ORDRE DES INGÉNIEURS DU QUÉBEC

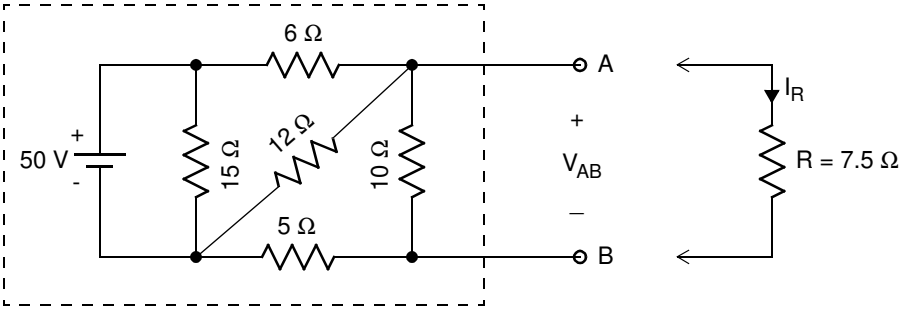
MAY 2025 SESSION

Open-book examination
Calculators: only authorized models
Time allowed: 3 hours

20-MB-B2 ELECTRIC CIRCUITS AND POWER

Problem no. 1 (16 points)

Consider the resistive circuit shown in the following figure.

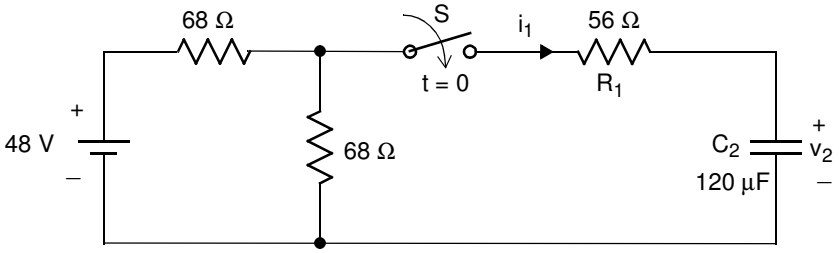


a) Using a method of your choice, **determine** the Thévenin equivalent across terminals A-B. *(10 points)*

b) A resistor R = 7.5 Ω is connected across terminals A-B. **Calculate** the current I_R and the power dissipated in resistor R. *(6 points)*

Problem no. 2 (17 points)

In the circuit shown in the following figure, switch S has been open for a very long time.



At time t = 0, switch S is closed and kept closed for the rest of the time.

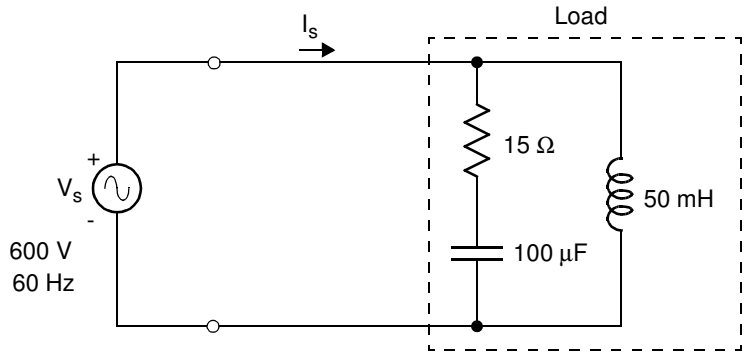
a) **Determine** the current $i_1(t)$ and the voltage $v_2(t)$ for t > 0. *(9 points)*

b) **Plot** the current $i_1(t)$ and the voltage $v_2(t)$ as a function of time. *(5 points)*

What is the duration of the transient? *(3 points)*

Problem no. 3 (17 points)

A 60 Hz sinusoidal voltage source is connected to an RLC load as shown in the following figure.



The rms value of the source V_s is 600 V. The phase of the source V_s is 0.

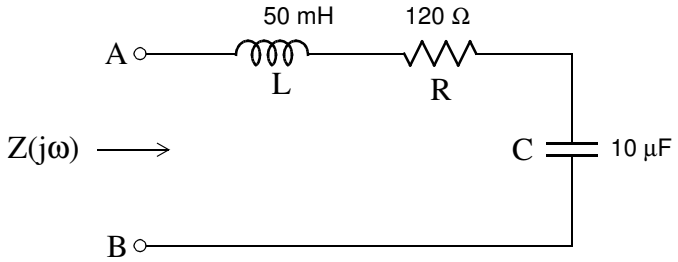
a) **Calculate** the current $\mathbf{I}_s$ (rms value and phase) *(8 points)*

Draw a vector diagram to illustrate the relationship between $\mathbf{V}_s$ and $\mathbf{I}_s$. *(4 points)*

b) **Calculate** the active power dissipated in the load. *(5 points)*

Problem no. 4 (17 points)

Consider the circuit shown in the following figure.



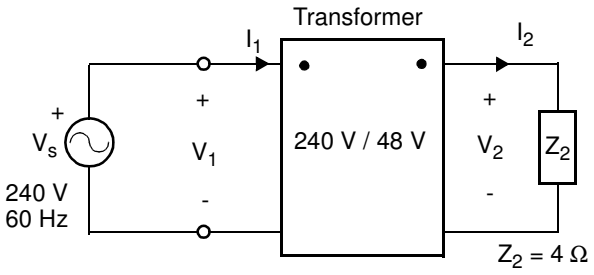
a) **Determine** the impedance Z(jω) seen across terminals A and B of the circuit. *(8 points)*

b) **Determine** and **plot** the modulus and angle of Z(jω) as a function of ω. *(5 points)*

c) **Determine** the resonant frequency ω_0 of the circuit. *(4 points)*

Problem no. 5 (17 points)

Consider the circuit shown in the following figure.



The transformer parameters are given: R_s= 3.6 Ω, X_s= 7.2 Ω, $R_m = \infty$, $X_m = \infty$.

A resistive load $Z_2 = 4\ \Omega$ is connected to the secondary.

a) **Calculate** the voltage V_2 and the current I_2 at the transformer secondary. *(8 points)*

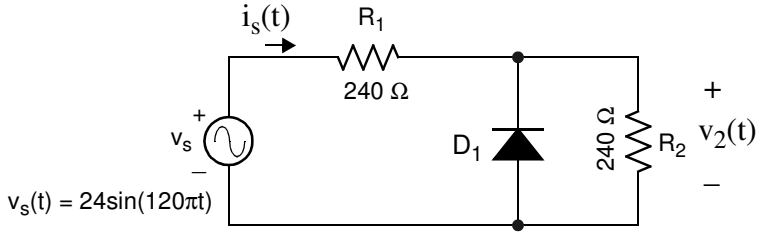
b) **Calculate** the active power P_2 delivered to the load. *(3 points)*

Calculate the power dissipated in the transformer. *(3 points)*

Deduce the transformer efficiency. *(3 points)*

Problem no. 6 (16 points)

Consider the circuit shown in the following figure.



The conduction voltage of diode D_1 is equal to $V_F = 0.7$ V.

a) Using the constant V_F model for the diode, **determine** and **plot** the voltage $v_2(t)$ as a function of time. Clearly indicate the particular values of voltage $v_2(t)$. *(8 points)*

b) **Determine** and **plot** the current $i_s(t)$ as a function of time. Clearly indicate the particular values of current $i_s(t)$. *(6 points)*

c) **Calculate** the power dissipated in resistor R_1. *(2 points)*