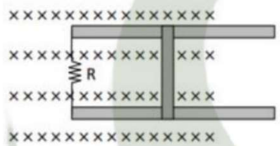
5. A rectangular coil of 100 turns has dimensions $15cm \times 10cm$. It is rotated at the rate of 300 revolution per minute in a uniform magnetic field of flux density $0.6T$. Calculate the maximum emf induced in it.

6. A $0.25m$ long bar moves along the two parallel rails (of negligible resistances) which are connected to a 6Ω resistor as shown in the figure. The system is placed in a uniform magnetic field of flux density $1.20T$ acting perpendicularly inwards to plane of paper.



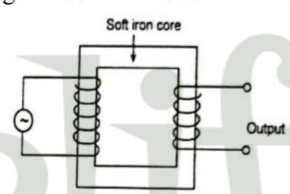
a. Why does the current appear in the resistor when the bar is kept in motion along the rails?
b. At certain instant, the current in the resistor is $1.75A$ and flowing counter clockwise in the circuit. What is the magnitude and direction of the velocity of the bar at that instant?

7. a. State the principle of AC generator. Write the expression of emf induced in AC generator. Also sketch the graph showing nature of induced emf in AC generator.
b. The armature of a small generator consists of a flat, square coil with 120 turns and sides with a length of $1.60cm$. the coil rotates in a magnetic field of $0.0750T$. What is the angular speed of the coil if the maximum emf produced is $24mV$?

8. What is eddy current and explain how they arise? Give few examples where eddy currents are useful and harmful.

9. a. What is self-inductance of an inductor. Why self-induced emf is called back emf?
b. Why self-induction is called electrical inertia?
c. The current in an inductor of self-inductance $40mH$ is to be increased uniformly from $1A$ to $11A$ in 4 $millisenconds$. What is the emf produced in the inductor during this process? **[$100V$]**
d. An air-cored solenoid having a diameter of $4cm$ and a length of $60cm$ is wound with 4000 $turns$. Find the inductance of the solenoid. What will be the inductance of the solenoid if it has an iron core of relative permeability 400?
d. Two closely wound circular coils have the same number of turns, but ne has twice the radius of other. What is the ratio of self-inductance of the two coils?
e. A plane circular coil has 200 turns and its radius is $0.10m$. It is connected to a battery. After switching on the circuit a current of 2A is set up in the coil. Calculate the energy stored in the coil.

10. The schematic diagram of a transformer is shown in figure. It consists of 500 turns in the primary coil and 100 turns in the secondary coil.
 a) A step down transformer transforms a supply line voltage $220V$ into $100V$. Primary coil has 500 turns. The efficiency and power transmitted by the transformer are 80% and $80KW$. Find the number of turns in secondary coil and power supplied.
 b) What are the different power losses in transformer? What measures do you take to minimize these loses?



Alternating Current

$\Rightarrow I_{avg} = \dfrac{2}{\pi} I_0 = 0.637 I_0 = 63.7\ \%\ of\ I_0$ & $V_{avg} = \dfrac{2}{\pi} V_0 = 0.637 V_0 = 63.7\ \%\ of\ V_0$

$\Rightarrow I_{rms} \dfrac{1}{\sqrt{2}} I_0 = 0.707 I_0 = 70.7\ \%\ of\ I_0$ & $V_{rms} = \dfrac{1}{\sqrt{2}} V_0 = 0.707 V_0 = 70.7\ \%\ of\ V_0$

AC through Resistor: $V = V_0 \sin\omega t$ & $I = I_0 \sin\omega t$, Phase difference is zero.

AC through Inductor: $V = V_0 \sin(\omega t + \frac{\pi}{2})$ & $I = I_0 \sin\omega t$, phase difference is $\frac{\pi}{2}$.

Inductive Reactance: $X_L = \omega L = 2\pi f L = \frac{V_0}{I_0} = \frac{V_{rms}}{I_{rms}}$ (Unit: Ohm 'Ω' or Henry/s)

$X_L \propto f$, higher frequency of AC, greater will be the opposition. (Inductor acts as an insulator for high frequency AC)

In DC circuit, $f = 0$, $X_L = 2\pi f L = 0$ (short circuit), A pure inductance offers zero resistance to DC

AC through Capacitor: $V = V_0 \sin(\omega t - \frac{\pi}{2})$ & $I = I_0 \sin\omega t$, phase difference is $\frac{\pi}{2}$.

Capacitive Reactance: $X_c = \frac{1}{\omega C} = \frac{1}{2\pi f C} = \frac{V_0}{I_0} = \frac{V_{rms}}{I_{rms}}$ (Unit: Ohm 'Ω' or Henry/s)

$X_C \propto \frac{1}{f}$, higher frequency of AC, smaller will be the opposition. A pure capacitance offers zero resistance to high frequency AC.

In DC circuit, $f = 0$, $X_C \propto \frac{1}{f} = \infty$ (Open circuit) Thus, capacitor acts as a perfect insulator.

AC Through LR series Circuit: $V = I\sqrt{R^2 + {X_L}^2} = IZ$, here, Z is the impedance of the circuit $Z = \sqrt{R^2 + {X_L}^2} = \sqrt{R^2 + (2\pi f L)^2}$, Phase angle is positive, voltage leads current by phase angle Φ & Phase angle: $\tan\Phi = \frac{Z}{R}$

AC Through RC series Circuit: $V = I\sqrt{R^2 + {X_C}^2} = IZ$, here, Z is the impedance of the circuit $Z = \sqrt{R^2 + {X_C}^2} = \sqrt{R^2 + (\frac{1}{2\pi f C})^2}$, Phase angle is negative, current leads voltage by phase angle Φ & Phase angle: $\tan\Phi = \frac{Z}{R}$

Series LCR Circuit: $V = I\sqrt{R^2 + (X_L - X_C)^2} = IZ$, , here, Z is the impedance of the circuit $Z = \sqrt{R^2 + (2\pi f L - \frac{1}{2\pi f C})^2}$

{If internal resistance (r_L) of inductor (coil) is given then, Impedance $\sqrt{(R + r_L)^2 + (X_L - X_C)^2}$
And voltage across inductor is $V_L = IZ_L$ where $Z_L = \sqrt{(r_L)^2 + (X_L)^2}$}

Resonance in series LCR circuit: When $X_L = X_C$, then $Z = R$ and circuit allows maximum current for a certain frequency of source is called resonance.

The circuit offers minimum impedance and maximum current, the circuit behaves purely resistive and phase difference is zero.

Series resonance allows (accepts) maximum current across the circuit, and it is called accepter circuit.

For resonance frequency: $X_L = X_C \Rightarrow 2\pi f L = \frac{1}{2\pi f c} \Rightarrow f = \frac{1}{2\pi\sqrt{LC}}$

Power Consumed in Series LCR: $P_{rms} = V_{rms} I_{rms} \cos\emptyset$, here $\cos\emptyset$ is called power factor

Power Factor: $\cos\emptyset = \frac{R}{Z}$,**Quality Factor**= $\frac{1}{R}\sqrt{\frac{L}{C}}$