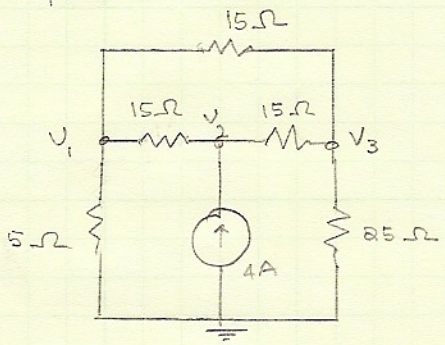
HW #2 Solution

#2.49



FIND V_1, V_2, V_3

Solution :

Using nodal analysis

NODE 1 : $\frac{V_1}{5} + \frac{V_1 - V_2}{15} + \frac{V_1 - V_3}{15} = 0$

$$5V_1 - V_2 - V_3 = 0 \quad \text{——} ①$$

NODE 2 : $\frac{V_2 - V_1}{15} + \frac{V_2 - V_3}{15} = 4.$

$$-V_1 + 2V_2 - V_3 = 60 \quad \text{——} ②$$

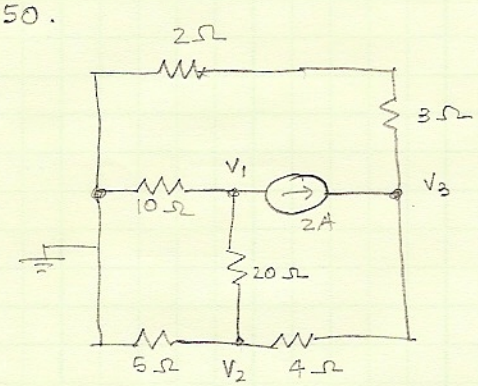
NODE 3 : $\frac{V_3}{25} + \frac{V_3 - V_1}{15} + \frac{V_3 - V_2}{15} = 0$

$$-5V_1 - 5V_2 + 13V_3 = 0 \quad \text{——} ③$$

SOLVE eqn ①, ② and ③ :

$$\boxed{\begin{aligned} V_1 &= 15\,V \\ V_2 &= 50\,V \\ V_3 &= 25\,V \end{aligned}}$$

2.50.



FIND V_1, V_2, V_3.

Solution.

Using NODAL ANALYSIS.

NODE 1 : $\frac{V_1}{10} + \frac{V_1 - V_2}{20} + 2A = 0$

$$3V_1 - V_2 = -40 \quad \text{—— (1)}$$

NODE 2 : $\frac{V_2}{5} + \frac{V_2 - V_1}{20} + \frac{V_2 - V_3}{4} = 0$

$$-V_1 + 10V_2 - 5V_3 = 0 \quad \text{—— (2)}$$

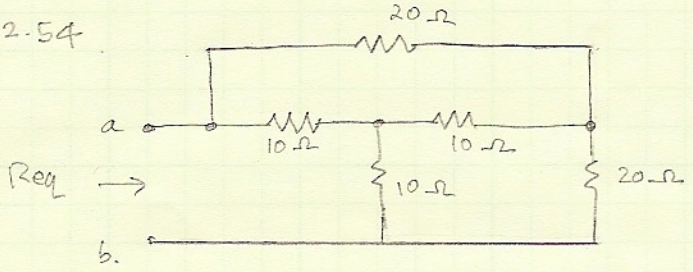
NODE 3 : $\frac{V_3}{5} + \frac{V_3 - V_2}{4} - 2A = 0.$

$$-5V_2 + 9V_3 = 40 \quad \text{—— (3)}$$

Solving eqns (1), (2) & (3):

$V_1 = -12.90$ V
$V_2 = 1.29$ V
$V_3 = 5.16$ V

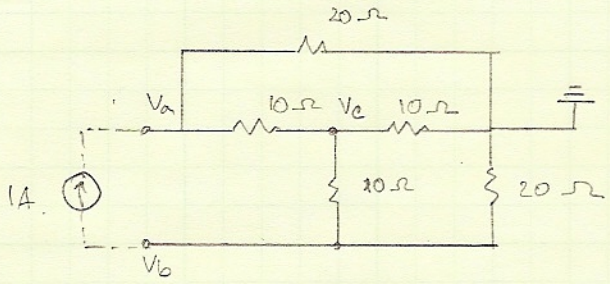
2.54



FIND REQ.

ANSWER:

Let's apply 1A across terminal a-b.



Use Nodal analysis.

Node a. $\frac{V_a}{20} + \frac{V_a - V_c}{10} = 1A$

$3V_A - 2V_c = 20$ — (1)

Node b. $\frac{V_b}{20} + \frac{V_b - V_c}{10} = -1A$.

$3V_b - 2V_c = -20$. — (2)

Node c. $\frac{V_c}{10} + \frac{V_c - V_a}{10} + \frac{V_c - V_b}{10} = 0$.

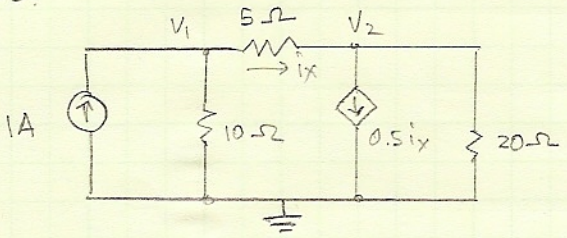
$-V_a - V_b + 3V_c = 0$ — (3)

Solving for (1), (2), (3): $V_a = 6.667$ V
$V_b = -6.667$ V
$V_c = 0$ V

$V_a - V_b = 6.667 - (-6.667)$ V
$= 13.334$ V.

Therefore $R_{EQ} = \frac{V_a - V_b}{1A} = \frac{13.334\,V}{1A} = 13.334\ \Omega = R_{EQ}$.

2.55.



FIND V_1, V_2, i_x.

Answer:

Use Nodal Analysis.

Node 1: $\frac{V_1}{10} + \frac{V_1 - V_2}{5} = 1A.$

$$3V_1 - 2V_2 = 10 \quad \text{——} (1)$$

Node 2: $\frac{V_2}{20} + \frac{V_2 - V_1}{5} + 0.5i_x = 0$

$$-4V_1 + 5V_2 + 10i_x = 0 \quad \text{——} (2)$$

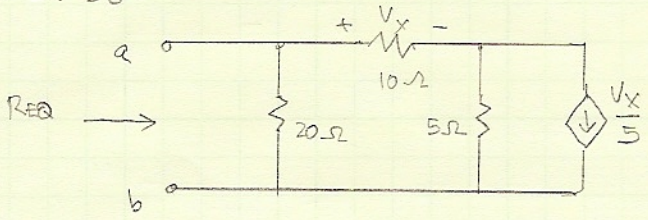
Also,

$$\frac{V_1 - V_2}{5} = i_x \Rightarrow V_1 - V_2 - 5i_x = 0 \quad \text{——} (3)$$

Solving (1), (2), & (3), we have

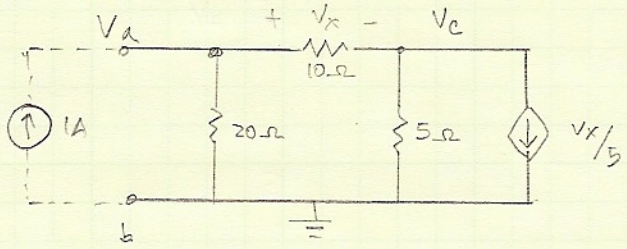
V_1	= 6 V
V_2	= 4 V
i_x	= 0.4 A

2.58



FIND REQ.

Solution.



Let V_b be the ground $\Rightarrow V_b = 0$.

Node a. $\frac{V_a}{20} + \frac{V_a - V_c}{10} = 1A.$

$$3V_a - 2V_c = 20 \quad \text{—— ①}$$

NODE C. $\frac{V_c}{5} + \frac{V_c - V_a}{10} = -\frac{V_x}{5}$

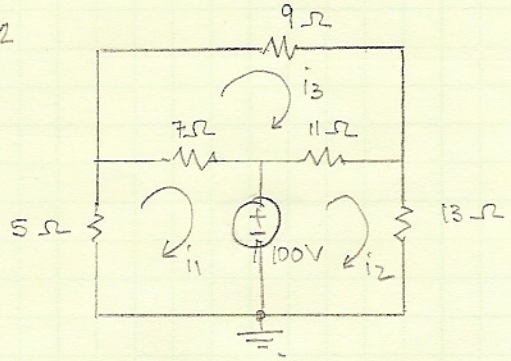
$$-V_a + 3V_c + 2V_x = 0 \quad \text{—— ②}$$

Also, $V_a - V_c = V_x \Rightarrow V_a - V_c - V_x = 0 \quad \text{—— ③}$

Solving for Eqns ①, ②, & ③ : $V_a = 4V$
$V_c = -4V$
$V_x = 8V$

Therefore, $R_{EQ} = \frac{V_a - V_b}{1A} = \frac{(4-0)V}{1A} = 4\Omega = R_{EQ}$

2.62



FIND P_{100V}.

Answer :

Loop 1 : $5i_1 + 7(i_1 - i_3) + 100\,V = 0$.

$$12\,i_1 - 7\,i_3 = -100 \quad \text{—— (1)}$$

Loop 2 : $-100\,V + 11(i_2 - i_3) + 13\,i_2 = 0$

$$24\,i_2 - 11\,i_3 = 100 \quad \text{—— (2)}$$

Loop 3 : $7(i_3 - i_1) + 11(i_3 - i_2) + 9\,i_3 = 0$

$$-7i_1 - 11\,i_2 + 27\,i_3 = 0$$

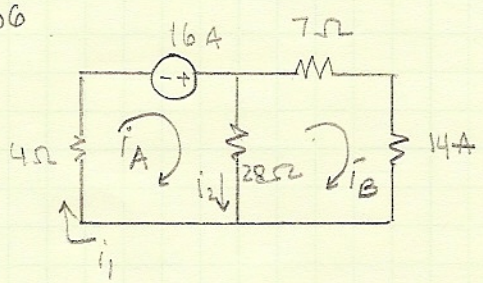
Solving EQNS (1), (2) and (3), WE get

$$i_1 = -8.74\,A$$
$$i_2 = 3.85\,A$$
$$i_3 = -0.699\,A$$

THEREFORE $P_{100} = V(i_2 - i_1)$

$$= 100\,V\,(3.85 - (-8.74))\,A$$
$$= 1259\,W$$
$$= 1.26\,kW.$$

2.66



FIND i_1 and i_2

ANSWER :

Loop A : $4i_A - 16A + 28(i_A - i_B) = 0$

$$32 i_A - 28 i_B = 16 \quad \text{——} (1)$$

Loop B : $28(i_B - i_A) + 7 i_B + 14 i_B = 0$

$$-28 i_A + 49 i_B = 0 \quad \text{——} (2)$$

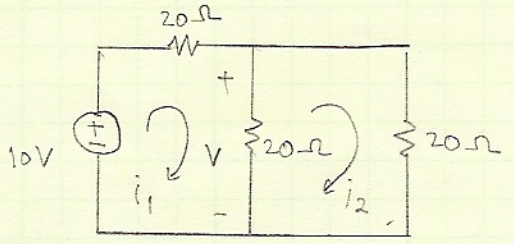
Solve for EQNS (1) AND (2) :

$i_A = 1A$
$i_B = 0.571\ A$.

THEREFORE, $i_1 = i_A = 1A$.

$i_2 = i_A - i_B = (1 - 0.571)A$
$= 0.429\ A$

2.69



FIND V USE mesh CURRENT analysis

ANSWER :

Loop 1 : $-10V + 20i_1 + 20(i_1 - i_2) = 0$

$$40i_1 - 20i_2 = 10 \quad \text{——— (1)}$$

Loop 2 : $20(i_2 - i_1) + 20i_2 = 0$

$$-20i_1 + 40i_2 = 0 \quad \text{——— (2)}$$

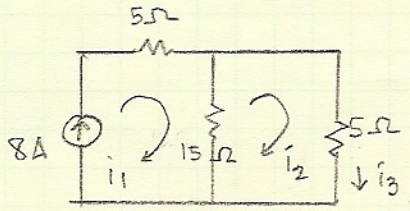
Solve eqns (1) and (2) : $i_1 = 0.333\ A$
$i_2 = 0.1667\ A$

THEREFORE $V = R_{20}(i_1 - i_2)$

$= 20\Omega(0.333 - 0.167)A$

$= 3.33\ V$

2.70.



FIND i_3 USING mesh ANALYSIS

ANSWER

Loop 1 : $i_1 = 8A$

Loop 2 : $15(i_2 - i_1) + 5i_2 = 0$

$-15i_1 + 20i_2 = 0$

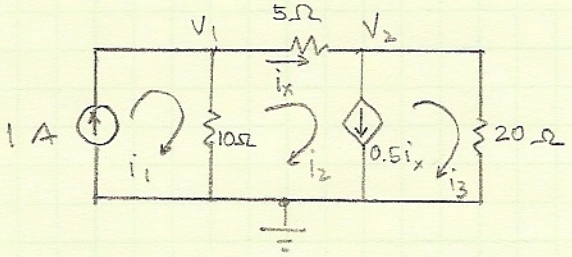
and $i_1 = 8A \rightarrow -15(8) + 20i_2 = 0$

$20i_2 = 120\ A$

$i_2 = 6A$

Therefore $i_3 = i_2 = 6A$.

2.xx



FIND i_x USING mesh analysis

$i_x = i_2$

ANSWER.

From loop 1, WE KNOW $i_1 = 1A$ —— ①

SUPER MESH 2 and 3:

$$10(i_2 - i_1) + 5i_2 + 20i_3 = 0$$

$$-10i_1 + 15i_2 + 20i_3 = 0 \quad \text{—— ②}$$

CONSTRAINT

$$i_2 - i_3 = 0.5\,i_x$$

$i_x = i_2 \Rightarrow i_2 - i_3 = 0.5\,i_2$

$$0.5\,i_2 - i_3 = 0 \quad \text{—— ③}$$

SOLVING FOR eqns ①, ②, AND ③:

$i_1 = 1\,A$
$i_2 = 0.4\,A$
$i_3 = 0.2\,A$

THEREFORE, $i_x = i_2 = 0.4A$