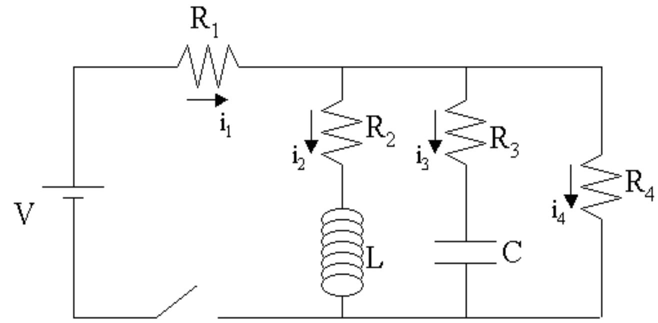
Q- Four resistors (R_1 = 60 Ohms, R_2 = 220 Ohms, R_3 = 330 Ohms, and R_4 = 480 Ohms), an ideal inductor (L = 8 mH), and a capacitor (C = 250 μF) are connected to a battery (V = 9V) through a switch as shown in the figure below. What is U_{stored}, the total stored energy in the circuit elements (not including the battery) a long time after the switch is closed?



The switch has been open for a long time before it is closed at t = 0.

Long time after the switch is closed the currents in different parts of the circuit becomes constant and inductor will behave as a conductor and the current through the capacitor will be zero and hence for current in the circuit R_1 is in series with the parallel combination of R_2 and R_4 and hence the current through the battery will be

$$i_1 = \frac{V}{R_1 + \frac{R_2 R_4}{R_2 + R_4}} = \frac{9}{60 + \frac{220*480}{220+480}} = 4.27*10^{-2}\,A$$

Hence potential difference across R_4 and the capacitor will be V - potential difference across the resistance R_1

$$V_C = 9 - 4.27*10^{-2}*60 = 6.439 \text{ V}$$

Thus the energy stored in the capacitor will be

$$U_C = \tfrac{1}{2} CV_C^2 = 0.5*250*10^{-6}*6.439^2 = 5.18*10^{-3} \text{ J}$$

The current through the inductor will be given by the loop rule as

$$I_2 = 6.439/220 = 2.93*10^{-2} \text{ A}$$

Hence the energy stored in the inductor will be

$$U_L = \tfrac{1}{2} L*I_2^2 = 0.5*8*10^{-3}*(2.93*10^{-2})^2 = 3.43*10^{-6} \text{ J}$$

Hence the total energy stored will be

$U = U_C + U_L = 5.18*10^{-3} + 3.43*10^{-6} = 5.183*10^{-3}$ J

$U_{stored} = 5.183*10^{-3}$ J

(No energy is stored in a resistor)