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Electric Circuits

Unit: 2 | Lecture: 9

Solution of some selected problem

Ohm's Law, Kirchhoff's Laws, Voltage Division, Current Division and Wye-Delta Transformations

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Problems 2.2

Find the hot resistance of a light bulb rated 60W, 120 V.

$P = 60W \qquad v = 120\ V \qquad R = ???$

$$p = vi = i^2R = \frac{v^2}{R}$$

$$p = \frac{v^2}{R}$$

$$R = \frac{v^2}{p} \qquad = \frac{(120)^2}{60} \qquad = 240\ \Omega$$

Problems 2.3

A bar of silicon is 4 cm long with a circular cross section. If the resistance of the bar is 240Ω, what is the cross-sectional radius of the bar?

$l = 4\ cm \qquad R = 240\Omega \qquad \rho = 6.4 \times 10^2 \Omega.m \qquad r = ???$

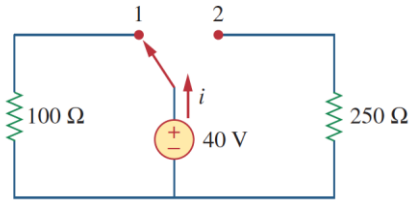
$$R = \rho\frac{l}{A} \rightarrow A = \rho\frac{l}{R} \rightarrow \pi r^2 = \rho\frac{l}{R}$$

$$r^2 = \rho\frac{l}{\pi R} \rightarrow r^2 = 6.4 \times 10^2 \frac{4 \times 10^{-2}}{\pi \times 240}$$

$$r^2 = 0.0339 \rightarrow r = 0.184\ m$$

Problems 2.4

(a) Calculate current i in the circuit when the switch is in position 1.
(b) Find the current i when the switch is in position 2.



(a) switch is in position 1

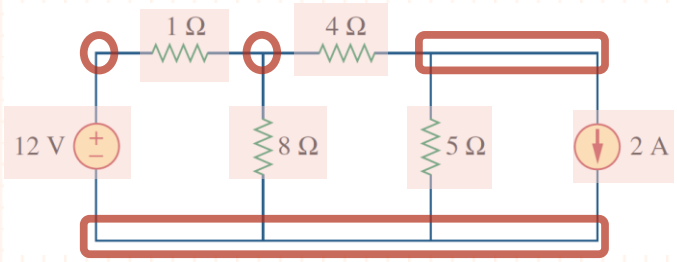
$$i = \frac{v}{R} = \frac{40}{100} = 0.4\ A$$

(b) switch is in position 2

$$i = \frac{v}{R} = \frac{40}{350} = 0.16\ A$$

Problems 2.7

Determine the number of branches and nodes in the circuit.

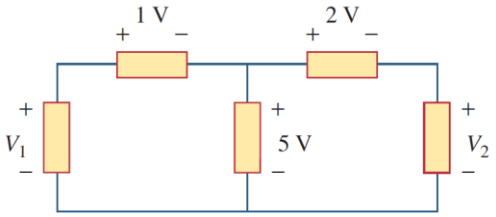


6 branches

4 nodes

Problems 2.11

Calculate V_1 and V_2 in the circuit



Applying KVL to the left loop

$$-V_1 + 1 + 5 = 0$$

$$V_1 = 6\,V$$

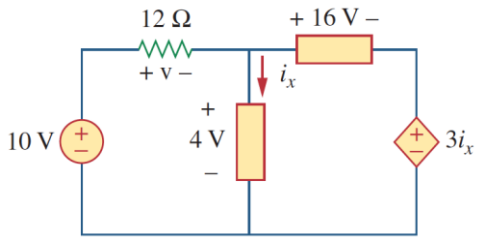
Applying KVL to the right loop

$$-5 + 2 + V_2 = 0$$

$$V_2 = 3\,V$$

Problems 2.15

Calculate v and i_x in the circuit



Applying KVL to the left loop

$$-10 + v + 4 = 0$$

$$v = 6\ V$$

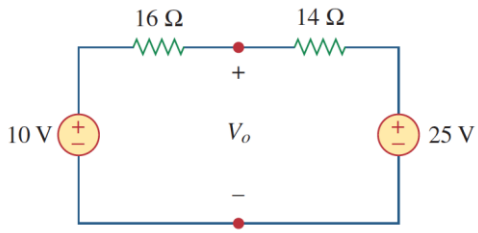
Applying KVL to the right loop

$$-4 + 16 + 3i_x = 0$$

$$i_x = -4\ A$$

Problems 2.16

Determine V_o in the circuit



Applying KVL to the circuit

$$-10 + (16 \times I) + (14 \times I) + 25 = 0$$

$$30I - 10 + 25 = 0$$

$$I = \frac{10 - 25}{30} = -0.5\ A$$

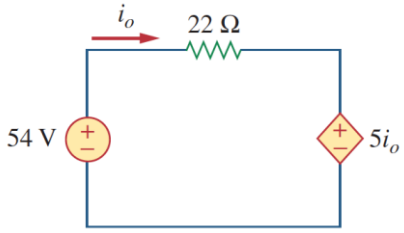
Applying KVL to the left loop

$$-10 + 16I + V_0 = 0 \quad \Rightarrow \quad -10 + 16 \times (-0.5) + V_0 = 0$$

$$V_0 = 18\ V$$

Problems 2.20

Determine i_o in the circuit



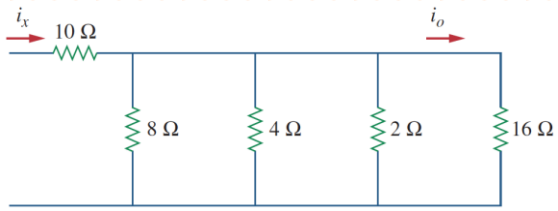
Applying KVL to the circuit

$$-54 + 22i_o + 5i_o = 0$$

$$i_o = \frac{54}{27} = 2\text{A}$$

Problems 2.26

For the circuit i_o=3 A, Calculate i_x and the total power absorbed by the entire circuit.



$$v_{16\Omega} = i_o 16 = 3 \times 16 = 48\ V$$

$$v_{16\Omega} = v_{2\Omega} = v_{4\Omega} = v_{8\Omega} = 48\ V$$

$$i_{2\Omega} = \frac{48}{2} = 24\ A$$

$$i_{4\Omega} = \frac{48}{4} = 12\ A$$

$$i_{8\Omega} = \frac{48}{8} = 6\ A$$

$$i_x = i_{2\Omega} + i_{4\Omega} + i_{8\Omega} + i_{16\Omega}$$

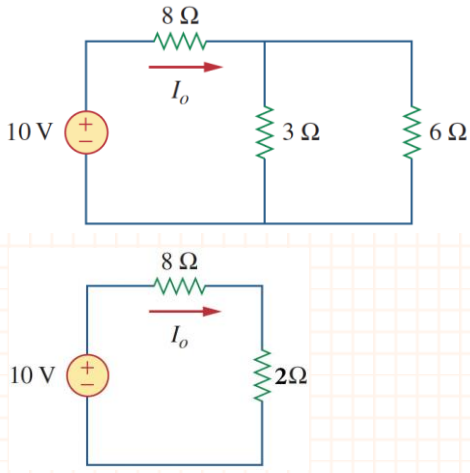
$$i_x = 24 + 12 + 6 + 3 = 45\ A$$

$$p = 45^2 \times 10 + 6^2 \times 8 + 12^2 \times 4 + 24^2 \times 2 + 3^2 \times 16$$

$$p = 22{,}356\ W$$

Problems 2.27

Calculate I_o in the circuit



$$3\Omega||6\Omega = \frac{3 \times 6}{3+6} = 2\Omega$$

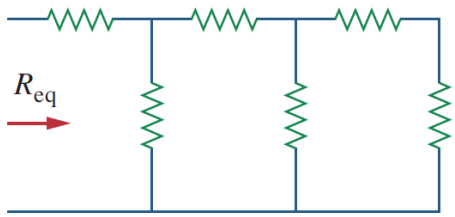
Applying KVL to the circuit

$$-10 + (8 \times I_o) + 2 \times I_o = 0$$

$$I_o = \frac{10}{8+2} = 1\ A$$

Problems 2.29

All resistors in are 5Ω each. Find R_{eq}



The last 2 resistor on the left are in series

$5 + 5 = 10\Omega$

$$10\Omega||5\Omega = \frac{10 \times 5}{10+5} = 3.3\Omega$$

3.3Ω in series with $5\Omega = 8.3\Omega$

$$8.3\Omega||5\Omega = \frac{8.3 \times 5}{8.3+5} = 3.1\Omega$$

3.1Ω in series with $5\Omega = 8.1\Omega = R_{eq}$