Solutions for Fundamentals of Electric Circuits 7th Edition by Alexander

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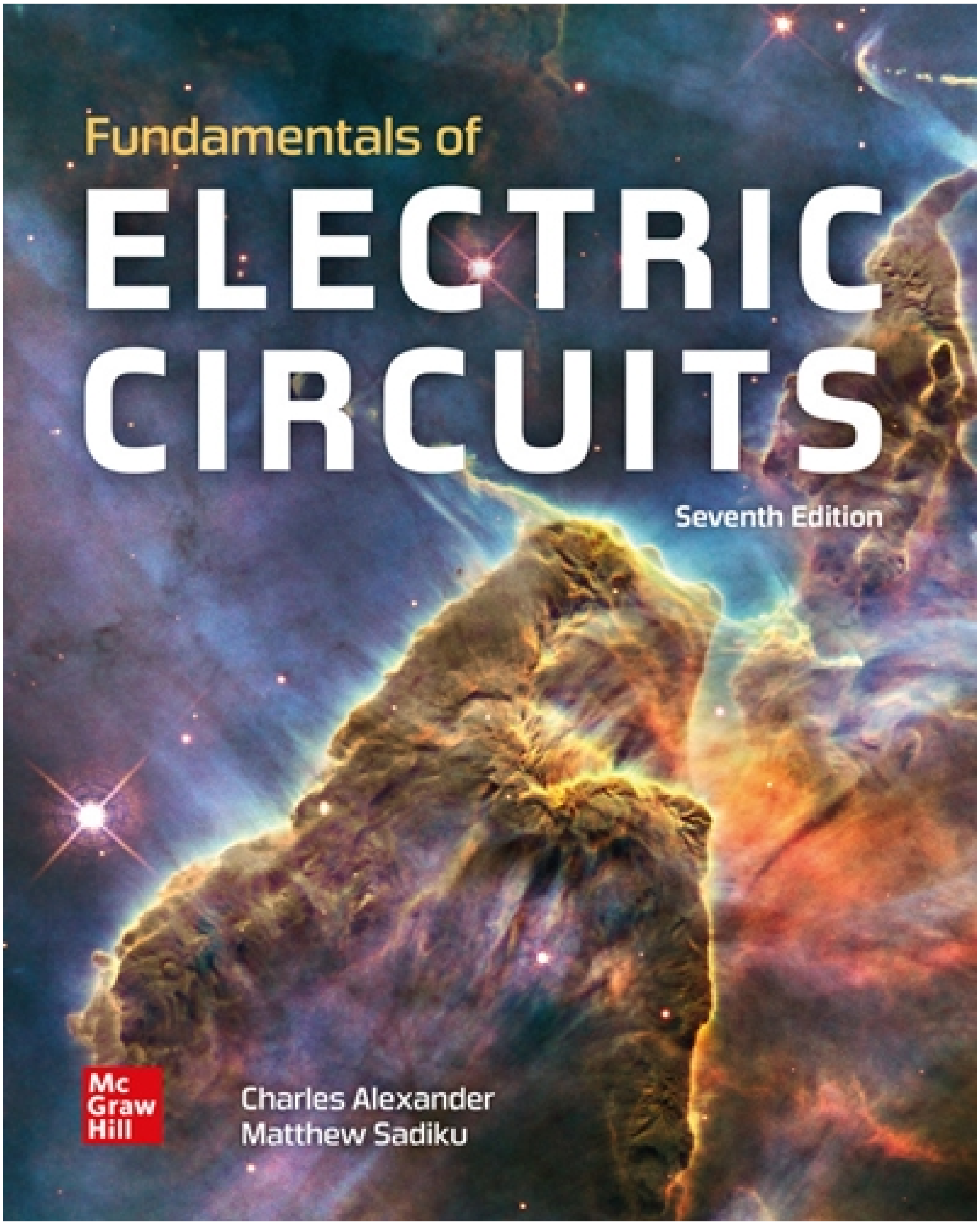


Solutions

CHAPTER 1

P.P.1.1 A proton has 1.602×10^{-19} C. Hence, 6.667 billion protons have

$+1.602 \times 10^{-19} \times 6.667 \times 10^{9} =$ **1.6021×10^{-9} C**

P.P.1.2 $i = dq/dt = d(20–15t–10e^{-3t})/dt = (–15–10(–3)e^{-3t})$ mA

At $t = 1.0$ sec, $i = –15+30e^{-3} = –15+1.4936 =$ **–13.506 mA**

P.P.1.3 $q = \int i dt = \int_0^1 8dt + \int_1^2 8t^2 dt = 8t\big|_0^1 + \frac{8}{3}t^3\Big|_1^2$
$= 8 + 8(8–1)/3 =$ **26.67 C**

P.P.1.4 (a) $V_{ab} = dw/dq = 100/5 =$ **20 V**

(b) $V_{ab} = dw/dq = 100/–10 =$ **–10 V**

P.P.1.5 (a) $v = 6\, i = 30 \cos (60 \pi t)$

$p = v\, i = 150 \cos^2 (60 \pi t)$

At $t = 5$ ms, $p = 150 \cos^2 (60 \pi\, 5\text{x}10^{-3}) = 150 \cos^2 (0.3 \pi)$

= **51.82 watts**

(b) $v = 6 + 10\int_0^t i dt = 6 + \int_0^t 50\cos (60 \pi t)\, dt = 6 + \frac{50}{60\pi} \sin (60 \pi t)$

$p = vi = 5 \cos (60 \pi t)[6 + (50/(60 \pi)) \sin (60 \pi t)]$

At $t = 5$ ms, $p = 5 \cos (0.3\pi)\{6 + (50/(60 \pi)) \sin (0.3 \pi)\}$

$=5(0.58779)(6+(0.26526)(0.80902)) =$ **18.264 watts**

P.P.1.6 $p = v\, i = 115 \times 12 = 1380$ watts; $w = p \times t$

$W = 1380\text{x}24 =$ **33.12 k watt-hours**

P.P.1.7 $p_1 = 5(-45) = \mathbf{-225\ w}$

$p_2 = 2(\mathbf{45}) = \mathbf{90\ w}$

$p_3 = 0.12xI(20) = 0.6(25)(20) = \mathbf{60\ w}$

$p_4 = 3(25) = \mathbf{75\ w}$

Note that all the absorbed power adds up to zero as expected.

P.P.1.8 $i = dq/dt = e\frac{dn}{dt} = -1.6 \times 10^{-19} \times 10^{13} = -1.6 \times 10^{-6}$ A

$p = v_0\, i = 25 \times 10^3 \times (1.6 \times 10^{-6}) = \mathbf{40\ mW}$

P.P.1.9

Minimum monthly charge	= $12.00
First 100 kWh @ $0.16/kWh	= $16.00
Next 160 kWh @ $0.10/kWh	= $16.00
Remaining 0 kWh @ $0.06/kWh	= $0.00
Total Charge	= $44.00

Average cost = $44/[100+160+0] = **16.923 cents/kWh**

P.P.1.10 This assigned practice problem is to apply the detailed problem solving technique to some of the more difficult problems of Chapter 1.

CHAPTER 2

P.P.2.1 $i = V/R = 110/15 =$ **7.333 A**

P.P.2.2 (a) $v = iR =$ 3 mA[10 kohms] = **30 V**

(b) $G = 1/R = 1/10$ kohms = **100 µS**

(c) $p = vi =$ 30 volts[3 mA] = **90 mW**

P.P.2.3 $p = vi$ which leads to $i = p/v = [30\cos^2(t)\ \text{mW}]/[15\cos(t)\ \text{mA}]$

or $i =$ **2cos(t) mA**

$R = v/i = 15\cos(t)\text{V}/2\cos(t)\text{mA} =$ **7.5 kΩ**

P.P.2.4 5 branches and 3 nodes. The 1 ohm and 2 ohm resistors are in parallel. The 4 ohm resistor and the 10 volt source are also in parallel.

P.P.2.5 Applying KVL to the loop we get:

$-32 + 4i - (-8) + 2i = 0$ which leads to $i = 24/6 = 4\text{A}$

$v_1 = 4i =$ **16 V** and $v_2 = -2i =$ **–8 V**

P.P.2.6 Applying KVL to the loop we get:

$-70 + 10i + 2v_x + 5i = 0$

But, $v_x = 10i$ and $v_0 = -5i$. Hence,

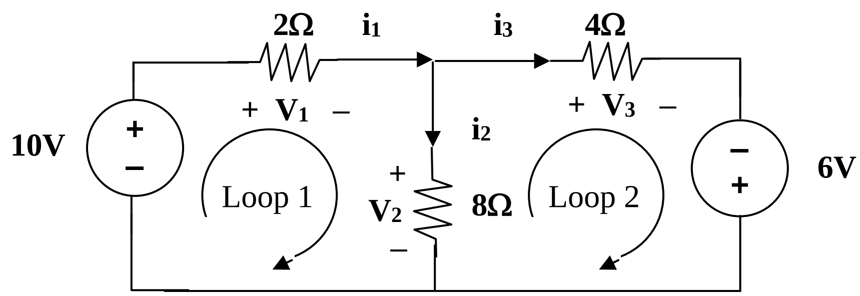
$-70 + 10i + 20i + 5i = 0$ which leads to $i = 2$ A.

Thus, $v_x =$ **20V** and $v_0 =$ **–10 V**

P.P.2.7 Applying KCL, $0 = -9 + i_0 + [i_0/4] + [v_0/8]$, but $i_0 = v_0/2$

Which leads to: $9 = (v_0/2) + (v_0/8) + (v_0/8)$ thus, v_0 = **12 V** and i_0 = **6 A**

P.P.2.8



At the top node, $0 = -i_1 + i_2 + i_3$ or $i_1 = i_2 + i_3$ (1)

For loop 1 $-10 + V_1 + V_2 = 0$
or $V_1 = 10 - V_2$ (2)

For loop 2 $-V_2 + V_3 - 6 = 0$
or $V_3 = V_2 + 6$ (3)

Using (1) and Ohm's law, we get

$$(V_1/2) = (V_2/8) + (V_3/4)$$

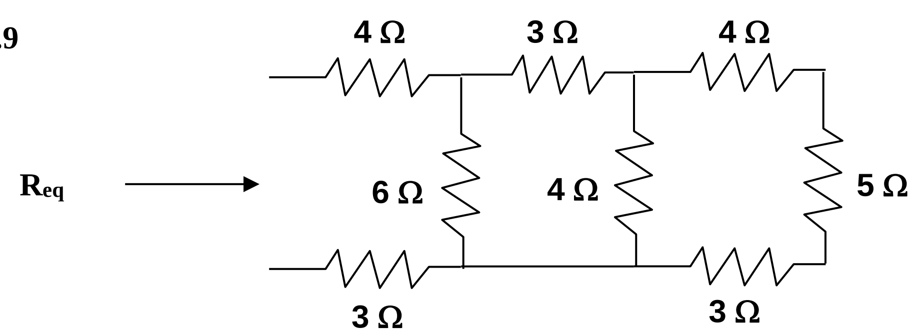
and now using (2) and (3) in the above yields

$$[(10 - V_2)/2] = (V_2/8) + (V_2 + 6)/4$$

or $[7/8]V_2 = 14/4$ or V_2 = **4 V**

$V_1 = 10 - V_2$ = **6 V**, $V_3 = 4+6$ = **10 V**, $i_1 = (10-4)/2$ = **3 A**,
$i_2 = 4/8$ = **500 mA**, i_3 = **2.5 A**

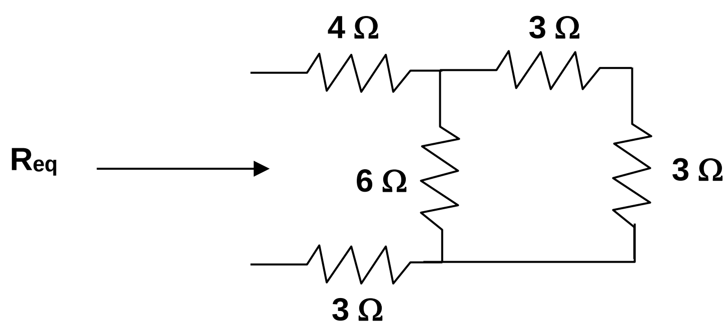
P.P.2.9



Combining the 4 ohm, 5 ohm, and 3ohm resistors in series gives 4+3+5 = 12.

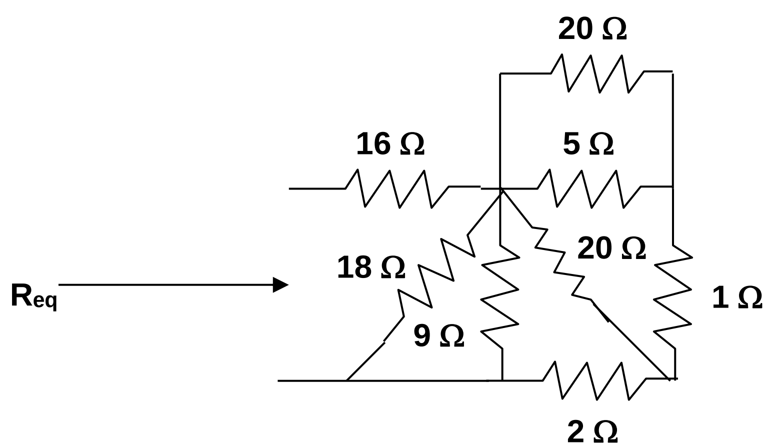
But, 4 in parallel with 12 produces [4x12]/[4+12] = 48/16 = 3ohm.

So that the equivalent circuit is shown below.



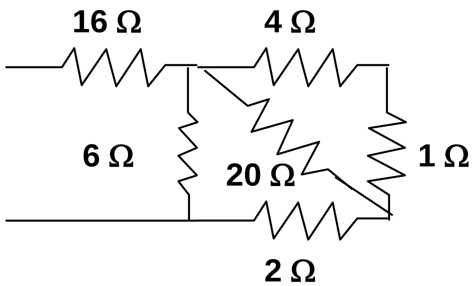
Thus, $\mathbf{R_{eq}}$ = 4 + 3 + [6x6]/[6+6] = **10 Ω**

P.P.2.10

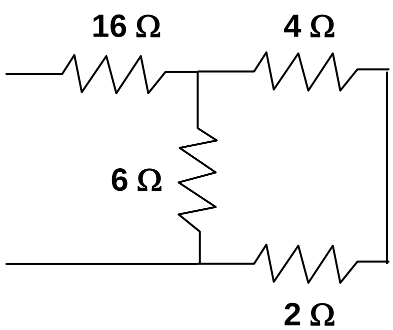


Combining the 9 ohm resistor and the 18 ohm resistor yields [9x18]/[9+18] = 6 ohms.

Combining the 5 ohm and the 20 ohm resistors in parallel produces [5x20/(5+20)] = 4 ohms We now have the following circuit:



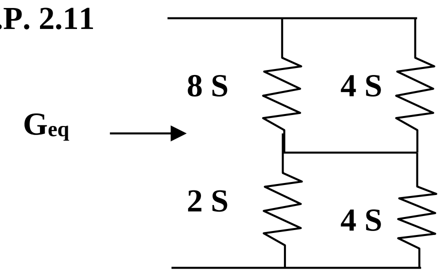
The 4 ohm and 1 ohm resistors can be combined into a 5 ohm resistor in parallel with a 20 ohm resistor. This will result in [5x20/(5+20)] = 4 ohms and the circuit shown below:



The 4 ohm and 2 ohm resistors are in series and can be replaced by a 6 ohm resistor. This gives a 6 ohm resistor in parallel with a 6 ohm resistor, [6x6/(6+6)] = 3 ohms. We now have a 3 ohm resistor in series with a 16 ohm resistor or 3 + 16 = 19 ohms. Therefore:

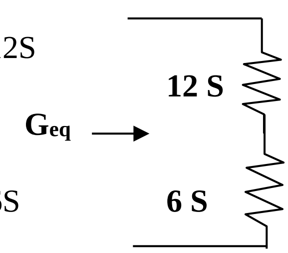
$$\mathbf{R_{eq} = 19 \text{ ohms}}$$

P.P. 2.11



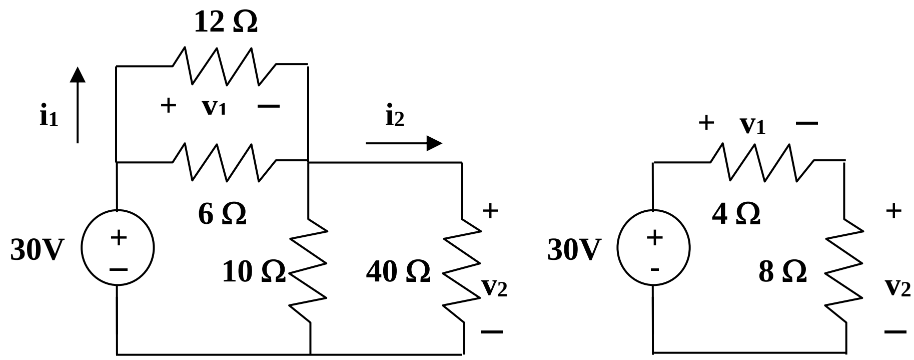
8||4 = 8+4 = 12S

2||4 = 2+4 = 6S



12 S in series with 6 S = {12x6/(12+6)] = 4 or: $\mathbf{G_{eq} = 4\ S}$

P.P.2.12



6||12 = [6x12/(6+12)] = 4 ohm and 10||40 = [10x40/(10+40)] = 8 ohm.

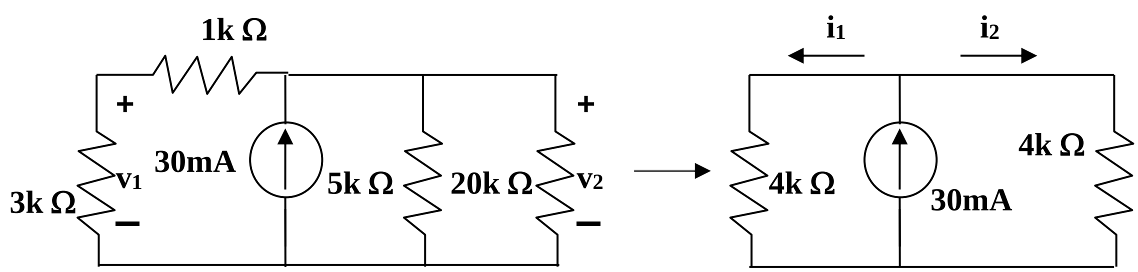
Using voltage division we get:

v_1 = [4/(4+8)] (30) = **<u>10 volts</u>**, **v_2** = [8/12] (30) = **<u>20 volts</u>**

i_1 = v_1/12 = 10/12 = **<u>833.3 mA</u>**, **i_2** = v_2/40 = 20/40 = **<u>500 mA</u>**

P_1 = v_1 i_1 = 10x10/12 = **<u>8.333 watts</u>**, **P_2** = v_2 i_2 = 20x0.5 = **<u>10 watts</u>**

P.P.2.13



Using current division, i_1 = i_2 = (30 mA)(4 kohm/(4 kohm + 4 kohm)) = 15mA

(a) **v_1** = (3 kohm)(15 mA) = **45 volts**
v_2 = (4 kohm)(15 mA) = **60 volts**

(b) For the 3k ohm resistor, **P_1** = v_1 x i_1 = $45 x 15 x 10^{-3}$ = **675 mw**
For the 20k ohm resistor, **P_2** = $(v_2)^2$ /20k = **180 mw**

(c) The total power supplied by the current source is equal to:
P = v_2 x 10 mA = $60 \times 30 \times 10^{-3}$ = **1.8 W**

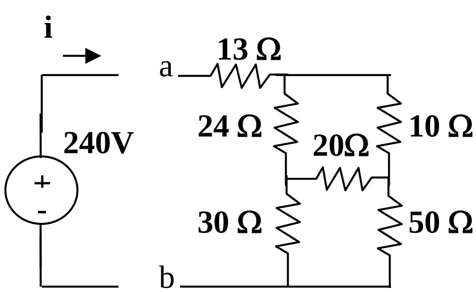
P.P.2.14

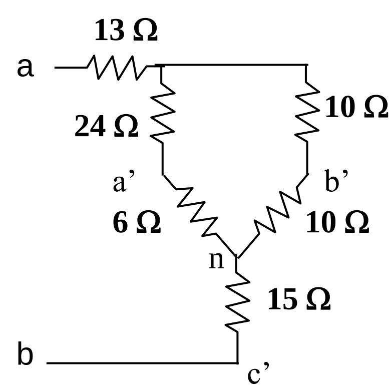
$\mathbf{R_a}$ = $[R_1 R_2 + R_2 R_3 + R_3 R_1]/ R_1$ = [10x20 + 20x40 + 40x10]/10 = **140 ohms**

$\mathbf{R_b}$ = $[R_1 R_2 + R_2 R_3 + R_3 R_1]/ R_2$ = 1400/20 = **70 ohms**

$\mathbf{R_c}$ = $[R_1 R_2 + R_2 R_3 + R_3 R_1]/ R_3$ = 1400/40 = **35 ohms**

P.P.2.15 We first find the equivalent resistance, R. We convert the delta sub-network to a wye connected form as shown below:





$R_{a'n}$ = 20x30/[20 + 30 + 50] = 6 ohms, $R_{b'n}$ = 20x50/100 = 10 ohms
$R_{c'n}$ = 30x50/100 = 15 ohms.

Thus, R_{ab} = 13 + [(24 + 6)||(10 + 10)] + 15 = 28 + 30x20/(30 + 20) = **40 ohms.**

i = 240/ R_{ab} = 240/40 = **6 amps**

P.P.2.16 **For the parallel case, v = $\mathbf{v_0}$ = 110volts.**
p = vi ⟹ i = p/v = 40/110 = 364 mA

For the series case, v = v_0/N = 110/10 = 11 volts
i = p/v = 40/11 = **3.64 amps**

P.P.2.17 We use equation (2.61)

(a) $\mathbf{R_1}$ = $50 \times 10^{-3}/ (1-10^{-3})$ = 0.05/999 = **50 mΩ (shunt)**

(b) $\mathbf{R_2}$ = $50 \times 10^{-3}/(100 \times 10^{-3} - 10^{-3})$ = 50/99 = **505 mΩ (shunt)**

(c) $\mathbf{R_3}$ = $50 \times 10^{-3}/(10 \times 10^{-3}-10^{-3})$ = 50/9 = **5.556 Ω (shunt)**