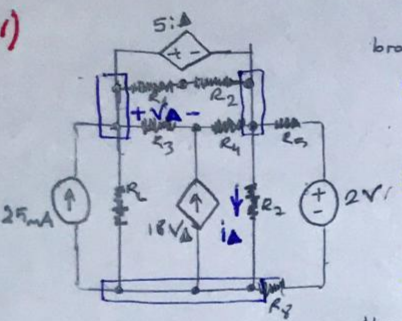
4.1)



a) 12 branches, 8 branches with resistors, independent 2 branches, 2 branches with dependent sources.

b) The current is unknown in every branch containing 25mA current source, so the current unknown 11 branches.

c) 10 essential branches $-R_1-R_2$, R_8-2V. The remaining eight branches are essential containing single element.

d) The current is known only essential branch containing the current source, and is unknown in the remaining 9 branches.

e) 7 nodes - three identified by boxes, two identified by triangles, one identified diamond.

f) There are 5 essential nodes, three identified boxes. and two identified triangles.

g) A mesh is like a window pane, and as can be seen from the figure there are 6 window panes or meshes.

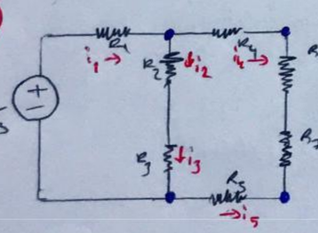
4.2) a) There are 9 essential branches current is unknown, so we need 9 simultaneous equations to describe the circuit.

b) 5 essential nodes, KCL at 5-1=4 of these essential nodes.

c) The remaining 4 equations needed to describe the circuit will be derived from KVL.

d) We must avoid using the bottom left-most mesh, since it contains a current source, and we have no way determining the voltage drop across a current source. The two meshes on the bottom that share the dependent source must be handled in a special way.

4.3)



a) There are eight compenents, seven resistor and voltge source. There are eight unknown currents. V_s and R_1 series, same current. R_4, R_6 series some current, R_5, R_7 series. Therefore, we only need 5 equations to find the 5 distinct currents.

b) There are three essential nodes in circuit, identify the boxes. At two of these nodes KCL equations. A KCL equation at the third node would dependent on the first two.

c) $-i_1+i_2+i_4=0$ $\quad$ $i_1-i_3+i_5=0$

d) Three meshes: Left V_s, R_1, R_2, R_3 Top right; R_2, R_4, R_6 Bottom right; R_3, R_5, R_7

We can write KVL equations for all three meshes.

4.4) a) At node a: $-i_1+i_2+i_4=0$

At node b: $-i_2+i_3-i_4-i_5=0$

At node c: $i_1-i_3+i_5=0$

b) There are many possible solutions.

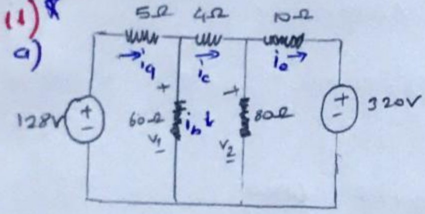
For example: adding the equations at nodes a and c gives the equation at node b.

$(-i_1+i_2+i_4)+(i_1-i_3+i_5)=0$

$i_2-i_3+i_4+i_5=0$

node b with both sides multiplied by -1.

4.11)* a)



$$\frac{V_1-128}{5}+\frac{V_1}{60}+\frac{V_1-V_2}{4}=0$$

$$\frac{V_2-V_1}{4}+\frac{V_2}{80}+\frac{V_2-320}{10}=0$$

$$V_1\left(\frac{1}{5}+\frac{1}{60}+\frac{1}{4}\right)+V_2\left(-\frac{1}{4}\right)=\frac{128}{5}$$

$$V_1\left(-\frac{1}{4}\right)+V_2\left(\frac{1}{4}+\frac{1}{80}+\frac{1}{10}\right)=\frac{320}{10}$$

$V_1=162V$

$V_2=200V$

$$i_a=\frac{128-162}{5}=-6.8A$$

$$i_b=\frac{162}{60}=2.7A$$

$$i_c=\frac{162-200}{4}=-9.5A$$

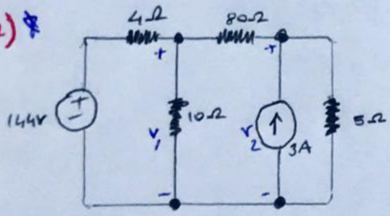
$$i_d=\frac{200}{80}=2.5A$$

$$i_e=\frac{200-320}{10}=-12A$$

b) $P_{128V}=-(128).(-6.8)=870.4W$

$P_{320V}=320.(-12)=-3840W$

4.12)*

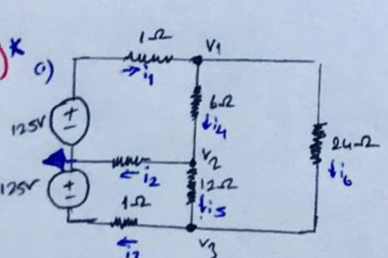


$$\frac{V_1-144}{4}+\frac{V_1}{10}+\frac{V_1-V_2}{80}=0 \quad \text{so} \quad 29V_1-V_2=2880$$

$$-3+\frac{V_2-V_1}{80}+\frac{V_2}{5}=0 \quad \text{so} \quad -V_1+17V_2=240$$

$V_1=100V$ $\quad V_2=20V$

4.15)* a)



$$\frac{V_1-125}{1}+\frac{V_1-V_2}{6}+\frac{V_1-V_3}{24}=0$$

$$\frac{V_2-V_1}{6}+\frac{V_2}{2}+\frac{V_2-V_3}{12}=0$$

$$\frac{V_3+125}{1}+\frac{V_3-V_2}{12}+\frac{V_3-V_1}{24}=0$$

b) $125i_1+125i_3=\underline{5273.09W}$

$i_1^2(1)+i_2^2(2)+i_3^2(1)+i_4^2(6)+i_5^2(12)+i_6^2(24)=\underline{5273.09W}$

$$V_1\left(\frac{1}{1}+\frac{1}{6}+\frac{1}{24}\right)+V_2\left(-\frac{1}{6}\right)+V_3\left(-\frac{1}{24}\right)=125$$

$$V_1\left(-\frac{1}{6}\right)+V_2\left(\frac{1}{6}+\frac{1}{2}+\frac{1}{12}\right)+V_3\left(-\frac{1}{12}\right)=0$$

$$V_1\left(-\frac{1}{24}\right)+V_2\left(-\frac{1}{12}\right)+V_3\left(\frac{1}{1}+\frac{1}{12}+\frac{1}{24}\right)=-125$$

Solving $V_1=101.24V$

$V_2=10.66V$

$V_3=-106.57V$

$$i_1=\frac{125-101.24}{1}=23.76A$$

$$i_2=\frac{10.66}{2}=5.33A$$

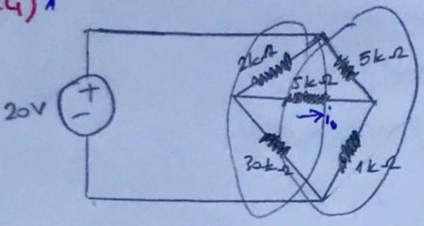
$$i_3=\frac{-106.57+125}{1}=18.43A$$

$$i_4=\frac{101.24-10.66}{6}=15.10A$$

$$i_5=\frac{10.66+106.57}{12}=9.77A$$

$i_6=8.66A$

4.24) *



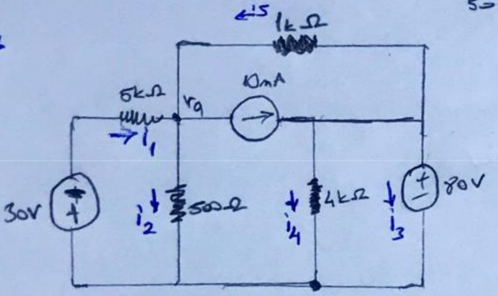
$$\frac{V_1}{30.000} + \frac{V_1 - V_2}{5000} + \frac{V_1 - 20}{2000} = 0 \quad \text{so, } 22V_1 - 6V_2 = 300$$

$$\frac{V_2}{1000} + \frac{V_2 - V_1}{5000} + \frac{V_2 - 20}{5000} = 0 \quad \text{so, } -V_1 + 7V_2 = 20$$

$$i_o = \frac{15-5}{5000} = 2mA \leftarrow \quad V_1 = 15V, \; V_2 = 5V$$

4.27) *

a)



Calculate the currents

$$\frac{V_a + 30}{5000} + \frac{V_a}{500} + \frac{V_a - 80}{1000} = 0$$

$$V_a + 30 + 10V_a + 5V_a - 400 + 50 = 0 \; ; \quad 16V_a = 320, \; V_a = 20$$

$$i_1 = \frac{-30-20}{5000} = -10mA \qquad i_5 = \frac{60}{1000} = 60mA$$

$$i_2 = \frac{20}{500} = 40mA \qquad i_3 + i_4 + i_5 - 10mA = 0$$

$$i_4 = \frac{80}{4000} = 20mA \qquad i_3 = -70mA$$

b)

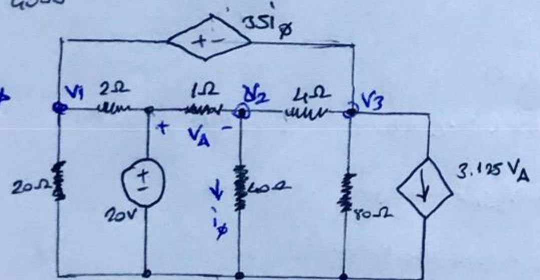
$$P_{5k} = -0.01^2 \cdot 5000 = 0.5W$$

$$P_{500\Omega} = (0.04)^2 \cdot 500 = 0.8W$$

$$P_{1k} = 60^2 / 1000 = 3.6W$$

$$P_{4k} = (80)^2 / 4000 = 1.6W$$

4.30) *



$$\frac{V_1}{20} + \frac{V_1 + 20}{2} + \frac{V_3 - V_2}{4} + \frac{V_3}{80} + 3.125V_\Delta = 0$$

$$\frac{V_2}{40} + \frac{V_2 - V_3}{4} + \frac{V_2 - 20}{1} = 0$$

$$V_\Delta = 20 - V_2$$

$$V_1 - 35i_\phi = V_3$$

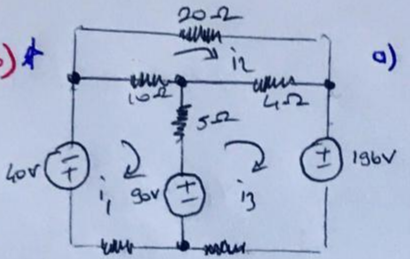
$$i_\phi = V_2 / 40$$

$$V_1 = -20.25V, \quad V_2 = 10V, \quad V_3 = -29V$$

$$i_g = \frac{20 - 20.25}{2} + \frac{20 - 10}{1} = 30.125A$$

$$P_g = 20 \cdot (30,125) = 6025W$$

4.36)*



a) $40+10(i_1-i_2)+5(i_1-i_3)+90+30i_1=0$

$20i_2+4(i_2-i_3)+10(i_2-i_1)=0$

$196+2i_3-90+5(i_3-i_1)+4(i_3-i_2)=0$

$i_1=-5A;\quad i_2=-3A;\quad i_3=-13A$

$P_{40}=40i_1=-200W$ $\qquad P_{196}=196i_3=-2548W$

$P_{90}=90.(i_1-i_3)=720$

b)

$P_{20\Omega}=9.20=180W$

$P_{10\Omega}=4.10=40W$

$P_{4\Omega}=100.4=400W$

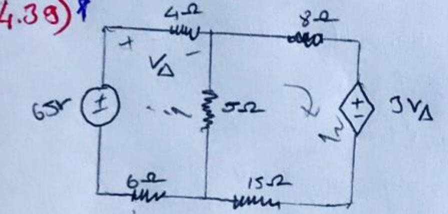
$P_{5\Omega}=64.5=320W$

$P_{30\Omega}=25.30=750W$

$P_{2\Omega}=2.169=338W$

$\Sigma P_{abs}=2748W$

4.39)*



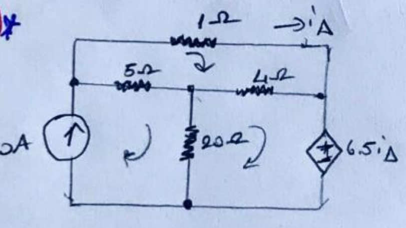
$-65V+4i_1+5(i_1-i_2)+6i_1=0$

$8i_2+3V_\Delta+15i_2+5(i_2-i_1)=0$

$V_\Delta=4i_1$

$i_1=4A,\quad i_2=-1A,\quad V_\Delta=16V,\quad P_{15\Omega}=15.1=15W$

4.46)*



$10i_\Delta-4i_1=0$

$-4i_\Delta+24i_1+6.5i_\Delta=400\quad,\ i_1=15A\ ,\quad i_\Delta=16A$

$V_{20A}=-20V_{20A}=-20.120=-2400W$

$P_{6.5i_\Delta i_1}=(6.5).16.15=1560W$

$P_{1\Omega}=256.1=256W$

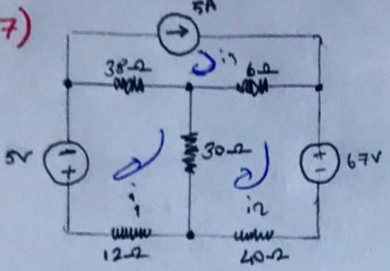
$P_{5\Omega}=16.5=80W$

$P_{4\Omega}=1.4=4W$

$P_{20\Omega}=25.20=500W$

$\Sigma_p=2400W$

4.47)



$5+38(i_1-i_2)+30(i_1-i_2)+12i_1=0$

$67+40i_2+30(i_2-i_1)+6(i_2-5)=0$

$i_1=2.5A \qquad i_2=0.5A$

b) $P_{5V}=5.(2.5)=12.5$

$P_{67V}=67.(0.5)=33.5$

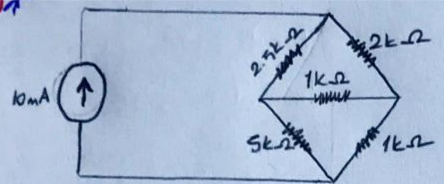
a) $V_{5A}=38(2.5-5)+6.(0.5+5)=-122V$

$P_{5A}=5.-122=-610W$

c) $\Sigma_{resistors}=(2.5)^2.38+(4.5)^2.6+2^2.30+(2.5)^2.12+(0.5)^2.40=564$

$\Sigma P_{abs}=564+12.5+33.5=610W$

4.54)



a) Use the mesh current method to minimize the number of simultaneous equations.

b) $2500(i_1-0.01)+2000i_1+1000(i_1-i_2)=0$

$5000(i_2-0.01)+1000(i_2-i_1)+1000i_2=0$

$i_1(2500+2000+1000)+i_2(-1000)=25$

$i_1(-1000)+i_2(7000)=50$

$i_1=6mA \quad , \quad i_2=8mA$

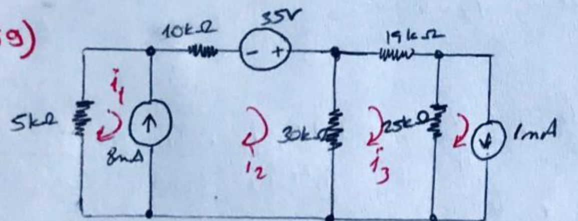
c) No, the voltage across the 10A current source.

d) $V_g=2000i_1+1000i_2=20V$

$P_{10mA}=-20.(0.01)=-200mW$

10mA source develops 200mW

4.59)



a) ?

b) $5000i_1+40000i_2-30000i_3=35$

$i_2-i_1=0.008$

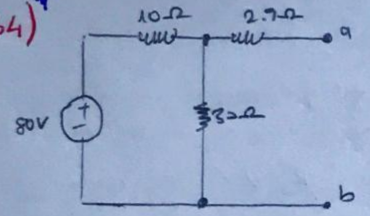
$-30000i_2+70000i_3=25$

$i_1=-5.33mA, \quad i_2=2.66mA, \ i_3=1.5mA$

$V_o=(25.000).(i_3-001)=(25000).(0.0005)=12.5V$

Thévenin

4.64)*

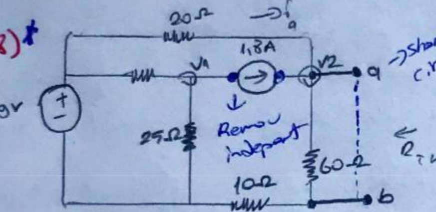


$V_{Th} = \frac{30}{80} \cdot 80 = 60V$

$R_{Th} = 2.5 + \frac{30.10}{40} = 10\Omega$

We may use thevenin theorem to simplify portion the circuit

4.78)*

a) 

$\frac{V_2 - 9V}{20\Omega} + \frac{V_2}{70\Omega} = 0$

$V_2 = 35V$

$V_{Th} = \frac{60}{70} \cdot 35 = 30V$

Short Circuit

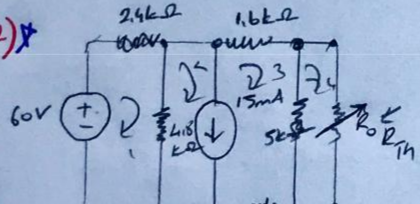
$\frac{35 - V_2}{20} + \frac{V_2}{10} - 1.8 = 0$, $V_2 = 15V$

$i_a = \frac{9-15}{20} = -0.3A$, $i_{sc} = 1.8 - 0.3 = 1.5A$

$R_{Th} = \frac{30}{1.5} = 20\Omega$

b) $20 + \left(\frac{1}{10} + \frac{1}{60}\right) = 20\Omega = R_{Th}$

4.82)*



a) $R_{Th} = 5000 || (1600 + 2400 || 4800 + 1800) = 2.5k\Omega$

$R_o = R_{Th} = 2.5k\Omega$

b) $7200 i_1 - 4800 i_2 = 60$

$-4800 i_1 + 4800 i_2 + 8400 i_3 = 0$

$i_2 - i_3 = 0.015$

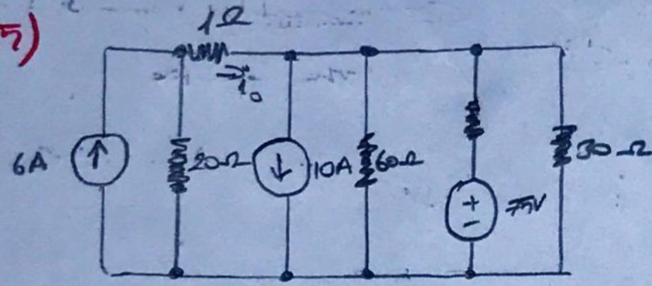
$i_1 = 19.4mA$ $i_2 = 16.6mA$, $i_3 = 1.6mA$

$V_{Th} = 8V$

c) ?

*

4.95)



<u>6A</u>

$$\frac{1}{30}+\frac{1}{5}+\frac{1}{60} = \frac{60}{15} = 4\,\Omega$$

2 12

$$i_1 = \frac{20}{20+5}\cdot 6 = 4.8A$$

<u>10A</u>

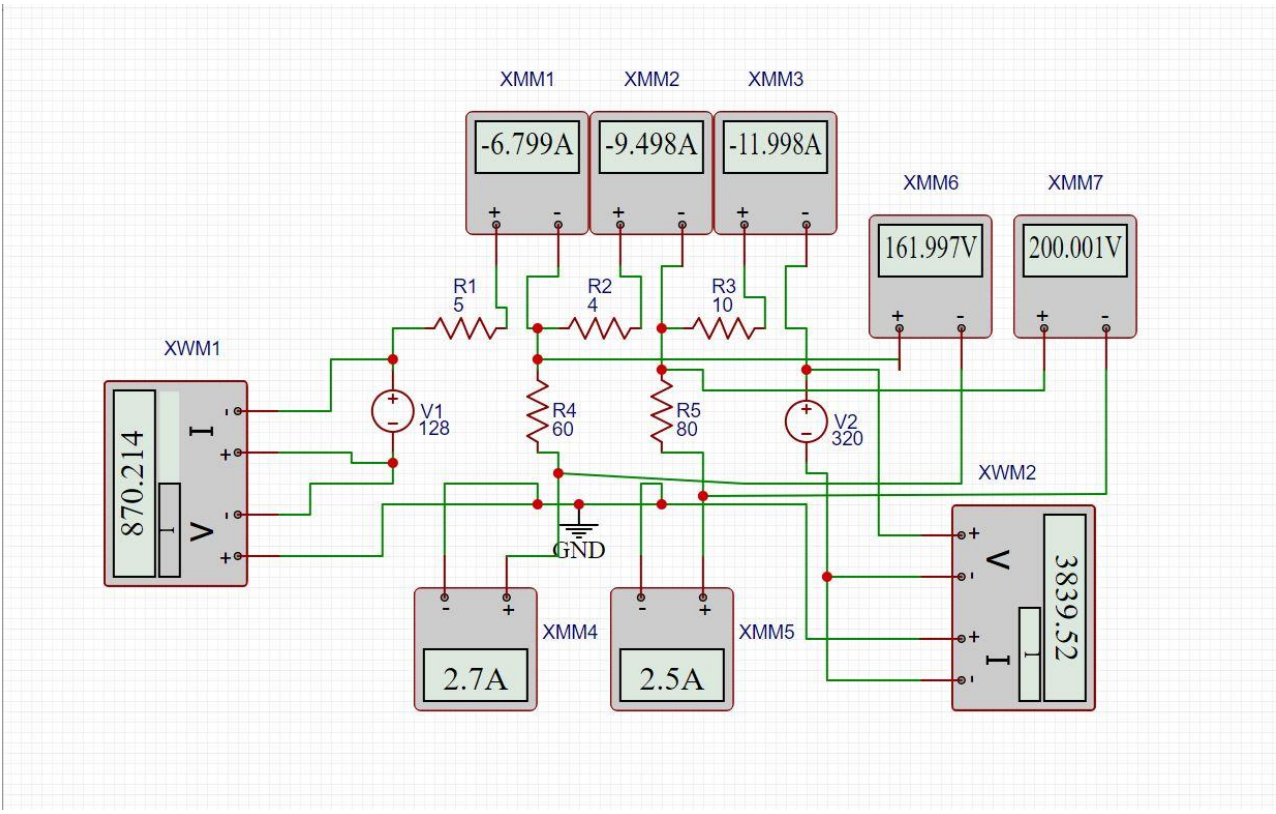
$$\frac{4}{25}\cdot 10 = 1.6A = i_2$$

<u>75V</u>

$$-\frac{4}{25}\cdot 15 = -2.4A = i_3$$

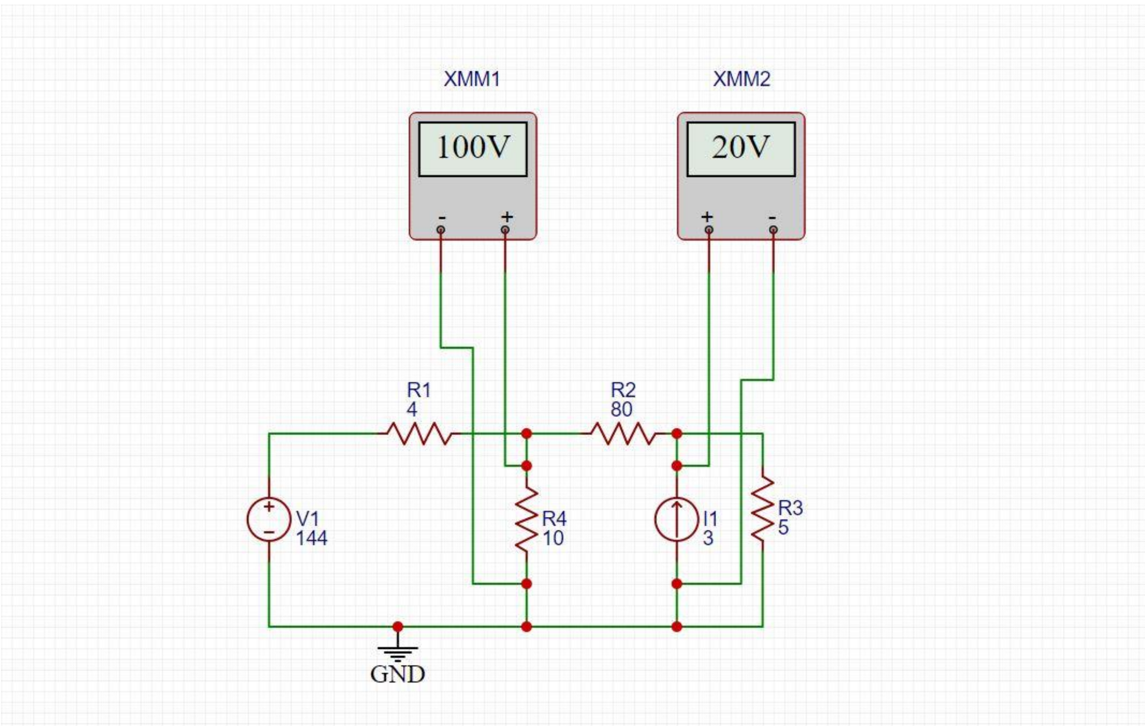
$$\Sigma_i = 4A$$

4.11



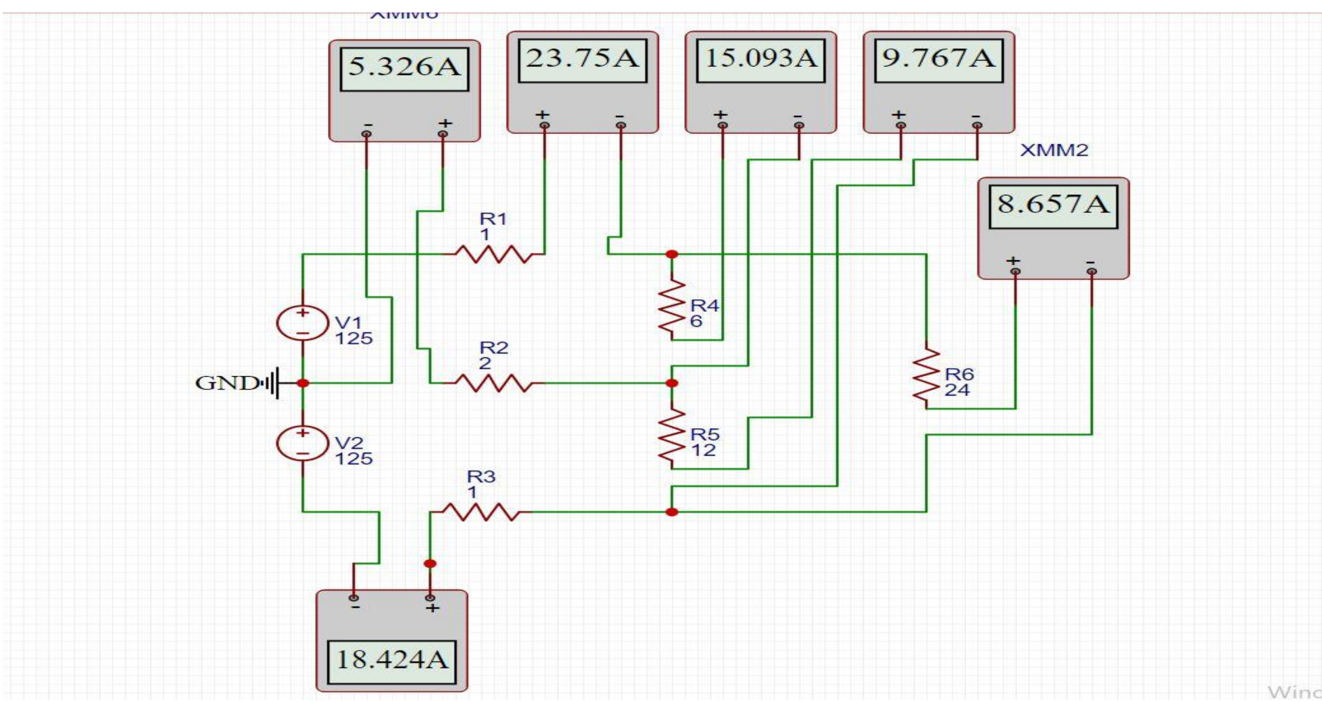
XMM1
XMM2
XMM3
-6.799A
-9.498A
-11.998A
XMM6
XMM7
161.997V
200.001V
R1
5
R2
4
R3
10
XWM1
870.214
V1
128
R4
60
R5
80
V2
320
XWM2
GND
3839.52
XMM4
XMM5
2.7A
2.5A

4.12



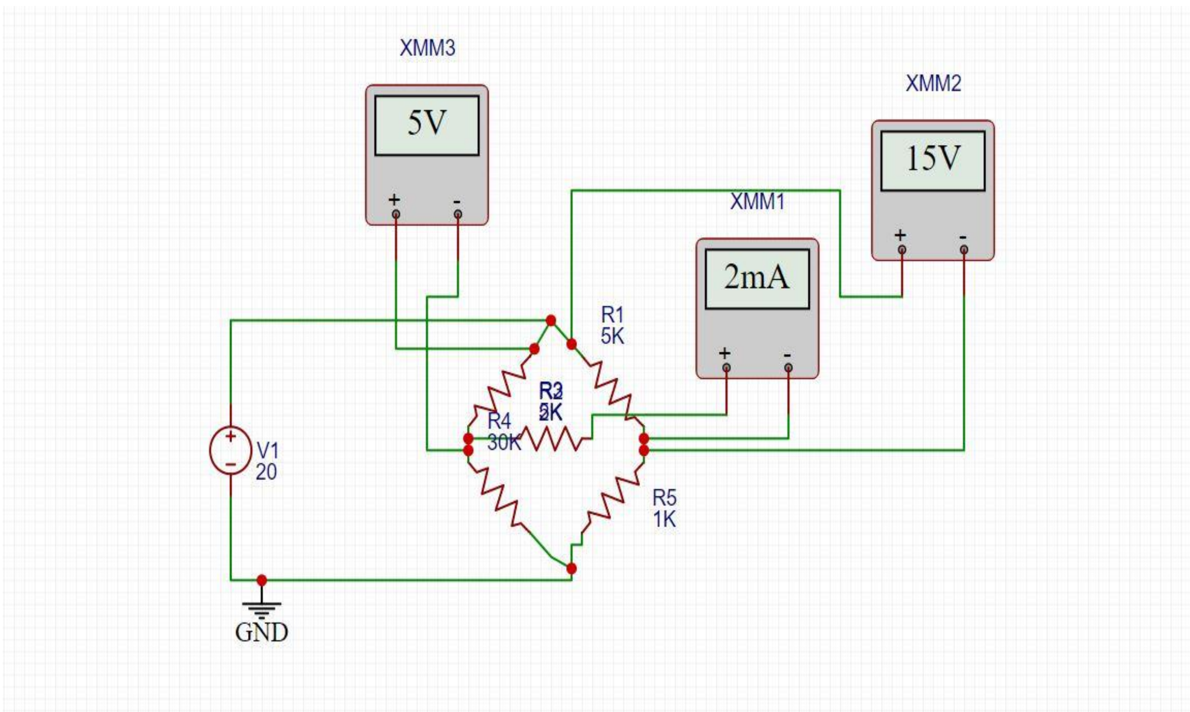
XMM1
100V
XMM2
20V
R1
4
R2
80
V1
144
R4
10
I1
3
R3
5
GND

4.15

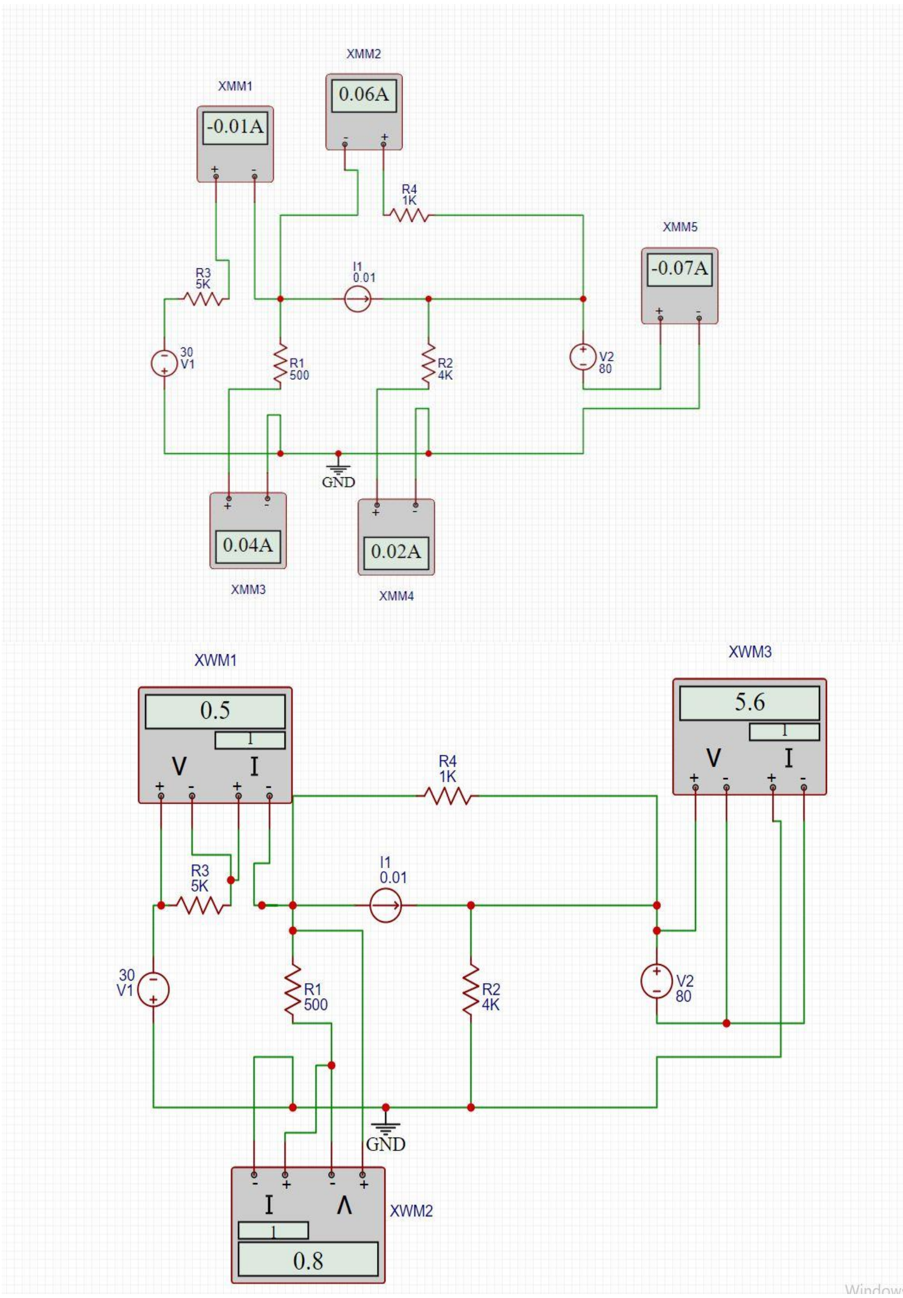


5.326A
23.75A
15.093A
9.767A
XMM2
8.657A
R1
1
R4
6
V1
125
GND
R2
2
R6
24
R5
12
V2
125
R3
1
18.424A

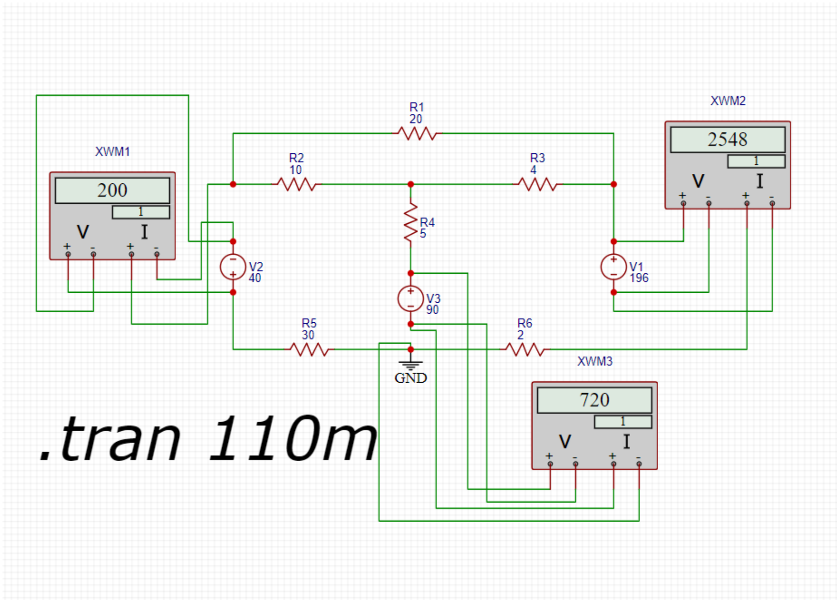
4.24



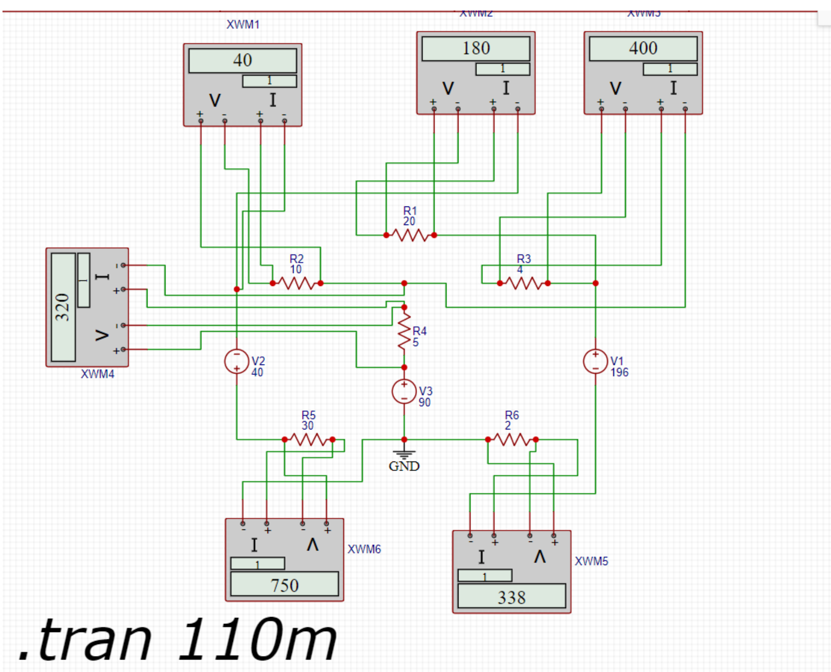
4.27A-B


XMM1
-0.01A
XMM2
0.06A
R4
1K
XMM5
-0.07A
R3
5K
I1
0.01
30
V1
R1
500
R2
4K
V2
80
GND
0.04A
XMM3
0.02A
XMM4
XWM1
0.5
V
I
XWM3
5.6
V
I
R4
1K
R3
5K
I1
0.01
30
V1
R1
500
R2
4K
V2
80
GND
I
V
XWM2
0.8

4.36A-B

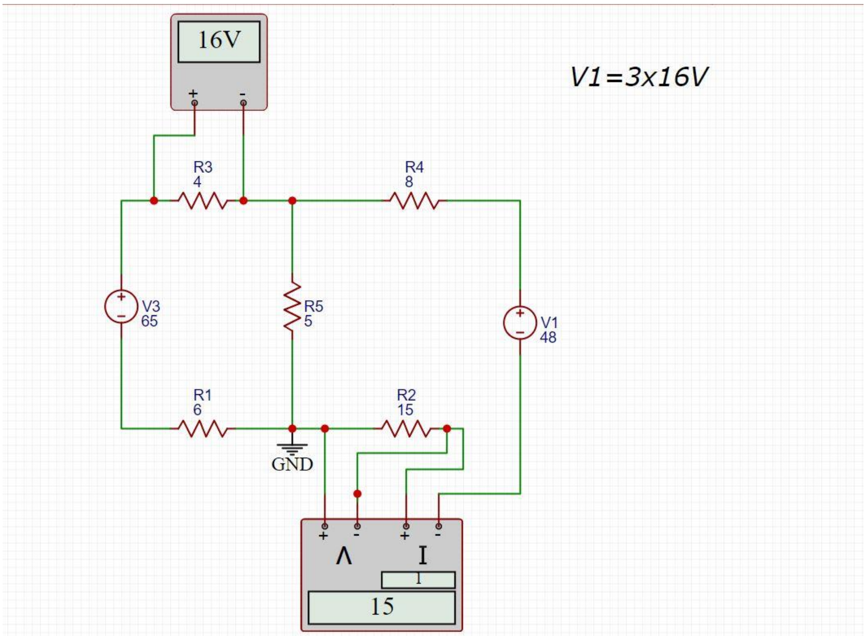


XWM1
200
V
I
R1
20
R2
10
R3
4
R4
5
XWM2
2548
V2
40
V1
196
V3
90
R5
30
R6
2
GND
XWM3
720
.tran 110m

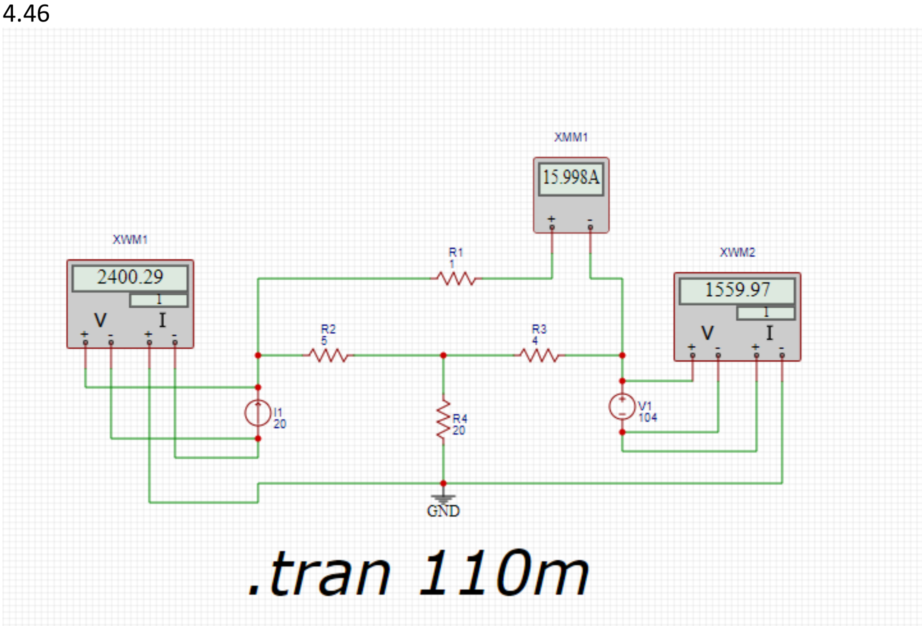


XWM1
40
XWM2
180
XWM3
400
R1
20
R2
10
R3
4
320
XWM4
R4
5
V2
40
V1
196
V3
90
R5
30
R6
2
GND
750
XWM6
338
XWM5
.tran 110m

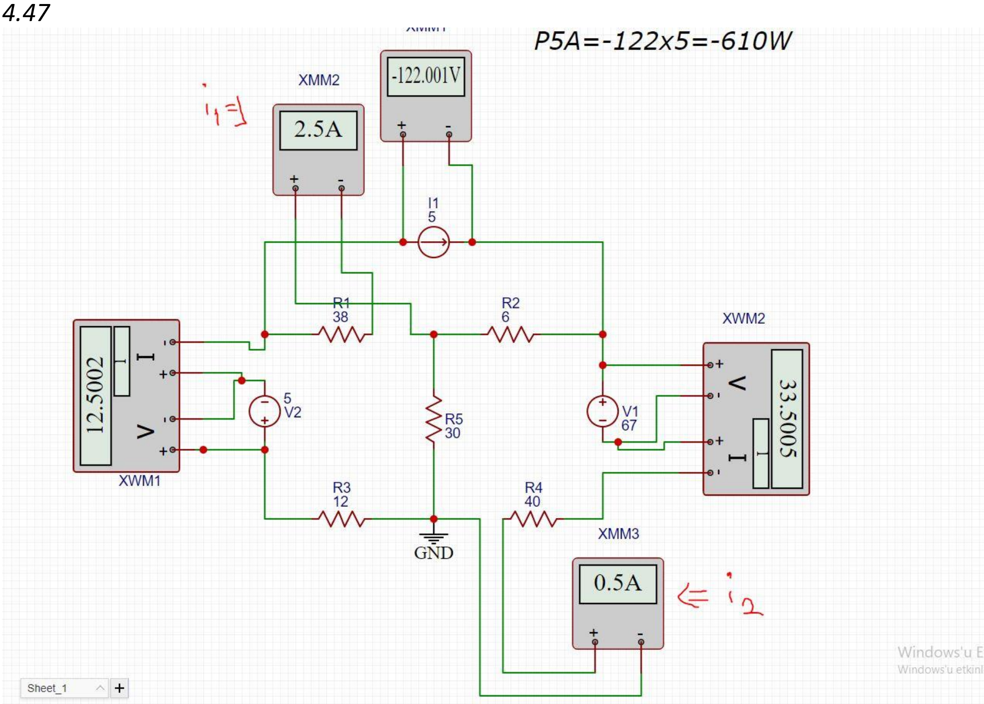
4.39


16V
V1=3x16V
R3
4
R4
8
V3
65
R5
5
V1
48
R1
6
R2
15
GND
V
I
15

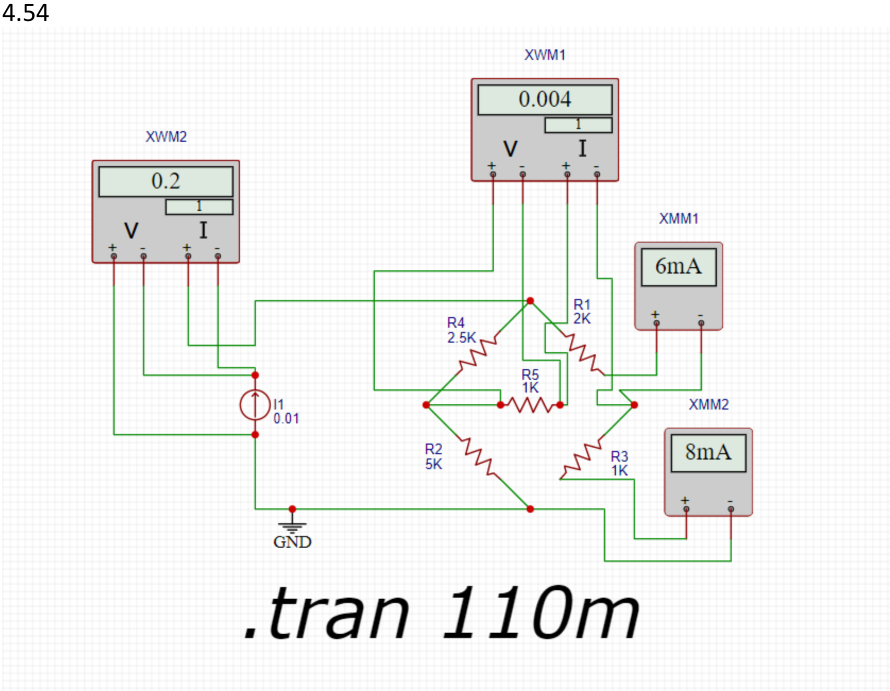
4.46


XMM1
15.998A
XWM1
2400.29
R1
1
XWM2
1559.97
R2
5
R3
4
I1
20
R4
20
V1
104
GND
.tran 110m

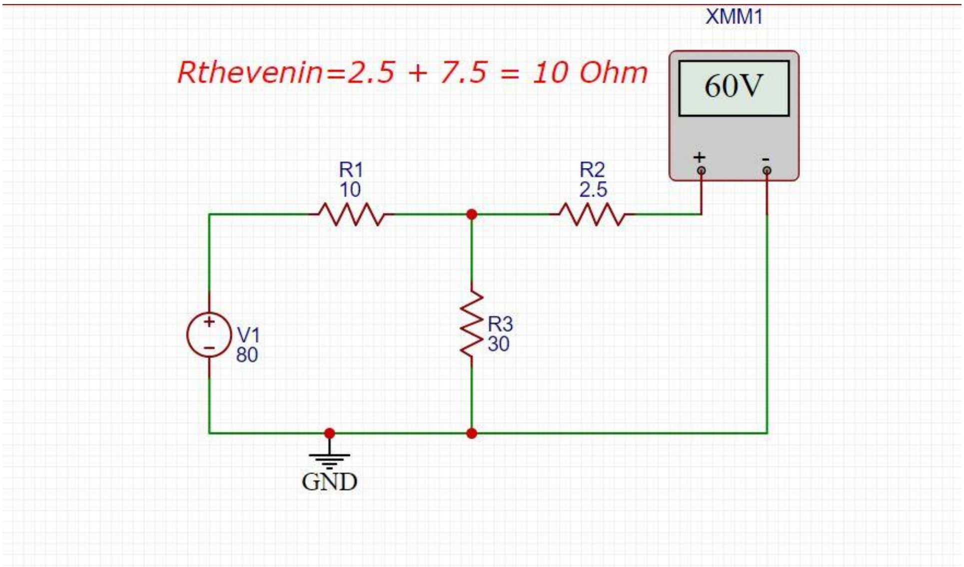
4.47


P5A=-122x5=-610W
XMM2
2.5A
-122.001V
i_1=
I1
5
R1
38
R2
6
XWM2
12.5002
V
I
5
V2
R5
30
V1
67
V
33.5005
I
XWM1
R3
12
R4
40
GND
XMM3
0.5A
⇐ i_2
Sheet_1

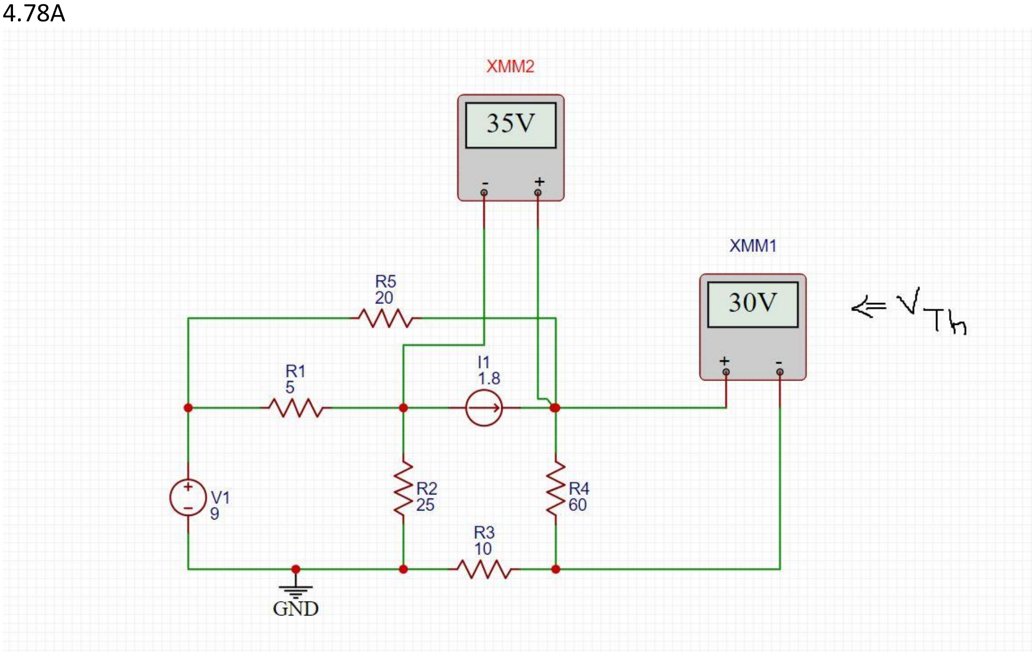
4.54


XWM1
0.004
V
I
XWM2
0.2
V
I
XMM1
6mA
R1
2K
R4
2.5K
R5
1K
I1
0.01
XMM2
8mA
R2
5K
R3
1K
GND
.tran 110m

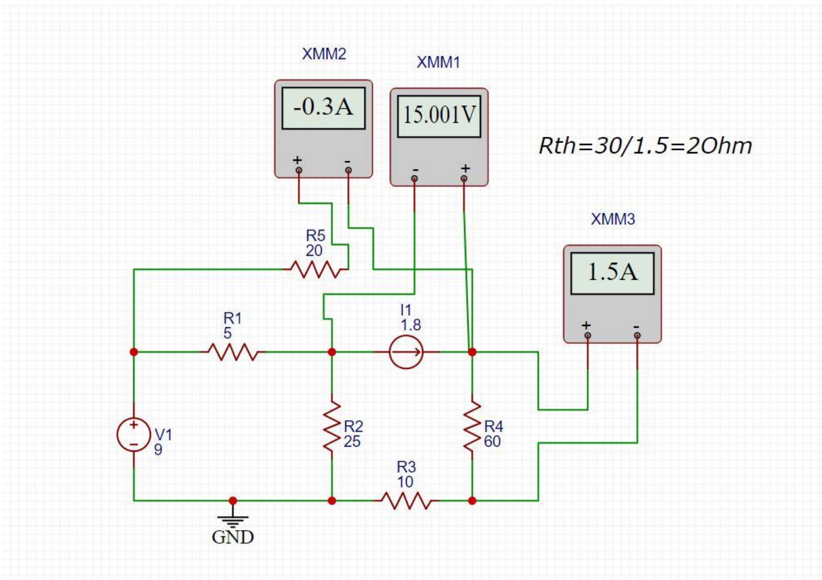
4.64


XMM1
Rthevenin=2.5 + 7.5 = 10 Ohm
60V
+
-
R1
10
R2
2.5
R3
30
V1
80
GND

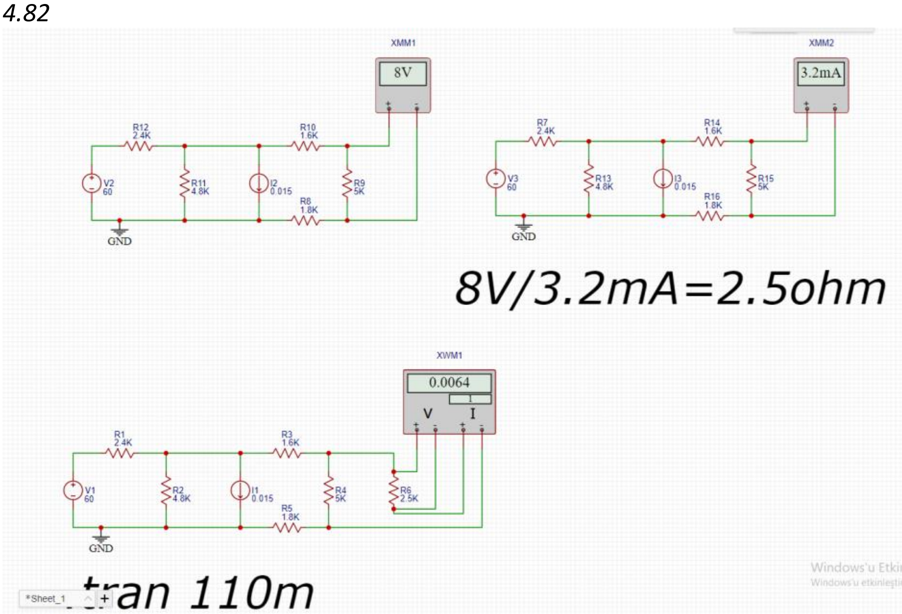
4.78A


XMM2
35V
-
+
XMM1
30V
⇐ V_{Th}
+
-
R5
20
R1
5
I1
1.8
R2
25
R4
60
R3
10
V1
9
GND

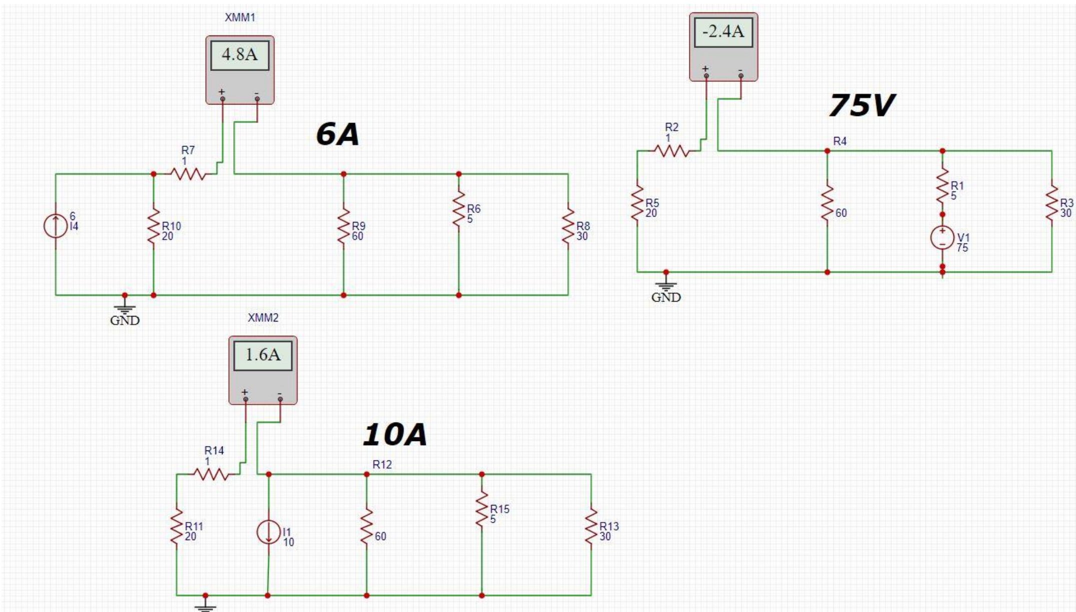
4.78B


XMM2
-0.3A
XMM1
15.001V
Rth=30/1.5=2Ohm
XMM3
1.5A
R5
20
R1
5
I1
1.8
R2
25
R4
60
V1
9
R3
10
GND

4.82


XMM1
8V
XMM2
3.2mA
8V/3.2mA=2.5ohm
XWM1
0.0064
V
I
GND
*Sheet_1
tran 110m

4.95



XMM1
4.8A
6A
R7
1
6
I4
R10
20
R9
60
R6
5
R8
30
GND
-2.4A
75V
R2
1
R4
R5
20
60
R1
5
V1
75
R3
30
GND
XMM2
1.6A
10A
R14
1
R12
R11
20
I1
10
60
R15
5
R13
30