Marwari college Darbhanga

Subject---physics (Hons)

Class--- B. Sc. Part 2

Paper---04 ; Group—A

Topic--- Decay of current in RL circuit (Electricity)

Lecture series –53

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(B) Decay of current

- When the switch S is thrown down to b as shown below in the figure ,the L-R circuit is again closed and battery is cut off

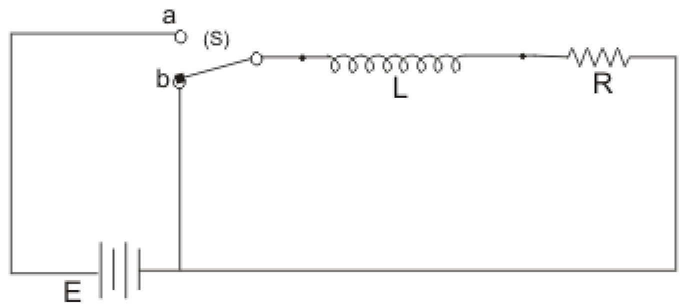

Figure 6. Battery is now cut off from the circuit

- In this condition the current in the circuit begins to decay
- Again from equation (8) since V=0 this time, so the equation for decay is

$$L\frac{dI}{dt} + RI = 0$$

Or,

$$\frac{dI}{I} = \frac{-R}{L}dt$$

Integrating on both sides

$$\int\frac{dI}{I} = \frac{-R}{L}\int dt$$

Or,

$$\ln I = \frac{-R}{L}t + C_1 \qquad \text{----(12)}$$

In this case initially at time t=0 current $I=I_{max}$ so $C_1=\ln I_0$

Putting this value of C_1 in equation (12)

$$\ln I = \frac{-R}{L}t + \ln I_{max}$$

Or,

$$I = I_{max}e^{-\frac{R}{L}t} \qquad \text{---(13)}$$

Hence current decreases exponentially with time in the circuit in accordance with the above equation after the battery are cutoff from the circuit.

- Figure below shows the graph between current and time

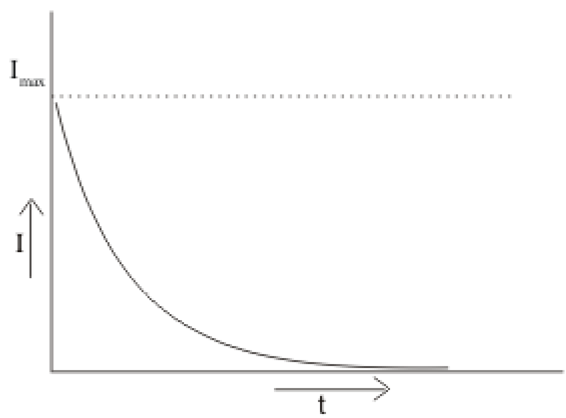

Figure 7. Current decreasing exponentially with time

- If in equation (13)
  $t=\tau_L=L/R$
  then
  $I=I_{max}e^{-1}=.37I_{max}$
  hence the time in which the current decrease from the maximum value to 37% of the maximum value I_{max} is called the time constant of the circuit
- From equation (13) it is clear that when R is large ,current in the L-R circuit will decrease rapidly and there is a chance of production of spark
- To avoid this situation L is kept large enough to make L/R large so that current can decrease slowly
- For large time constant the decay is slow and for small time constant the decay is fast