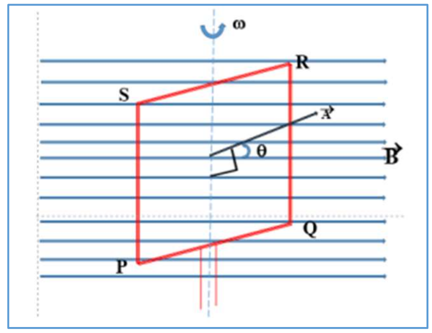
Emf induced in a rotating coil in uniform magnetic field:



Let us consider a rectangular coil PQRS of area A and total no. of turns N is rotating in uniform magnetic field B with constant angular velocity ω. Suppose at any instant of time the normal to the plane of coil makes an angle θ with direction of magnetic field. When the coil rotates, the angle between normal to the plane of coil and magnetic field changes continuously due to which the magnetic flux linked with coil becomes variable and an amount of emf is induced in the coil.

Now, Magnetic flux link with each turns,

$$\emptyset' = \vec{B}.\vec{A} = BA\cos\theta$$

And, total magnetic flux link with the coil is, i.e. flux linkage

$$\emptyset = N\emptyset' = NBA\cos\theta$$

$$or, \emptyset = NBA\cos\omega t - - - - - (1)$$

$\theta = \omega t,$ is the angular displacement of the coil.

As the coil rotates, the magnetic flux linked with it changes and hence an induced emf is set up in the coil.

From faraday's law,

$$\varepsilon = -\frac{d\emptyset}{dt}$$

$$or, \varepsilon = -\frac{d}{dt}(NBA\cos\omega t)$$

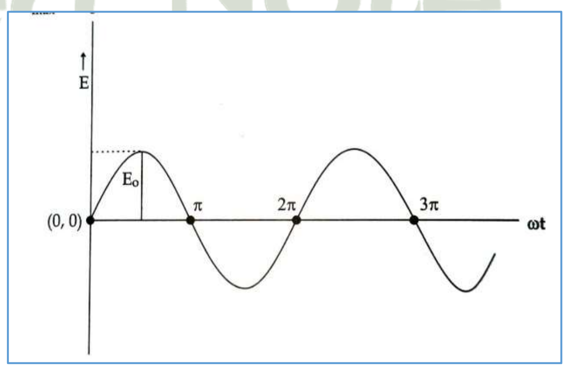
$$or, \varepsilon = -NBA\omega\,(-\sin\omega t)$$

$$or, \varepsilon = NBA\omega\sin\omega t$$

$$\boldsymbol{or, \varepsilon = \varepsilon_0 \sin\omega t - - - - - - (2)}$$

Where, $\varepsilon_0 = NBA\omega$ is the maximum value of induced emf.

Since the induced emf E depends on periodic function $\sin\omega t$, the emf is periodic in nature. The emf represented by equation (2) is alternating emf.



We know $E = IR$,

So the equation (2) is written as,

$$IR = I_0 R\sin\omega t$$

$$\boldsymbol{I = I_0 \sin\omega t}$$

This equation represents the alternating nature of current.