Answer

Using resistor and inductor relations, R = v/i and v = L.di/dt.

Time constant of an RL circuit is given by T = L/R

$$v = 90e^{-50t} \quad \& \quad i = 30e^{-50t}$$

(a) $$R = \frac{v}{i} = \frac{90e^{-50t}}{30e^{-50t}} = \underline{3\,\Omega}$$

$$v = -L\frac{di}{dt} \quad \Big| \Rightarrow \quad 90e^{-50t} = -L(-50)\,30e^{-50t}$$

$$\therefore \underline{L = 60\,\text{mH}}$$

(b) Time constant : $$\frac{L}{R} = \frac{60\,\text{mH}}{3\,\Omega} = 20\,\text{ms} = \frac{1}{50}\,\text{s}$$

$$\therefore \quad \underline{\tau = 20\,\text{ms}}$$

(c) Initial energy : $t = 0$.

$$v = 90$$

$$i = 30$$

$$\Rightarrow \text{Energy} = \frac{1}{2}Li^2 = \frac{1}{2} \times (60 \times 10^{-3})(30)^2$$

$$\underline{E_0 = 27\,\text{J}}$$

(d) Energy @ $t = 10\,\text{ms}$

$$v = 90e^{-50(10\times10^{-3})} \simeq 54.5878\,\text{V}$$

$$i = 30e^{-50(10\times10^{-3})} \simeq 18.1959\,\text{V}$$

$$\Rightarrow E(t = 10\,\text{ms}) = \frac{1}{2}Li^2$$

$$E = \frac{1}{2}(60 \times 10)(18.1959) = 9.9327\ J$$

$\therefore$ Fraction of energy dissipated : $\dfrac{E_0 - E}{E}$

$$= \frac{27 - 9.9327}{27}$$

$$= \underline{\underline{0.6321}}$$

$$= 63.21\%$$

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