Universidade Federal do Ceará
Instituto de Tecnologia
Departamento de Engenharia Elétrica

Circuitos Elétricos

Capítulo 4 C – Técnicas de Análise de Circuitos

Prof. Fabrício Nogueira

Técnicas de Análise de Circuitos

Método das Correntes de Malha

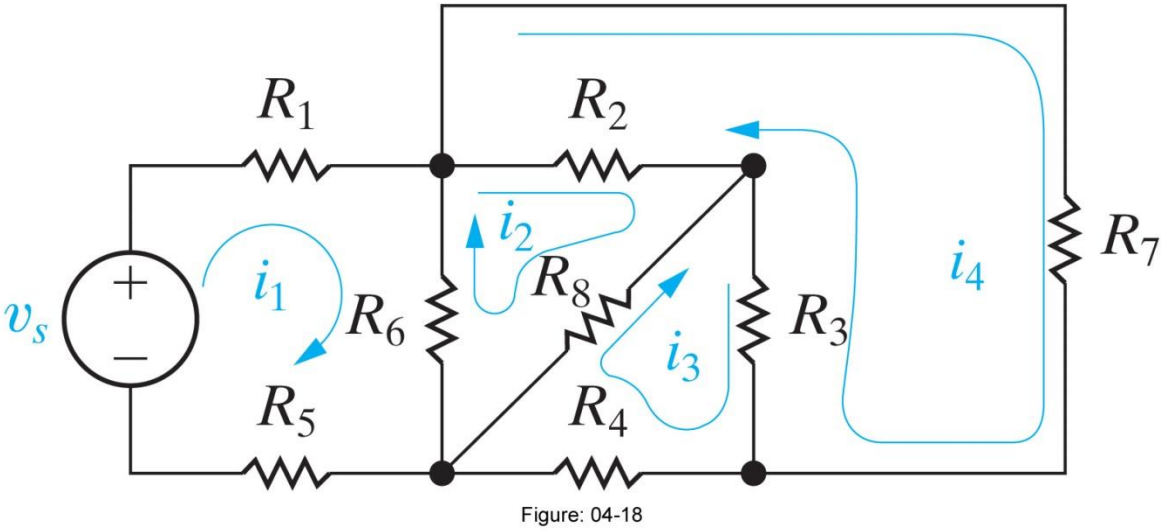


Figure: 04-18

Método das Correntes de Malha

- Aplicando as Leis de Kirchhoff:

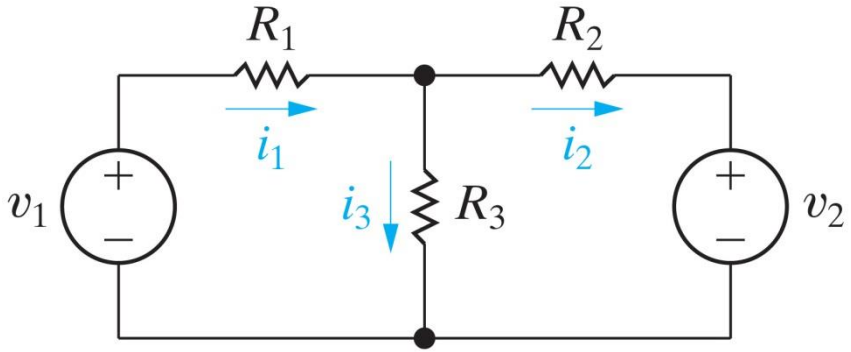


Figure: 04-19

$$i_1 = i_2 + i_3,$$

$$v_1 = i_1 R_1 + i_3 R_3,$$

$$-v_2 = i_2 R_2 - i_3 R_3.$$

$$v_1 = i_1(R_1 + R_3) - i_2 R_3,$$

$$-v_2 = -i_1 R_3 + i_2(R_2 + R_3).$$

Técnicas de Análise de Circuitos

Método das Correntes de Malha

- Aplicando as Leis de Kirchhoff:

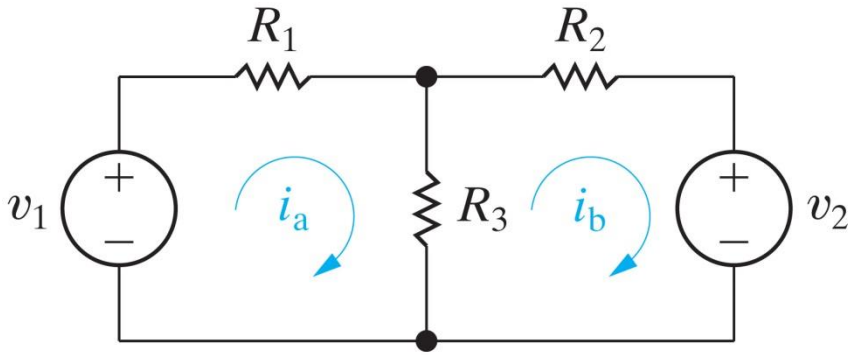


Figure: 04-20

$$v_1 = i_a R_1 + (i_a - i_b) R_3,$$
$$-v_2 = (i_b - i_a) R_3 + i_b R_2.$$

$$i_1 = i_a,$$
$$i_2 = i_b,$$
$$i_3 = i_a - i_b.$$

$$v_1 = i_a(R_1 + R_3) - i_b R_3,$$
$$-v_2 = -i_a R_3 + i_b(R_2 + R_3).$$

Método das Correntes de Malha

- Exemplo:

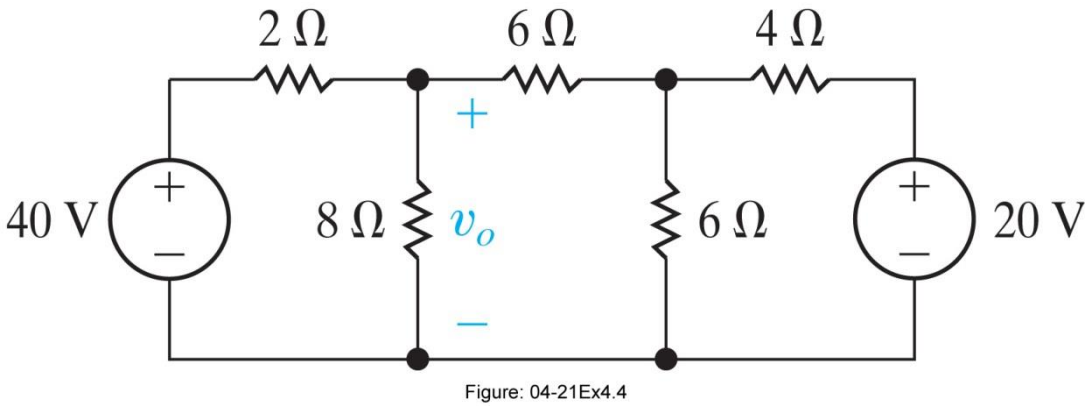


Figure: 04-21Ex4.4

a) Use the mesh-current method to determine the power associated with each voltage source in the circuit shown in Fig. 4.21.

b) Calculate the voltage v_o across the 8 Ω resistor.

Técnicas de Análise de Circuitos

Método das Correntes de Malha

- Example:

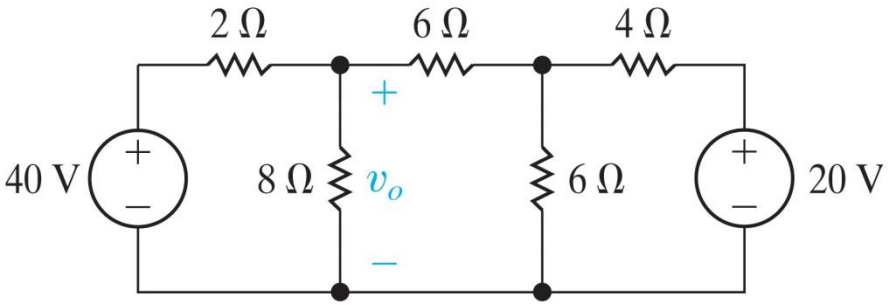


Figure: 04-21Ex4.4

$$-40 + 2i_a + 8(i_a - i_b) = 0,$$

$$8(i_b - i_a) + 6i_b + 6(i_b - i_c) = 0,$$

$$6(i_c - i_b) + 4i_c + 20 = 0.$$

$$10i_a - 8i_b + 0i_c = 40;$$

$$-8i_a + 20i_b - 6i_c = 0;$$

$$0i_a - 6i_b + 10i_c = -20.$$

$$i_a = 5.6 \text{ A},$$

$$i_b = 2.0 \text{ A},$$

$$i_c = -0.80 \text{ A}.$$

$$p_{40V} = -40i_a = -224 \text{ W}.$$

$$p_{20V} = 20i_c = -16 \text{ W}.$$

$$v_o = 8(i_a - i_b) = 8(3.6) = 28.8 \text{ V}.$$

Método das Correntes de Malha

- Assessment problem:

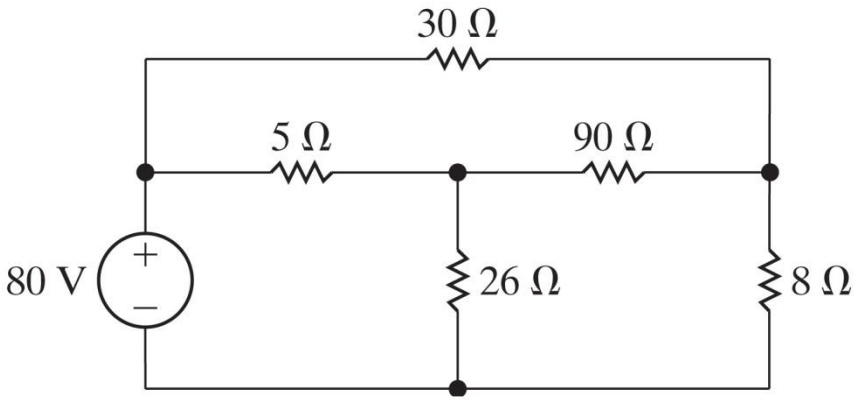


Figure: 04-22-01AO2-4.7

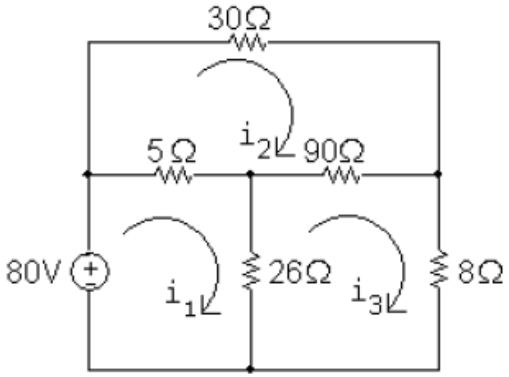
4.7 Use the mesh-current method to find (a) the power delivered by the 80 V source to the circuit shown and (b) the power dissipated in the 8 Ω resistor.

Answer: (a) 400 W;
(b) 50 W.

Técnicas de Análise de Circuitos

Método das Correntes de Malha

- Solution:



$$
\begin{aligned}
-80 + 5(i_1 - i_2) + 26(i_1 - i_3) &= 0 \\
30i_2 + 90(i_2 - i_3) + 5(i_2 - i_1) &= 0 \\
8i_3 + 26(i_3 - i_1) + 90(i_3 - i_2) &= 0
\end{aligned}
\quad \Rightarrow \quad
\begin{aligned}
31i_1 - 5i_2 - 26i_3 &= 80 \\
-5i_1 + 125i_2 - 90i_3 &= 0 \\
-26i_1 - 90i_2 + 124i_3 &= 0
\end{aligned}
$$

$$i_1 = 5 \text{ A}; \qquad i_2 = 2 \text{ A}; \qquad i_3 = 2.5 \text{ A}$$

$$p_{8\Omega} = (8)i_3^2 = 8(2.5)^2 = 50 \text{ W}$$

$$p_{80V} = -(80)i_1 = -(80)(5) = -400 \text{ W}$$

Técnicas de Análise de Circuitos

Método das Correntes de Malha

Use the mesh-current method of circuit analysis to determine the power dissipated in the 4 Ω resistor in the circuit shown in Fig. 4.23.

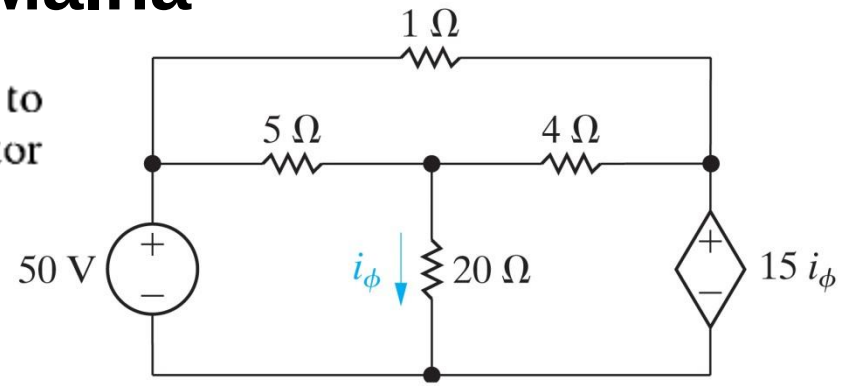


Figure: 04-23Ex4.5

$$50 = 5(i_1 - i_2) + 20(i_1 - i_3),$$

$$0 = 5(i_2 - i_1) + 1i_2 + 4(i_2 - i_3),$$

$$0 = 20(i_3 - i_1) + 4(i_3 - i_2) + 15i_\phi.$$

$$i_\phi = i_1 - i_3,$$

$$50 = 25i_1 - 5i_2 - 20i_3,$$

$$0 = -5i_1 + 10i_2 - 4i_3,$$

$$0 = -5i_1 - 4i_2 + 9i_3.$$

$$i_2 = 26 \text{ A},$$

$$i_3 = 28 \text{ A}.$$

$$p_{4\Omega} = (i_3 - i_2)^2(4) = (2)^2(4) = 16 \text{ W}.$$

Técnicas de Análise de Circuitos

Caso especial: Supermalha

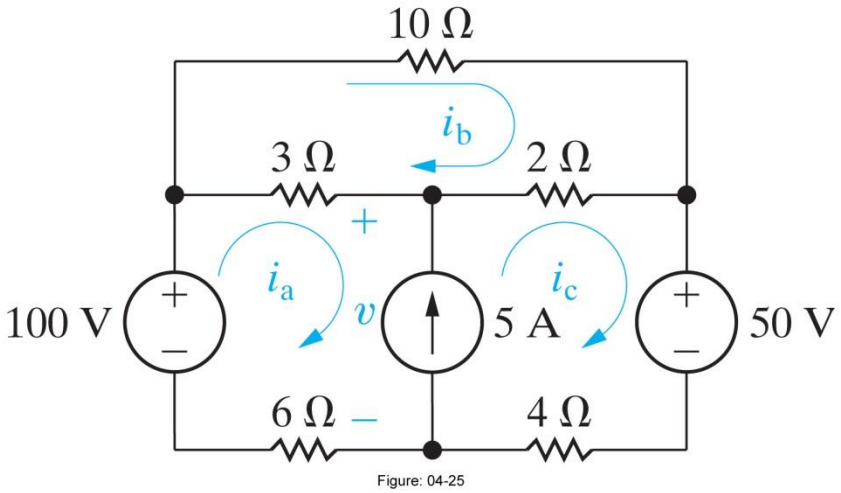


Figure: 04-25

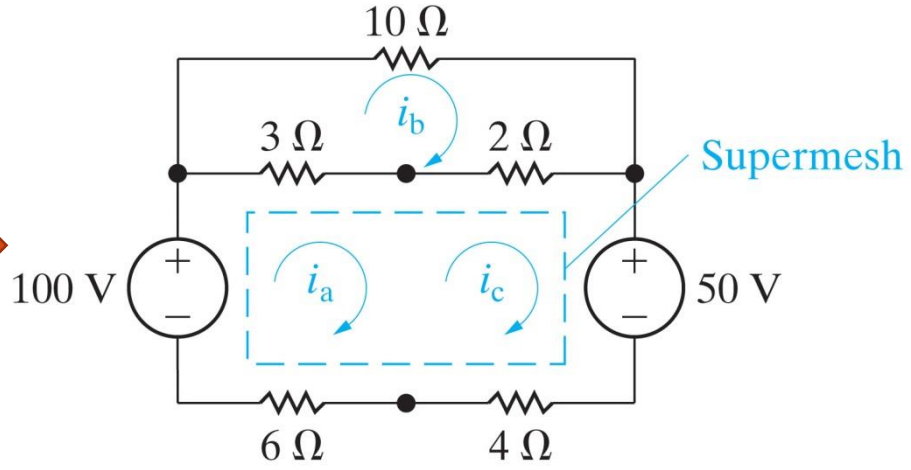


Figure: 04-26

Malha a) $100 = 3(i_a - i_b) + v + 6i_a,$

Malha c) $-50 = 4i_c - v + 2(i_c - i_b).$

$$50 = 9i_a - 5i_b + 6i_c.$$

$$-100 + 3(i_a - i_b) + 2(i_c - i_b) + 50 + 4i_c + 6i_a = 0,$$

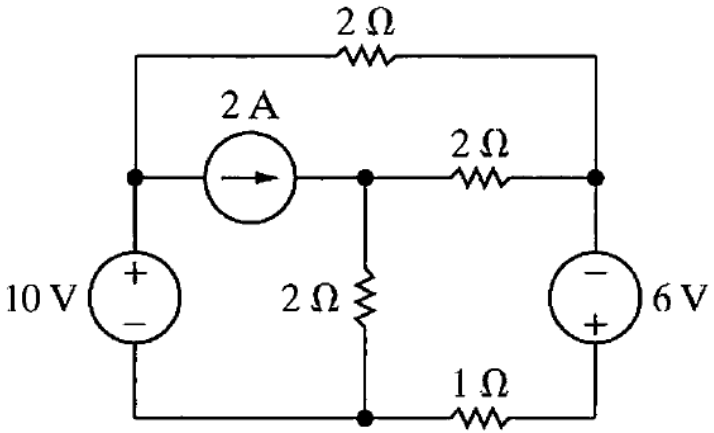
$$50 = 9i_a - 5i_b + 6i_c.$$

Malha b)

Técnicas de Análise de Circuitos

Exercício

Use the mesh-current method to find the power dissipated in the 1 Ω resistor in the circuit shown.

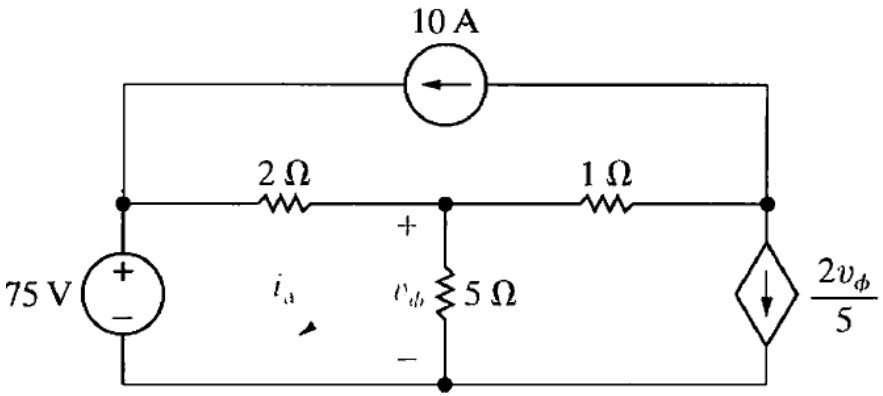


Answer: 36 W.

Técnicas de Análise de Circuitos

Exercício

Use the mesh-current method to find the mesh current i_a in the circuit shown.



Answer: 15 A.

Circuitos Resistivos

Referências Bibliográficas:

Nilsson, J.W. e Riedel, S.A., Circuitos Elétricos, 8ª Edição, Pearson Prentice Hall, São Paulo, 2009.

Svodoba, J.A. and Dorf, R.C., Introduction to Electric Circuits, 9th edition, Wiley, 2011.