

ORDRE DES INGÉNIEURS DU QUÉBEC

NOVEMBER 2020 SESSION

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

16-EL-A1-CIRCUITS

Question 1 (20 points)

Considering that the amplifiers of the circuit shown in Figure 1 are ideal and operating in linear mode and, that the capacitors are initially discharged,

- Give the value of resistor R_7 knowing that the output voltage in steady-state is $V_{out} = 24V$ when a constant voltage $V_{in} = 10V$ is applied at the input of the circuit.
- In the same conditions, find the power that will be dissipated through resistor R_7 .

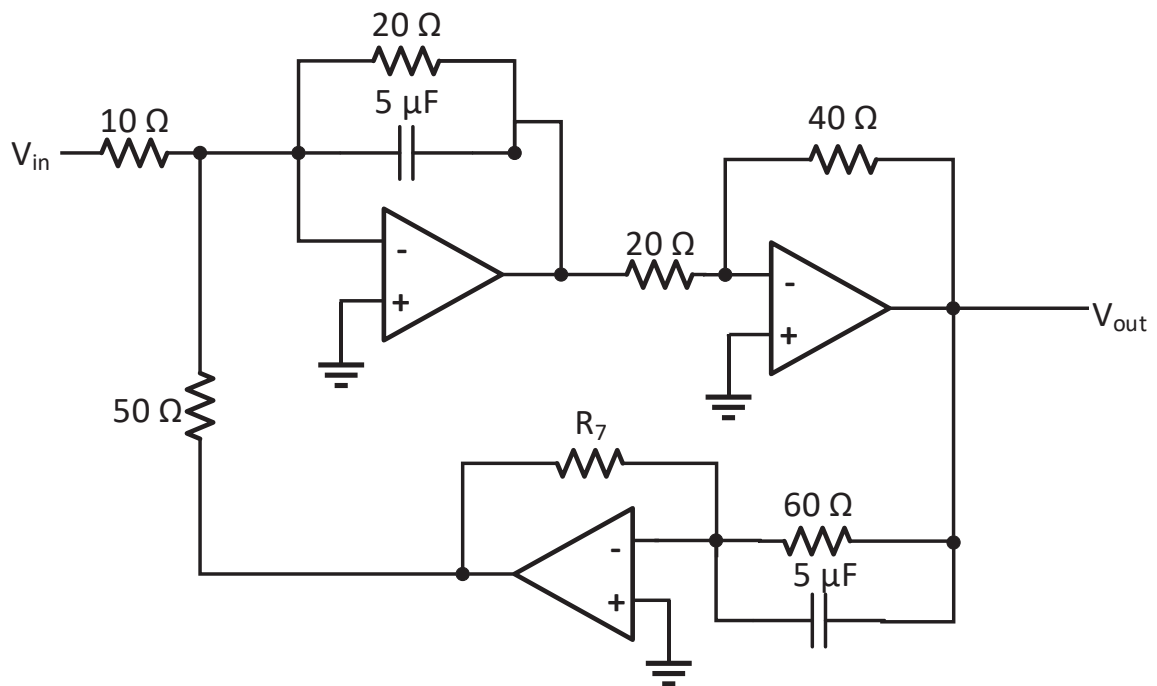


Figure 1

Question 2 (15 points)

Considering the circuit shown in Figure 2, find the values of V_1 and V_{in} when $V_o = 10\text{ V}$.

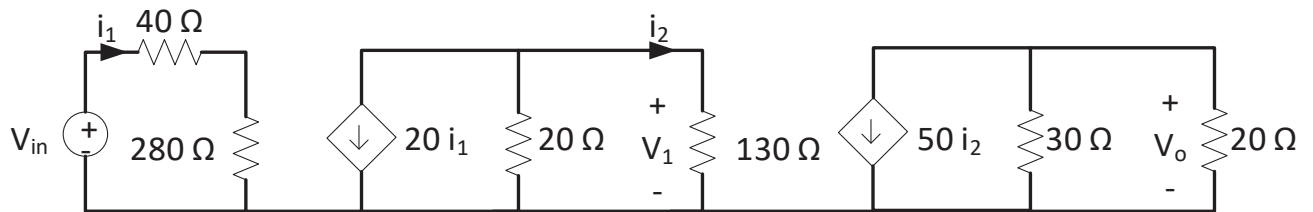


Figure 2

Question 3 (15 points)

Considering the circuit shown in Figure 3,

- Draw the equivalent Norton circuit.
- Find the maximal value of the power that can be transferred to a charge connected between nodes a and b.

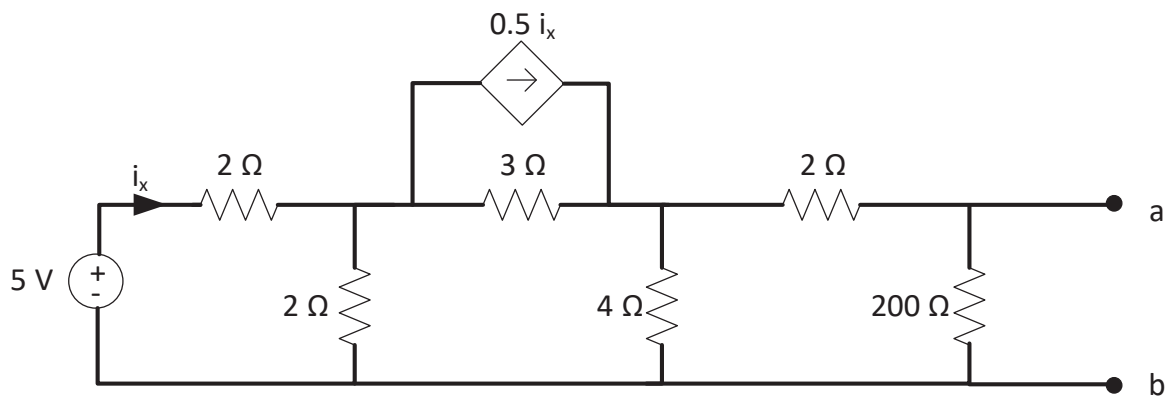


Figure 3

Question 4 (15 points)

Find the voltage at node V_1 of the circuit shown in Figure 4.

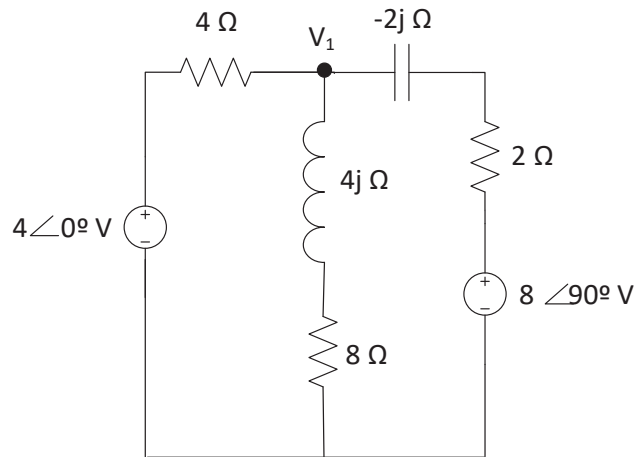


Figure 4

Question 5 (15 points)

Considering the circuit shown in Figure 5 where the switch is turned on at $t = 0$ (after being in its initial state for a long time),

- Give the expression of the voltage $v(t)$ at the capacitor for $t \geq 0$.
- Give the expression of the current $i(t)$ for $t \geq 0^+$.

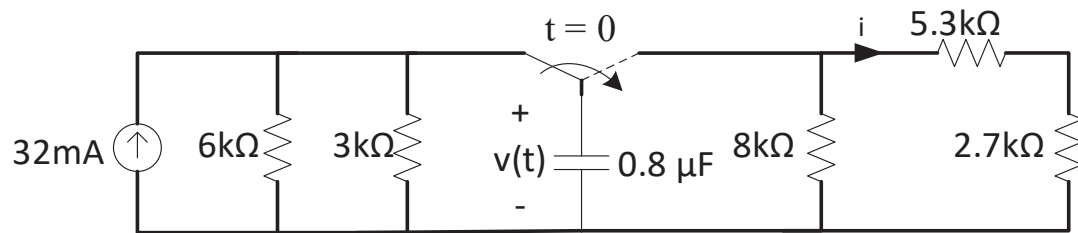


Figure 5

Question 6 (20 points)

Considering the circuit shown in Figure 6 where load 1 (L_1) is a $20\ \Omega$ resistor in series with an inductive reactance of $80\ \Omega$, load 2 (L_2) is a $40\ \Omega$ resistor in series with a capacitive reactance of $50\ \Omega$, load 3 (L_3) is a $20\ \Omega$ resistor in series with a capacitive reactance of $15\ \Omega$ and the frequency of the input voltage is $60\ \text{Hz}$,

- Give the power factor of each load and indicate if it is leading or lagging.
- Give the power factor of the composite load seen by the voltage source and indicate if it is leading or lagging.
- What would be the passive element to connect between nodes a and b in order to obtain a unity power factor (as seen by the voltage source)?

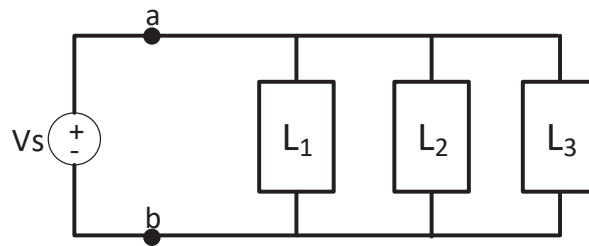


Figure 6