Answer on Question 58845, Physics, Electromagnetism

Question:

The magnetic flux through each loop of a 35-loop coil is given by

$$(36t - 0.71t^3) \cdot 10^{-2}\ T \cdot m^2,$$

where the time is in seconds. Determine the induced emf at $t = 5.0\ s$.

a) $6.17\ V$ b) $14.43\ V$

c) $17.49\ V$ d) $9.17\ V$

Solution:

We can find the induced emf from the Faraday's law of induction. It states that the emf is given by the rate of change of the magnetic flux:

$$\mathcal{E} = -N\frac{d\Phi_B}{dt},$$

here, $\mathcal{E}$ is the induced electromotive force, Φ_B is the magnetic flux through a single loop of coil and N is the number of loops of coil.

Let's substitute N and Φ_B into the last formula and find the induced electromotive force:

$$\mathcal{E} = -N\frac{d\Phi_B}{dt} = (-35) \cdot \frac{d}{dt}[(36t - 0.71t^3) \cdot 10^{-2}\ T \cdot m^2\ ] =$$
$$= (-35) \cdot \frac{d}{dt}[(0.36t - 0.0071t^3)\ T \cdot m^2] =$$
$$= (-35) \cdot (0.36 - 3 \cdot 0.0071t^2)\ V = (0.7455t^2 - 12.6)\ V \approx$$
$$\approx (0.75t^2 - 12.6)\ V.$$

Finally, we can find the induced emf at $t = 5.0\ s$:

$$\mathcal{E}(t = 5.0\ s) = (0.75 \cdot (5.0\ s)^2 - 12.6)\ V = (18.75 - 12.6)\ V = 6.15\ V.$$

Answer: a) $6.17\ V$.