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**Q17.** I. Define modulation index.

II. Why is the amplitude of modulating signal kept less than the amplitude of carrier wave?

**Answer:**

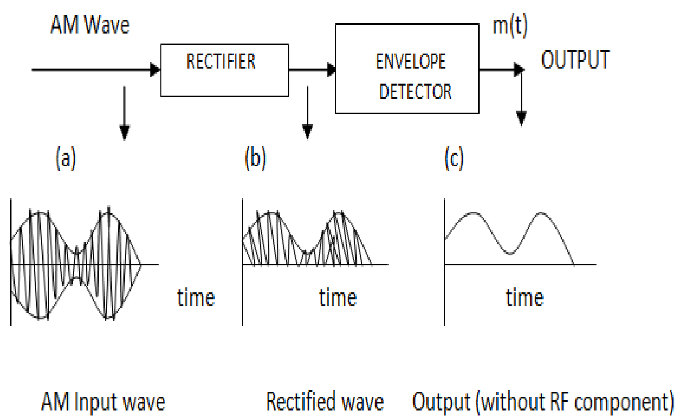
I. **Modulation index** is defined as ratio of amplitude of the modulated wave to the amplitude of the carrier wave.

$$\mu = \frac{A_m}{A_c}$$

Where $A_m$ = Amplitude of the modulated wave

$A_c$ = Amplitude of the carrier wave.

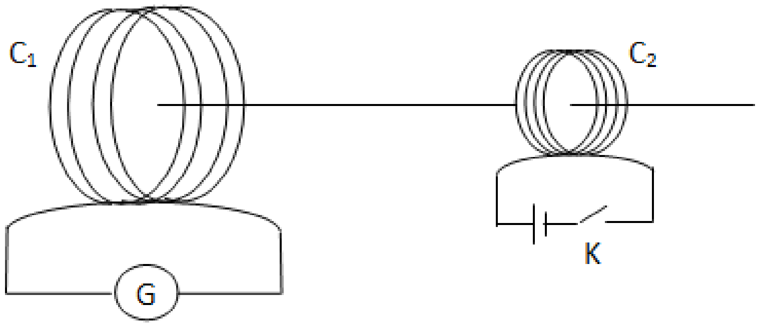
Thus the degree, to which the carrier wave is modulated, is called modulation index.




Modulating signal uses peak value of carrier, the envelop of the modulating signal varies above and below the peak carrier amplitude. If the amplitude of the modulating signal is greater than amplitude of the carrier then **distortion** will occur, this will cause incorrect information transmission. Therefore peak value of the modulating signal should be less than peak value of carrier.

**Q18.** A current is induced in coil $C_1$ due to the motion of current carrying coil $C_2$.

a. Write any two ways by which a large deflection can be obtained in the galvanometer G.
b. Suggest an alternative device to demonstrate the induced current in place of a galvanometer.




**Answer:**

(a) For deflection in the galvanometer electromagnetic induction should happen, i.e. magnetic lines of force should cut plane of $C_1$ and magnetic lines (flux) should also vary.

1. When the tapping key K is released, current in $C_2$ reduces to zero, magnetic flux cutting $C_1$ will change hence the galvanometer shows momentary deflection, the pointer in the galvanometer returns to zero almost instantly. Similarly if the K is pressed, current in $C_2$ increases from 0 hence magnetic flux cutting $C_1$ will change, we can observe deflection in $C_1$.If we varying this current in $C_2$ by using a Rheostat in the circuit of $C_1$ we can get large deflection in $C_1$ or moving coil $C_2$ faster.

2. For large deflection we can insert one ferro-magnetic rod say iron rod along the axis of $C_1$ and $C_2$, this helps to increase permittivity of the medium and negligible loss of magnetic lines which originates at the centre of $C_2$ and cuts plane of $C_1$ .

(b) Alternative device to detect em induction, In place of $C_1$ coil we can keep small magnetic needle to detect magnetic field produced by $C_2$.

**Q19.** (a) Define the terms (I) drift velocity, (II) relaxation time.

(b) A conductor of length L is connected to a dc source of emf $\varepsilon$. If this conductor is replaced by another conductor of same material and same area of cross section but of length 3L, how will the drift velocity change?

**Answer:**

a. (I) **Drift velocity:** The average velocity with which the free electrons get drifted towards the positive terminal under the effect of the applied external electric field.

(II) **Relaxation time:** The average time interval between two successive collisions of an electron with the ions or atoms of the conductor. Electron relaxes during the time interval $\tau$ is of the order of $10^{-14}\ s$.

b. We know that drift velocity is inversely proportional to length $V_d \propto \frac{1}{l}$

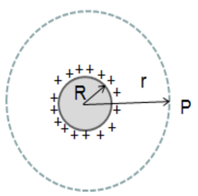
Therefore $V'_d \propto \frac{1}{3l}$ or $V'_d = V_d/3$, therefore drift velocity will be one-third.

**Q20.** Using Gauss's Law obtain the expression for the electric field due to a uniformly charged thin spherical shell of radius R at a point outside the shell. Draw a graph showing the variation of electric field with r, for r > R and r < R.

Answer: Q= charge on the surface of the shell
R=Radius of the shell
r=OP=distance of the given point from the centre of the shell.
ε=Permittivity of the medium
Let E= Electric intensity at P due to the charged shell.

Let us imagine a concentric shell of radius r passing through P this is our Gaussian surface.
Surface area of the Gaussian surface A= $4\pi r^2$
Since the lines of force leave the surface of a charged body perpendicularly hence the lines of force are all radial to the charged sphere and hence force are all radial to the charged sphere and hence they are also radial to the Gaussian surface and cutting the surface perpendicularly.

**Case I :When Point P lies outside the charged shell**




Using definition of flux through the Gaussian surface
$\phi = EA = E.4\pi r^2$ (1)
Applying the Gauss's theorem the flux through the Gaussian surface

$$\phi = \frac{\text{Charged enclosed}}{\varepsilon} = \frac{Q}{\varepsilon} \rightarrow (2)$$

Equating (1) and (2):

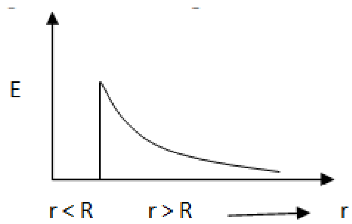
$$E.4\pi r^2 = \frac{Q}{\varepsilon}$$

$$E = \frac{1}{4\pi\varepsilon}\frac{Q}{r^2} \rightarrow (3)$$

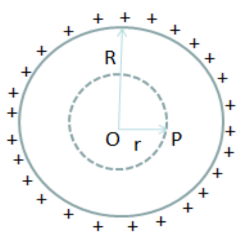
If we imagine a point charge Q at the center of the shell intensity at P

$$E = \frac{1}{4\pi\varepsilon}\frac{Q}{r^2} \rightarrow (4)$$

**Graph:**




**Case II :When Point P lies inside the charged shell**




$$\phi = \frac{\text{Charged enclosed}}{\varepsilon} = \frac{0}{\varepsilon} = 0 \rightarrow (5)$$

From equation (1) and (5):

$$E.4\pi r^2 = 0$$

$$\because r \neq 0 \therefore E = 0$$

Intensity at a point inside a charged shell is zero.