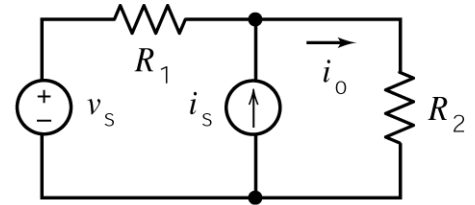# Another Sample ES 250 Second Midterm Exam

1. This circuit has two inputs, v_s and i_s, and one output i_o. The output is related to the inputs by the equation

$$i_o = a\, i_s + b\, v_s$$

Given the following two facts:

The output is $i_o = 0.45$ A when the inputs are $i_s = 0.25$ A and $v_s = 15$ V.

and

The output is $i_o = 0.30$ A when the inputs are $i_s = 0.50$ A and $v_s = 0$ V.

The values of the constants a and b are $\quad a = \underline{\quad 0.6 \quad}$ and $b = \underline{\quad 0.02 \quad}$ A/V.
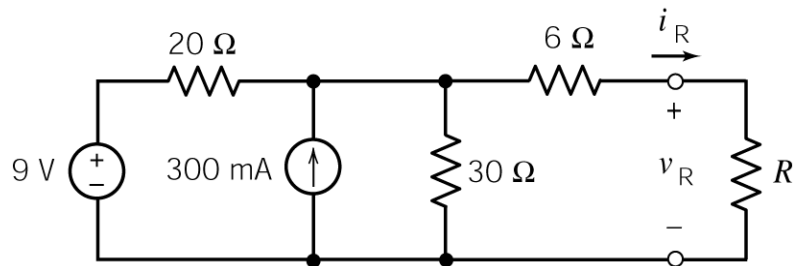
The values of the resistances are $R_1 = \underline{\quad 30 \quad}\ \Omega$ and $R_2 = \underline{\quad 20 \quad}\ \Omega$.

2. Fill in the blanks in the following statements:

When $R = 9\ \Omega$ then $v_R = \underline{\quad 3 \quad}$ V.

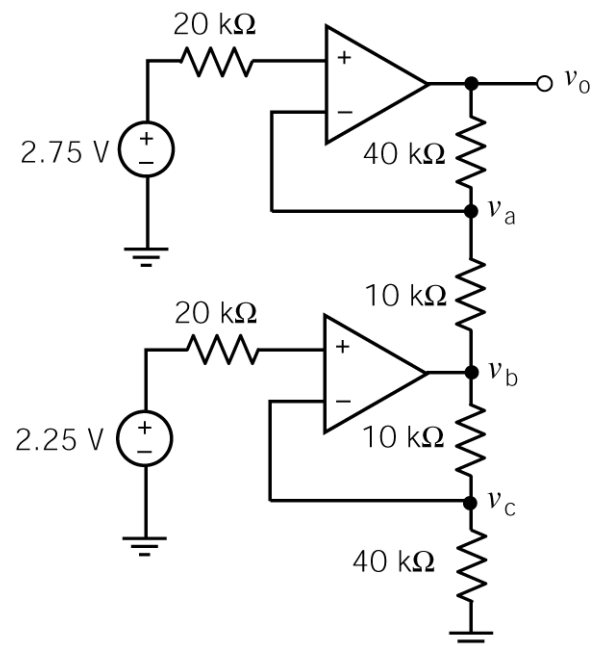When $R = \underline{\quad 27 \quad}\ \Omega$ then $v_R = 5.4$ V.

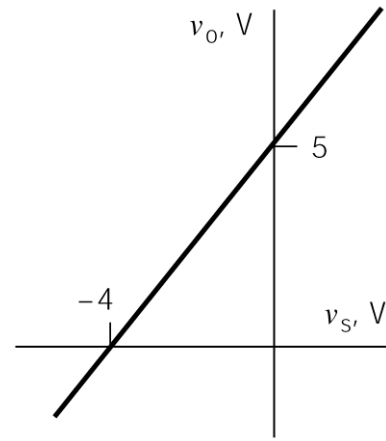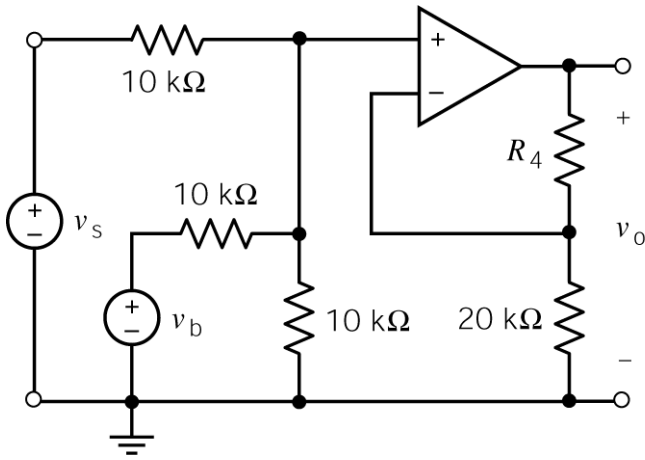When $R = \underline{\quad 12 \quad}\ \Omega$ then $i_R = 300$ mA.

3. Determine the values of the node voltages v_a, v_b, v_c and v_o:

$v_a = \underline{\quad 2.75 \quad}$ V, $v_b = \underline{\quad 2.8125 \quad}$ V,

$v_c = \underline{\quad 2.25 \quad}$ V, and $v_o = \underline{\quad 2.50 \quad}$ V.

4.

The input to this circuit is the voltage, v_s. The output is the voltage v_o. The voltage v_b is used to adjust the relationship between the input and output. Determine values of R_4 and v_b that cause the circuit input and output have the relationship specified by the graph
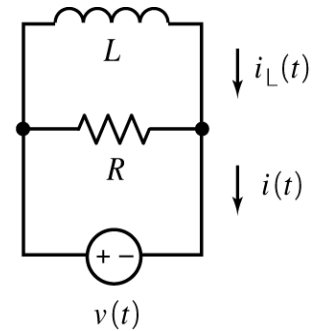
$$v_b = \_\_\_\_4\_\_\_\_ \text{ V and } R_4 = \_\_\_\_55\_\_\_\_ \text{ k}\Omega.$$

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

The output is the current: $i(t) = -1.2e^{-20t} - 1.5$ A for $t > 0$

The initial condition is $i_L(0) = -3.5$ A. Determine the values of the resistance and inductance:

$$R = \_\_\_5\_\_\_ \Omega \text{ and } L = \_\_\_0.1\_\_\_ \text{ H}.$$

6. The initial inductor current is $i(0) = 25$ mA.

Determine the values of the inductor current at 2, 3, 6 and 9 seconds:

$i(2) = \_\_\_-15\_\_\_$ mA,

$i(3) = \_\_\_-55\_\_\_$ mA,

$i(6) = \_\_\_\_5\_\_\_$ mA,

$i(9) = \_\_\_\_65\_\_\_$ mA.
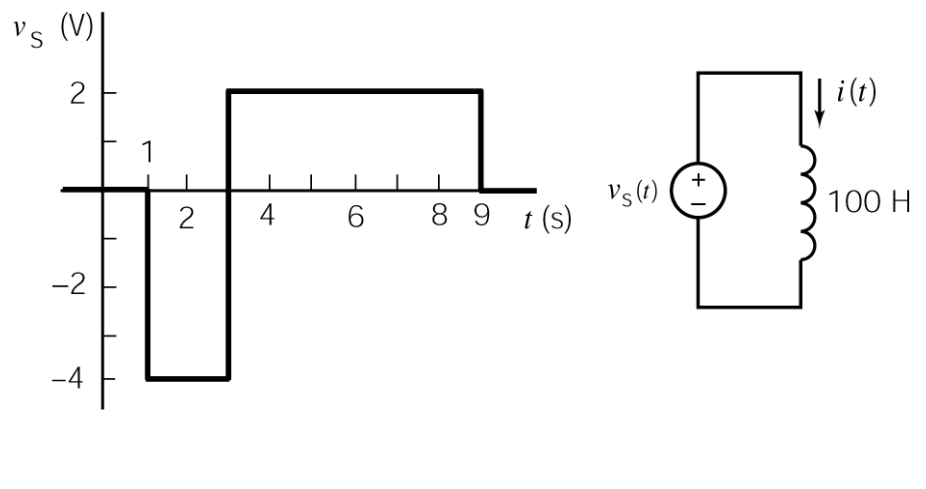
7.

a. When $C = 10$ F then $C_{eq} = $ ___25___ F.

b. When $C = $ ___3.2___ F then $C_{eq} = 8$ F.
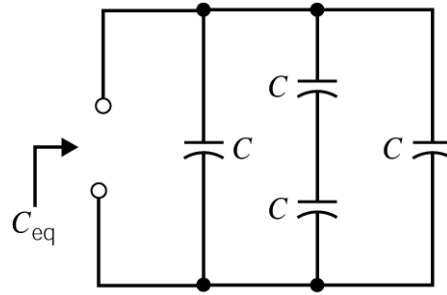
8. This circuit has reached steady state before the switch opens at time $t = 0$. Determine the values of $i_L(t)$, $v_C(t)$ and $v_R(t)$ immediately before the switch opens:
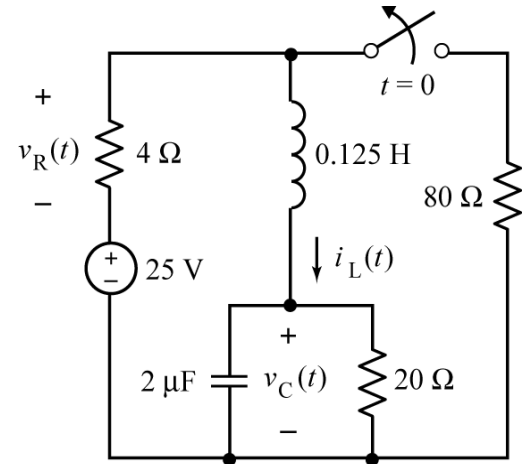
$$i_L(0-) = \underline{\quad 1 \quad} \text{ A}, \quad v_C(0-) = \underline{\quad 20 \quad} \text{ V}$$

and

$$v_R(0-) = \underline{\quad -5 \quad} \text{ V}$$

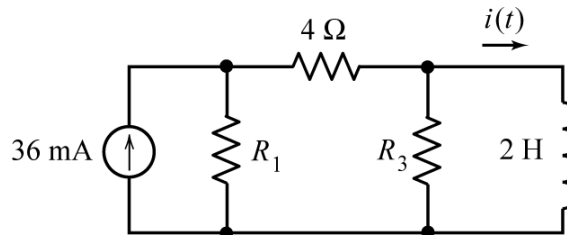Determine the value of $v_R(t)$ immediately after the switch opens:

$$v_R(0+) = \underline{\quad -4 \quad} \text{ V}$$

9. After time $t = 0$, a given circuit is represented by this circuit diagram.

a. Suppose that the inductor current is

$$i(t) = 21.6 + 28.4 e^{-4t} \text{ mA} \quad \text{for } t \geq 0$$

Determine the values of R_1 and R_3: $R_1 = $ ___6___ Ω and $R_3 = $ ___40___ Ω.

b. Suppose instead that $R_1 = 16 \ \Omega$, $R_3 = 20 \ \Omega$, the initial condition is $i(0) = 10$ mA, and the inductor current is $i(t) = A - Be^{-at}$ for $t \geq 0$. Determine the values of the constants A, B, and a:

$$A = \underline{\quad 28.8 \quad} \text{ mA}, \quad B = \underline{\quad -18.8 \quad} \text{ mA} \quad \text{and} \quad a = \underline{\quad 5 \quad} \text{ s}.$$

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

$$\tau = \underline{\quad 3 \quad} \text{ s} \quad \text{and} \quad v(\infty) = \underline{\quad 24 \quad} \text{ V}$$

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

$$\tau = \underline{\quad 2.25 \quad} \text{ s} \quad \text{and} \quad v(\infty) = \underline{\quad 12 \quad} \text{ V}$$