Q1: A series AC circuit containing an inductor (20 mH), a capacitor (120 F) and a resistor (60 Ω) is driven by an AC source of 24 V/50 Hz. The energy dissipated in the circuit in 60 s is

(a) 3.39×10^{3} J

(b) 5.65×10^{2} J

(c) 2.26×10^{3} J

(d) 5.17×10^{2} J

5. In given AC circuit,

$L = 20mH = 20 \times 10^{-3} H$

$C = 120\mu F$ (C is written in F & not μF by mistake in question)

$R = 60\Omega$

AC source is $(24V / 50Hz) \Rightarrow V_{rms} = 24V$, $\nu = 50Hz$

$\Rightarrow \omega = 2\pi\nu$

$= 2\pi(50) \Rightarrow 100\pi$ rad/s

$\therefore X_C = \frac{1}{\omega C} \Rightarrow \frac{10^6}{(100\pi)(120)} \Rightarrow \frac{10^3}{12\pi}\ \Omega$

$X_L = \omega L \Rightarrow (100\pi)(20 \times 10^{-3}) \Rightarrow 2\pi\ \Omega$

$\Rightarrow (X_C - X_L)^2 = \left(\frac{10^3}{12\pi} - 2\pi\right)^2 \Omega$

$= 410\ \Omega^2$

$$\therefore Z^2 = R^2 + (X_C - X_L)^2$$

$$= (60)^2 + (41\,0)$$

$$\boxed{Z^2 = 4010\ \Omega^2}$$

$$\therefore P_{av} \text{ dissipated} = (\mathcal{E}_{rms})(I_{rms}) \cos\phi$$

$$= (\mathcal{E}_{rms})\left(\frac{\mathcal{E}_{rms}}{Z}\right)\left(\frac{R}{Z}\right) \quad \left(\because \cos\phi = \frac{R}{Z}\right)$$

$$= \frac{\mathcal{E}_{rms}^2 R}{Z^2}$$

$$= \frac{(24)^2(60)}{(4010)}$$

$$= 8.62\ W$$

$$\therefore \text{Energy dissipated} = (P_{av} \text{ dissipated}) \times \text{time}$$

$$= 8.62 \times 60 \quad (\because t = 60\ s \text{ given})$$

$$= 517\ J$$