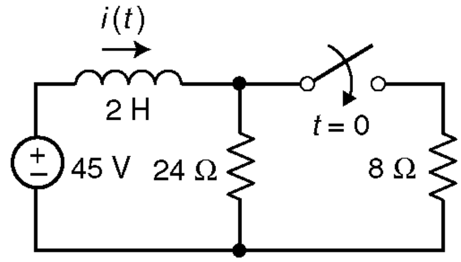
ES 250 2nd Midterm Exam - Fall 2013

Name __________________k5_________________ Student #__________

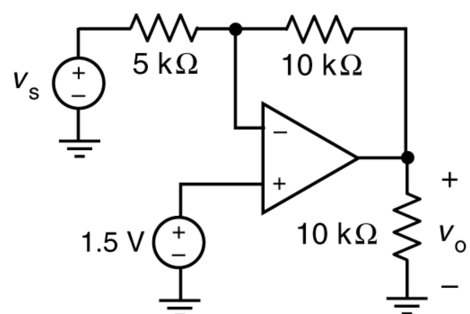
1. The switch in this circuit closes at time $t = 0$. Let $i(0)$ denote the inductor current when the switch is open and the circuit is at steady state. Similarly, let $i(\infty)$ denote the steady state inductor current when the switch is closed.



Determine the values of $i(0)$ and $i(\infty)$:

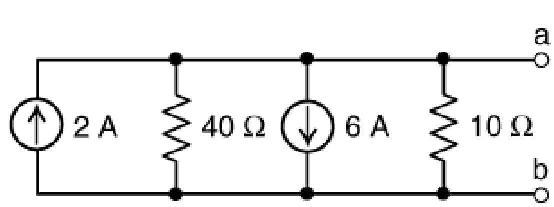
$i(0)$ = ___1.875__A and $i(\infty)$ = __7.5___A.

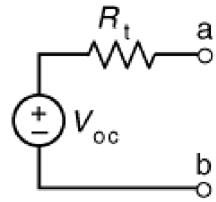
2. The input to this circuit is the voltage v_s. The output is the voltage v_o. The output is related to the input by the equation $v_o = m\, v_s + b$ where m and b are constants. The values of m and b are:



m = __–2__V/V and b = __4.5__V.

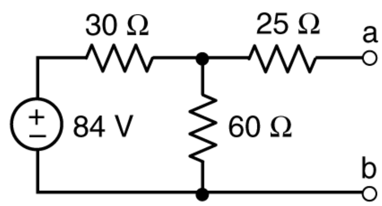
3. Here's a circuit and its Thevenin equivalent circuit. Determine the values of the Thevenin resistance, R_t, and of the open-circuit voltage, V_{oc}.

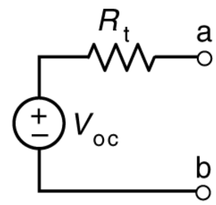




R_t = ___8___ Ω and V_{oc} = ___–32______V

4. Here's a circuit and its Thevenin equivalent circuit. Determine the values of the Thevenin resistance, R_t, and of the open-circuit voltage, V_{oc}.





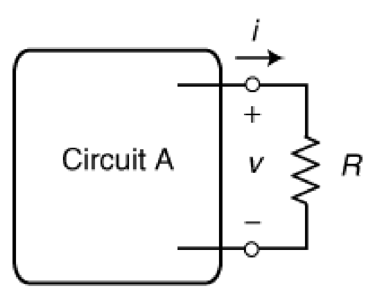
R_t = ___45___ Ω and V_{oc} = ___56______V

5. Given that $0 \le R \le \infty$ in this circuit, and given these two observations:

When $R = 0$ then $i = 0.25$ A.

When $R = \infty$ then $v = 15$ V.

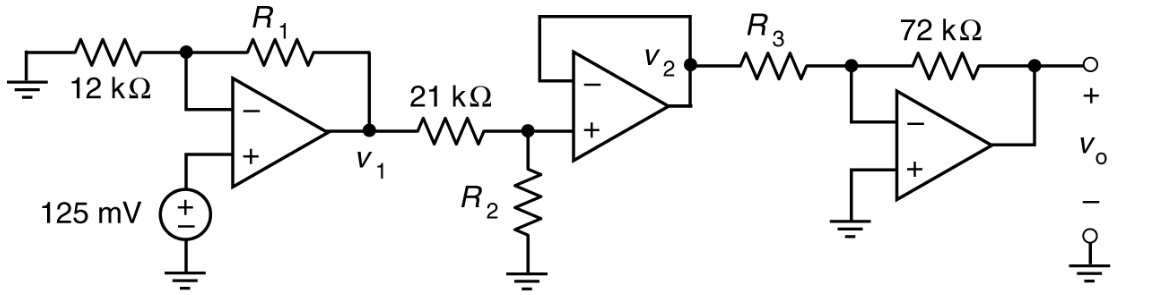
Fill in the blanks in the following statements:



a) When R = _____30____Ω then $v = 5$ V.

b) When R = ____15____Ω then $i = 0.20$ A.

6.



The values of the node voltages v_1, v_2 and v_o, are $v_1 = 875$ mV, $v_2 = 350$ mV and $v_o = -600$ mV. Determine the value of the resistances R_1, R_2 and R_3:

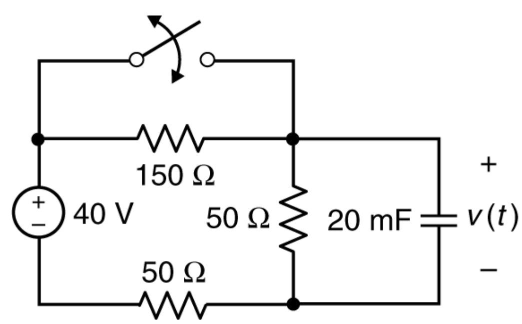
R_1 = ____72___ kΩ, R_2= ____14____ kΩ and R_3= ____42____ kΩ.

7 a) Determine the time constant, τ, and the steady state capacitor voltage, $v(\infty)$, when the switch is **open**:

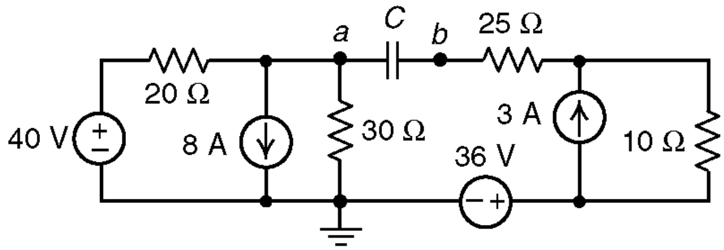
τ = ____0.8____ s and $v(\infty)$ = ____8_____ V

b) Determine the time constant, τ, and the steady state capacitor voltage, $v(\infty)$, when the switch is **closed**:

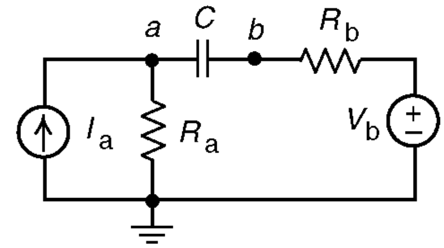
τ = ___0.5____ s and $v(\infty)$ = ___20____ V



8.



original circuit



equivalent circuit

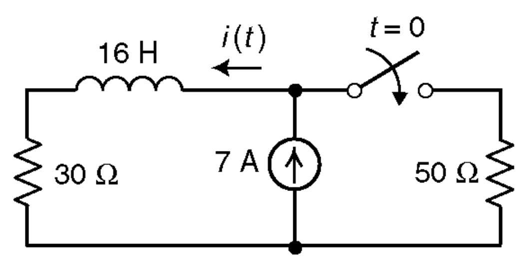
The equivalent circuit on the right is obtained from the original circuit on the left using source transformations and equivalent resistances. (The lower case letters *a* and *b* identify the nodes of the capacitor in both the original and equivalent circuits.) Determine the values of R_a, I_a, R_b and V_b in the equivalent circuit:

R_a, = ___12__ Ω, I_a = ___–6___A, R_b = ___35___ Ω and V_b = ___66__V.

9. This circuit is at steady state before the switch closes. The inductor current can be represented as

$$i(t) = A + B e^{-at} \text{ Amps for } t > 0$$

Determine the values of the real constants *A*, *B* and *a*:

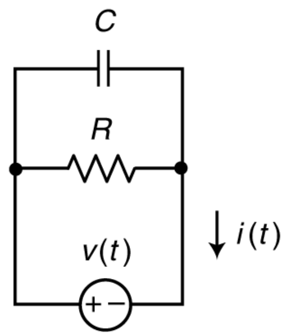


A = ___4.375___ Amps, *B* = ____2.625___ Amps and *a* = ____5___ 1/s.

10. The input to this circuit is the voltage: $v(t) = 20 + 4e^{-7t}$ V for $t > 0$

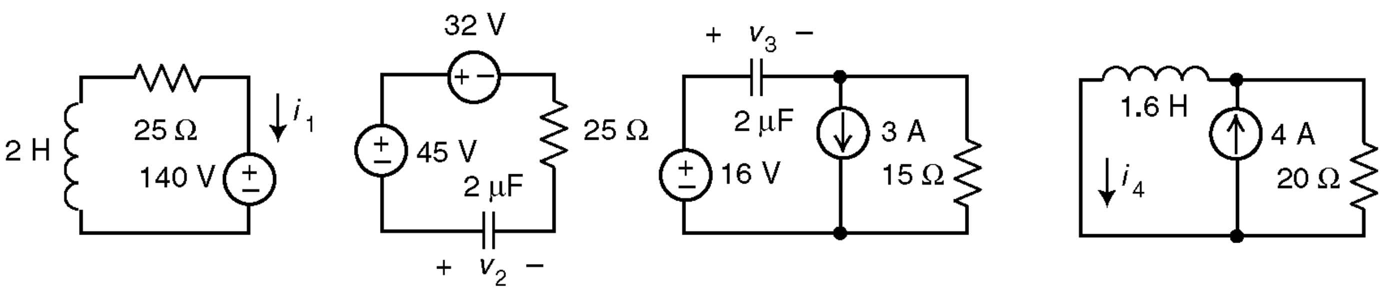
The output is the current: $i(t) = 2.5 - 7.2e^{-7t}$ A for $t > 0$

Determine the values of the resistance and capacitance:



$R =$ ____8____ Ω and $C =$ ____275_____ **mF**.

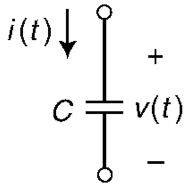
11. Here are 4 separate dc circuits. Because they are dc circuits, the capacitors in these circuits act like open circuits and the inductors act like short circuits. Determine the values of i_1, v_2, v_3 and i_4.



$i_1 =$ ___–5.6_____ A, $v_2 =$ ___–13_____ V, $v_3 =$ ___61_____ V and $i_4 =$ ___4_____ A.

Element Equations

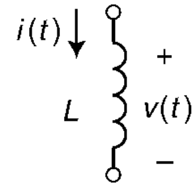
Capacitor:



$$v(t) = \frac{1}{C}\int_{-\infty}^{t} i(\tau)\,d\tau$$

$$i(t) = C\frac{d\,v(t)}{d\,t}$$

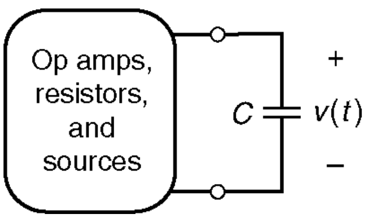
Inductor:



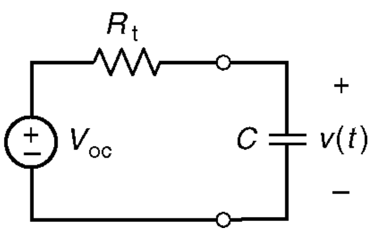
$$i(t) = \frac{1}{L}\int_{-\infty}^{t} v(\tau)\,d\tau$$

$$v(t) = L\frac{d\,i(t)}{d\,t}$$

First-Order Circuits

<table>
<tr><th>FIRST-ORDER CIRCUIT CONTAINING A CAPACITOR</th><th>FIRST-ORDER CIRCUIT CONTAINING AN INDUCTOR</th></tr>
<tr><td>


Replace the circuit consisting of op amps, resistors, and sources by its Thévenin equivalent circuit:

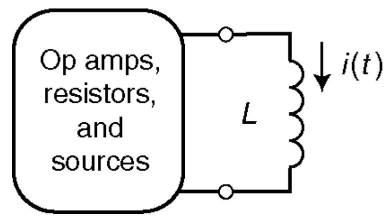


The capacitor voltage is:

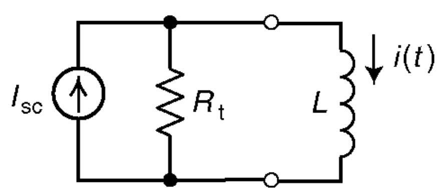
$$v(t) = V_{oc} + \left(v(0) - V_{oc}\right)e^{-\frac{t}{\tau}}$$

where the time constant, τ, is

$$\tau = R_t\,C$$

and the initial condition, $v(0)$, is the capacitor voltage at time $t = 0$.
</td><td>


Replace the circuit consisting of op amps, resistors, and sources by its Norton equivalent circuit:



The inductor current is

$$i(t) = I_{sc} + \left(i(0) - I_{sc}\right)e^{-\frac{t}{\tau}}$$

where the time constant, τ, is

$$\tau = \frac{L}{R_t}$$

and the initial condition, $i(0)$, is the inductor current at time $t = 0$.
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