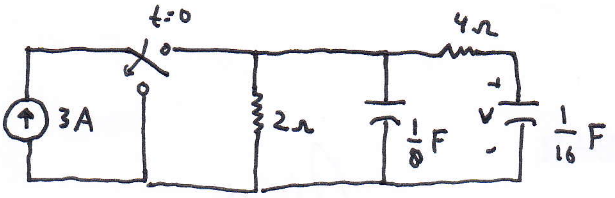
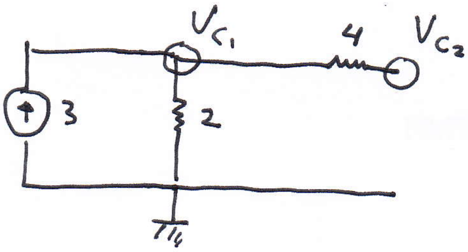
Find v for $t>0$ if the circuit is in steady state at $t=0^-$ 9.6



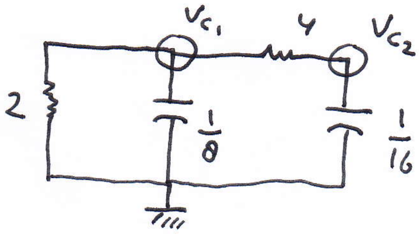
Answer:

Circuit at $t=0^-$



$$V_{c_1} = V_{c_2} = 3 \cdot 2 = 6 \text{ volt}$$

Circuit at $t=0^+$



Node V_{c_1}:

$$\frac{V_{c_1}}{2} + \frac{1}{8}\frac{\partial V_{c_1}}{dt} + \frac{V_{c_1}-V_{c_2}}{4} = 0 \quad \times 8$$

$$4V_{c_1} + \frac{\partial V_{c_1}}{dt} + 2V_{c_1} - 2V_{c_2} = 0$$

$$6V_{c_1} + \frac{\partial V_{c_1}}{dt} - 2V_{c_2} = 0 \quad \dots (1)$$

Node V_{c_2}:

$$\frac{V_{c_2}-V_{c_1}}{4} + \frac{1}{16}\frac{\partial V_{c_2}}{dt} = 0 \quad \times 16$$

$$4V_{c_2} - 4V_{c_1} + \frac{\partial V_{c_2}}{dt} = 0 \quad \dots (2)$$

$$4V_{c_1} = \frac{\partial V_{c_2}}{dt} + 4V_{c_2}$$

$$V_{c_1} = \frac{1}{4}\frac{\partial V_{c_2}}{dt} + V_{c_2} \quad \dots (3)$$

$$\frac{\partial V_{c_1}}{dt} = \frac{1}{4}\frac{\partial^2 V_{c_2}}{dt} + \frac{\partial V_{c_2}}{dt} \quad \dots (4)$$

(1), (3) & (4)

$$\left(\frac{6}{4}\frac{\partial V_{c_2}}{dt} + 6V_{c_2}\right) + \left(\frac{1}{4}\frac{\partial^2 V_{c_2}}{dt} + \frac{\partial V_{c_2}}{dt}\right) - 2V_{c_2} = 0$$

$$\frac{1}{4}\frac{\partial^2 V_{c_2}}{dt} + \frac{10}{4}\frac{\partial V_{c_2}}{dt} + 4V_{c_2} = 0 \quad \times 4$$

$$\frac{\partial^2 V_{c_2}}{dt} + 10\,\partial V_{c_2} + 16V_{c_2} = 0$$

transformasi:

$$s^2 + 10s + 16 = 0$$

$$(s+8)(s+2) = 0$$

$$V_{c_2} = A_1 \cdot e^{-2t} + A_2 \cdot e^{-8t}$$

$$V_{c_1} = \frac{1}{4}\left(-2A_1 e^{-2t} - 8A_2 e^{-8t}\right) + A_1 e^{-2t} + A_2 e^{-8t}$$

$$= \frac{1}{2}A_1 e^{-2t} - A_2 e^{-8t}$$

Saat $t=0$:

$$A_1 + A_2 = 6$$

$$\frac{1}{2}A_1 - A_2 = 6 \quad +$$

$$\frac{3}{2}A_1 = 12$$

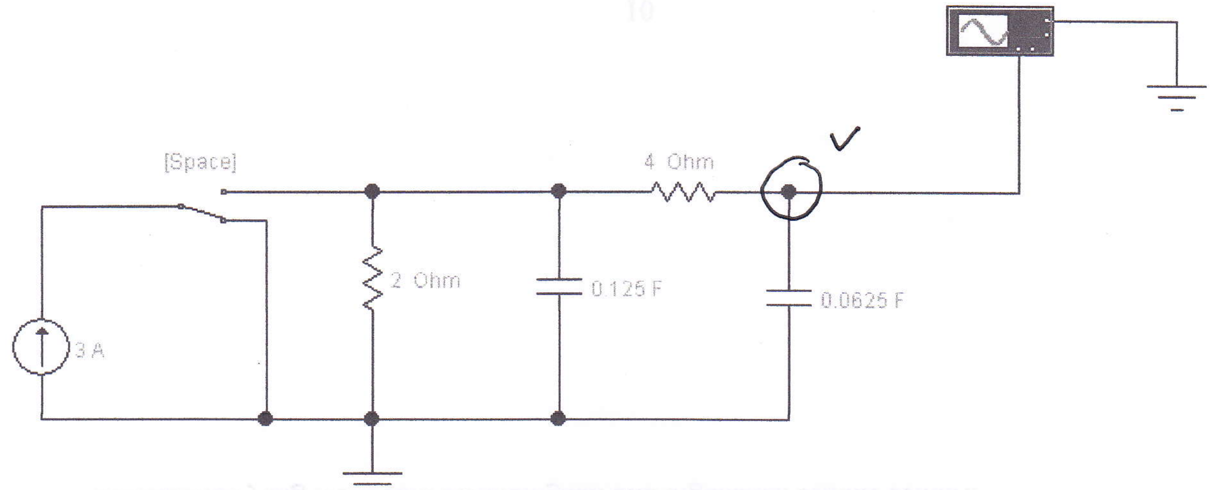
$$A_1 = 12 \times \frac{2}{3} = 8$$

$$A_2 = 6 - A_1 = -2$$

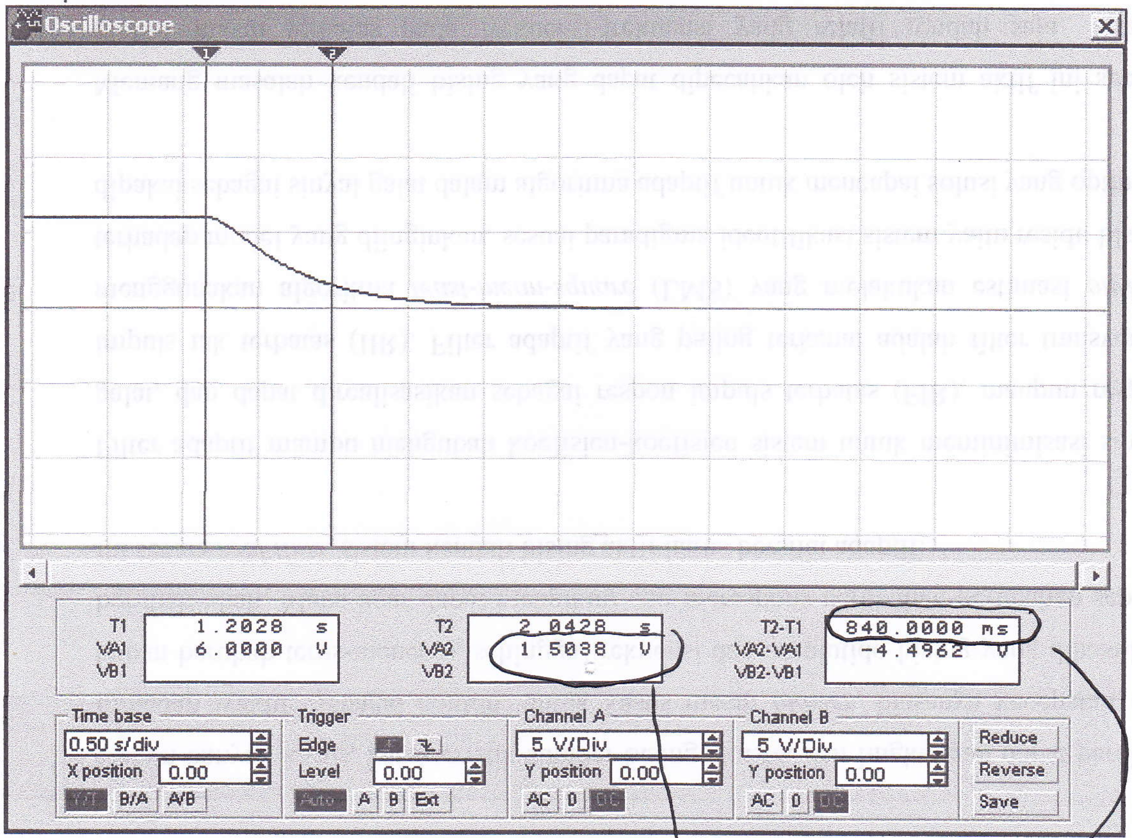
$$\therefore V = 8e^{-2t} - 2e^{-8t}$$

Using EWB for solving Problem 9.6

EWB



Example EWB Simulation



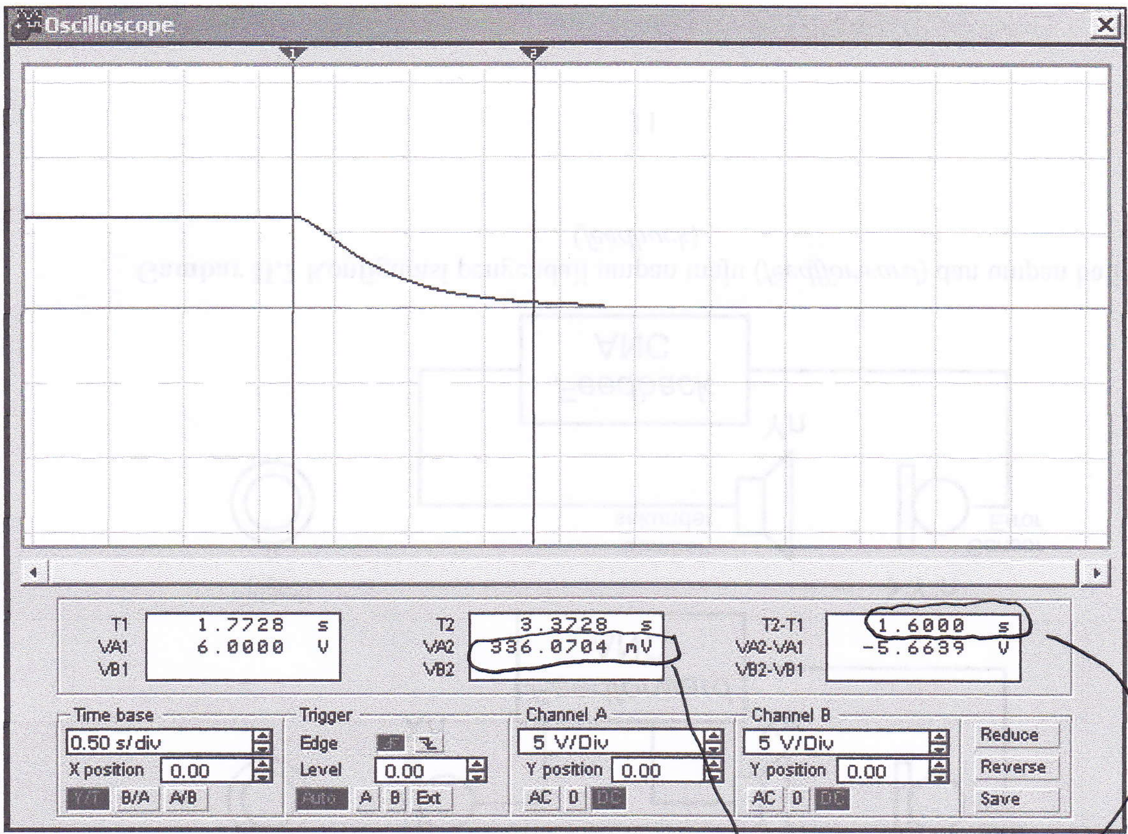
at $t = 840\ ms$

$V = 1{,}5038\ V$

from analysis:

at $t = 0{,}84\ s$, $V = 8 \cdot e^{-2 \cdot 0{,}84} - 2 \cdot e^{-8 \cdot 0{,}84}$

$= 1{,}488579$



at $t = 1,6$ s
$V = 336,0704$ mV

from analysis:

at $t : 1,6$ s, $V = 8 \cdot e^{-2 \cdot 1,6} - 2 \cdot e^{-8 \cdot 1,6}$

$= 0,326092$ V