (A_c + A_m \sin \omega_m t) \sin \omega_c t$$

$$c_m(t) = A_c \left(1 + \frac{A_m}{A_c} \sin \omega_m t\right) \sin \omega_c t \qquad \text{........(1)}$$

$$c_m(t) = A_c \sin \omega_c t + \mu A_c \sin \omega_m t \sin \omega_c t \qquad \text{......(2)}$$

Here, $\mu = A_m/A_c$ is the modulation index.



Maximum amplitude, $V_{max} = V_c + V_m$

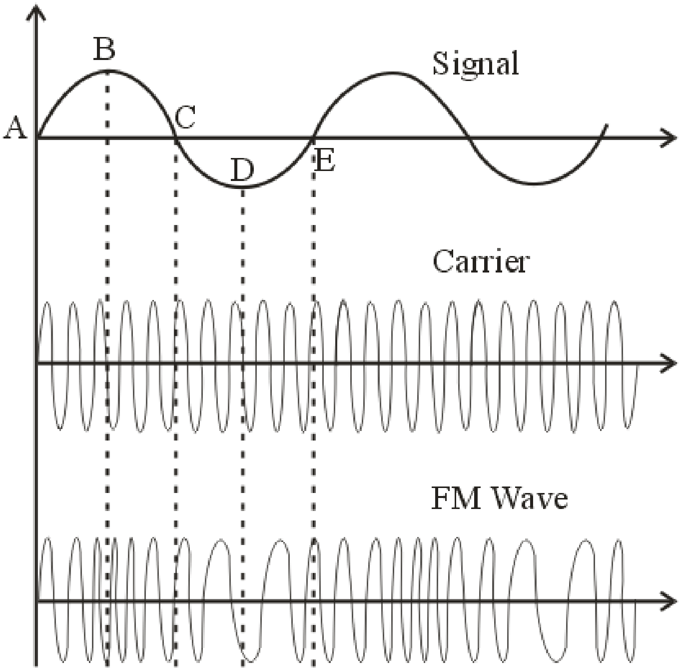
Minimum amplitude, $V_{min} = V_c - V_m$

Modulation index, $$\mu = \frac{V_{max} - V_{min}}{V_{max} + V_{min}}$$

Frequency Modulation

When the frequency of the carrier wave is changed in accordance with the intensity of the modulating signal, it is called frequency modulation.

When the signal (audio) voltage is zero as at A, C & E the carrier frequency is unchanged. When the signal approaches its positive peaks as at B, the carrier frequency is increased to the maximum as shown by the closely spaced cycles. During the negative peaks of the signal as at D, the carrier frequency is reduced to the minimum as shown by the widely spaced cycles.



Modulation factor or index and Carrier Swing (CS):

Modulation factor $m = \frac{\text{max. frequency deviation}}{\text{Modulating frequency}} = \frac{\Delta f}{f_m}, \Delta f = f_{max} - f = f_c - f_{min}$

$$v_{FM} = V_c \cos[\omega_c t + m_t \cos \omega_m t]$$

Side Bands: FM wave consists of an infinite number of side frequency components on each side of the frequency $f_c, f_c \pm f_m, f_c \pm 2f_m, f_c \pm 3f_m$, & so on.

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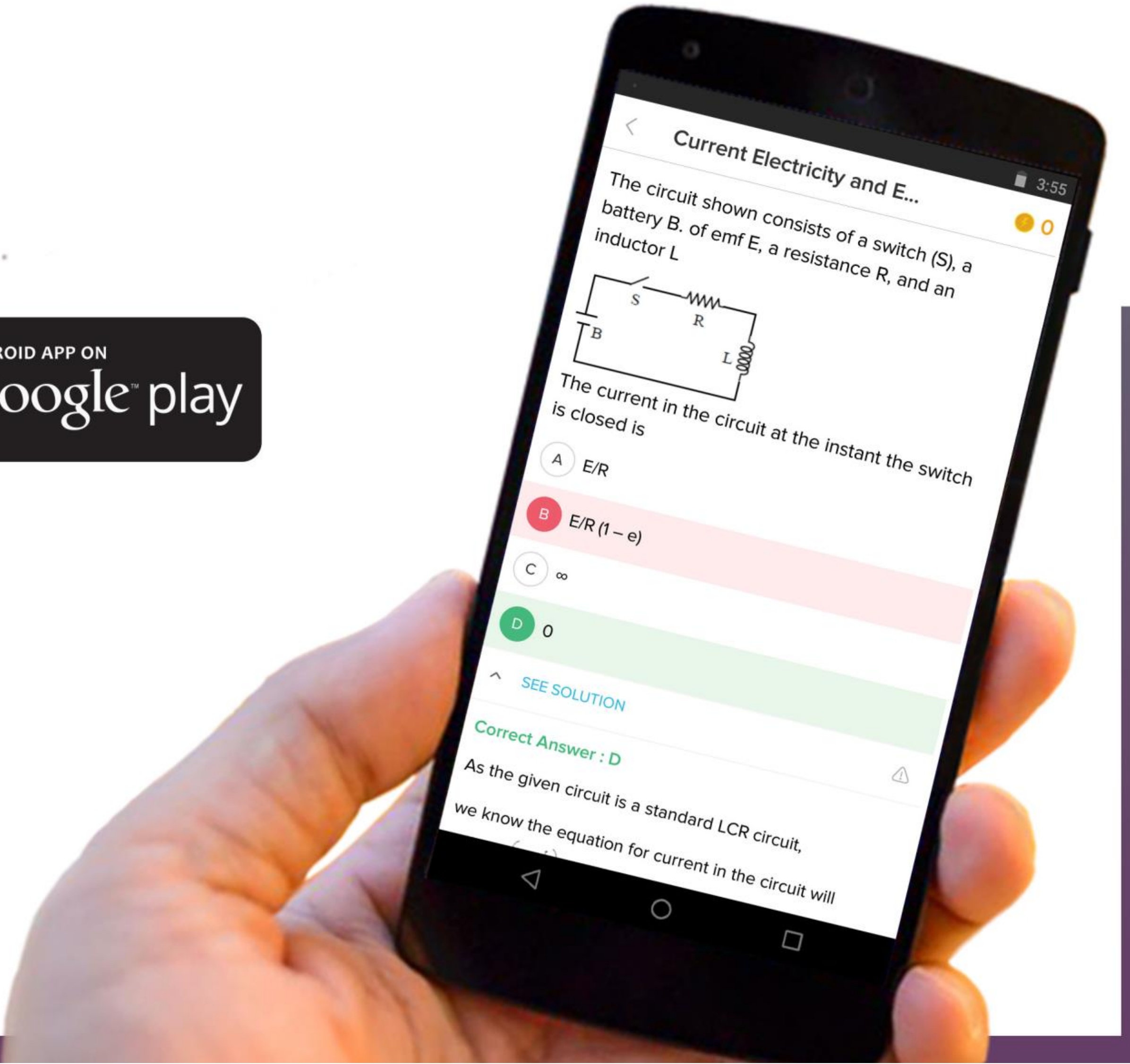

3:55
Current Electricity and E...
0
The circuit shown consists of a switch (S), a battery B. of emf E, a resistance R, and an inductor L
S
R
B
L
The current in the circuit at the instant the switch is closed is
A E/R
B E/R (1 – e)
C ∞
D 0
SEE SOLUTION
Correct Answer : D
As the given circuit is a standard LCR circuit,
we know the equation for current in the circuit will