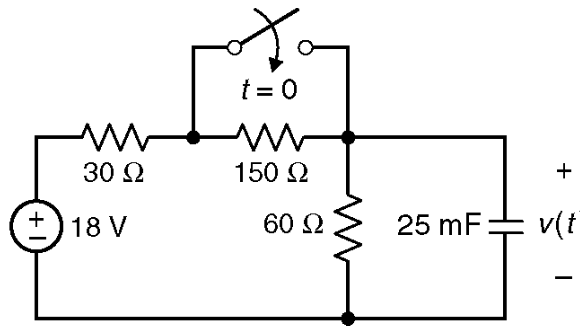
ES 250 2nd Midterm Exam - Fall 2013

Name ________________k1________________ Student #__________

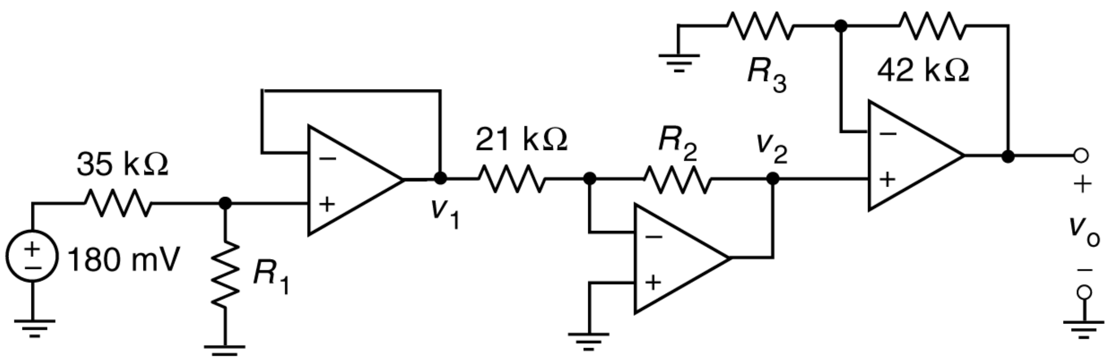
1. The switch in this circuit closes at time $t = 0$. Let $v(0)$ denote the capacitor voltage when the switch is open and the circuit is at steady state. Similarly, let $v(\infty)$ denote the steady state capacitor voltage when the switch is closed.



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

$v(0)$ = __4.5__V and $v(\infty)$ = __12__V.

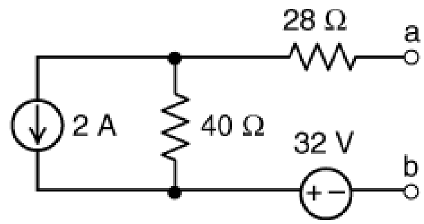
2.

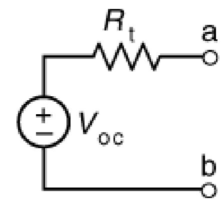


The values of the node voltages v_1, v_2 and v_o, are v_1 = 80 mV, v_2 = –320 mV and v_o = –960 mV. Determine the value of the resistances R_1, R_2 and R_3:

R_1 = _____28___ kΩ, R_2 = ____84____ kΩ and R_3 = ____21___ kΩ.

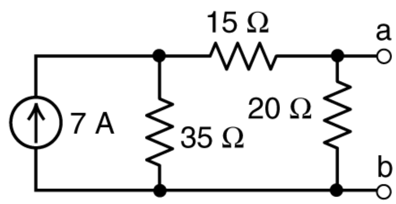
3. Here's a circuit and its Thevenin equivalent circuit. Determine the values of the Thevenin resistance, R_t, and of the open-circuit voltage, V_{oc}.

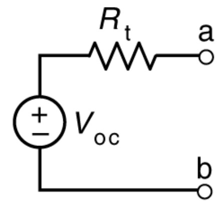




R_t = ___68___ Ω and V_{oc} = ___–48______V

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}.



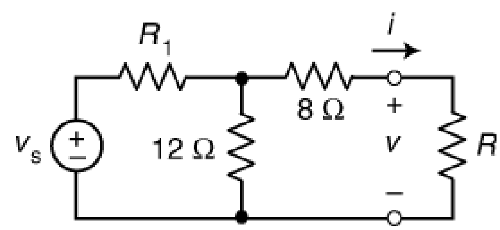


R_t = ___14.29___ Ω and V_{oc} = ___70______V

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

When $R = 0$ then $i = 3$ A.
When $R = \infty$ then $v = 36$ V.

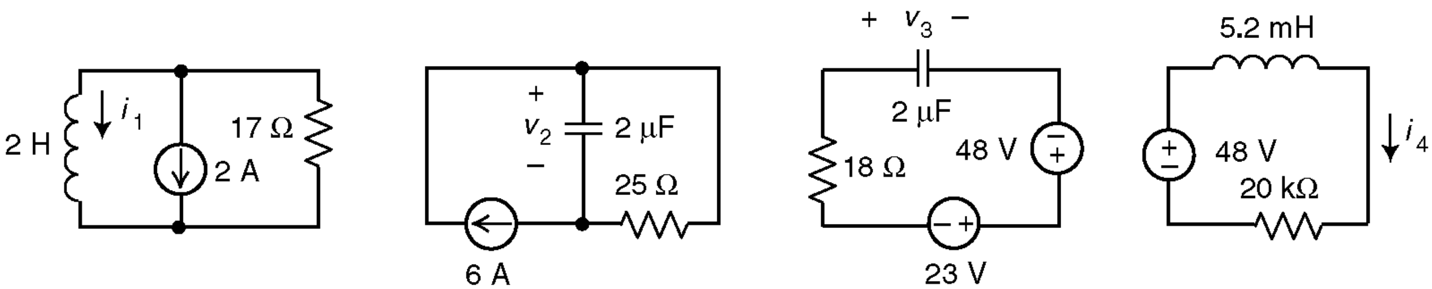
Fill in the blanks in the following statements:



a) When R = ____12____Ω then v =18 V.

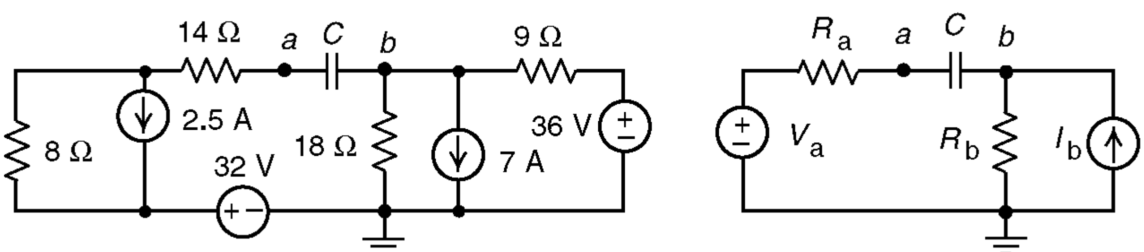
b) When R = ____24____Ω then i =1 A.

6. 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 = ___–2_____ A, v_2 = ____150_____ V, v_3 = ____25_____ V and i_4 = ____2.4_____ **mA**.

7.

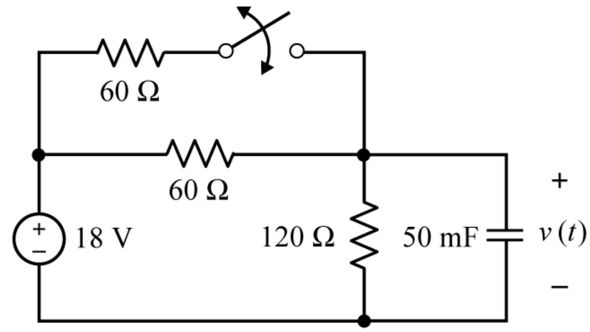


original circuit equivalent circuit

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, V_a, R_b and I_b in the equivalent circuit:

R_a, = __22__ Ω, V_a = __12__V, R_b = __6___ Ω and I_b = ___–3__A.

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

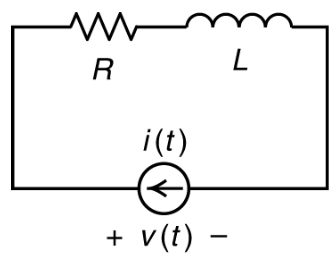


τ = _____2_____ s and $v(\infty)$ = ____12_____ V

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

τ = ____1.2____ s and $v(\infty)$ = ___14.4____ V

9. The input to this circuit is the current: $i(t) = 5 + 2e^{-7t}$ A for $t > 0$

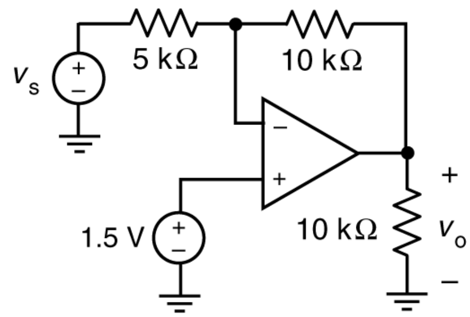


The output is the voltage: $v(t) = 100 - 30e^{-7t}$ V for $t > 0$

Determine the values of the resistance and inductance:

R = ____20____ Ω and L = ____5_____ H.

10. 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:

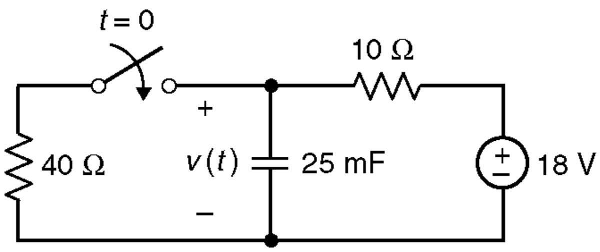


$m =$ __–2__V/V and $b =$ __4.5__V.

11. This circuit is at steady state before the switch closes. The capacitor voltage can be represented as

$$v(t) = A + B\,e^{-at} \text{ V} \quad \text{for } t > 0$$

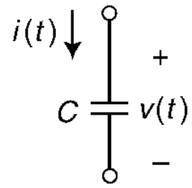
Determine the values of the real constants A, B and a:



$A =$ ___14.4___ V, $B =$ _____3.6___ V and $a =$ ______5___ 1/s.

Element Equations

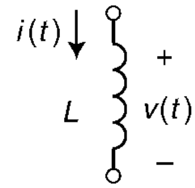
Capacitor:



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

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

Inductor:

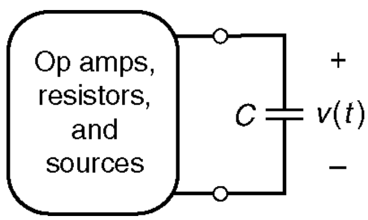


$$i(t) = \frac{1}{L}\int_{-\infty}^{t} v(\tau)\,d\tau$$

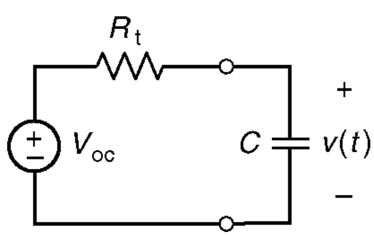
$$v(t) = L\frac{d\,i(t)}{d\,t}$$

First-Order Circuits

FIRST-ORDER CIRCUIT CONTAINING A CAPACITOR



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



The capacitor voltage is:

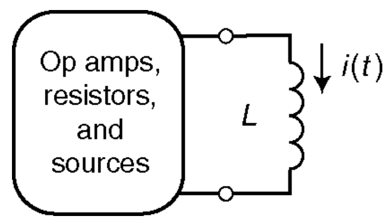
$$v(t) = V_{\text{oc}} + \left(v(0) - V_{\text{oc}}\right)e^{-\frac{t}{\tau}}$$

where the time constant, τ, is

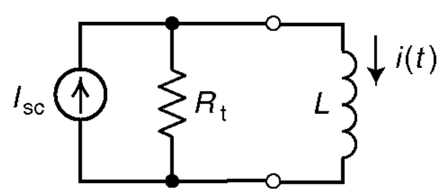
$$\tau = R_{\text{t}}\,C$$

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

FIRST-ORDER CIRCUIT CONTAINING AN INDUCTOR



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



The inductor current is

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

where the time constant, τ, is

$$\tau = \frac{L}{R_{\text{t}}}$$

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