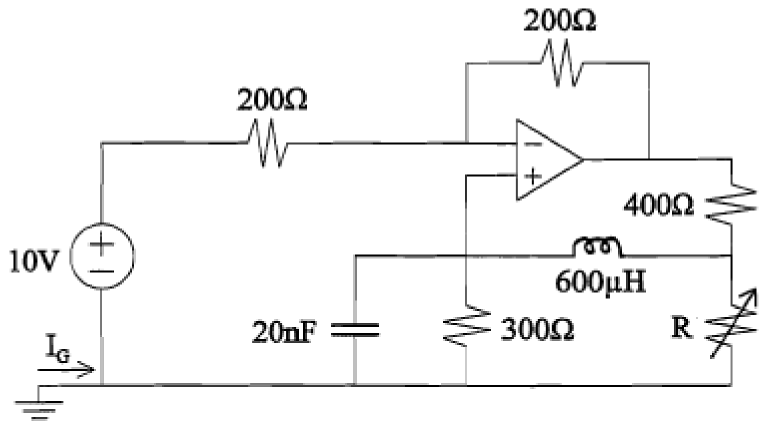
ECSE 200: Fundamentals of Electrical Engineering

Assignment 7

Winter 2006

Question 1

Consider the linear circuit shown below. Assume that the op-amp is ideal, and that the circuit is stable and operating in D.C. steady-state. Answer the following questions:



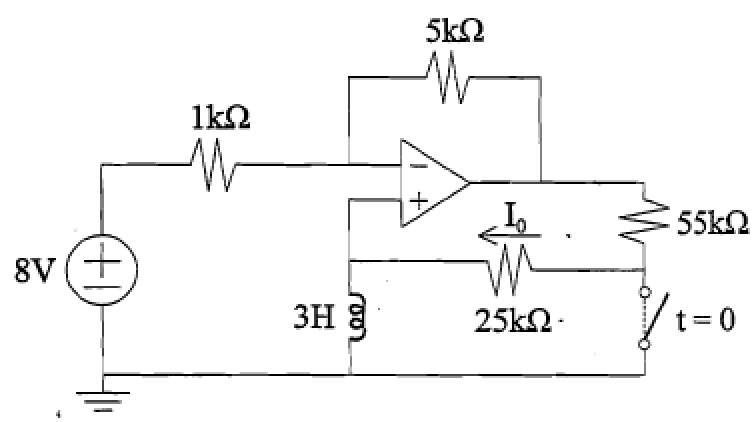
(a) Calculate the power supplied to the circuit by the independent source if R = 600Ω.

(b) Find the value (non-negative) of the variable resistance R that yields $I_G = 250\text{mA}$.

(c) Find the two non-negative values of R that would yield the highest and the lowest stored energy levels for the passive elements of the circuit. Also, find the values of these two steady-state stored energy levels, and briefly explain how they would be affected (increase / decrease / no change) if the 600μH inductor was non-ideal.

Question 2

Assume the ideal op-amp circuit below is stable, and answer the following questions: (The switch is open for all t < 0, then closes at t = 0, and remains closed for all t > 0.)

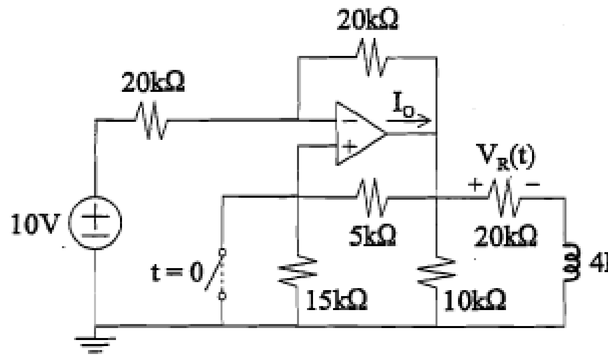


(a) Find the value of the energy that is stored by the inductor at time $t = 0^-$.

(b) Determine the current labeled I_0, as a function of time, for all time t > 0.

Question 3

Assume the ideal op-amp circuit below is stable, and answer the following questions:
(The switch is open for all t < 0, then closes at t = 0, and remains closed for all t > 0.)



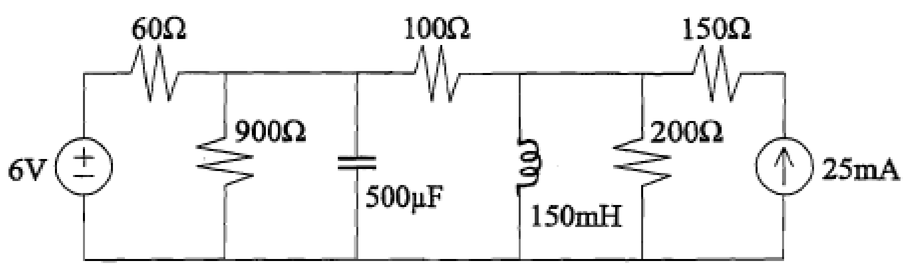
(a) Determine the resistor voltage labeled $V_R(t)$ for all time $t > 0$.

(b) Determine the op-amp output current labeled I_O for all time $t > 0$.

(c) Explain qualitatively how and why the individual voltage and current results found in parts (a) and (b) would change (or not change) if the inductor was non-ideal.

Question 4

Consider the circuit provided below. Assume that all the elements are linear and ideal, and that the circuit is operating in DC steady-state. Answer the questions listed below:



(a) Calculate the powers supplied by the two sources (two values).

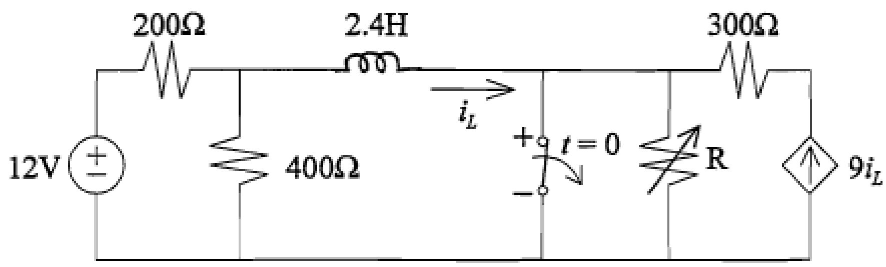
(b) Determine which resistor dissipates the most heat per second, and find the value of the electrical energy absorbed by that resistor in one second.

(c) Determine which resistor dissipates the least heat per second, and find the value of the electrical energy absorbed by that resistor in one second.

(d) Calculate the energies stored by the capacitor and the inductor (two values).

Question 5

Consider the switched R-L circuit provided below. The switch is set to remain closed until time $t = 0$, at which time it opens and stays open. Assume all the circuit elements are ideal, and answer the questions listed below.



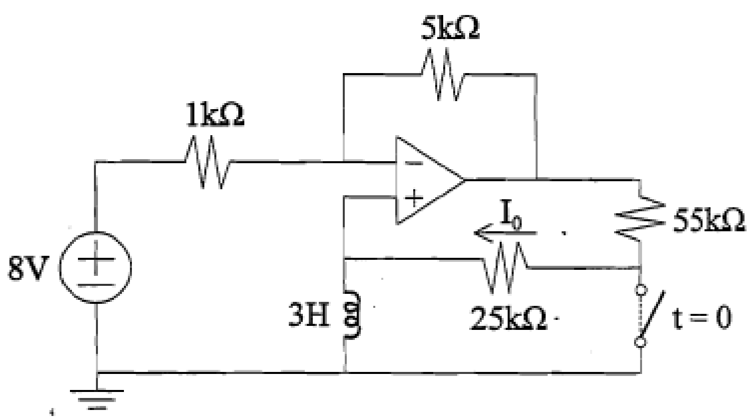
(a) Find the voltage across the open-circuited switch for all time $t > 0$, if R = 50Ω. Assume that the circuit is operating in *dc* steady state just prior to time $t = 0$.

(b) Find the value of R which minimizes the energy stored by the inductor as $t \to \infty$.

(c) Find the value of R which maximizes the energy stored by the inductor as $t \to \infty$.

Question 6

Assume the ideal op-amp circuit below is stable, and answer the following questions: (The switch is open for all $t < 0$, then closes at $t = 0$, and remains closed for all $t > 0$.)

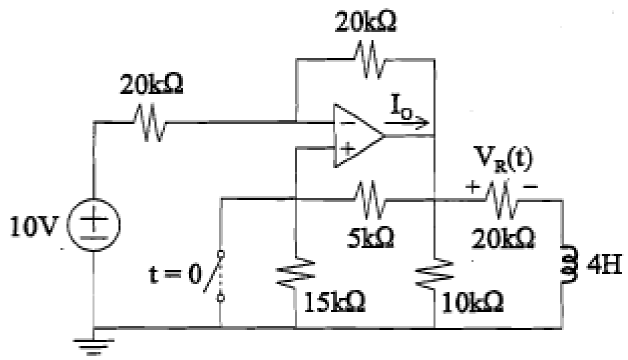


(a) Find the value of the energy that is stored by the inductor at time $t = 0^-$.

(b) Determine the current labeled I_0, as a function of time, for all time $t > 0$.

Question 7

Assume the ideal op-amp circuit below is stable, and answer the following questions:
(The switch is open for all t < 0, then closes at t = 0, and remains closed for all t > 0.)



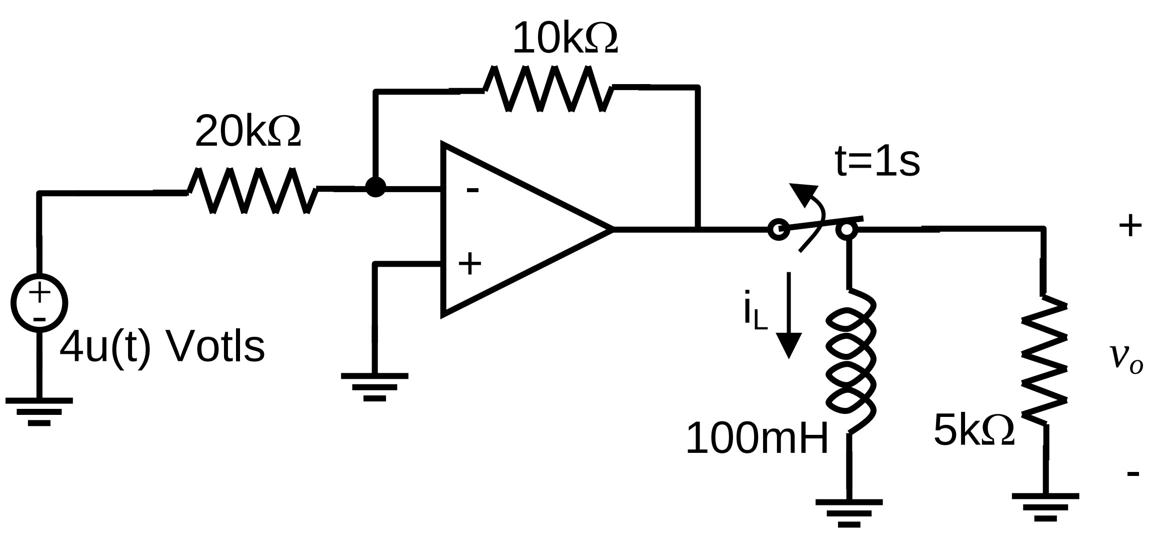
(a) Determine the resistor voltage labeled $V_R(t)$ for all time t > 0.

(b) Determine the op-amp output current labeled I_o for all time t > 0.

(c) Explain qualitatively how and why the individual voltage and current results found in parts (a) and (b) would change (or not change) if the inductor was non-ideal.

Question 8

For the following circuit, calculate the value of $i_L(t)$ for t > 0



Question 9

QUESTION 2: (6MARKS)

Assume the circuit in Figure Q2.1 is in steady state at t<0. At t=20ms, the current in the inductor is measured to be i_L=1.22A.

a) Calculate the time constant of the circuit.
b) Calculate the current i_1 in the 50Ω resistor at t=40ms.

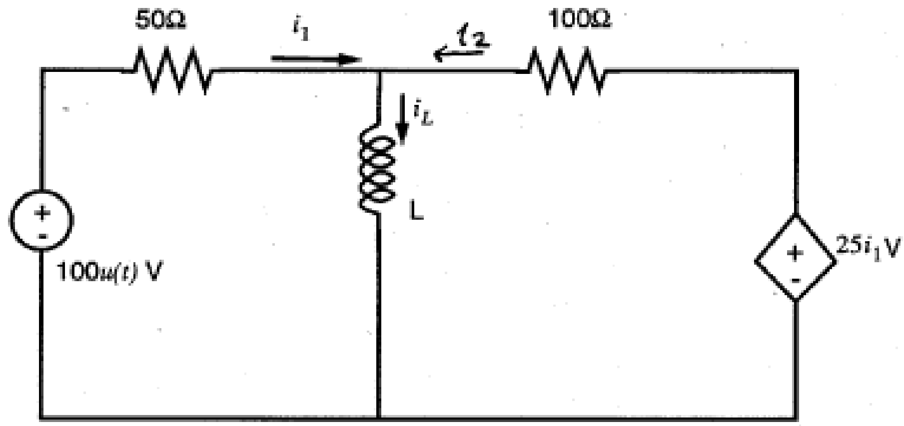
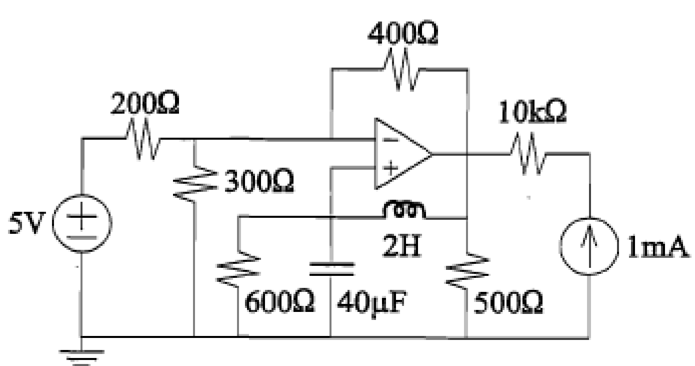


Figure Q2.1

Question 10

Consider the circuit provided below. Assume that all the elements are linear and ideal, and that the circuit is in stable DC steady-state operation. Answer the questions below:



(a) Calculate the powers supplied by the two sources (two values).

(b) Determine which resistor dissipates the <u>most</u> heat per second, and find the value of the electrical energy absorbed by that resistor in one second.

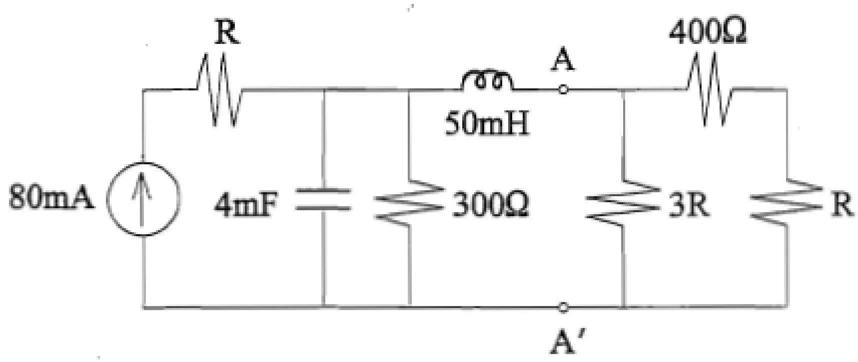
(c) Determine which resistor dissipates the <u>least</u> heat per second, and find the value of the electrical energy absorbed by that resistor in one second.

(d) Calculate the energies stored by the capacitor and the inductor (two values).

Question 11

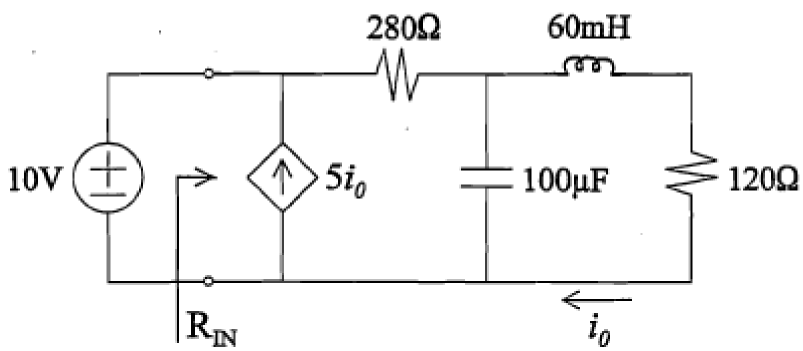
Consider the circuit given below. Calculate the value of R that yields maximum power transfer to the two-terminal network connected at the right-hand-side of terminals AA' if the entire circuit is operating in DC steady-state. Also, find the steady-state energies stored by the capacitor and the inductor, for this optimal value of R.

Note: The parameter "R" appears in the definition of three different circuit resistors.



Question 12

Assume that the circuit shown below is operating under *d.c. steady-state* conditions for the purpose of answering the following questions.



a) Calculate the steady-state power supplied by the current source.

b) Calculate the steady-state input resistance seen by the voltage source.

c) Calculate the steady-state energies stored by the capacitor and the inductor.