ORDRE DES INGÉNIEURS DU QUÉBEC

NOVEMBER 2019 SESSION

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

16-EL-A1-CIRCUITS

Question 1 (10 points)

Considering that the operational amplifiers of the circuit shown in Figure 1 are ideal and operate in the linear area,

a) Find the output voltage, $v_{o.}$
b) Give the power dissipated through the 4kΩ resistor.

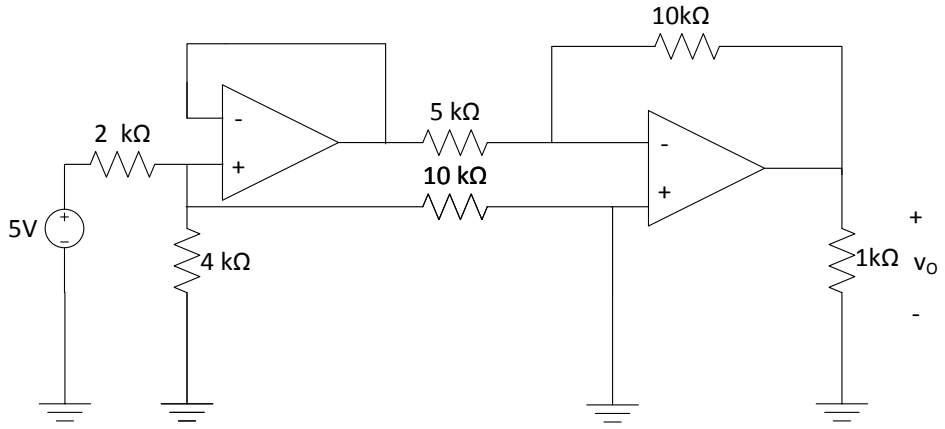

Figure 1

Question 2 (10 points)

Considering the circuit shown in Figure 2, find the current i_x and the voltage v_x.

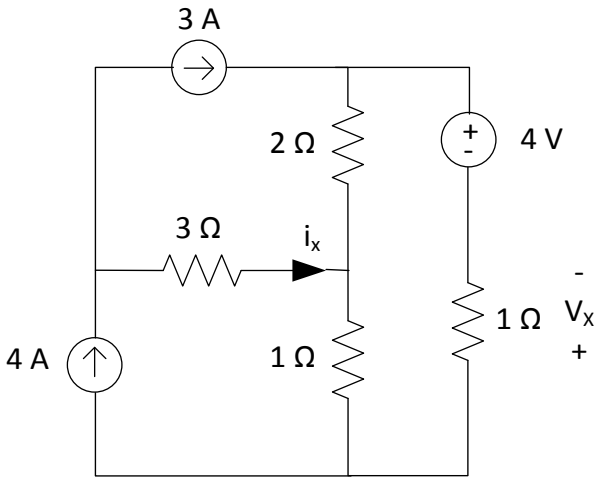

Figure 2

Question 3 (15 points)

Considering the circuit shown in Figure 3,

a) Find the value of **α** which makes the Thévenin resistor shown through connectors **a** and **b** to be 4 Ω.
b) For the Thévenin resistor given in a), find the value of the load R_c that should be connected to connectors **a** and **b** in order to obtain a maximal power transfer through this load.
c) Give the value of this maximal power.

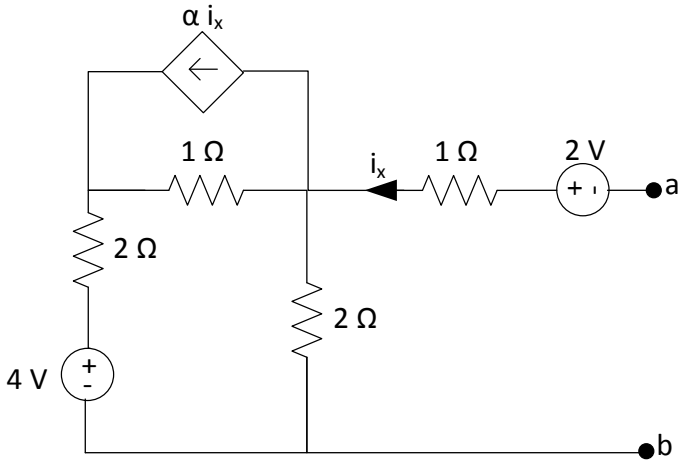

Figure 3

Question 4 (15 points)

Considering the circuit shown in Figure 4 where $i_L(0) = -1$ A,

a) Find the equation of $i_L(t)$ for $t \geq 0$.
b) Find the equation of $V_L(t)$ for $t \geq 0$.

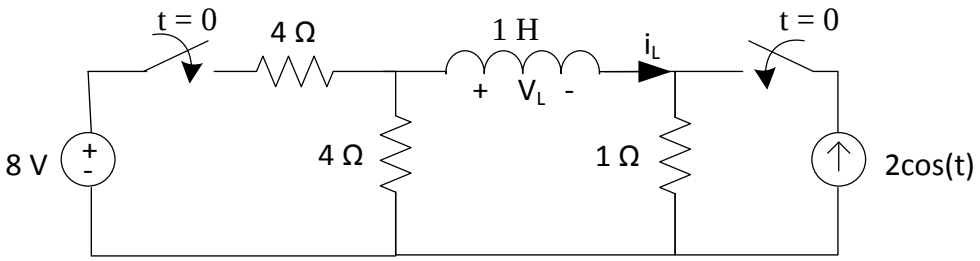

Figure 4

Question 5 (15 points)

Considering that for the circuit shown in Figure 5, the RMS voltage of the source (V_s) is $100\angle 0^o$V,

a) Find the power factor (as seen by the source) and state whether it is lagging or leading.
b) Find the value of the capacitance to connect between connectors **a** and **b** in order to obtain a unity power factor.

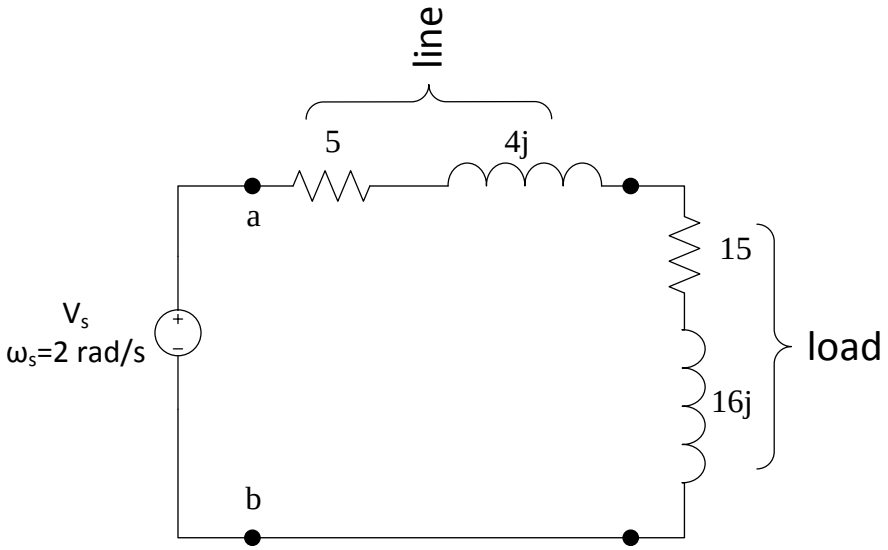

Figure 5

Question 6 (20 points)

Considering the circuit shown in Figure 6,

a) Draw the Thévenin equivalent circuit.
b) Find the values of the components to connect between points **a** and **b** in order to maximize the average output power of this circuit.
c) Give the value of this maximal average output power.

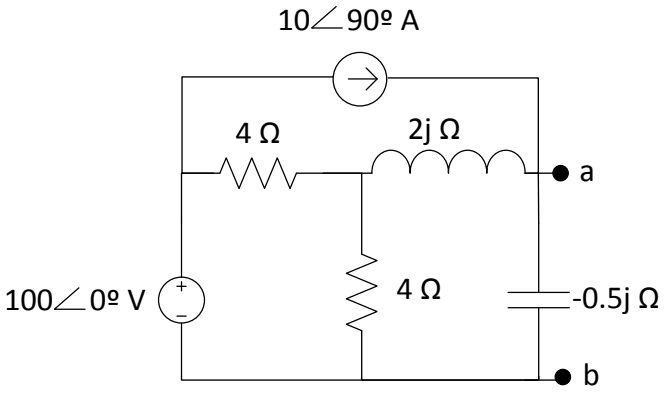

Figure 6

Question 7 (15 points)

Find the voltage at node V1 of the circuit shown in Figure 7.

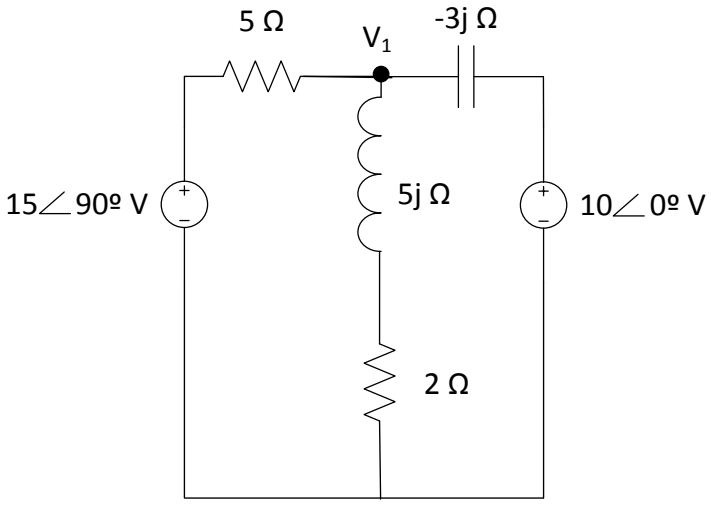

Figure 7