Basic Electrical Technology

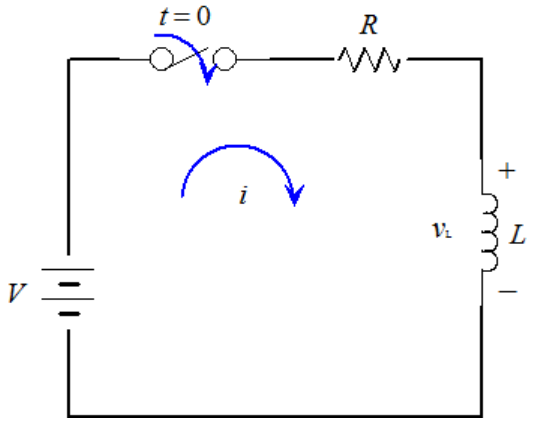
Class 10 – 27 November 2021

- R L Transients

Growth of Current in an Inductive Circuit

Applying KVL,

$$V - R\,i - L\frac{di}{dt} = 0$$



Initial Conditions,

$$At\ t = 0\ sec, i = 0\ A$$

Final current & voltage equation,

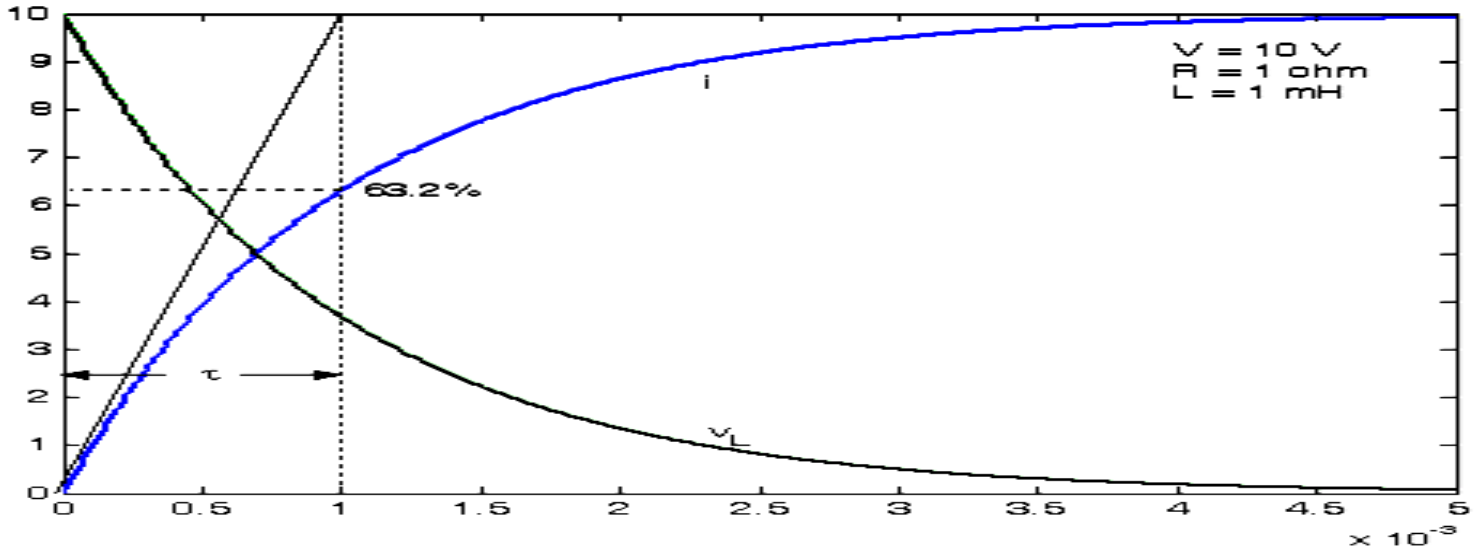
$$i = \frac{V}{R}\left(1 - e^{-\frac{Rt}{L}}\right)$$

$$v_L = V\,e^{-\left(\frac{R}{L}\right)t}$$

Growth of current in an inductive circuit

Time Constant (τ): Time taken by the current through the inductor to reach its final steady state value, had the initial rate of rise been maintained constant

$$\tau = \frac{L}{R}$$

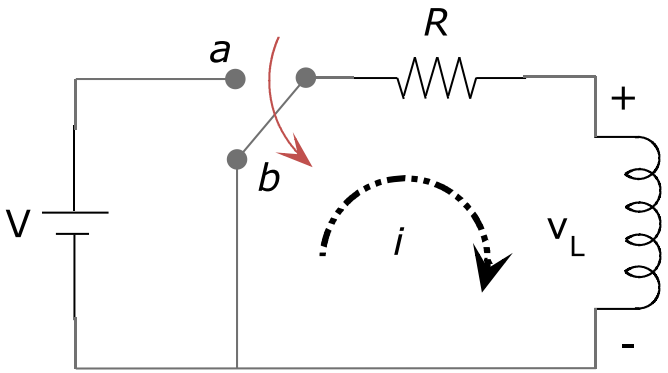


Decay of current in an Inductive Circuit

- Initial current is through inductor is

$$I_0 = V/R$$

- At $t = 0$, switch is moved from position a to b



Applying KVL,

$$L\frac{di}{dt} + R\,i = 0$$

Using initial conditions and then solving

$$i = I_0 e^{\left(\frac{-Rt}{L}\right)}$$

$$v_L = -V\,e^{-\left(\frac{Rt}{L}\right)}$$

Decay of current in an Inductive Circuit

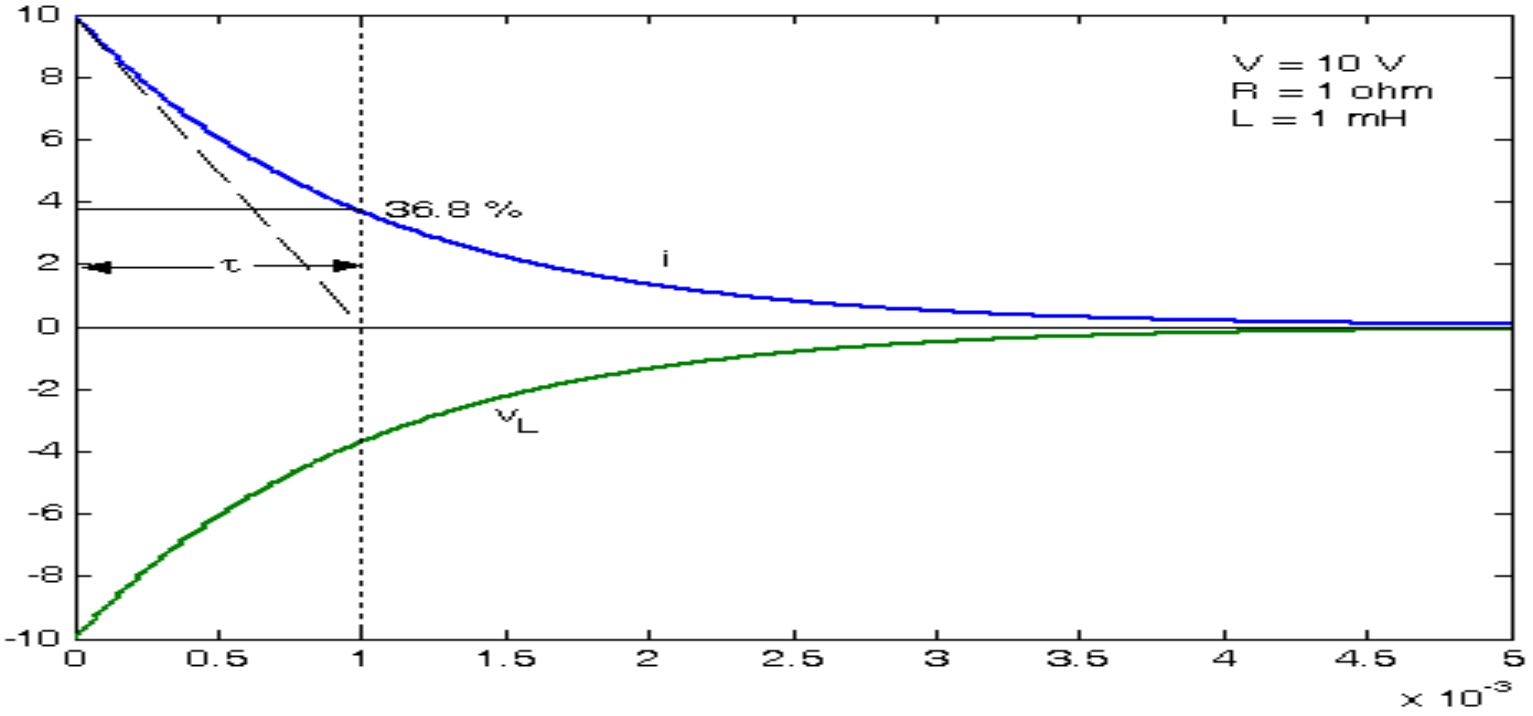


Illustration 1

A coil of inductance 0.04 H and resistance 10 is connected to a 120 V, d.c. supply. Determine

(a) the final value of current.

(b) the time constant of the circuit.

(c) the value of current after a time equal to the time constant from the instant the supply voltage is connected.

(d) the expected time for the current to rise to within 1% of its final value.

Ans: (a) 12A ; (b) 4ms (c) 7.58A (d) 18.421ms

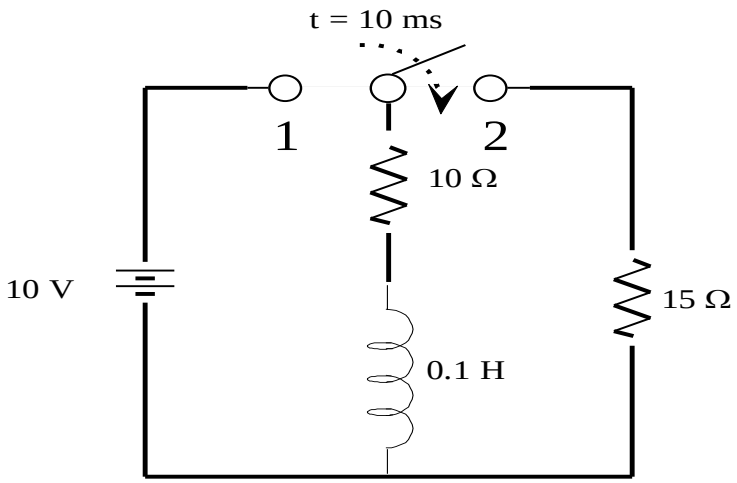
Illustration 2

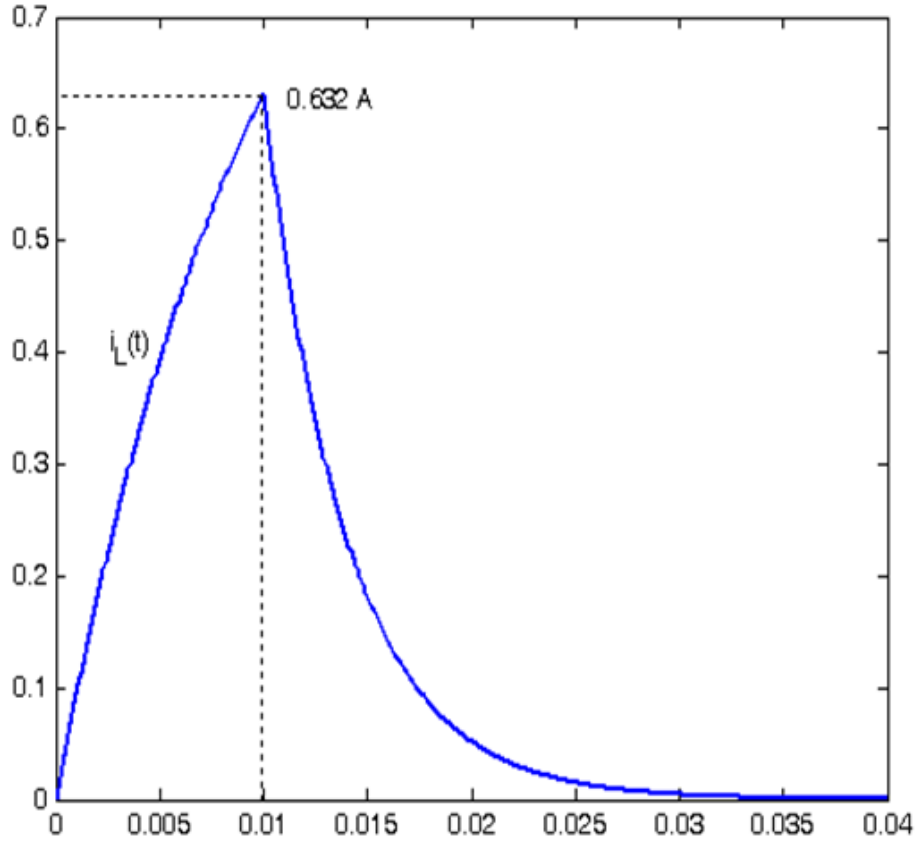
An R-L series circuit is designed for a steady current of 250mA. A current of 120 mA flows in the circuit at an instant 0.1 sec after connecting the supply voltage. Calculate i) time constant of the circuit ii) the time from closing the circuit at which the circuit current has reached 200 mA.

Ans: i)Time constant = 0.1529 s ii) t= 0.2461 s

Illustration 3

In the network shown in figure, the switch is closed to position 1 at t = 0 and is moved to position 2 at 10 ms. Determine iL(t) & sketch it.




0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.632 A
$i_L(t)$
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
0.04