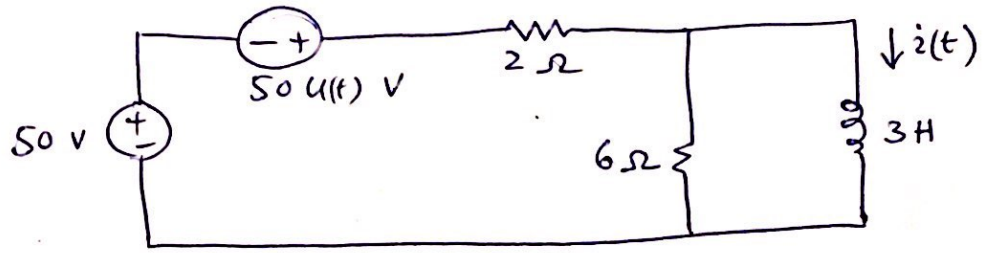
Example 8.8 The Complete Response of RL Circuit

(PP292 8th Ed) (PP286 7th Ed Hkd)

Determine $i(t)$.

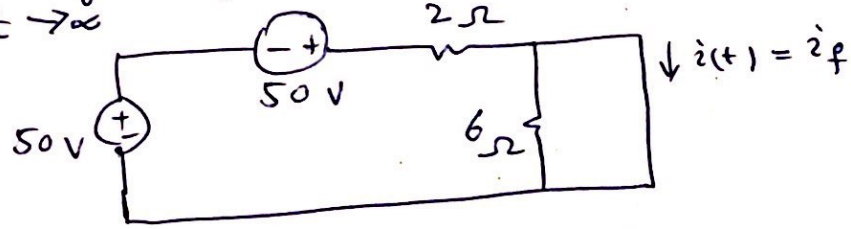


Solution:

$$i(t) = i_f + i_n$$

To find i_f:

$t \to \infty$



So $i_f = \frac{50+50}{2} = 50$ A ——— Ans

To determine i_n:

we know $i_n = K e^{-t/\tau}$

so $\tau = \frac{L}{R_{eq}} = \frac{3}{2\|6} = \frac{3}{\frac{12}{8}} = \frac{24}{12} = 2$ Sec

Thus $i_n = K e^{-0.5t}$ amperes

Now $i(t) = i_f + i_n$ ——— Ans

So $i(t) = 50 + K e^{-0.5t}$

Note: Initial condition applies to the complete response.

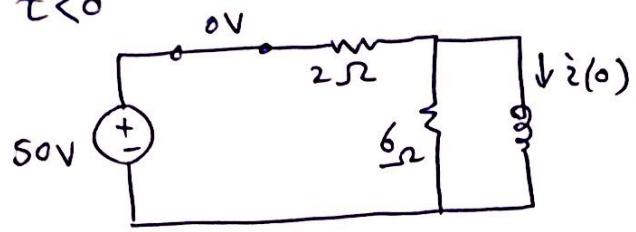
Therefore to find value of K, we calculate $i(0) = ?$

——— Contd

— contd (293)

— Now the circuit for determining $i(0)$ is:

$t<0$



So $i(0) = \frac{50}{2} = 25$ A

— Hence $i(t) = 50 + ke^{-0.5t}$ becomes

$$i(0) = 25 = 50 + k$$

or $k = -25$

— Therefore $i(t) = 50 - 25e^{-0.5t}$ A $\quad t > 0$

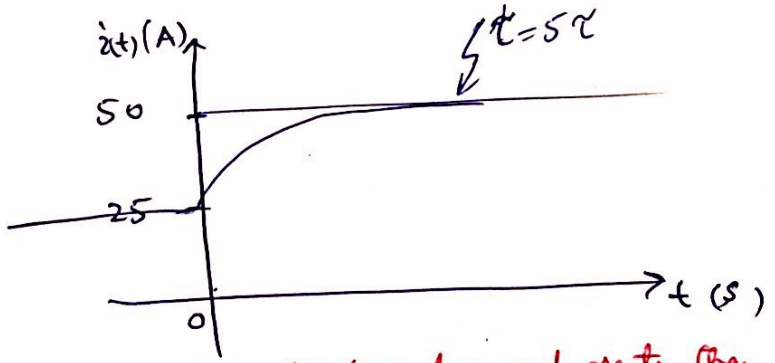
To complete the solution,

$$i(t) = 25 \text{ A} \quad t < 0$$

— This can be written as a single expression:

$$i(t) = 25 + 25\left(1 - e^{-0.5t}\right)u(t) \quad \text{A}$$

— The sketch is:



(Fig 8.38 $i(t)$ for time less and greater than zero)