Chapter 30 - Faraday's and Lenz's Laws

Faraday's Law of Induction

Q1. Consider a circular loop of radius R = 20 cm lying in the x-y plane. There is throughout the region a uniform magnetic field given by:B = (5.0i + 4.0j + 3.0k) T.
Calculate the magnetic flux though the loop.Ans:0.38 Tm^2
Q2. A uniform magnetic field B = (2.0 i + 4.0 j + 5.0 k) T intersects a circular surface of radius 2 cm lying in the yz plane. What is the magnetic flux through this surface? Ans:2.5×10^{-3} Tm^2
Q3. Consider a cube of side L= 10 cm positioned as shown in Figure 6. Throughout the region, There is a magnetic field B= (4.0i + 5.0j - 6.0k) T. Calculate the magnetic flux through the shaded face of the cube. Ans:-0.06 Tm^2

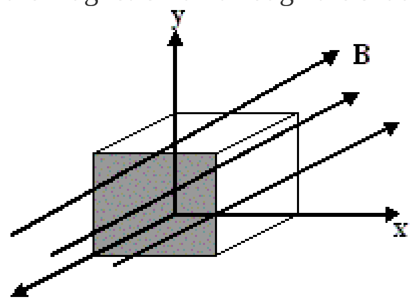

Figure 6

Q4. A constant magnetic flux of 4.0×10^{-5} Wb is maintained through a coil for 0.5 s. What emf is induced in the coil by this flux during that period?Ans:Zero.
Q5. A 2.0 Tesla uniform magnetic field makes an angle of 60 degrees with the xy-plane. The magnetic flux through an area of 3 m^2 portion of the xy-plane is:Ans:5.2 Wb.
Q6. Figure 12 shows a conducting loop consisting of a half circle of radius 0.20 m and three straight sections. The loop lies in a uniform magnetic field that is directed as shown in the figure and is given by:B = $4.5t^2$ - 10t, with B in tesla and t in seconds. What is the magnitude of the induced emf at t = 10 s? Ans:8.2 V

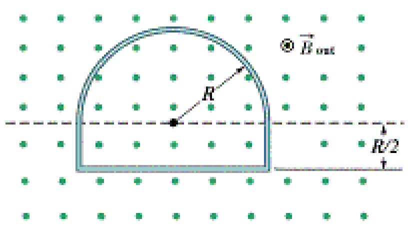

Figure 12

Q7. A 400-turn coil of total resistance 6.0 ohm has a cross sectional area of 30 cm^2. How rapidly should a magnetic field parallel to the coil axis change in order to induce a current of 0.3 A in the coil?Ans:1.5 T/s.
Q8. A circular wire loop of area 0.5 m^2 is perpendicular to a magnetic field of 0.8 T. If the coil is removed completely from the field in 0.1 s, the average emf induced in the loop has a magnitude:Ans:4.0 V.

Lenz's Law

Q9. A plane loop of wire consisting of a single turn of cross- sectional area 0.20 m^2 is perpendicular to a magnetic field that increases uniformly in magnitude from 0.25 T to 3.25 T in a time of 2.0 s. What is the resistance of the coil if the induced current has a value of 2.0 A?Ans:0.15 Ohm.
Q10.Each turn of a 100-turn coil, whose resistance is 60 Ohm, encloses an area of 80 cm^2. What should be the rate of change of a magnetic field parallel to its axes in order to induce a current of 1 mA in the coil?Ans:0.075 T/s.
Q11. A flat coil of wire consisting of 20 turns, each with an area of 50 cm^2, is positioned perpendicularly to a uniform magnetic field that increases its magnitude at a constant rate from 2.0 T to 6.0 T in 2.0 s. If the coil has a total resistance of 0.4 ohms, what is the magnitude of the induced current in the coil?Ans:0.5 A
Q12. The square circuit shown in Figure 8 is in a uniform magnetic field directed into the page and is decreasing at a rate of 1.5 T/s. Calculate the induced current in the circuit if the resistance of the wire 10 ohms. Ans:2.16 milli-A

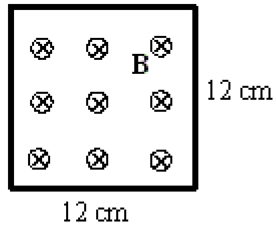

Figure 8

Induction and Energy Transfers

Q13. In the arrangement shown in Figure (7), a conducting bar moves to the right. Assume R=10 Ohm, L=0.5 m, and that a uniform 3.5 T magnetic field is directed into the page. Neglect the mass of the bar, find the power dissipated in the resistor such that the bar moves to the right with a constant speed of 4.0 m/s? Ans:4.9 W.

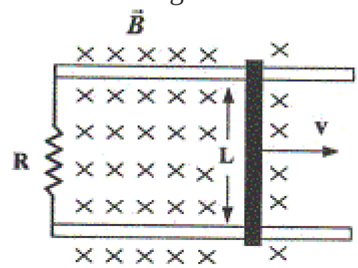

Figure # 7

Q14. A conducting rod of length 1.2 m is moving with a speed of 10 m/s as shown in Figure 9. If the magnetic field is 0.55 T into the page, calculate the potential difference between the ends of the rod. Ans:6.6 V

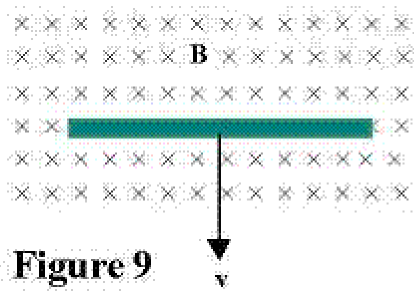

Figure 9

Q15. Figure 7 shows a conducting bar moving with a constant speed of 5.0 m/s to the right. Assume that R = 5.0 Ohms, L = 0.20 m, and that a uniform magnetic field of 3.5 T is directed into the page. Calculate the magnitude of the applied force pulling the bar.(Neglect the mass of the bar.) Ans:0.49 N

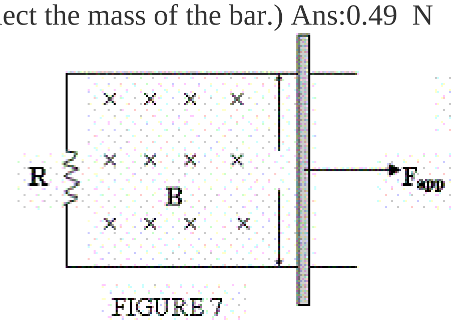

FIGURE 7

Q16. The square coil shown in figure 12 is 20 cm on a side and has 15 turns of wire on it. It is moving to the right at 2 m/s. Find the induced emf in it at the instant shown, and the direction of the induced current in the coil. (The magnetic field is 0.2 T and its direction is out of the page.) Ans:1.2 V, clockwise

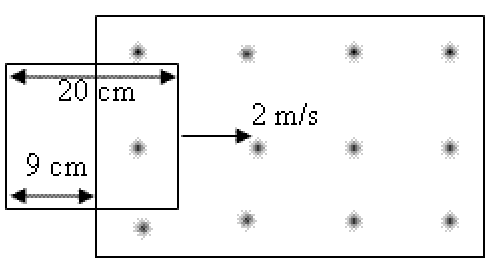

Figure 12