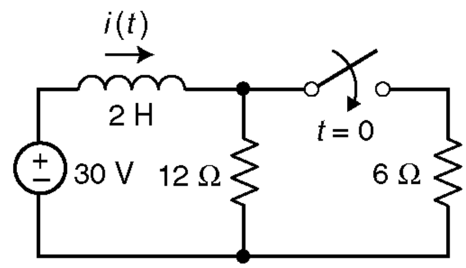
ES 250 2nd Midterm Exam - Fall 2013

Name ________________k6_______________ Student #__________

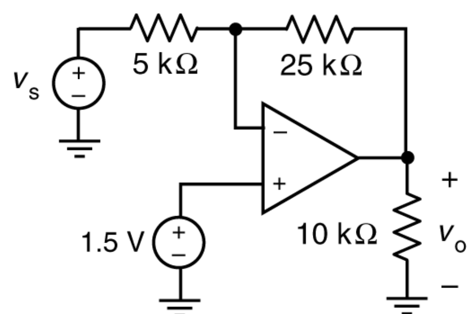
1. The switch in this circuit closes at time $t = 0$. Let $i(0)$ denote the inductor current when the switch is open and the circuit is at steady state. Similarly, let $i(\infty)$ denote the steady state inductor current when the switch is closed.



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

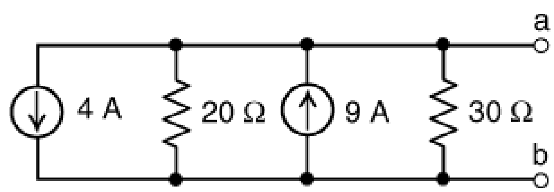
$i(0)$ = ___2.5__A and $i(\infty)$ = __7.5___A.

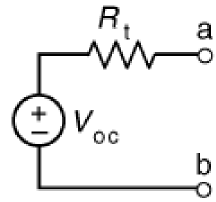
2. The input to this circuit is the voltage v_s. The output is the voltage v_o. The output is related to the input by the equation $v_o = m\, v_s + b$ where m and b are constants. The values of m and b are:



m = __−5__V/V and b = ___9__V.

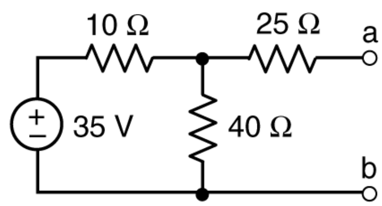
3. Here's a circuit and its Thevenin equivalent circuit. Determine the values of the Thevenin resistance, R_t, and of the open-circuit voltage, V_{oc}.

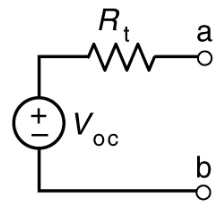




R_t = ___12___ Ω and V_{oc} = ___60______V

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}.





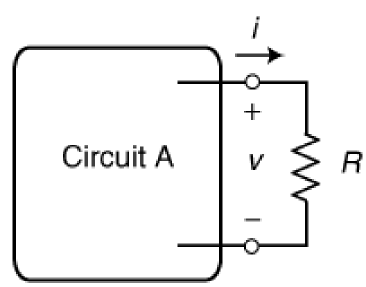
R_t = ___33___ Ω and V_{oc} = ___28______V

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

When $R = 0$ then $i = 1.5$ A.

When $R = \infty$ then $v = 24$ V.

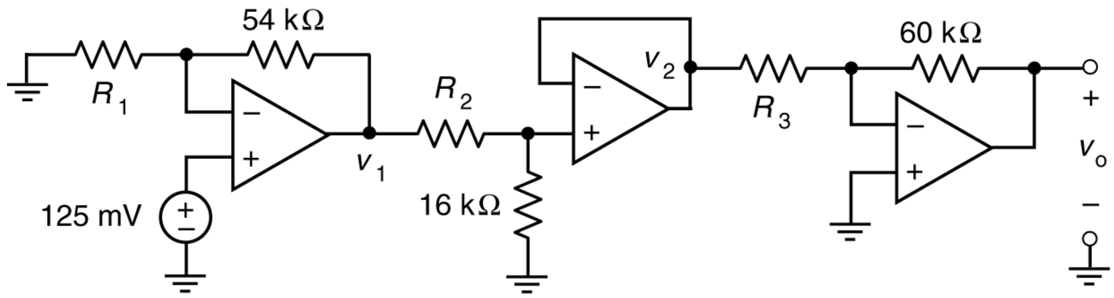
Fill in the blanks in the following statements:



a) When R = __1.4545__Ω then $v = 2$ V.

a) When R = ___104____Ω then $i = 0.20$ A..

6.

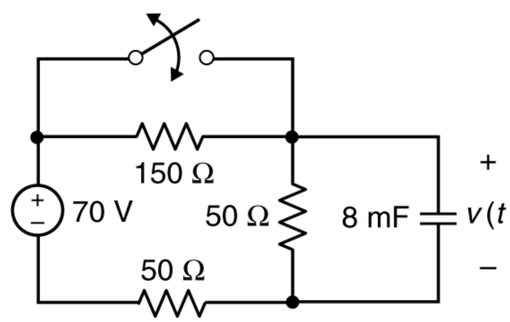


The values of the node voltages v_1, v_2 and v_o, are $v_1 = 875$ mV, $v_2 = 350$ mV and $v_o = -600$ mV. Determine the value of the resistances R_1, R_2 and R_3:

R_1 = ______9____ kΩ, R_2 = _____24_____ kΩ and R_3 = _____35_____ kΩ.

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

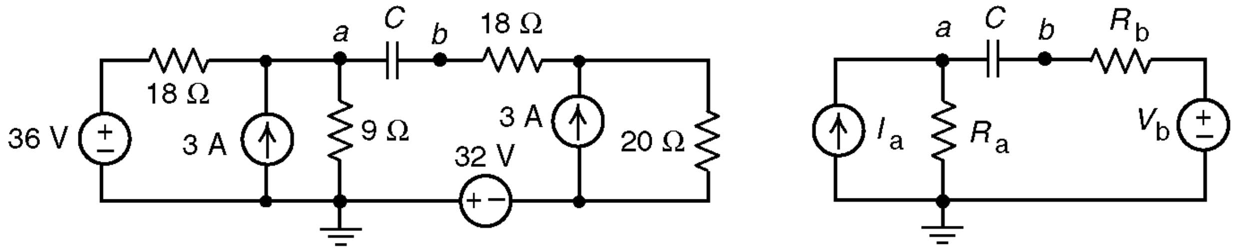
τ = ___320_____ **ms** and $v(\infty)$ = _____14______ V



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

τ = ___200___ **ms** and $v(\infty)$ = ___35____ V

8.



original circuit　　　　equivalent circuit

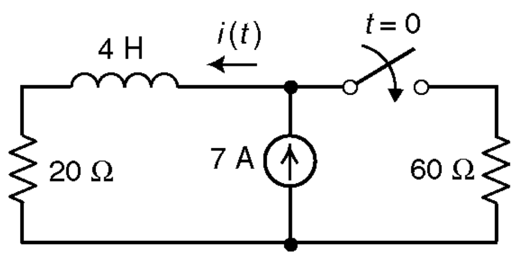
The equivalent circuit on the right is obtained from the original circuit on the left using source transformations and equivalent resistances. (The lower case letters *a* and *b* identify the nodes of the capacitor in both the original and equivalent circuits.) Determine the values of R_a, I_a, R_b and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

R_a, = ___6___ Ω, I_a = ___5____A, R_b = ___38___ Ω and V_b = ___28___V.

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

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

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



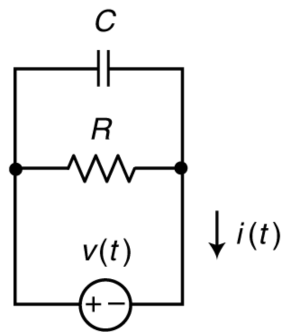
A = ___5.25___ Amps, *B* = _____1.75___ Amps and *a* = _____20___ 1/s.

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

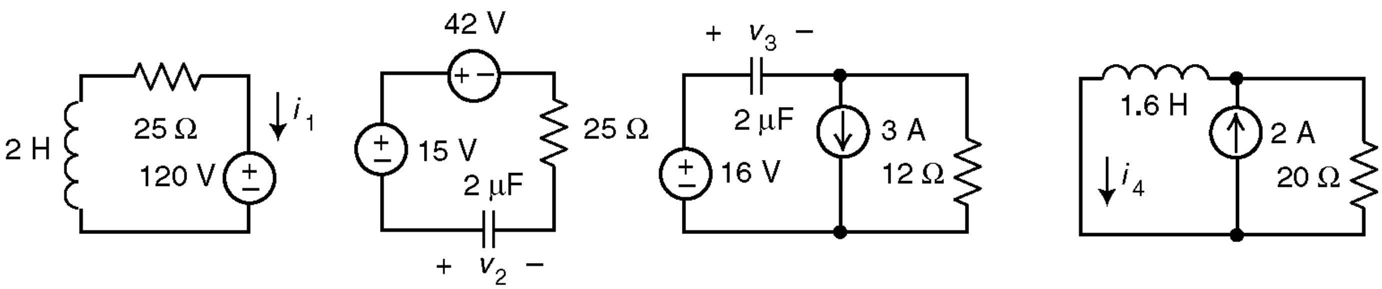
The output is the current: $i(t) = 4 - 2.7e^{-7t}$ A for $t > 0$

Determine the values of the resistance and capacitance:

$R =$ ____5____ Ω and $C =$ ____125_____ **mF**.



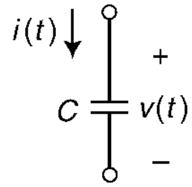
11. Here are 4 separate dc circuits. Because they are dc circuits, the capacitors in these circuits act like open circuits and the inductors act like short circuits. Determine the values of i_1, v_2, v_3 and i_4.



$i_1 =$ ___–4.8_____ A, $v_2 =$ ___27_____ V, $v_3 =$ ___52_____ V and $i_4 =$ ___2_____ A.

Element Equations

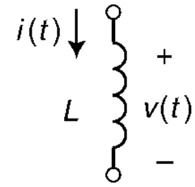
Capacitor:



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

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

Inductor:

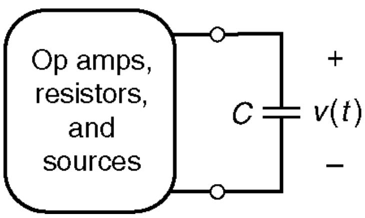


$$i(t)=\frac{1}{L}\int_{-\infty}^{t} v(\tau)\,d\tau$$

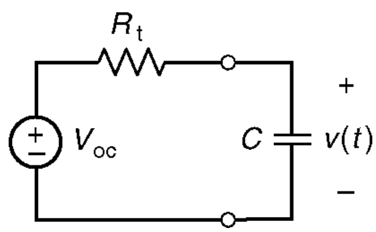
$$v(t)=L\frac{d\,i(t)}{d\,t}$$

First-Order Circuits

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:

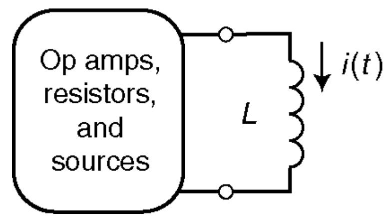
$$v(t)=V_{\text{oc}}+\left(v(0)-V_{\text{oc}}\right)e^{-\frac{t}{\tau}}$$

where the time constant, τ, is

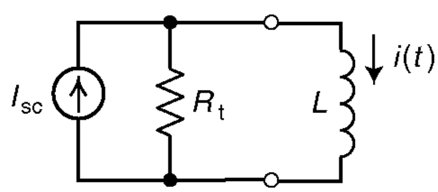
$$\tau=R_{\text{t}}\,C$$

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 $t = 0$.