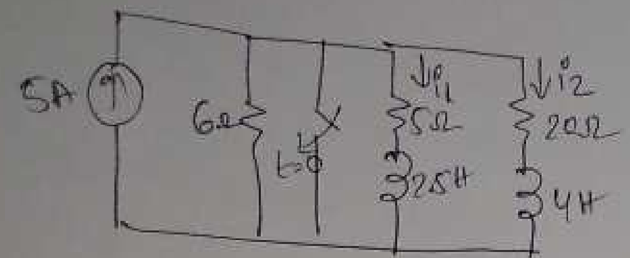
Answer

7.57) Find $i_1(t)$ & $i_2(t)$ for $t>0$. in the circuit. Page No (1)



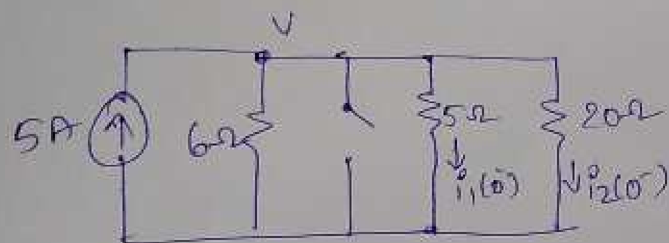
Current through the inductor

$$\boxed{i(t) = (i(0) - i(\infty))e^{-t/\tau} + i(\infty)} \quad t>0.$$

for $t<0$, circuit is under steady-state condition

Inductors → Short circuited.

Switch → open.



By Nodal analysis

$$5 = \frac{V}{6} + \frac{V}{5} + \frac{V}{20}$$

$$5 = \frac{10V + 12V + 3V}{60}$$

$$\Rightarrow 300 = 25V$$

$$\Rightarrow V = \frac{300}{25} \Rightarrow \boxed{V = 12 \text{ volts}}$$

Therefore,

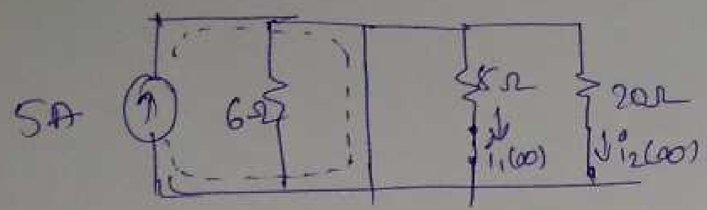
$$i_1(0^-) = \frac{V}{5} = \frac{12}{5} = 2.5A$$

$$i_2(0^-) = \frac{V}{20} = \frac{12}{20} = 0.6A$$

As we know inductor doesn't allow sudden changes in current. So, $i_1(0) = i_1(0^-) = i_1(0^+)$

$$\boxed{\begin{aligned} i_1(0) &= i_1(0^-) = 2.5A \\ i_2(0) &= i_2(0^-) = 0.6A \end{aligned}}$$

at $t=\infty$, circuit becomes



Here total current is diverted through short circuited path. Hence $\boxed{i_1(\infty) = i_2(\infty) = 0}$

Time-constant for $i_1 \Rightarrow \tau_1 = L_1/R_1 = \frac{2.5}{50} = \frac{1}{2}$

Time-constant for $i_2 \Rightarrow \tau_2 = L_2/R_2 = \frac{4}{20} = \frac{1}{5}$

Therefore

$$i_1(t) = \left(i_1(0) - i_1(\infty) \right) e^{-t/\tau_1} + i_1(\infty)$$

$$= (2.5 - 0)\, e^{-t/1/2} + 0$$

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$$\boxed{i_1(t) = 2.5 e^{-2t} \text{ A} \quad t>0}$$

$$i_2(t) = \left(i_2(0) - i_2(\infty) \right) e^{-t/\tau_2} + i_2(\infty)$$

$$= (0.6 - 0)\, e^{-t/1/5} + 0$$

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$$\boxed{i_2(t) = 0.6 e^{-5t} \text{ A} \quad t>0}$$

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