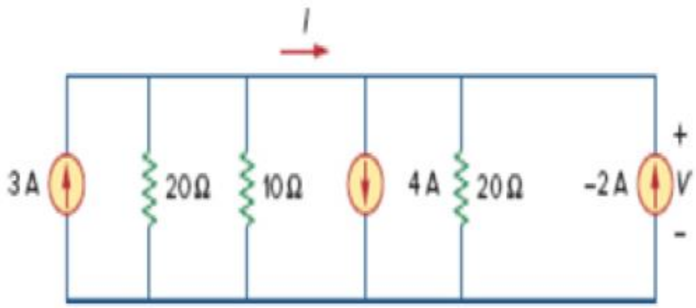
Homework #2 Solutions

Problem 2.18

Find I and V in the circuit of Fig. shown below.



Solution.

Step 1. We can make use of both Kirchhoff's KVL and KCL. KVL tells us that the voltage across all the elements of this circuit is the same in every case. Ohm's Law tells us that the current in each resistor is equal to V/R. Finally we can use KCL to find I.

Applying KCL and summing all the current flowing out of the top node and setting it to zero we get, –3 + [V/20] + [V/10] + 4 + [V/20] – [–2] = 0.

Finally at the node to the left of I we can write the following node equation which will give us

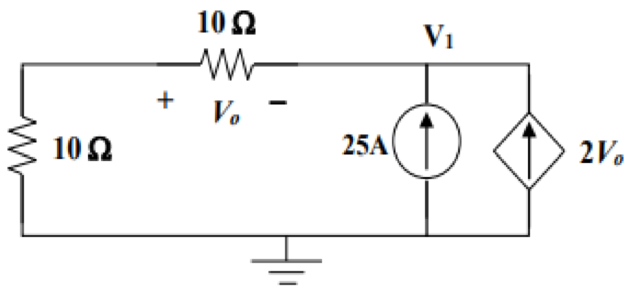
I –3 + [V/20] + [V/10] + I = 0.

Step 2. [0.05+0.1+0.05]V = 0.2V = 3–4–2 = –3 or V = –15 volts.

I = 3–V[0.05+0.1] = 3–[–15]0.15 = 5.25 amps.

Problem 2.22

Find Vo in the circuit in Fig. below and the power absorbed by the dependent source.



Solution:

At the node, KCL requires that [–Vo/10]+[–25]+[–2Vo] = 0 or 2.1Vo = –25

or Vo = –11.905 V

The current through the controlled source is i = 2V0 = –23.81 A

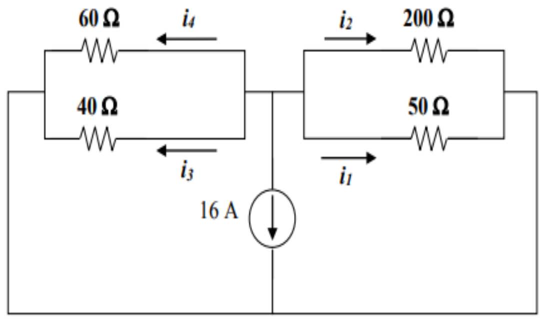
and the voltage across it is V1 = (10+10) i0 (where i0 = –V0/10) = 20(11.905/10) = 23.81 V. Hence,

$P_{\text{dependent source}}$ = V1(–i) = 23.81x(–(–23.81)) = 566.9 W

Checking, (25–23.81)2 (10+10) + (23.81)(–25) + 566.9 = 28.322 – 595.2 + 566.9 = 0.022 which is equal zero since we are using four places of accuracy!

Problem 2.32

Find i1 through i4 in the circuit in Fig. below.



Solution

We first combine resistors in parallel.

$$40\|60 = \frac{40x60}{100} = 24\ \Omega \text{ and } 50\|200 = \frac{50x200}{250} = 40\ \Omega$$

Using current division principle,

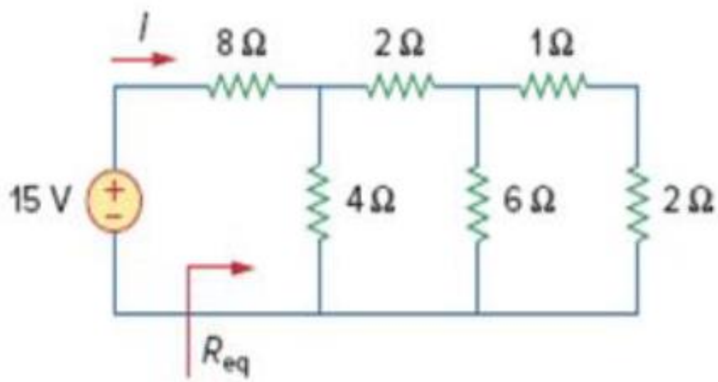
$$i_1 + i_2 = \frac{24}{24+40}(-16) = -6A, i_3 + i_4 = \frac{40}{64}(-16) = -10A$$

$$i_1 = \frac{200}{250}(6) = \mathbf{-4.8\ A} \text{ and } i_2 = \frac{50}{250}(-6) = \mathbf{-1.2\ A}$$

$$i_3 = \frac{60}{100}(-10) = \mathbf{-6\ A} \text{ and } i_4 = \frac{40}{100}(-10) = \mathbf{-4\ A}$$

Problem 2.40:

For the ladder network shown below, find *I* and *R*eq.



Solution 2.40

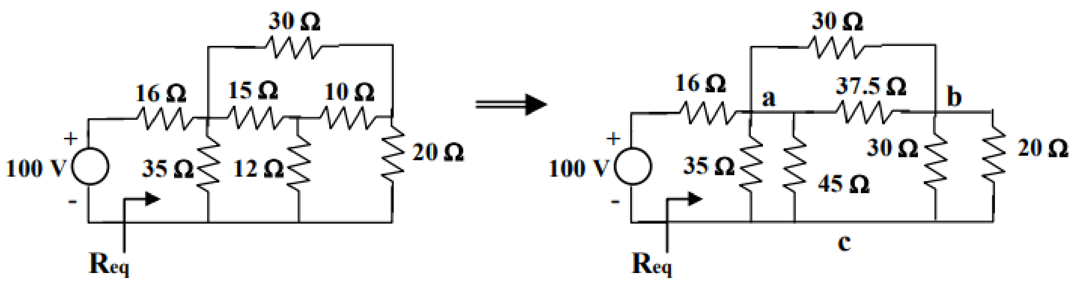
$$\text{Req} = 8 + 4\|(2 + 6\|3) = 8 + 2 = \mathbf{10\ \Omega}$$

$$I = \frac{15}{R_{eq}} = \frac{15}{10} = \mathbf{1.5\ A}$$

Problem 2.56: Determine *V* in the circuit shown below.

Solution:

We need to find Req and apply voltage division. We first transform the Y network to Δ



$$R_{ab} = \frac{15x10 + 10x12 + 12x15}{12} = \frac{450}{12} = 37.5\Omega$$

$$R_{ac} = 450/(10) = 45\Omega, R_{bc} = 450/(15) = 30\Omega$$

Combining the resistors in parallel,

$$30||20 = (600/50) = 12\ \Omega,$$

$$37.5||30 = (37.5x30/67.5) = 16.667\ \Omega$$

$$35||45 = (35x45/80) = 19.688\ \Omega$$

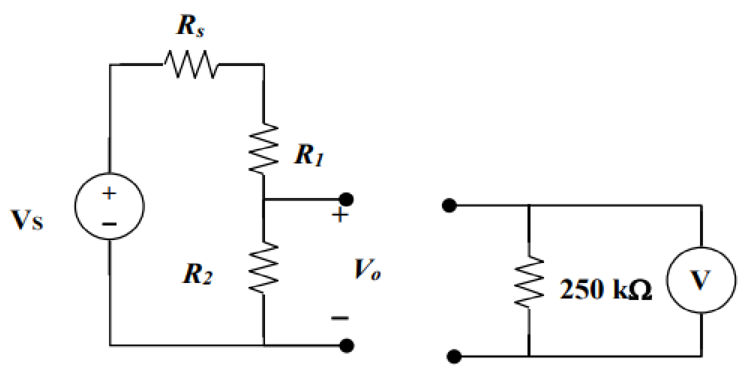
$$R_{eq} = 19.688||(12 + 16.667) = 11.672\Omega$$

By voltage division,

$$v = \frac{11.672}{11.672 + 16}100 = \underline{\mathbf{42.18\ V}}$$

Problem 2.69

A voltmeter is used to measure Vo in the circuit in Fig. 2.129. The voltmeter model consists of an ideal voltmeter in parallel with a 250-kΩ resistor. Let Vs = 95 V, Rs = 25 kΩ, and R1 = 40 kΩ. Calculate Vo with and without the voltmeter when (a) R2 = 5 kΩ (b) R2 = 25 kΩ (c) R2 = 250 kΩ



Solution:

Step 1. $$V_o = V_s \frac{\left(\frac{250kR_2}{250k+R_2}\right)}{R_s+R_1+\frac{250kR_2}{250k+R_2}} = 95\frac{\left(\frac{250kR_2}{250k+R_2}\right)}{65k+\frac{250kR_2}{250k+R_2}}$$ and

$$V_0 = V_s\frac{R_2}{R_s+R_1+R_2} = 95\frac{R_2}{65k+R_2}.$$

Step 2. (a) $$V_o = 95\frac{\left(\frac{250kR_2}{250k+R_2}\right)}{65k+\frac{250kR_2}{250k+R_2}} = 95(4.902/69.902) = \mathbf{6.662\ volts}$$ and

$$V_o = 95\frac{R_2}{65k+R_2} = 95(5k/70k) = \mathbf{6.786\ volts}$$

(b) $V_o = 95 \frac{\left(\frac{250k R_2}{250k + R_2}\right)}{65k + \frac{250k R_2}{250k + R_2}}$ = 95(22.727/87.727) = **24.61 volts** and

$V_o = 95 \frac{R_2}{65k + R_2}$ = 95(25/90) = **26.39 volts**

(c) $V_o = 95 \frac{\left(\frac{250k R_2}{250k + R_2}\right)}{65k + \frac{250k R_2}{250k + R_2}}$ = 95(125/190) = **62.5 volts** and

$V_o = 95 \frac{R_2}{65k + R_2}$ = 95(250/315) = **75.4 volts**