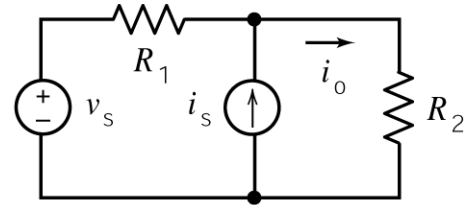


Another Sample ES 250 Second Midterm Exam

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 $a = \underline{\quad 0.6 \quad}$ and $b = \underline{\quad 0.02 \quad}$ A/V.

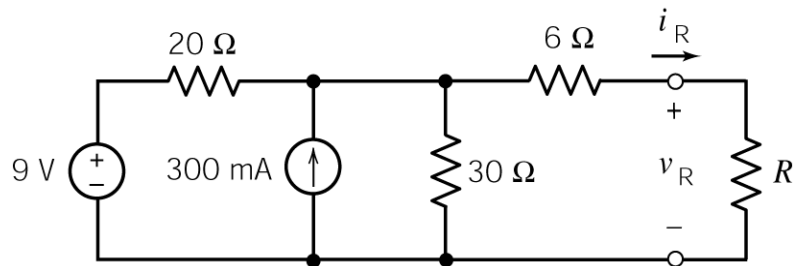
The values of the resistances are $R_1 = \underline{\quad 30 \quad}$ Ω and $R_2 = \underline{\quad 20 \quad}$ Ω .

2. Fill in the blanks in the following statements:

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

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

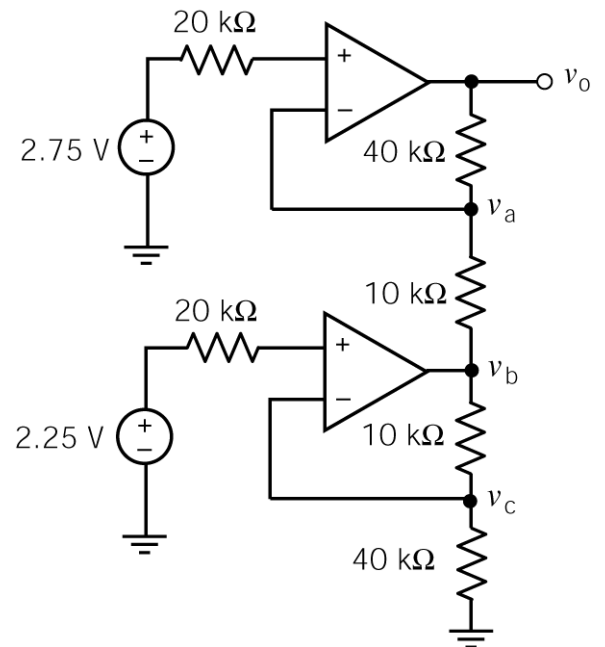
When $R = \underline{\quad 12 \quad}$ Ω then $i_R = 300$ mA.



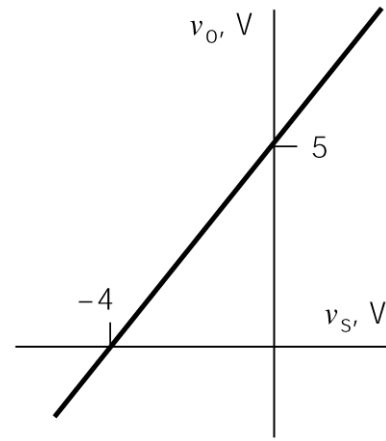
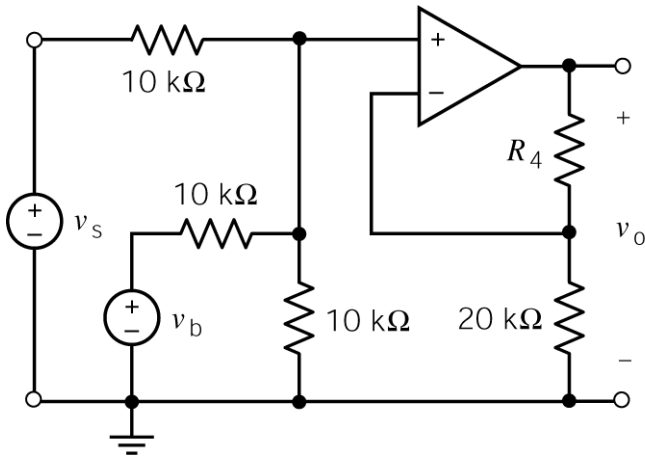
3. Determine the values of the node voltages v_a , v_b , v_c and v_o :

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

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



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

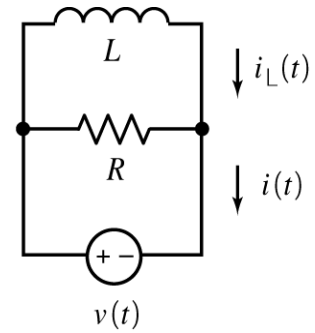
$$v_b = \underline{4} \text{ V and } R_4 = \underline{55} \text{ k}\Omega.$$

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:

$$R = \underline{5} \text{ } \Omega \text{ and } L = \underline{0.1} \text{ H.}$$



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

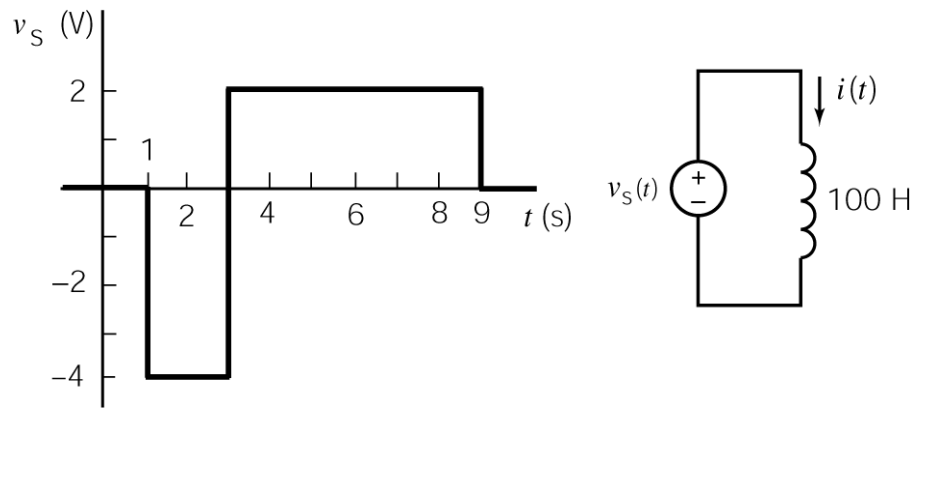
Determine the values of the inductor current at 2, 3, 6 and 9 seconds:

$$i(2) = \underline{-15} \text{ mA,}$$

$$i(3) = \underline{-55} \text{ mA,}$$

$$i(6) = \underline{5} \text{ mA,}$$

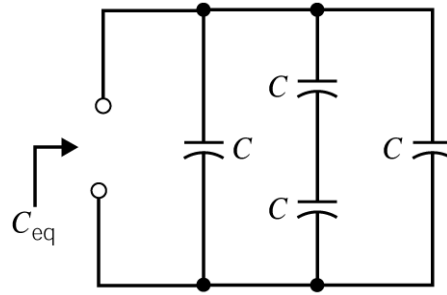
$$i(9) = \underline{65} \text{ mA.}$$



7.

a. When $C = 10 \text{ F}$ then $C_{\text{eq}} = \underline{25} \text{ F}$.

b. When $C = \underline{3.2} \text{ F}$ then $C_{\text{eq}} = 8 \text{ F}$.



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:

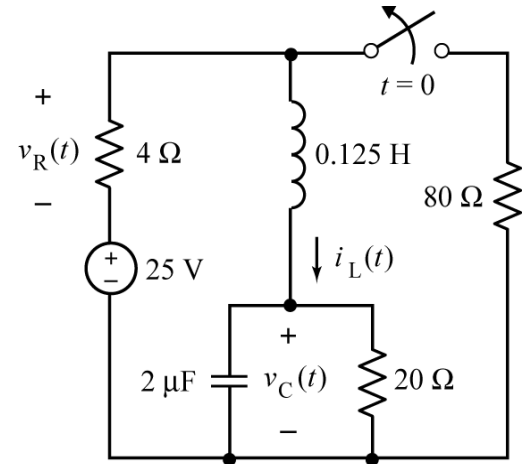
$$i_L(0^-) = \underline{1} \text{ A}, \quad v_C(0^-) = \underline{20} \text{ V}$$

and

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

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

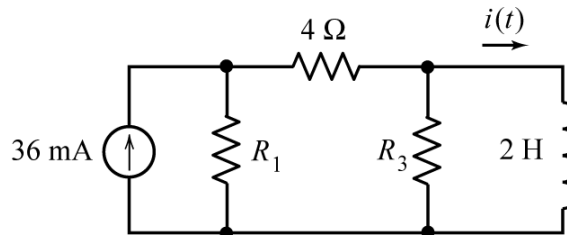
$$v_R(0^+) = \underline{-4} \text{ V}$$



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

a. Suppose that the inductor current is

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



Determine the values of R_1 and R_3 : $R_1 = \underline{6} \Omega$ and $R_3 = \underline{40} \Omega$.

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

$$A = \underline{28.8} \text{ mA}, \quad B = \underline{-18.8} \text{ mA} \quad \text{and} \quad a = \underline{5} \text{ s}^{-1}$$

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

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

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

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

