Answer on Question #61362-Physics-Electromagnetism

9) A certain generator consists of a rectangular coil of 250 turns and an area of 50cm2. The coil rotates at a speed of 100 revolutions per second in a horizontal magnetic field 0.3T. Calculate the maximum induced emf in the coil and the induced emf when the plane of the coil is inclined at an angle of 35o to the horizontal

a) 235.6V and 193.0V

b) 344.2V and 230.2V

c) 144.3V and 96.5V

d) 56.4V and 26.7V

Solution

Let's use the Faraday's law and find the emf generated between the ends of the coil:

$$\mathcal{E} = -\frac{d\Phi_B}{\mathrm{dt}} = -\frac{d(NBAcos\theta)}{dt}$$

here, $\mathcal{E}$ is the emf generated between the ends of the coil, ΦB is the magnetic flux through the coil, N is the number of turns of the coil, B is the magnetic field, A is the cross-sectional area of the coil, θ is the angle between the magnetic field and the normal to the plane of the coil.

Since θ=ωt, we get:

$$\mathcal{E} = -\frac{d(NBAcos\omega\mathrm{t})}{dt} = NBA\omega\ sin\omega t.$$

The maximum value of the emf induced in the coil when θ=ωt=90°, so that the coil is in the plane of the magnetic field: $\mathcal{E}max$=$NBA\omega$,

here, ω is the angular frequency with which the coil rotates in a magnetic field.

Let's convert $revs/$ to $rads/$:

$$\omega\ =\ \left(100\frac{rev}{s}\right)\cdot\left(\frac{2\pi rad}{1\,rev}\right) =\ 628.32\,rad.$$

Finally, substituting ω into the formula for $\mathcal{E}max$, we can calculate the maximum value of the induced emf:

$$\mathcal{E}max\ =\ NBA\omega\ =\ 250\ \cdot\ 0.3\cdot\ 5\ \cdot\ 10^{-3}\cdot\ 628.32 =\ 235.6\,V.$$

b) To find the induced emf when the plane of the coil is inclined at an angle of θ = 35° to the horizontal (to the lines of the magnetic field), we can use the formula: $\mathcal{E}$ = $NBA\omega sin\omega t$.

Let's substitute the numbers:

$$\mathcal{E} = NBA\omega sin\omega t = 250\cdot 0.3\cdot 5\cdot 10^{-3}\cdot 628.32\cdot sin35° = 135.13\,V.$$

10) At which of the following values of t is the magnitude of the emf induced in the coil a maximum if a magnetic field perpendicular to the plane of a flat coil of copper wire has a time variation of the magnetic flux density given by B=Bosin(2Ùt=T) where Bo is the peak value of the magnetic flux density and T the period

a) T/8

b) T/4

c) 3T/8

d) T/2

Solution

Function $\sin x$ has maximum at $\frac{\pi}{2}$.

$$\frac{\pi}{2} = \frac{2\pi t}{T} \rightarrow t = \frac{T}{4}.$$

So the function

$$B = B_o \sin \frac{2\pi t}{T}$$

has a maximum at $t = \frac{T}{4}$.