ORDRE DES INGÉNIEURS DU QUÉBEC

November 2017 SESSION

Open-book examination
Calculators : only authorized models
Duration : 3 hours

16-MK-A2- CIRCUITS

Question 1 (10 points)

Find the equivalent resistance between terminals a and b for the circuit of Figure 1.

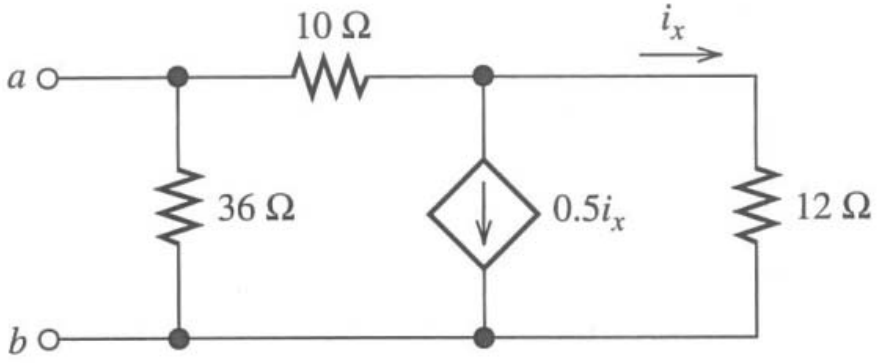

Figure 1

Question 2 (15 points)

The variable resistor R_0 in the circuit shown in Figure 2 is adjusted for maximum power transfer to R_0.

a) Find the value of R_0 (*10 points*).
b) Find the maximum power that can be delivered to R_0 (*5 points*).

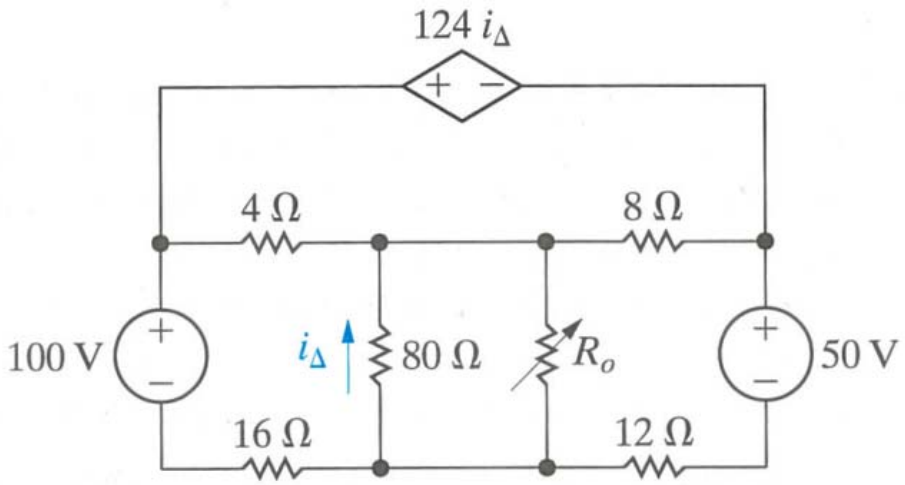

Figure 2

Question 3 (10 points)

Consider the circuit shown in in Figure 3 in which V_S is a DC source Assume that the circuit is in steady state with the switch closed prior to time $t = 0$. Find the expression of $v(t)$ for $t \geq 0$.

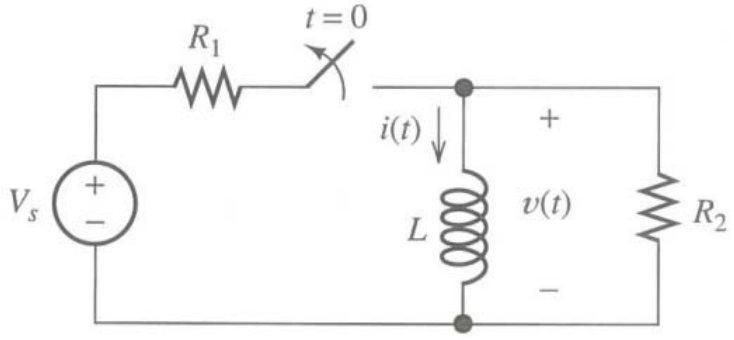

Figure 3

Question 4 (15 points)

Consider the circuit shown in Figure 4 with $R = 500\ \Omega$, $L = 10\ \mu H$ et $C = 1000$ pF.

a) Find the undamped resonant frequency, the damping coefficient, and the damping ratio (*5 points*).

b) The initial conditions are $v(0^+) = 0$ and $i_L(0^+) = 0$. Show that this requires that $\left.\frac{dv}{dt}\right]_{t=0^+} = 10^9\ Vs^{-1}$ (*5 points*).

c) Find the general solution $v(t)$ (*5 points*).

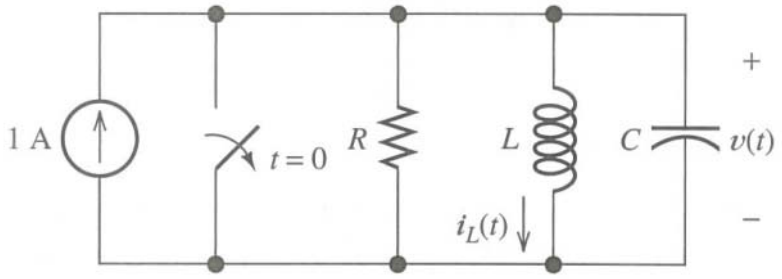

Figure 4

Question 5 (10 points)

Find the impedance Z_{ab} in the circuit shown in Figure 5. Express Z_{ab} in both polar and rectangular form.

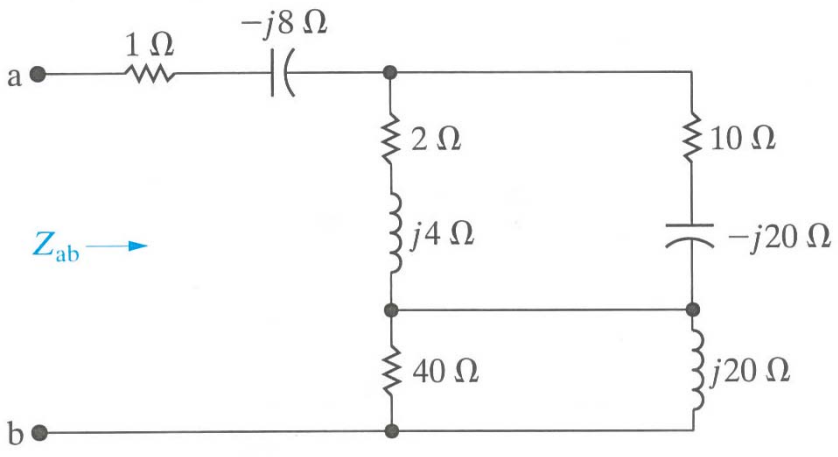

Figure 5

Question 6 (20 points)

The variable resistor R_0 in the circuit shown in Figure 6 is adjusted until maximum average power is delivered to R_0.

a) Find the value of R_0 (*5 points*).
b) Calculate the average power delivered to R_0 (*5 points*).
c) If R_0 is replaced with a variable impedance Z_0, what is the maximum average power that can be delivered to Z_0 (*5 points*)?
d) In case c), what percentage of the circuit's developed power is delivered to Z_0 (*5 points*)?

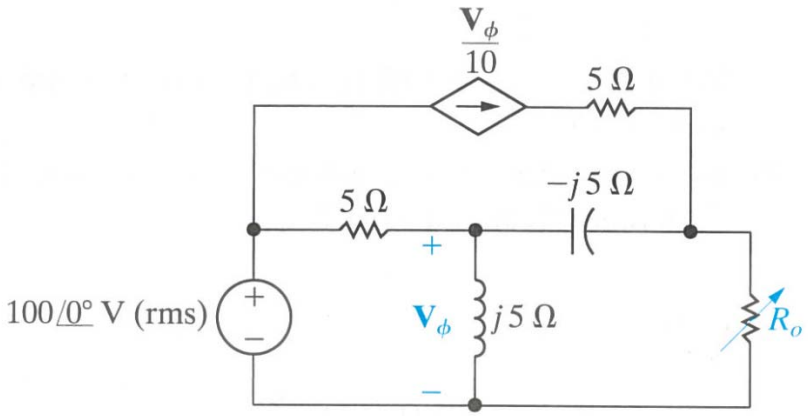

Figure 6

Question 7 (20 points)

The operational amplifier in the circuit shown in Figure 7 is considered ideal. Calculate the average power delivered to the 1 kΩ resistor when $v_g = \cos 1000t$ V.

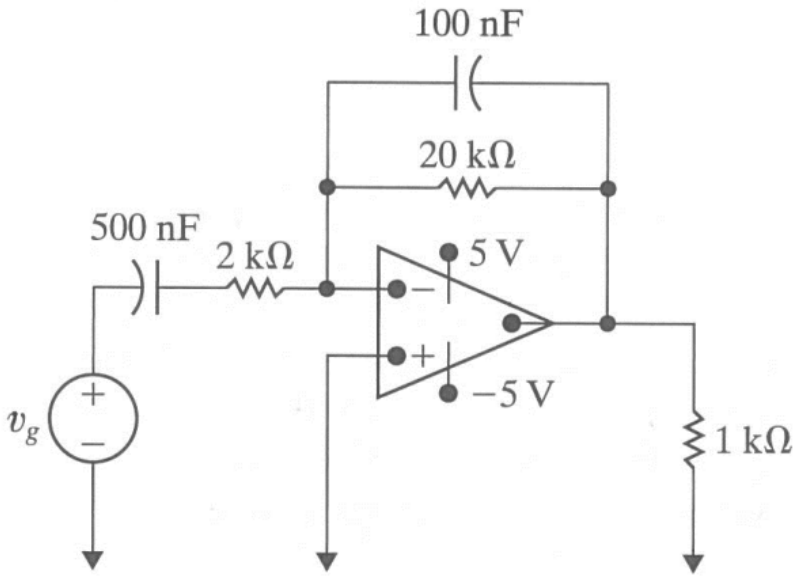

Figure 7