# Answer on Question#51505 - Physics - Electromagnetism

1. A voltmeter connected across a 60Hz ac source reads 240V. Write down the expression of the instantaneous voltage as a function of time.

2. An air-cored transformer is assumed to be 100% efficient. The ratio of the secondary turns to the primary turns is 1:20. A 240V ac supply is connected to the primary coil and a 6Ω load is connected to the secondary coil. What is the current in the primary coil?

3. A galvanometer of resistance 120Ω a full scale deflection with a current of 0.0005A. How would you convert it to an ammeter that reads a maximum current of 5A?

4. A proton with speed v perpendicular to a magnetic field B is experiences a force F. If the speed of the proton is doubled, the new force is

Solution:

1. The voltmeter reads the average voltage, which is $\sqrt{2}$ times smaller than the maximum voltage of source. So the instantaneous voltage is given by the expression
$$V(t) = 240\sqrt{2}\text{V} \cdot \cos(2\pi \cdot 60\text{Hz} \cdot t) = 240\sqrt{2}\text{V} \cdot \cos(120\pi \cdot s^{-1} \cdot t)$$
2. According to the ideal transformer identity
$$\frac{V_P}{V_S} = \frac{I_S}{I_P} = a,$$
where $V_S$ and $I_S$ – are voltage and current in the secondary coil, $V_P$ and $I_P$ – are voltage and current in the primary coil, and $1:20 = 1:a$.
So the voltage in the secondary coil is
$$V_S = a \cdot V_P = 20 \cdot 240\text{V} = 4800\text{V}$$
The current in the secondary coil is
$$I_S = \frac{V_S}{R} = \frac{4800\text{V}}{6\Omega} = 800\text{A}$$
The current in the primary coil is
$$I_P = \frac{I_S}{a} = \frac{800\text{A}}{20} = 40\text{A}$$
3. To convert a galvanometer to ammeter we should add to it some parallel resistance $R$. Since the galvanometer and the resistance $R$ are parallel, the voltage across this parallel connection is equal to the voltage across the galvanometer, which is
$$V_G = 120\Omega \cdot 0.0005\text{A} = 0.06\text{V}$$
The resistance of this parallel connection is
$$R_{\parallel} = \frac{R_G R}{R_G + R}$$
This ammeter should be able to read a maximum current of 5A, so
$$V_G = R_{\parallel} \cdot 5\text{A}$$
$$0.06\text{V} = \frac{120\Omega \cdot R}{120\Omega + R} 5\text{A}$$
$$R = \frac{7.2}{600 - 0.06}\Omega \approx \frac{7.2}{600}\Omega = 12\text{m}\Omega$$

4. The Lorenz force, acting on the proton moving with speed $v$ is

$$F = e \cdot v \cdot B$$

The Lorenz force, acting on the proton moving with speed $2v$ is

$$F' = e \cdot 2v \cdot B$$

So

$$\frac{F'}{F} = \frac{e \cdot 2v \cdot B}{e \cdot v \cdot B} = 2 \Rightarrow F' = 2F$$

Answer:

1. $V(t) = 240\sqrt{2}\text{V} \cdot \cos(120\pi \cdot s^{-1} \cdot t)$
2. $40\text{A}$
3. $12\text{m}\Omega$
4. $2F$