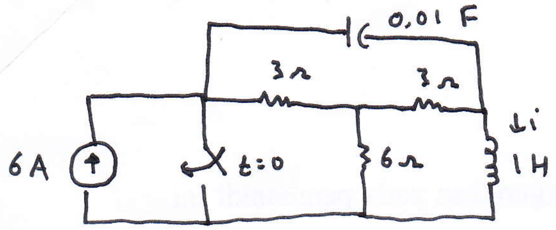
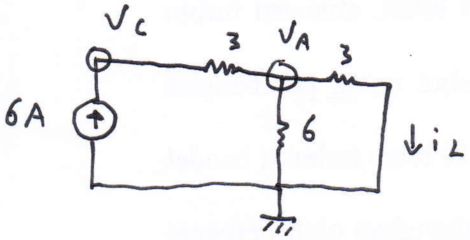
9.11. Find i for $t > 0$ if the circuit is in steady state at $t = 0^-$



answer

Circuit at $t = 0^-$



Node V_C:

$$-6 + \frac{V_C - V_A}{3} = 0 \quad \times 3$$

$$V_C - V_A = 18$$

$$V_A = V_C - 18 \quad \dots (1)$$

node V_A:

$$\frac{V_A - V_C}{3} + \frac{V_A}{6} + \frac{V_A}{3} = 0 \quad \times 6$$

$$2V_A - 2V_C + V_A + 2V_A = 0$$

$$5V_A = 2V_C \quad \dots (2)$$

(1) & (2)

$$5(V_C - 18) = 2V_C$$

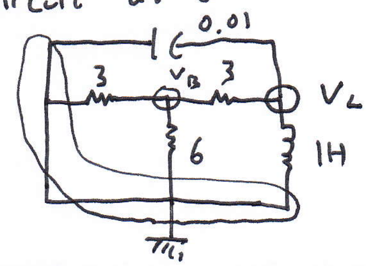
$$5V_C - 2V_C = 5 \cdot 18$$

$$V_C = \frac{5 \cdot \cancel{18}^{\,6}}{\cancel{3}_{\,1}} = \underline{30}$$

$$V_A = 12$$

$$i_L = \frac{V_A}{3} = \underline{4A}$$

Circuit at $t = 0^+$:



Node V_B:

$$\frac{V_B}{3} + \frac{V_B}{6} + \frac{V_B - V_L}{3} = 0 \quad \times 6$$

$$2V_B + V_B + 2V_B - 2V_L = 0$$

$$V_B = \frac{2}{5} V_L$$

Node V_L:

$$+\frac{1}{100}\frac{\partial V_L}{dt} + \frac{V_L - V_B}{3} + \int V_L\,dt + k = 0$$

$$+\frac{1}{100}\frac{\partial V_L}{dt} + \frac{3V_L}{15} + \int V_L\,dt + k = 0 \quad \times 100$$

$$+\frac{\partial V_L}{dt} + 20V_L + 100\int V_L\,dt + k = 0$$

differential:

$$\frac{\partial^2 V_L}{dt} + 20\frac{\partial V_L}{dt} + 100V_L = 0$$

transformasi:

$$s^2 + 20s + 100 = 0$$

$$(s + 10)(s + 10) = 0$$

$$V_L = (A_1 + A_2 t) \cdot e^{-10t}$$

$$V_L = (A_1 + A_2 t) . e^{-10t}$$

$$i_L = \frac{1}{L}\int V_L \, dt + i_0$$

$$i_L \approx (C_1 + C_2 t)\, e^{-10t}$$

$$V_L = C_2 e^{-10t} + (C_1 + C_2 t) \cdot -10 e^{-10t}$$

$$= -V_c$$

at $t = 0$:

$$4 = (C_1 + C_2 t)\, e^{-10t}$$

$$C_1 = 4$$

$$-30 = C_2 + -10 C_1$$

$$C_2 = -30 + 10 \cdot 4 = 10$$

$$\therefore \; i = (4 + 10t)\, e^{-10t}$$