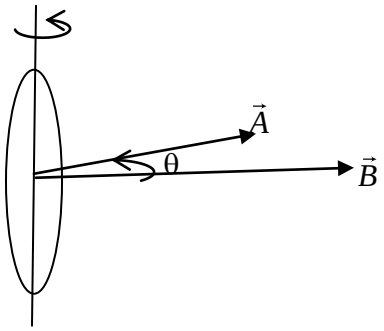
Q- A coil of area $0.1m^2$ is rotating at 60rev/s. with its axis of rotation perpendicular to a 0.2T uniform magnetic field.

(a) If the coil has 1000 turns, what is the maximum EMF generated in it?

(b) What is the orientation of the coil with respect to the magnetic field when the maximum induced voltage occurs?



(a) As the coil rotates, the angle its area vector makes with the field changes with time, and hence the flux through the coil will change, induces EMF in it.

Let a coil of are A and n number of turns is placed in a magnetic field B such that the area vector makes an angle θ with the field. The flux through the coil will be given by

$$\phi_B = n * B * A * \cos\theta$$

And hence from the faraday's law the induced EMF will be

$$e = -\frac{d\phi}{dt} = -\frac{d}{dt}\left(nBA\cos\theta\right) = -nBA * \frac{d(cos\theta)}{dt} = -nBA * \left(-\sin\theta\right)\frac{d\theta}{dt}$$

But as $d\theta/dt$ is the angular velocity of rotation of the coil we have the induced EMF as

$e = n\ B\ A\ \omega * \sin\theta$

For the induced EMF to be maximum, the value of $\sin\theta$ must be maximum and hence $\sin\theta = 1$

Hence the maximum induced EMF is given by substituting the values as

$e = 1000 * 0.2 * 0.1 * (60 * 2\pi\ rad/s) * 1 = 7539.8\ V$

(b) As we have seen earlier for the induced EMF to be maximum, the value of $\sin\theta$ should be 1 or the angle θ should be 90^0. Hence the EMF in the coil will be maximum when the area vector of the coil (axis of the coil) is perpendicular to the field or the plane of the coil is parallel to the magnetic field.