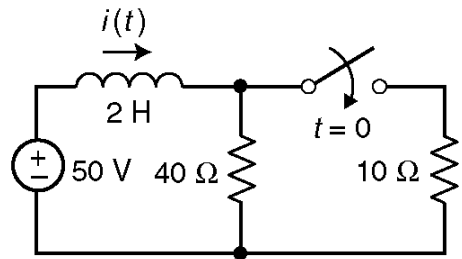# ES 250 2nd Midterm Exam - Fall 2013

Name _____k4_____          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.
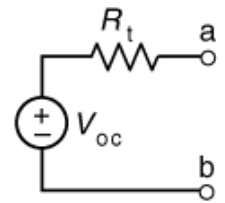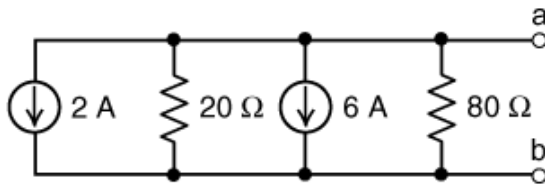
Determine the values of $i(0)$ and $i(\infty)$:

$i(0) = $ ___1.25__ A and $i(\infty) = $ __6.25___ 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:
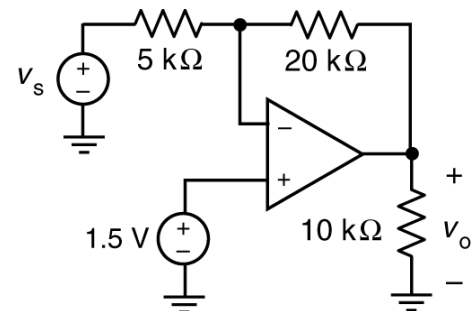
$m = $ ___−4__ V/V and $b = $ __7.5___ V.

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



$$R_t = \_\_16\_\_ \ \Omega \ \text{ and } \ V_{oc} = \_\_-128\_\_\_ \ V$$

**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, $V_{oc}$.
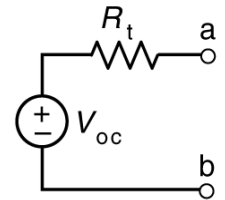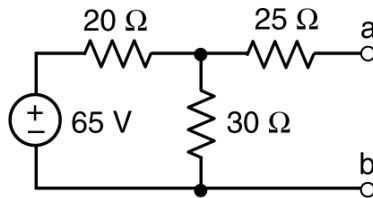


$$R_t = \_\_37\_\_ \ \Omega \ \text{ and } \ V_{oc} = \_\_39\_\_\_ \ V$$

**5.** Given that $0 \le R \le \infty$ in this circuit, and given these two observations:
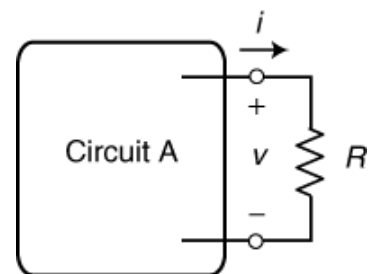
When $R = 0$ then $i = 1.5$ A.

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

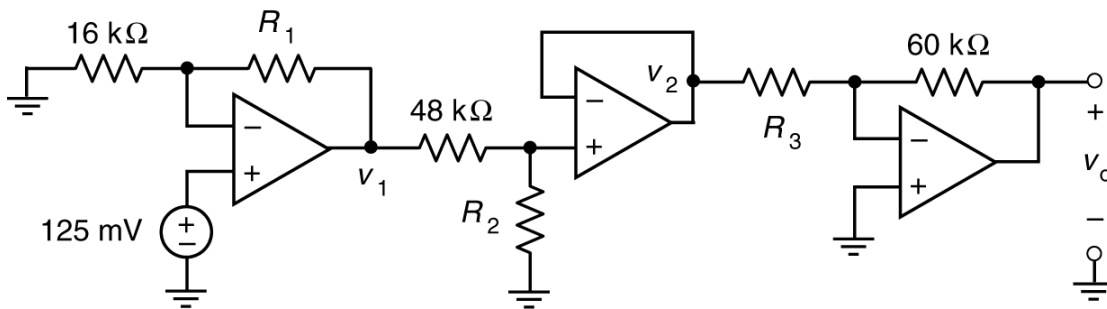Fill in the blanks in the following statements:



a) When $R = \_\_\_\_8\_\_\_\_ \ \Omega$ then $v = 8$ V.

b) When $R = \_\_\_24\_\_\_\_ \ \Omega$ then $i = 0.6$ 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.
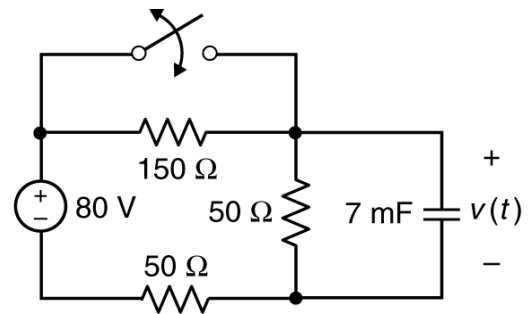Determine the value of the resistances $R_1$, $R_2$ and $R_3$:

$$R_1 = \underline{\quad 96 \quad} \text{ k}\Omega, \quad R_2 = \underline{\quad 32 \quad} \text{ k}\Omega \text{ and } R_3 = \underline{\quad 35 \quad} \text{ k}\Omega.$$

**7. a)** Determine the time constant, $\tau$, and the steady state capacitor voltage, $v(\infty)$, when the switch is **open**:
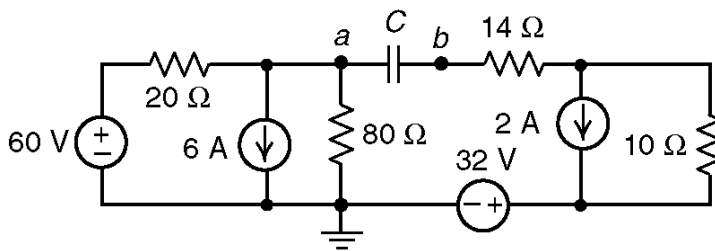
$\tau = \underline{\quad 280 \quad}$ **ms** and $v(\infty) = \underline{\quad 16 \quad}$ V

**b)** Determine the time constant, $\tau$, and the steady state capacitor voltage, $v(\infty)$, when the switch is **closed**:
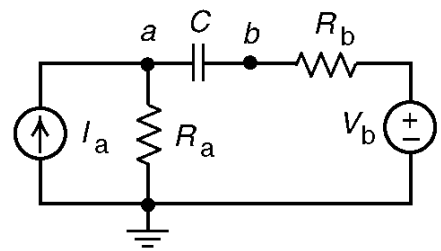
$\tau = \underline{\quad 175 \quad}$ **ms** and $v(\infty) = \underline{\quad 40 \quad}$ V

**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:

$$R_a = \underline{\quad 16 \quad} \Omega, \quad I_a = \underline{\quad -3 \quad} A, \quad R_b = \underline{\quad 24 \quad} \Omega \quad \text{and} \quad V_b = \underline{\quad 12 \quad} V.$$

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

$$i(t) = A + Be^{-at} \quad \text{Amps} \quad \text{for } t > 0$$
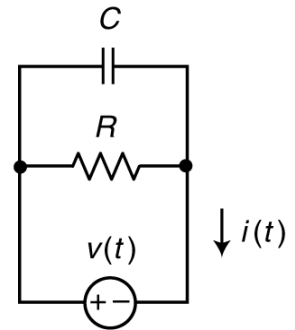
Determine the values of the real constants $A$, $B$ and $a$:
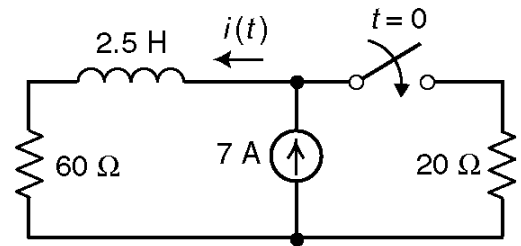


$A = \underline{\quad 1.75 \quad}$ Amps, $B = \underline{\quad 5.25 \quad}$ Amps and $a = \underline{\quad 32 \quad}$ 1/s.

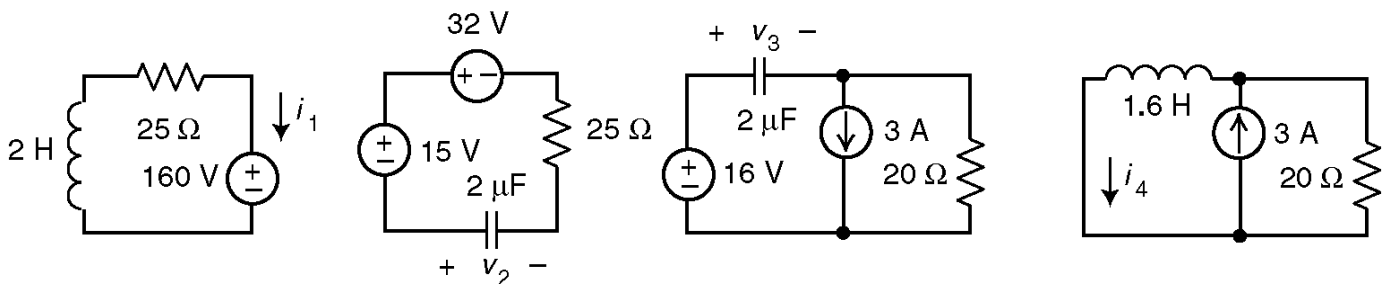**10.** The input to this circuit is the voltage: $v(t) = 20 + 4e^{-7t}$ V for $t > 0$

The output is the current: $i(t) = 2 - 10.1e^{-7t}$ A for $t > 0$

Determine the values of the resistance and capacitance:

$R = \underline{\quad 10 \quad}$ $\Omega$ and $C = \underline{\quad 375 \quad}$ 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 $i_4$.



$i_1 = \underline{\quad -6.4 \quad}$ A, $v_2 = \underline{\quad 17 \quad}$ V, $v_3 = \underline{\quad 76 \quad}$ V and $i_4 = \underline{\quad 3 \quad}$ A.