4Q.

6.26 A rectangular loop of wire ABCD is kept close to an infinitely long wire carrying a current $I(t) = I_o(1 - t/T)$ for $0 \le t \le T$ and $I(0) = 0$ for $t > T$ (Fig. 6.14). Find the total charge passing through a given point in the loop, in time T. The resistance of the loop is R.

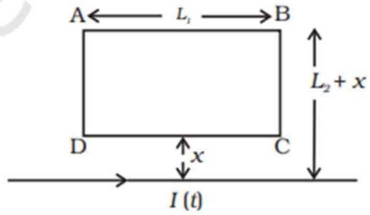
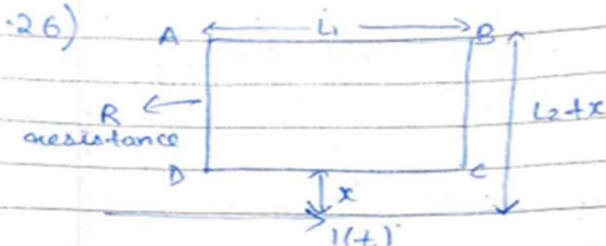


Fig. 6.14

6.26)



$$I(t) = \begin{cases} I_0\left(1 - t/T\right) & \text{for } 0 < t \le T \\ 0 & \text{for } t > T \end{cases}$$

$$\Phi = \frac{\mu_0 I(t) L_1}{2\pi} \ln\left(\frac{r_2}{r_1}\right)$$

$$\Phi = \frac{\mu_0 I(t) L_1}{2\pi} \ln\left(\frac{L_2 + x}{x}\right) \quad \text{for } 0 < t \le T$$

$$\mathcal{E} = -\frac{d\Phi}{dt} = \frac{\mu_0 L_1}{2\pi} \ln\left(\frac{L_2 + x}{x}\right)\left(\frac{-I_0}{T}\right)$$

$$\mathcal{E} = \frac{\mu_0 L_1 I_0}{2\pi T} \ln\left(\frac{L_2 + x}{x}\right)$$

$$I = \frac{\mathcal{E}}{R} = \frac{\mu_0 L_1 I_0}{2\pi R T} \ln\left(\frac{L_2 + x}{x}\right)$$

$$I = \frac{dQ}{dt} \Rightarrow Q = \int_0^T I \, dt$$

$$Q = \frac{\mu_0 L_1 I_0}{2\pi R T} \ln\left(\frac{L_2 + x}{x}\right) \int_0^T dt$$

Charge passing through a given point in time T $= \dfrac{\mu_0 L_1 I_0}{2\pi R} \ln\left(\dfrac{L_2 + x}{x}\right)$