Electric Circuits
ECSE 2010

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TA05

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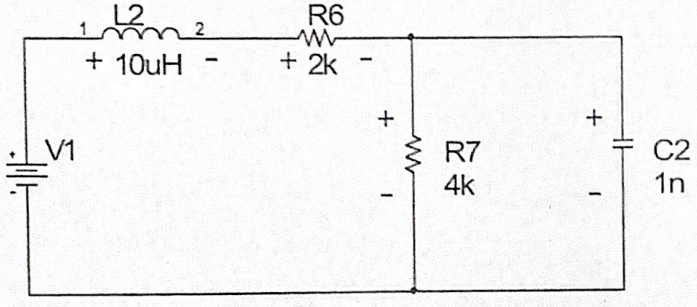
1)

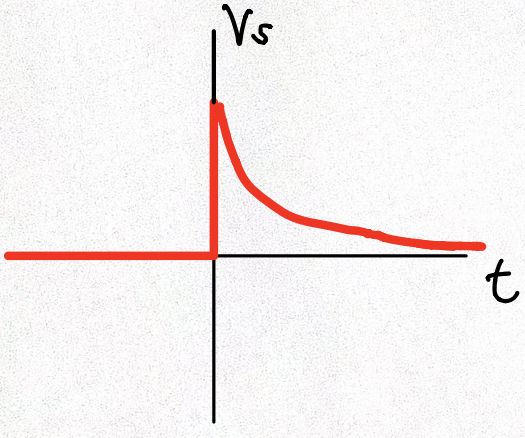


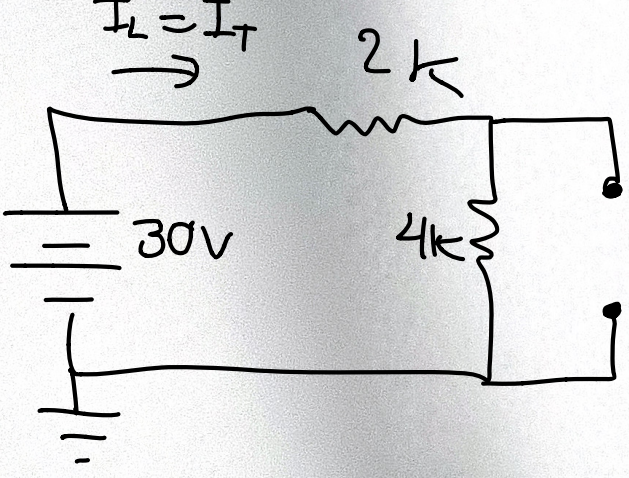
In the above circuit, the current is defined as follows:

$$V1 = \begin{cases} 30 & t < 0 \\ 0 & 0 < t \end{cases}$$ (the voltage source turns off at t = 0)

a. At t = 0⁻ (just before the voltage changes), for the polarities indicated in the circuit, determine the voltage across each component and the current through each component.

	Voltage	Current
R6	10V	5mA
R7	20V	5mA
L2	0V	5mA
C2	20V	0A





$$R_T = 2+4 = 6k\Omega$$

$$I_T = I_L = \frac{V_T}{R_T} = \frac{30V}{6k\Omega} = 5mA$$

$$V_{R_6} = 2k \cdot 5m = 10V$$

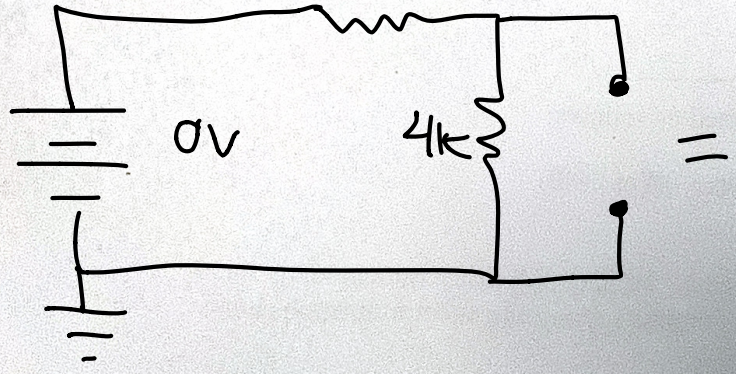
$$V_{R_7} = 4k \cdot 5m = 20V$$

$$VC_2 = V_{R_7} = 20V$$

b. At $t = 0^+$ (just after the voltage changes), for the polarities indicated in the circuit, determine the voltage across each component and the current through each component.

	Voltage	Current
R6	10V	5mA
R7	20V	5mA
L2	0V	5mA
C2	20V	0A

$I_L = I_T = I_L^{0^-}$



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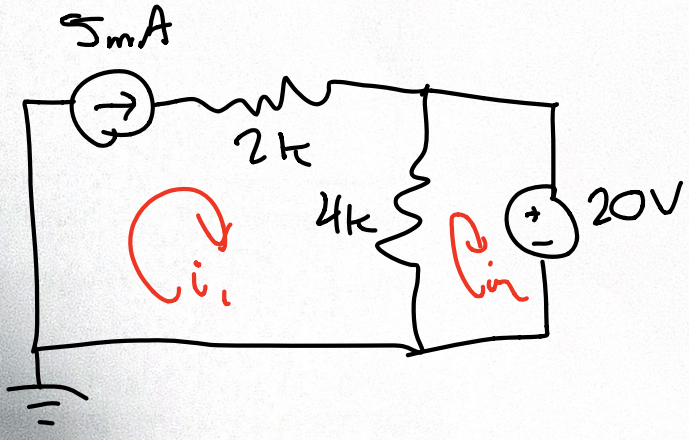


N1) $i_1 = 5mA$

$i_2 R_7 - i_1 R_7 + 20V = 0$

$-20 = 4k(i_2 - 5mA)$

$-5mA = i_2 - 5mA$

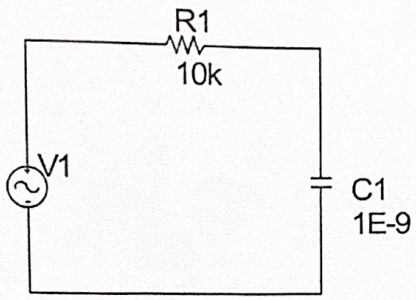
$i_2 = 0$

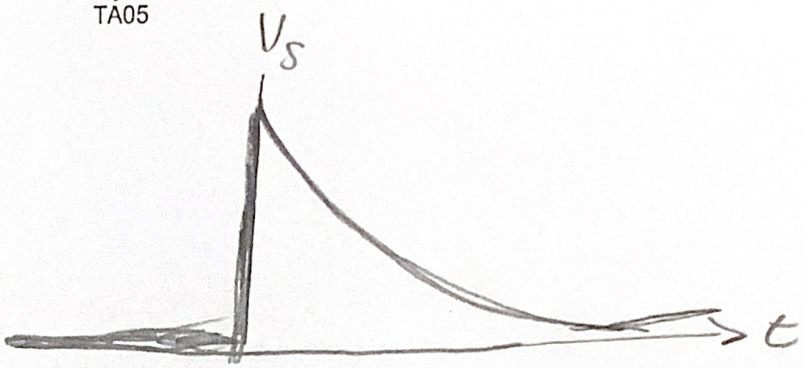
$I_{R_6} = I_{R_7} = i_1 = 5mA$

$V_{R_6} = I_{R_6} \cdot R_6 = 10V$

$V_{R_7} = I_{R_7} \cdot R_7 = 20V$

2)





$k = 1000$ ← abbreviation

Determine the voltage VC1 as a function of time for a source voltage

$$V_S = \begin{cases} 0 & t<0 \\ 5\exp(-5E4t) & 0<t \end{cases}$$

$V_c(t) = A_1 e^{-t/\tau} + A_2 e^{-50k\,t}$

$\tau = RC = 10k \cdot (1E-9) = 1 \cdot \frac{10^4}{10^9} = 1 \cdot 10^{-5}$

$1/\tau = 10^5$

$V_c(t) = A_1 e^{-10^5 \cdot t} + A_2 e^{-50k\,t}$

$V_c(0^-) = 0 = V_c(0^+)$

$V_c(0^+) = 0 = A_1 e^{-0} + A_2 e^{-0} = A_1 + A_2$

$RC \frac{dV_{CF}}{dt} + V_{CF} = V_S$

$RC \cdot \frac{d(A_2 e^{-50kt})}{dt} + A_2 (e^{-50kt}) = 5 e^{-50kt}$

$10^{-5} \cdot (-50kt) A_2 e^{-50kt} + A_2 (e^{-50kt}) = 5 e^{-50kt}$

$(1 - 0.5) A_2 = 0.5 A_2 = 5$

$A_2 = 10$ → $0 = A_1 + 10 \rightarrow A_1 = -10$

$V_c(t) = (-10) e^{-10^5 t} + 10 e^{-50{,}000\,t}$