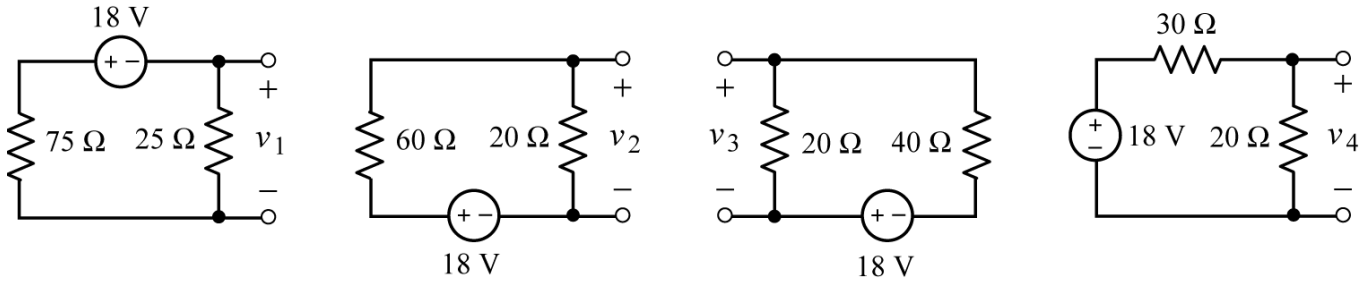


ES 250 Final Exam - Fall 2009

Name _____

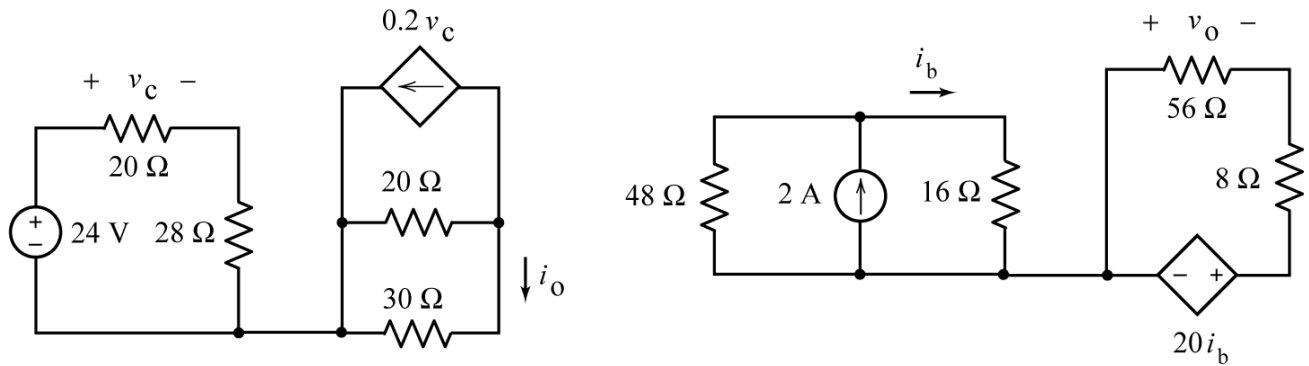
Student # _____

1. Here are 4 separate circuits. Determine the values of the voltages v_1, v_2, v_3 and v_4 .



$v_1 = \underline{-4.5} \text{ V}, v_2 = \underline{4.5} \text{ V}, v_3 = \underline{-6} \text{ V}$ and $v_4 = \underline{7.2} \text{ V}.$

2.

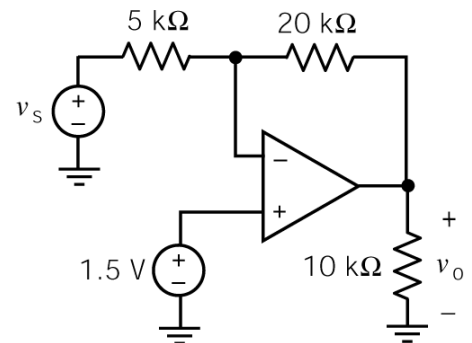


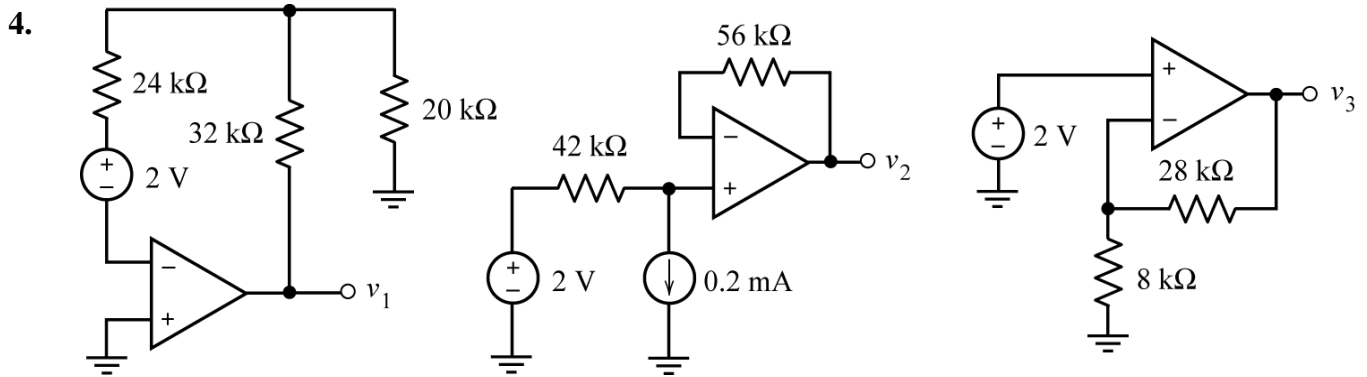
Here are 2 separate circuits. Determine the values of i_o and v_o :

$i_o = \underline{-0.8} \text{ A}$ and $v_o = \underline{-26.25} \text{ V}$

3. 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:

$m = \underline{-4} \text{ V/V}$ and $b = \underline{7.5} \text{ V}.$



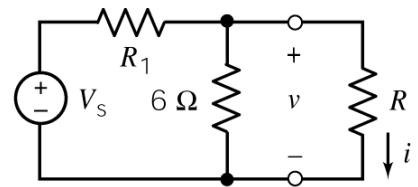


The outputs of these three op amp circuits are the node voltages v_1 , v_2 and v_3 . Determine the values of v_1 , v_2 and v_3 :

$$v_1 = \underline{5.2} \text{ V}, \quad v_2 = \underline{-6.4} \text{ V} \text{ and } v_3 = \underline{9} \text{ V}.$$

5. In this problem the values of V_s and R_1 do not change. In contrast, the value of R does change, causing the values of the voltage v and current i to change. Given the following data:

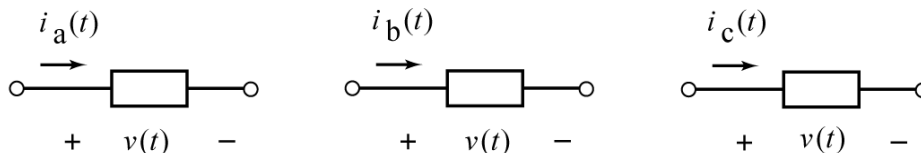
When $R = \infty$ then $v = 10 \text{ V}$. When $R = 0$ then $i = 2.5 \text{ A}$.



Determine the following:

- $V_s = \underline{30} \text{ V}$ and $R_1 = \underline{12} \Omega$.
- When $R = 4 \Omega$ then $i = \underline{1.25} \text{ A}$
- When $R = \underline{16} \Omega$ then $v = 8 \text{ V}$.

6. One of these three elements is a resistor, one is a capacitor and one is an inductor:



Given $v(t) = 24 \cos(5t) \text{ V}$,

And $i_a(t) = 3 \cos(5t) \text{ A}$, $i_b(t) = 12 \sin(5t) \text{ A}$ and $i_c(t) = -1.8 \sin(5t) \text{ A}$

Determine the resistance of the resistor, the capacitance of the capacitor and the inductance of the inductor. (We require positive values of resistor, capacitance and inductance.)

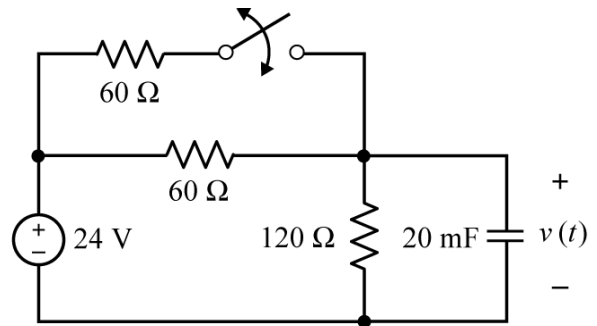
$$\text{resistance} = \underline{8} \Omega, \quad \text{capacitance} = \underline{0.015} \text{ F} \text{ and } \text{inductance} = \underline{0.4} \text{ H}$$

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

$$\tau = \underline{0.8} \text{ s} \quad \text{and} \quad v(\infty) = \underline{16} \text{ V}$$

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

$$\tau = \underline{0.48} \text{ s} \quad \text{and} \quad v(\infty) = \underline{19.2} \text{ V}$$

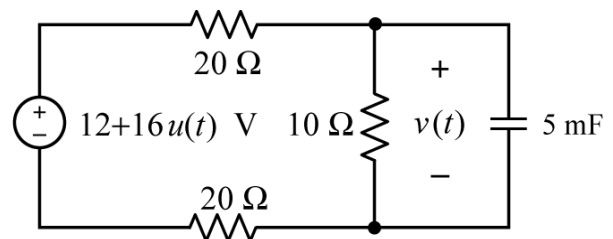


8. This circuit is at steady state before the input changes at time $t = 0$. The capacitor voltage can be represented as

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

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

$$A = \underline{5.6} \text{ V}, B = \underline{-3.2} \text{ V} \quad \text{and} \quad a = \underline{25} \text{ 1/s.}$$

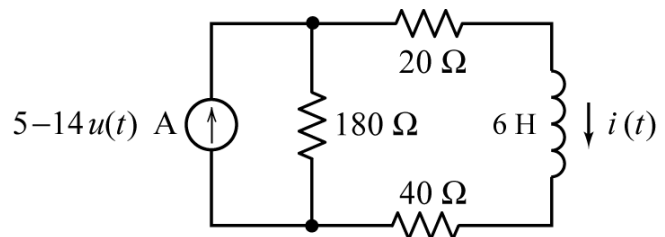


9. This circuit is at steady state before the input changes at time $t = 0$. The inductor current can be represented as

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

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

$$A = \underline{-6.75} \text{ Amps}, B = \underline{10.5} \text{ Amps} \quad \text{and} \quad a = \underline{40} \text{ 1/s.}$$



10. This circuit is at steady state. The currents $i_1(t)$ and $i_2(t)$ are given by

$$i_1(t) = 26 \cos(4200t + 25^\circ) \text{ mA}$$

and

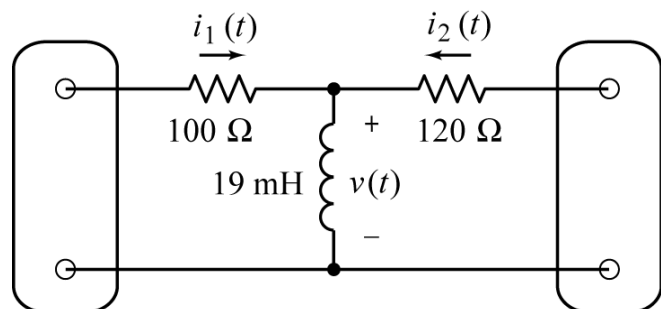
$$i_2(t) = -38 \cos(4200t + 140^\circ) \text{ mA}$$

The voltage $v(t)$ is represented as

$$v(t) = A \cos(4200t + \theta) \text{ V}$$

where $A > 0$ and $-180^\circ < \theta \leq 180^\circ$. Determine the values of A and θ .

$$A = \underline{4.338} \text{ V} \quad \text{and} \quad \theta = \underline{75.688} \text{ }^\circ.$$



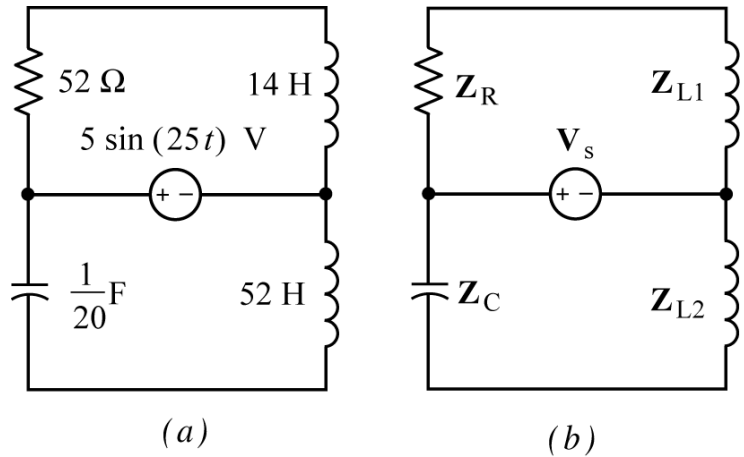
11. Figure (a) shows a circuit represented in the time domain. Figure (b) shows the same circuit represented in the frequency domain, using phasors and impedances. Z_R , Z_C , Z_{L1} , and Z_{L2} are the impedances corresponding to the resistor, capacitor, and two inductors in (a).

Suppose

$$Z_C = a + j b \Omega, Z_R = A \angle \theta \Omega, Z_{L1} = B \angle \phi \Omega$$

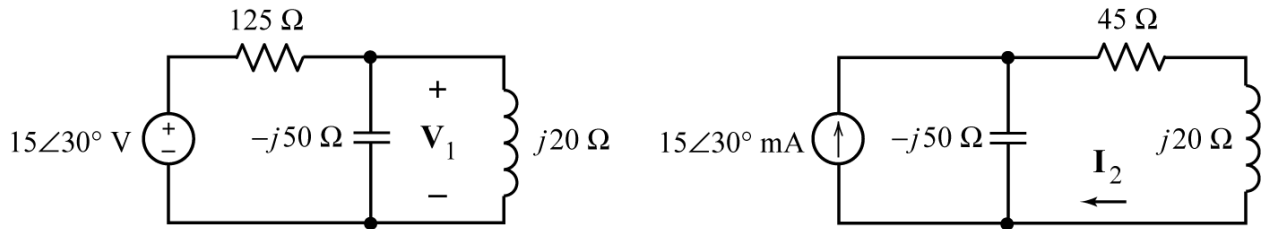
and $Z_{L2} = c + j d \Omega$.

Determine the values of a , A , B and d :



$$a = \underline{0} \Omega, A = \underline{52} \Omega, B = \underline{350} \Omega \text{ and } d = \underline{1300} \Omega$$

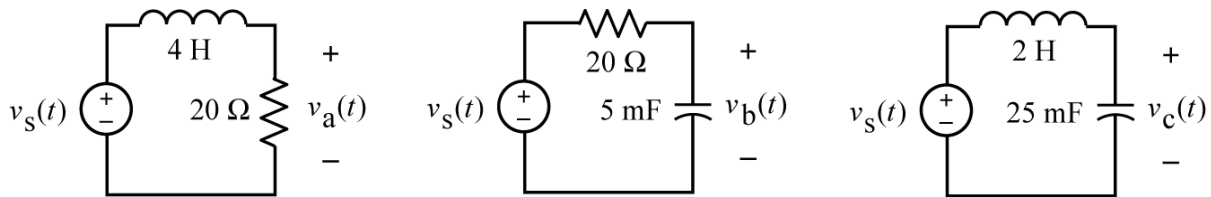
12.



Here are two circuits represented in the frequency domain. In the left circuit $V_1 = A \angle 105^\circ \text{ V}$ and in the right circuit $I_2 = B \angle -26.31^\circ \text{ mA}$, where A and B are real constants. Determine the values of A and B .

$$A = \underline{3.8675} \text{ V and } B = \underline{13.87} \text{ mA.}$$

13.



The input to each of these three circuits is the voltage $v_s(t) = 15 \cos(8t - 45^\circ) \text{ V}$. The outputs are the voltages

$$v_a(t) = D \cos(8t - 103^\circ) \text{ V, } v_b(t) = E \cos(8t - 83.7^\circ) \text{ V and } v_c(t) = F \cos(8t + 135^\circ) \text{ V}$$

where D , E and F are real constants representing the amplitudes of the outputs. Determine the values of D , E and F :

$$D = \underline{7.949} \text{ V, } E = \underline{11.71} \text{ V and } F = \underline{6.818} \text{ V}$$