Part II: Written Questions (Total 60 minutes; 3 questions)

Question 1 **(10 points, 12 minutes)**

It is known that $i_1 = \frac{1}{2} i_0$, and $v_1 = 3v_2$ in the following circuit.

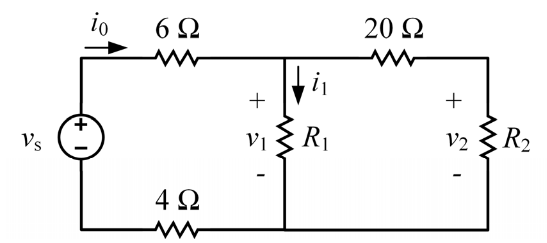


Fig. Q1

(1) Determine the values of R_1, and R_2. **(6 points)**

(2) If $i_1 = 0.8$ A, find the power supplied by the voltage source. **(4 points)**

Question 2 **(18 points, 22 minutes)**

A circuit is given in Fig. Q2.

(1) If $R_1 = 4\ \Omega$ and $R_2 = 2\ \Omega$, find the current i and voltage v; **(5 points)**

(2) If $i = 2$ A and $v = 36$ V, find the resistances R_1 and R_2; **(5 points)**

(3) Suppose the voltage and current sources supply powers of 36 W and 90 W, respectively, find the current i, voltage v, and resistances R_1 and R_2. **(8 points)**

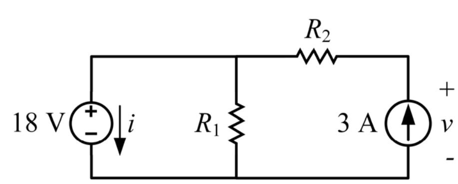


Fig. Q2

Question 3 **(22 points, 26 minutes)**

The following circuit has two parts: the '*Source*' and '*load*' parts.

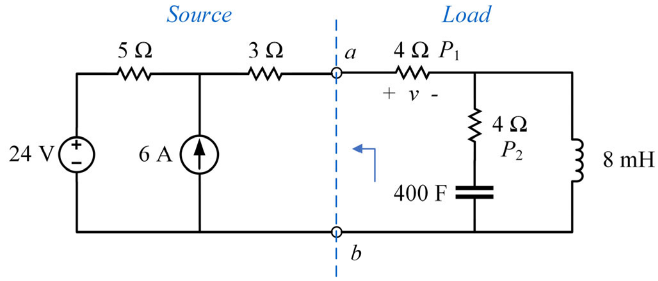


Fig. Q3a

(1) Find the Thevenin equivalent circuit looking into the '*source*' part from the terminals *a*-*b* in Fig. Q3a; **(4 points)**

(2) Find the voltage v and powers P_1 and P_2 consumed by the two 4-Ω resistors in Fig. Q3a; **(6 points)**

(3) If the '*load*' part is replaced by a resistor R in Fig. Q3b, find the resistance of R that will consume the maximum power P_{max} and the value of the corresponding P_{max}; and **(6 points)**

(4) If the '*load*' part is replaced by a current-controlled voltage source as shown in Fig. Q3c, find the current i. **(6 points)**

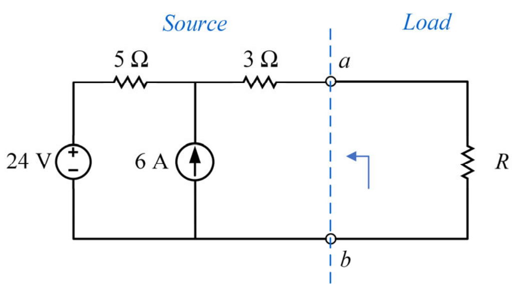


Fig. Q3b

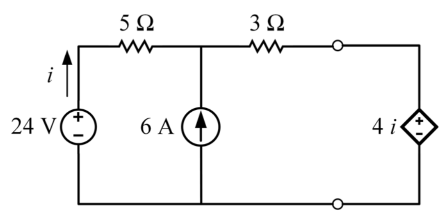
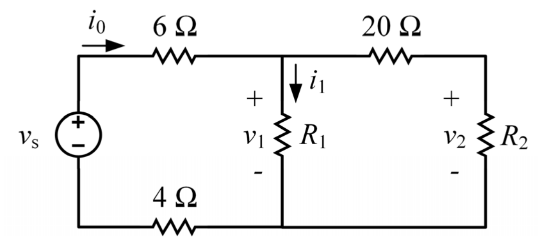


Fig. Q3c

Solution:

Q1

(1)



$i_1 = \frac{1}{2} i_0$, and

$$v_1 = v_{20\,\Omega} + v_2$$

Given by
$$v_1 = 3v_2$$
$$v_{20\,\Omega} = 2v_2$$

Based on voltage division

$$R_2 = \frac{1}{2} R_{20\,\Omega} = 10\ \Omega$$

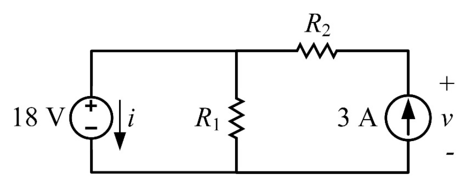
Given by
$$i_1 = \frac{1}{2} i_0$$

Based on Current division
$$R_1 = R_{20\,\Omega} + R_2 = 30\ \Omega$$

(2)

$$i_1 = 0.8\ \text{A}$$
$$i_0 = 2i_1 = 1.6\ \text{A}$$
$$R_{eq} = 6\ \Omega + 4\ \Omega + (R_1 || (R_{20\,\Omega} + R_2)) = 25\ \Omega$$
$$P = I^2 R_{eq} = 64\ \text{W}$$

Q2



$$v = 18 + 3R_2$$
$$i = 3 - \frac{18}{R_1}$$

(1)

v = 24 V, i = -1.5 A.

(2)

R_1 = 18 Ω, R_2 = 6 Ω

(3)

i = -36/18 = -2 A, v = 90/3 = 30 V

Then
R_1 = 3.6 Ω, R_2 = 4 Ω

Q3

(1)

R_{ab} = 8 Ω

When the current source is killed, $U_{ab1} = 24\ V$.

When the voltage source is killed,

$$I_N = 6 \times \frac{5}{8} = \frac{15}{4}\ A$$

$$\therefore U_{ab2} = 8 \times \frac{15}{4} = 30\ V$$

$$\therefore U_{ab} = U_{ab1} + U_{ab2} = 54\ V$$

(2)

Since this is a DC circuit, therefore the capacitor opens the circuit, and the inductor is regarded as a short line.

Thus, $P_2 = 0$.

Set I is the current through the resistor 4 Ω whose power is $P_1 =$ 0 W

$$I = \frac{54}{8+4} = 4.5 \text{ A}$$

$$P_1 = I^2 R = 4.5^2 \times 4 = 81 \text{ W}$$

(3)

The maximum power will be obtained when the load equals to the R_{th}, say $R = R_{th} = 8$ Ω.

Therefore, $P_{max} = \frac{54^2}{R_{ab}+R} \times \frac{1}{2} = 91.125\ W$

(4)

Set the current inside the first mesh and second mesh are I_1 and I_2, respectively.

Then, $i = I_1$

$$\begin{cases} 24 = 5I_1 + 3I_2 + 4I_1 \\ I_2 - I_1 = 6 \text{ A} \end{cases} \rightarrow i\ =\ I1 = 0.5 \text{ A}$$