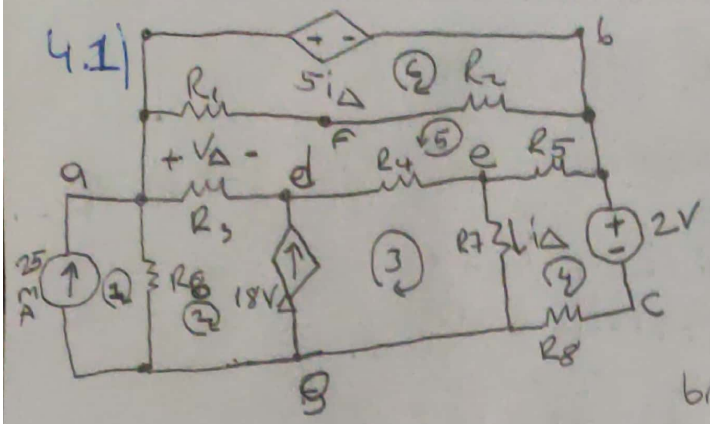
4.1)



nodes: a, b, c, d, e, f, g 7 nodes. (e)

branches: a-b, a-d, (a-g), b-e, b-c, b-f, c-g, d-e, d-g, e-g, a-f, (a-g)

12 branches. (a)

branches with unknown currents: all except 2mA current source 11 branches (b)

essential nodes: a, b, d, e, g 5 nodes. (f)

meshes: 6 meshes. (g)

essential branches: (a-b) (5iΔ), a-d, (a-g) (25mA), d-g, e-g, b-e, d-e, (a-g) (R6), (a-b) (R1-R2), (b-g) (R8, 2V)

10 essential branches. (c)

essential branches with unknown currents: all except the one with 25mA current source.

9 essential branches. (d)

4.2) a) Number of essential nodes with unknown currents is the number of needed equations. 9 equations.

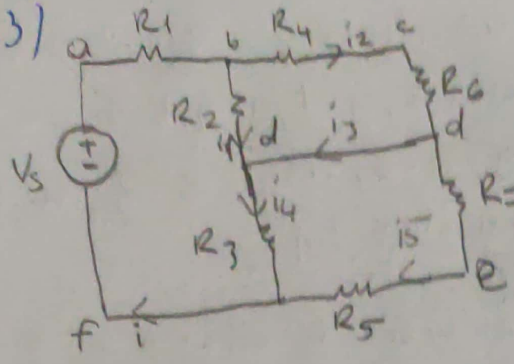
b) essential nodes - 1 = 4 eq. can be derived with KCL

↳ reference node

c) 9 - 4 = 5 eq. must be derived with KVL

d) mesh 2 and 3 should be avoided since we cant determine their voltage drop because they have current sources.

4.3)



a) 5 unknown current

b) 3 essential nodes (b, d, f) $3-1=2$ eq

c) b: $-i+i_1+i_2=0$

f: $+i-i_4-i_5=0$

d) $5-2=3$ eq

e) $-V_S + i.R_1 + i_1.R_2 + i_4.R_3 = 0$ (1)

$i_2(R_4+R_6) - i_1.R_2 = 0$ (2)

$i_5(R_7+R_5) - i_4.R_3$ (3)

4.4) a) $-i + i_2 + i_1 = 0$ (b)

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

$-i_5 - i_4 + i = 0$ (f)

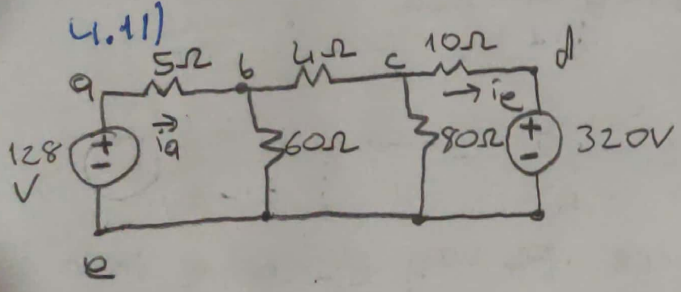
b) sum (b) and (f)

$i + i_2 + i_1 - i_5 - i_4 + i = 0$

multiply with (-1) (both sides)

(b) + (f) = (d) = 0

4.11)



a) reference node: e

b: $\frac{V_c - V_c}{4} + \frac{V_b}{60} + \frac{V_b - 128}{5} = 0$ (60|

c: $\frac{V_c - V_b}{4} + \frac{V_c}{80} + \frac{V_c - 320}{10} = 0$ (99

$15V_b - 15V_c + V_b + 12V_b - 1536 = 0$

$28V_b - 15V_c = 1536 \Rightarrow V_b = \frac{1536 + 15V_c}{28}$

$-20V_b + 29V_c = 2560$

$20V_c - 20V_b + V_c + 8V_c - 2560$

$-20\left(\frac{1536 + 15V_c}{28}\right) + 29V_c = 2560$

$\Rightarrow -\frac{5}{7}(1536 + 15V_c) + 29V_c = 2560$

$\Rightarrow -5(1536 + 15V_c) + 203V_c = 17920$

$\Rightarrow 128V_c = 25600 \Rightarrow V_c = 200V \quad V_b = \frac{1536 + 15.200}{28} = 162V$

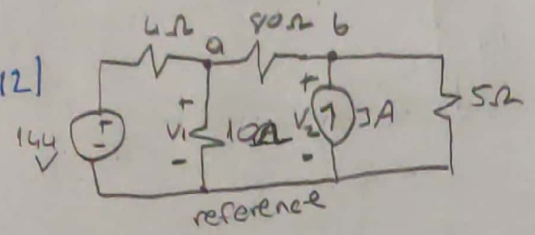
$i_a = \frac{128 - 162}{5} = -6,8A$

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

4.11] b) $P_{144V} = -128 \times 6{,}8 = 870{,}4W$ (absorbed)

$P_{320V} = 320 \times -12 = \underline{3840W}$ (developed)

4.12]



a) $\frac{V_1 - 144}{4} + \frac{V_1}{10} + \frac{V_1 - V_2}{80} = 0$

b) $-3 + \frac{V_2}{5} + \frac{V_2 - V_1}{80} = 0$

a) $20V_1 - 2880 + 8V_1 + V_1 - V_2 = 0$

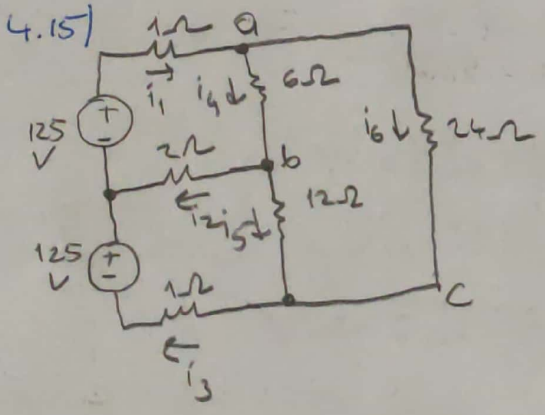
$V_2 = 29V_1 - 2880$

b) $-3 + \frac{29V_1 - 2880}{5} + \frac{28V_1 - 2880}{80} = 0$

$\Rightarrow -240 + 464V_1 - 46080 + 28V_1 - 2880 = 0$

$\Rightarrow 492V_1 = 49200 \Rightarrow \underline{V_1 = 100V}$ $V_2 = 29 \cdot 100 - 2880 = \underline{20V}$

4.15]



a) $\frac{V_a - 125}{1} + \frac{V_a - V_b}{6} + \frac{V_a - V_c}{24} = 0$

$24V_a - 3000 + 4V_a - 4V_b + V_a - V_c = 0$

① $29V_a - 4V_b - V_c = 3000$

b) $\frac{V_b}{2} + \frac{V_b - V_a}{6} + \frac{V_b - V_c}{12} = 0$

$6V_b + 2V_b - 2V_a + V_b - V_c = 0$

② $9V_b - 2V_a - V_c = 0$

c) $\frac{V_c + 125}{1} + \frac{V_c - V_b}{12} + \frac{V_c - V_a}{24} = 0$

$24V_c + 3000 + 2V_c - 2V_b + V_c - V_a = 0$

③ $27V_c - 2V_b - V_a = -3000$

$V_a = 101{,}24V$

$V_b = 10{,}66V$

$V_c = -106{,}57V$

b) $i_1 = \frac{(125 - 101{,}24)}{1} = 23{,}76A$ $i_2 = \frac{10{,}66}{2} = 5{,}33A$ $i_3 = \frac{-106{,}57 + 125}{1} = 18{,}43A$

$i_4 = \frac{(101{,}24 - 10{,}66)}{6} = 15{,}097A$ $i_5 = \frac{+10{,}66 + 106{,}57}{12} = 9{,}77A$

$i_6 = \frac{101{,}24 + 106{,}57}{24} = 8{,}66A$

$P_{developed} = 125 \cdot 5{,}33 + 125 \cdot 18{,}43 = \sum_{n=1}^{n=6} i_n^2 \cdot R_n = 5273{,}8W$

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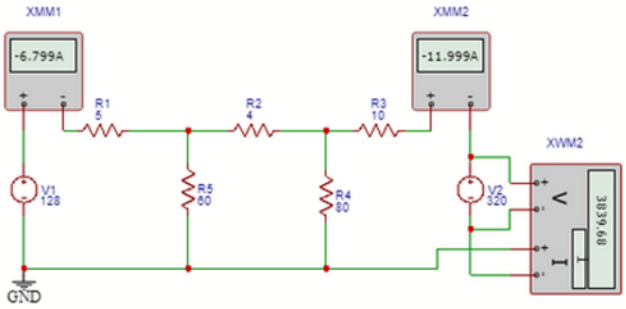
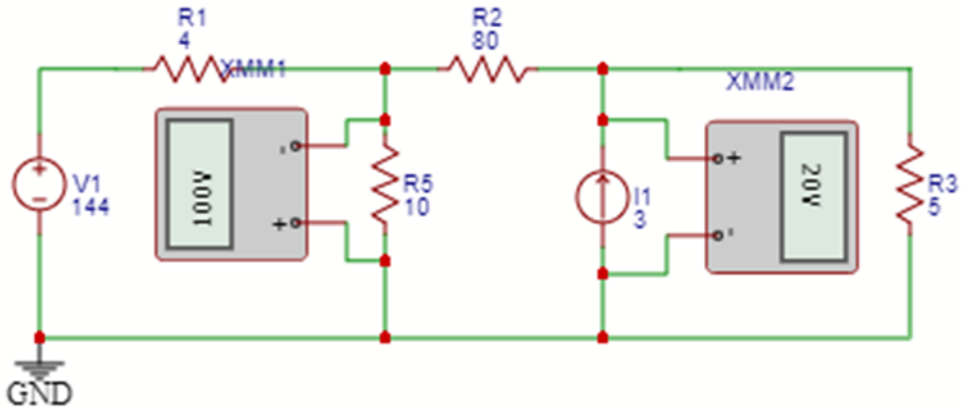


4.11

.tran 110m

TITLE: Sheet_1		REV: 1.0
EasyEDA	Company: Your Company	Sheet: 1/1
	Date: 2020-11-17	Drawn By: Gökbey Keskin



.tran 110m

4.12

TITLE: Sheet_1		REV: 1.0
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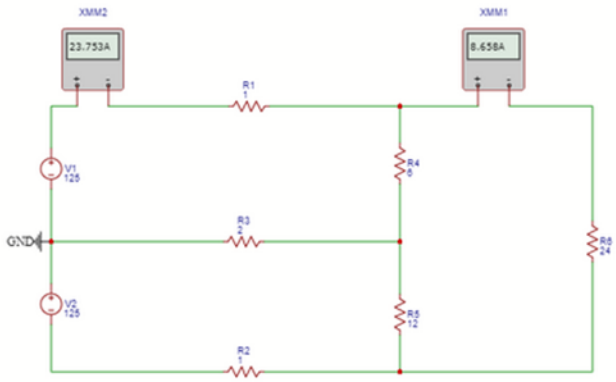


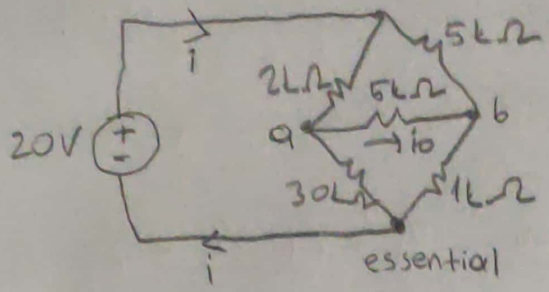
4.15

.tran 10m

I cant use wattmeter
on evey single element
because it says circuit
is too complicated.
But I checked every element
one at a time, values hold.

TITLE: Sheet_1		REV: 1.0
EasyEDA	Company: Your Company	Sheet: 1/1
	Date: 2020-11-17 Drawn By: Gökbey Keskin	

4.24]



a) $\frac{V_a-20}{2000}+\frac{V_a-V_b}{5000}+\frac{V_a}{30000}=0$

$15V_a-300+6V_a-6V_b+V_a=0$

$22V_a=300+6V_b$

$V_a=\frac{150+3V_b}{11}$

$\frac{V_b-20}{5000}+\frac{V_b-V_a}{5000}+\frac{V_b}{1000}=0$

$V_b-20+V_b-V_a+5V_b=0$

$7V_b=V_a+20$

$7V_b=\frac{150+3V_b}{11}+20$

$77V_b=150+3V_b+220$

$V_b=5V$

$V_a=\frac{150+3.5}{11}=15V$

$i_o=\frac{V_a-V_b}{5000}=\frac{10}{5000}=2mA$

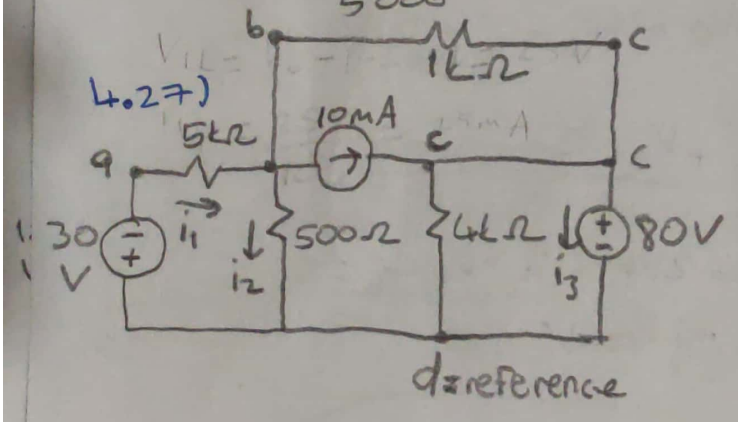
b) $V_{2k\Omega}=\frac{20-V_a}{2000}=2.5mA$

$V_{5k\Omega}=\frac{20-V_b}{5000}=3mA$

$i=2,5+3=5,5mA$

$P_{20V}=20V.5,5mA=110mW$

4.27)



$V_c=80V$ $V_a=-30V$

$\frac{V_b+30}{5000}+\frac{V_b}{500}+0,01+\frac{V_b-80}{1000}=0$

$V_b+30+10V_b+50+5V_b-400=0$

$16V_b=320$ $V_b=20V$

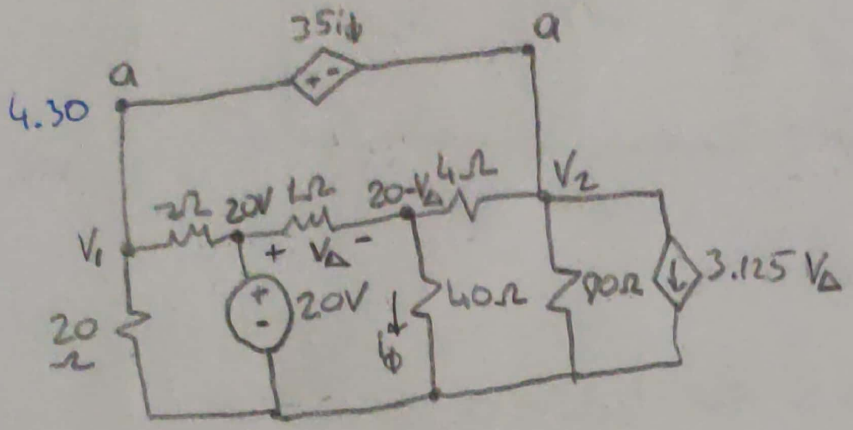
$i_1=\frac{-30-20}{500}=-0,01A=-10mA$

$i_2=\frac{20}{500}=0,04A=40mA$

$i_3=10mA+\frac{20-80}{1000}-\frac{80}{4000}=0,01+(-0,06)-0,02)=-0,07A=-70mA$

4.27) b) $30 \cdot (-0{,}01) + 80 \cdot (-0{,}07) = (-0{,}01)^2 \cdot 5000 + (0{,}04)^2 \cdot 500 + \left(\frac{80}{400}\right)^2 \cdot 400$

4.30



From the super node:

$V_1 - 35 i_\phi = V_2$

$i_\phi = \frac{V_1 - V_2}{35}$ (1)

$i_\phi = \frac{20 - V_\Delta}{40}$ (2)

for $20 - V_\Delta$:

$\frac{-V_\Delta}{1} + \frac{20 - V_\Delta}{40} + \frac{20 - V_\Delta - V_2}{4} = 0 \Rightarrow -40V_\Delta + 20 - V_\Delta + 200 - 10V_\Delta - 10V_2$

$= -51V_\Delta - 10V_2 + 220 = 0$ (3)

for the super node:

$\frac{V_1}{20} + \frac{V_1 - 20}{2} + \frac{V_2 - 20 + V_\Delta}{4} + \frac{V_2}{80} + 3{,}125 V_\Delta = 0$

Put $V_2 + 35 i_\phi$ for V_1 and $\frac{20 - V_\Delta}{40}$ for i_ϕ

$$\frac{V_2 + 35\left(\frac{20 - V_\Delta}{40}\right)}{20} + \frac{V_2 + 35\left(\frac{20 - V_\Delta}{40}\right) - 20}{2} + \frac{V_2 - 20 + V_\Delta}{4} + \frac{V_2}{80} + 3{,}125 V_\Delta$$

$160V_2 + 2800 - 140V_\Delta + 1600V_2 + 28000 - 1400V_\Delta + 800V_2 - 16000 + 800V_\Delta + 40V_2 + 10000 = 0$

$2600V_2 - 740V_\Delta = 24800$

$\Rightarrow 130V_2 - 37V_\Delta = 1240V$

$10V_2 + 51V_\Delta = 220V$ (3)

$V_2 = -29V \quad V_\Delta = 10V$

$V_1 = -20{,}25V \quad i_\phi = 0{,}25A$

$P_{20V} = \left(\frac{20 - V_1}{2} + \frac{V_\Delta}{1} + \frac{40{,}25}{2} + 10\right) \cdot 20$

$= 602{,}5W$

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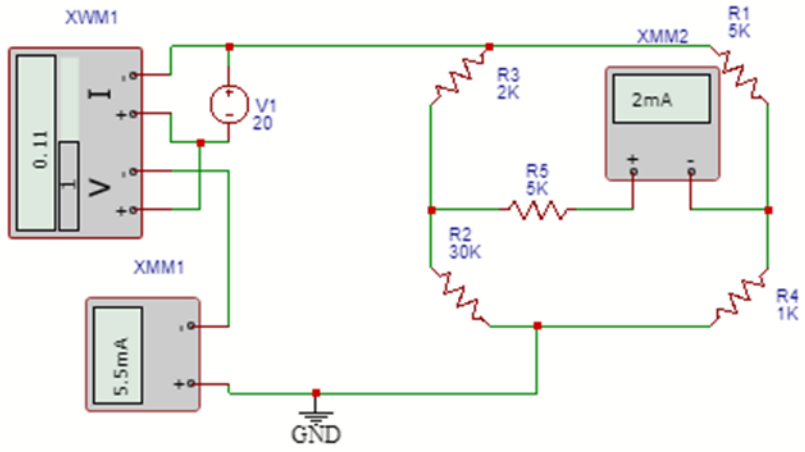

4.24

.tran 110m

TITLE: Sheet_1		REV: 1.0
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	Date: 2020-11-17 Drawn By: Gökbey Keskin	

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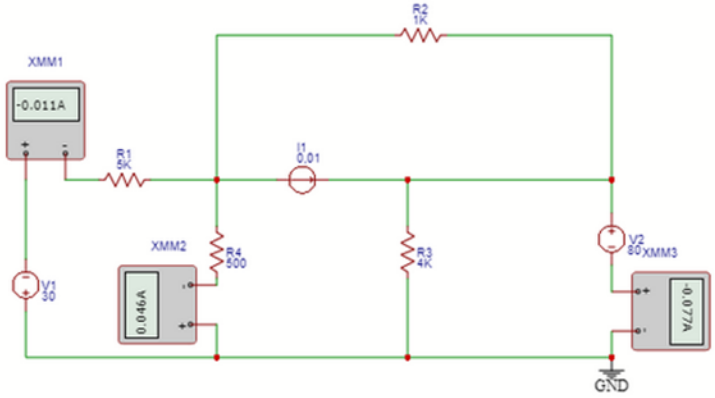
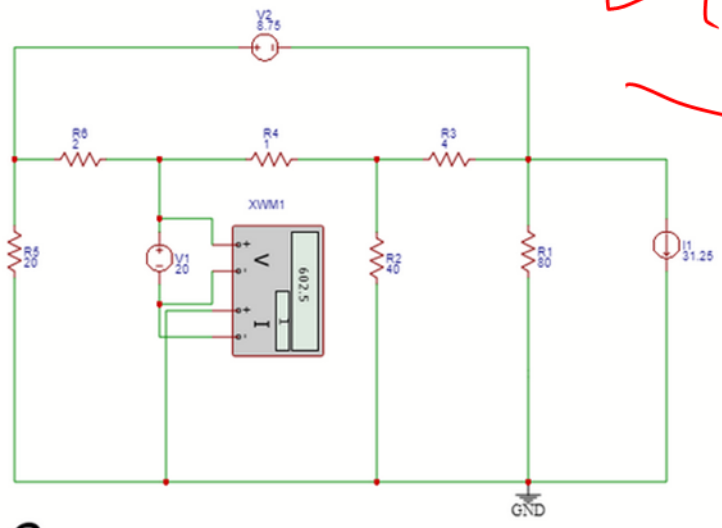


4.27

.tran 110m

TITLE: Sheet_1		REV: 1.0
EasyEDA	Company: Your Company	Sheet: 1/1
	Date: 2020-11-18	Drawn By: Gökbey Keskin

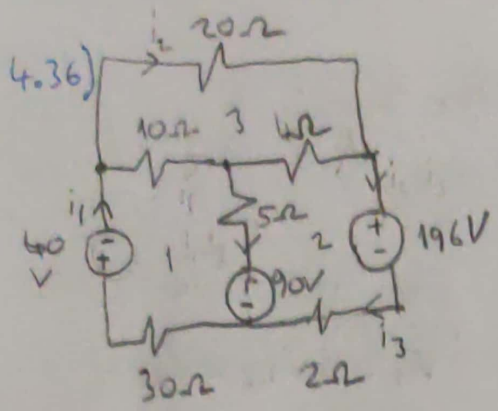


4.30

.tran 110m

TITLE: Sheet_1		REV: 1.0
EasyEDA	Company: Your Company	Sheet: 1/1
	Date: 2020-11-18	Drawn By: Gökbey Keskin

4.36)



a)

$40 + (i_1 - i_2).10 + (i_1 - i_3).5 + 90 + i_1.30 = 0$ (1)

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

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

$45 i_1 - 10 i_2 - 5 i_3 + 130 = 0$

$-10 i_1 + 34 i_2 - 4 i_3 = 0$

$-5 i_1 - 4 i_2 + 11 i_3 + 106 = 0$

$i_1 = -5\ A$

$i_2 = -3\ A$

$i_3 = -13\ A$

$P_{40V} = 40.-5 = -200W$ (delivers)

$P_{90V} = 90.(-5-(-13)) = 720\ W$ (absorbs)

$P_{196V} = 196.-13 = -2548\ W$ (delivers)

$2548 + 200 = \underline{2748W}$

b) $30.5^2 + 10.(5-3)^2 + 5.(-5+13)^2 + 90.(-5+13) + 2.13^2 + 4.(13-3)^2 + 20.(13)^2 = \underline{2748W}$

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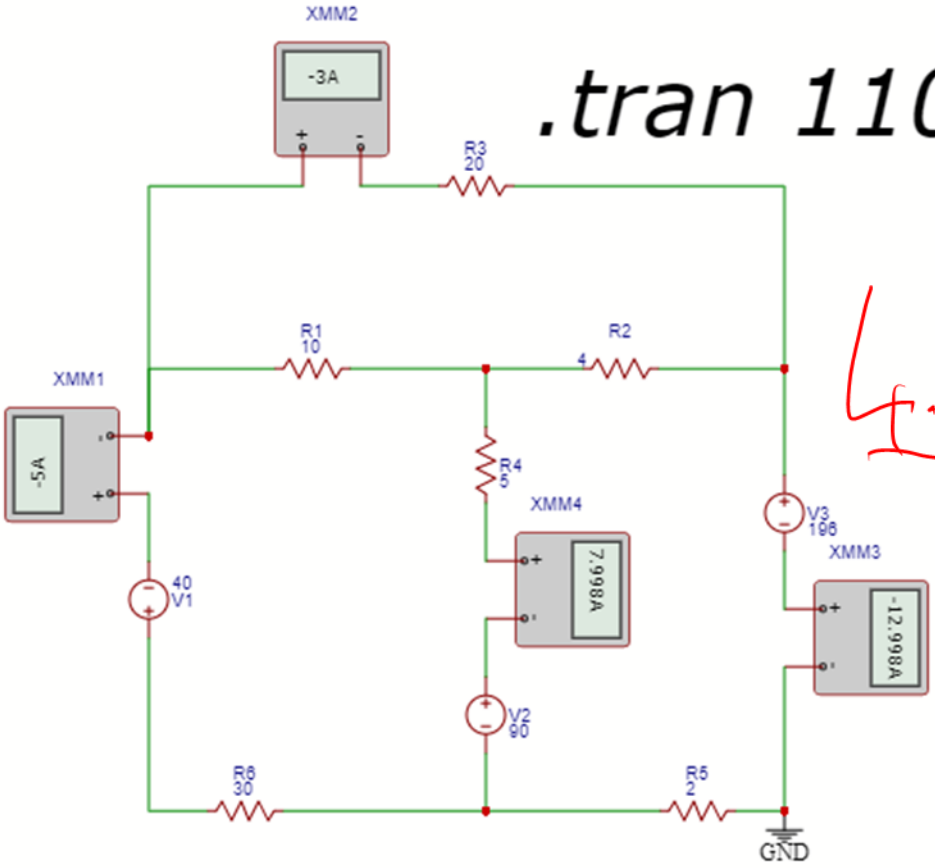

4.36

-5*40 = -200W(delivers)
-13*196=-2548W(delivers)
90*8 = 720W (absorbs)

TITLE: Sheet_1		REV: 1.0
EasyEDA	Company: Your Company	Sheet: 1/1
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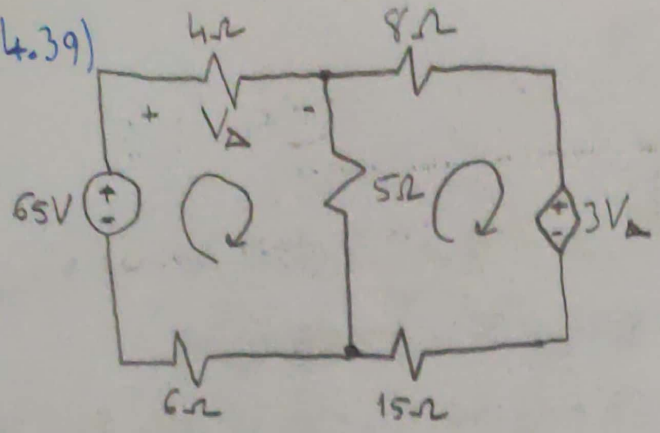
4.39)



$V_\Delta = i_1 \cdot 4$

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

$i_2 \cdot 8 + 3(i_1 \cdot 4) + i_2 \cdot 15 + (i_2 - i_1) \cdot 5 = 0$

$15 i_1 - 5 i_2 = 65$

$i_2 = 3 i_1 - 13$

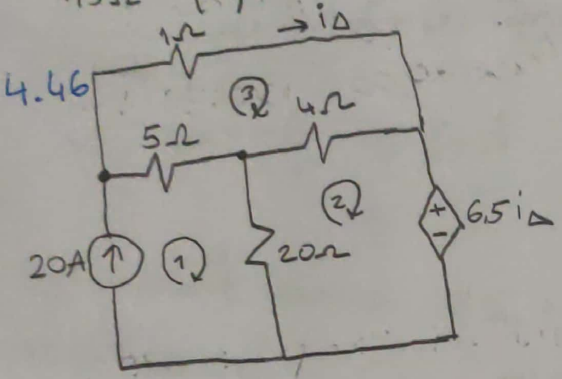
$28 i_2 + 12 i_1 - 5 i_1 = 0$

$28(3 i_1 - 13) + 12 \cdot i_1 - 5 i = 0$

$91 i_1 = 364 \Rightarrow i_1 = 4A \Rightarrow i_2 = 3 \cdot 4 - 13 = -1A$

$P_{15\Omega} = (-1)^2 \cdot 15 = 15W$

4.46



$i_1 = 20$

$6,5 i_\Delta + (i_2 - 20) \cdot 20 + (i_2 - i_\Delta) \cdot 4 = 0$

$2,5 i_\Delta + 24 i_2 = 400$

$i_\Delta \cdot 1 + (i_\Delta - i_2) \cdot 4 + (i_\Delta - 20) \cdot 5 = 0$

$10 i_\Delta - 4 i_2 = 100$

$-4 / \quad 2,5 i_\Delta + 24 i_2 = 400$

$-100 i_2 = -1500$

$i_2 = 15A$

$2,5 i_\Delta + 24 \cdot 15 = 400$

$i_\Delta = 16A$

$-V_{20A} + (20 - 16) \cdot 5 + (20 - 15) \cdot 20 = 0$

$V_{20A} = 120V$

$P_{20A} = -(120 \cdot 20) = -2400W$ (developed) 2400W

$P_{6,5 i_\Delta} = (6,5 \cdot 16) \cdot 15 = 1560W$ (absorbed)

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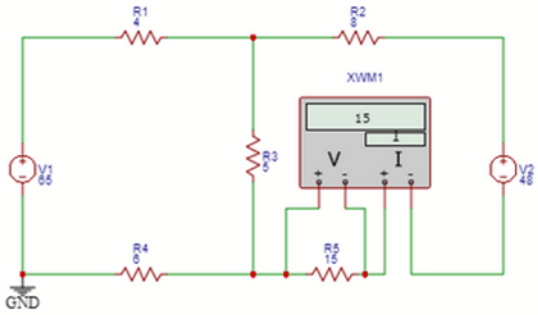
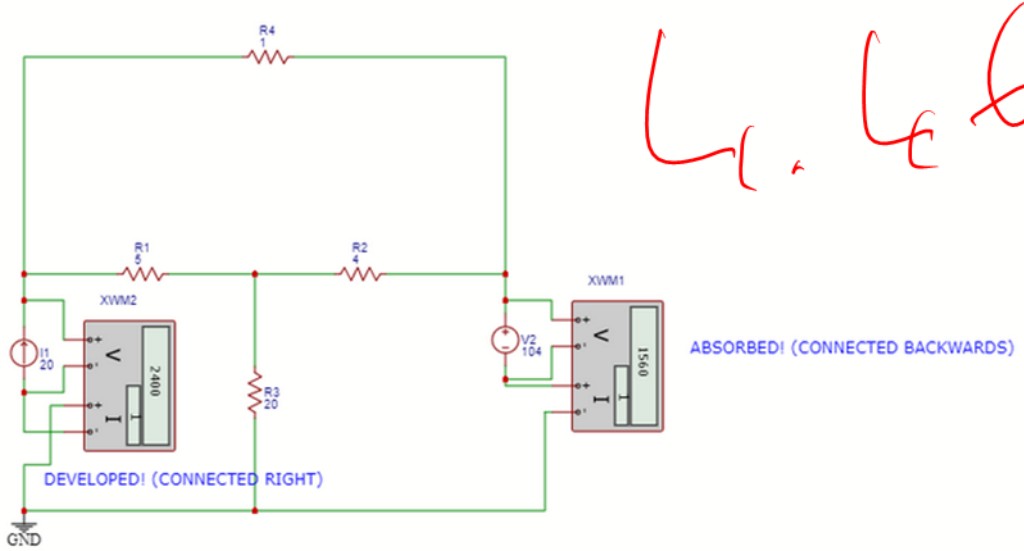


4.39

.tran 110m

TITLE: Sheet_1		REV: 1.0
EasyEDA	Company: Your Company	Sheet: 1/1
	Date: 2020-11-18	Drawn By: Gökbey Keskin

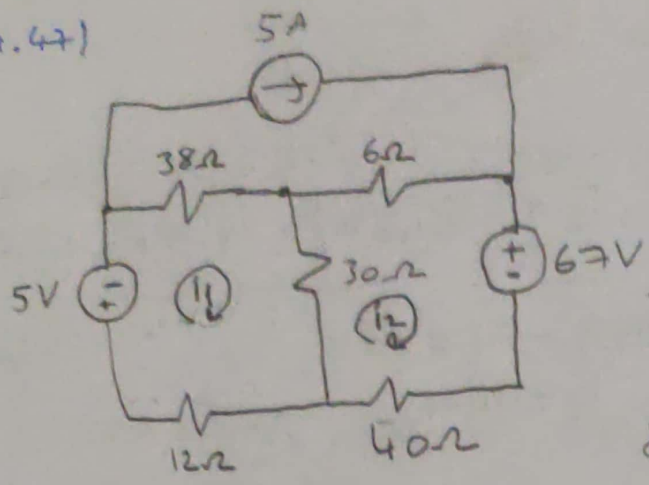


4.46

.tran 110m

TITLE: Sheet_1		REV: 1.0
EasyEDA	Company: Your Company	Sheet: 1/1
	Date: 2020-11-18	Drawn By: Gökbey Keskin

4.47)



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

$3 / \quad 80 i_1 - 30 i_2 = 185 \quad (1)$

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

$8 / \quad -30 i_1 + 76 i_2 = -37 \quad (2)$

$240 i_1 - 90 i_2 = 555$

$-240 i_1 + 608 i_2 = -296$

$518 i_2 = 259$

$i_2 = 0{,}5A \Rightarrow 80 i_1 - 30 \cdot (0{,}5) = 185 \Rightarrow i_1 = 2{,}5A$

$-V_{5A} + (5 - 0{,}5) \cdot 6 + (5 - 2{,}5) \cdot 38 = 0$

$V_{5A} = 122V \quad P_{5A} = 122.5 = 610W$

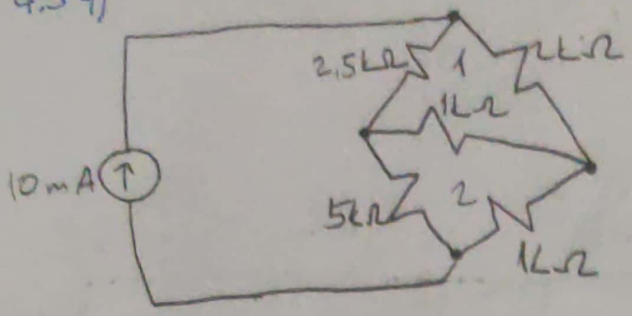
b) $P_{5V} = 2{,}5 \times 5 = 12{,}5W$ (absorbs)

$P_{67V} = 0{,}5 \times 67 = 33{,}5$ (absorbs

610W

c) $12{,}5 + 33{,}5 + (2{,}5)^2 \cdot 12 + (2{,}5 - 5)^2 \cdot 38 + (2{,}5 - 0{,}5)^2 \cdot 30 + (5 - 0{,}5)^2 \cdot 6 + (0{,}5)^2 \cdot 40 = 610W$

4.54)



a) I would use mesh-current method because there is only 2 unknown mesh currents but 3 unknown node voltages.

b)

$$i_1 \cdot 2000 + (i_1 - i_2) \cdot 1000 + (i_1 - 0{,}01) \cdot 2500 = 0$$

$$i_2 \cdot 1000 + (i_2 - 0{,}01) \cdot 5000 + (i_2 - 1) \cdot 1000 = 0$$

$$5500 i_1 - 1000 i_2 = 25 \quad /\times 7$$

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

$$+$$

$$37500 i_1 = 275A$$

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

$$P_{1k\Omega} = (0{,}008 - 0{,}006)^2 \cdot 1000 = 0{,}004 W$$

$$= \underline{4mW}$$

c) I wouldn't because all I have to do is find the voltage of 10mA current source.

d) $V_{10mA} + (0{,}01 - 0{,}006) \cdot 2500 + (0{,}01 - 0{,}002) \cdot 5000 = 0$

$$\Rightarrow V_{10mA} = 20V$$

$$20 \cdot 0{,}01 = \underline{0{,}2W}$$

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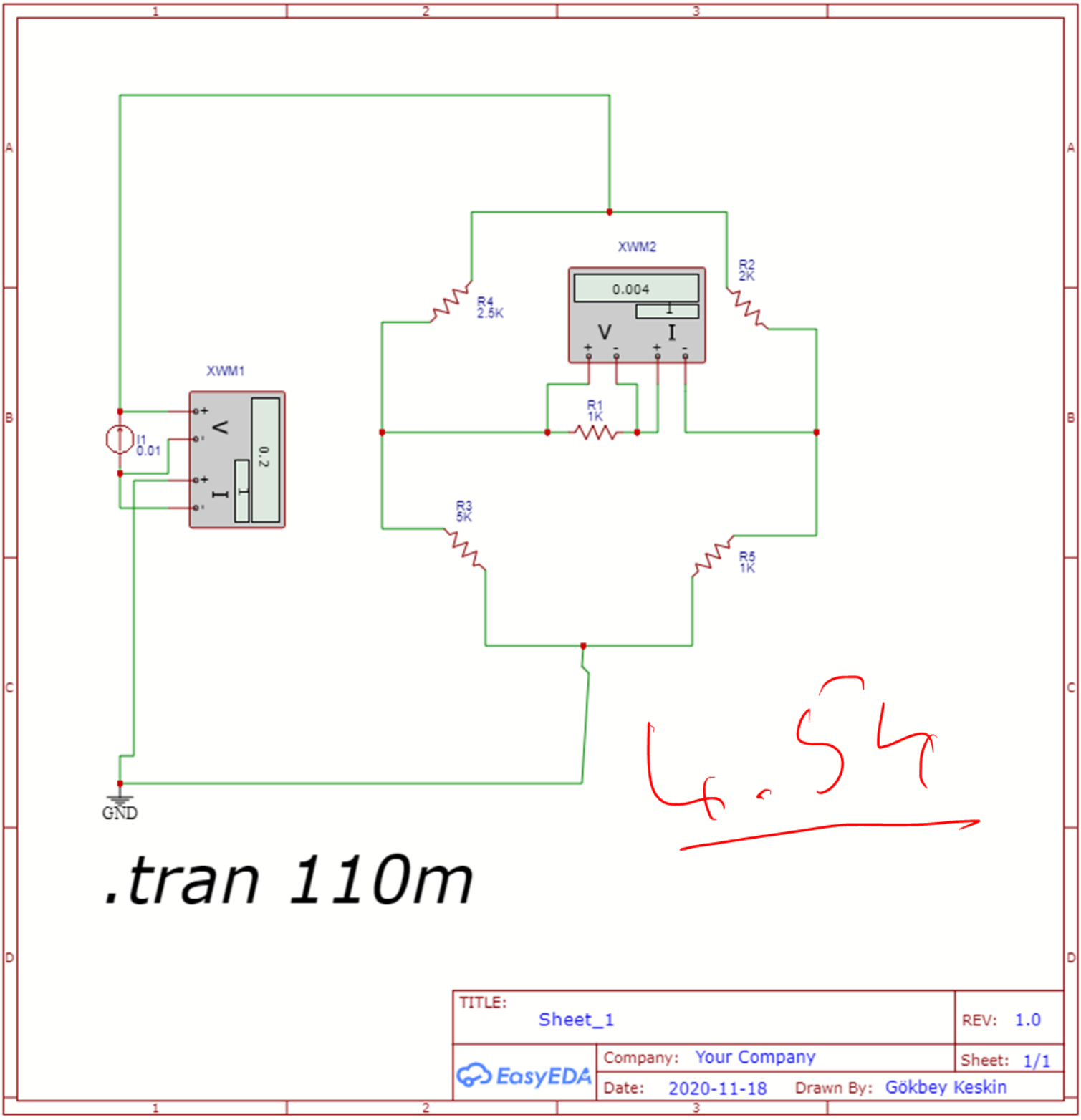
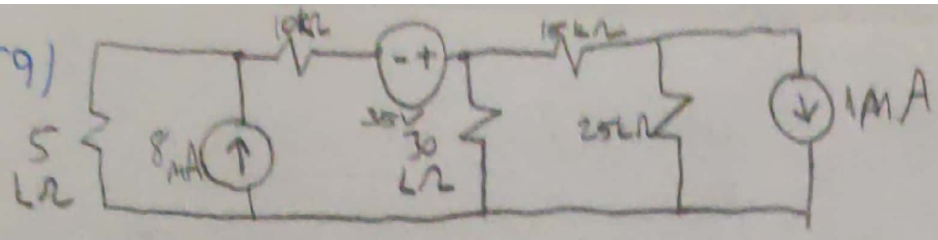
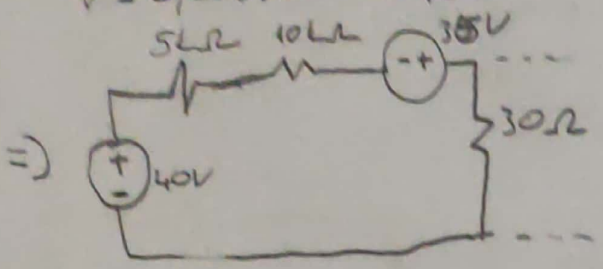
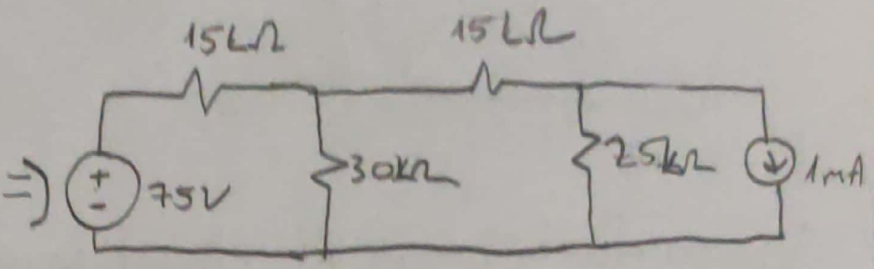


4.59)



$V = 0,008 \cdot 5000 = 40V$





$75 = 15000 \cdot i \Rightarrow i = 0,005A$ // $15k\Omega \| 30k\Omega = 10k\Omega$

$\Rightarrow$

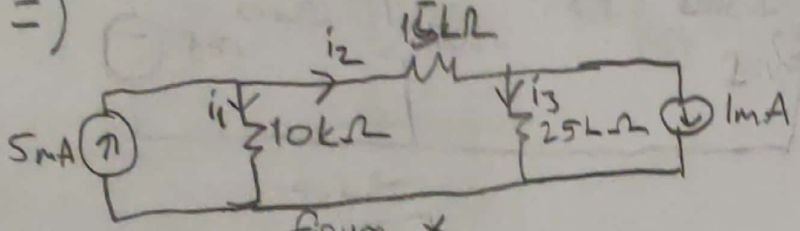


figure x

$$i_3 = \frac{0,005 \cdot 10}{50} + \left(\frac{-0,001 \cdot 25}{50}\right) = 0,0005A$$

$V_0 = 0,0005 \cdot 25000 = 12,5V$

6) Mesh analysis for figure x

$i \cdot 75 + (i-1) \cdot 25 + (i-5) \cdot 10 = 0$,

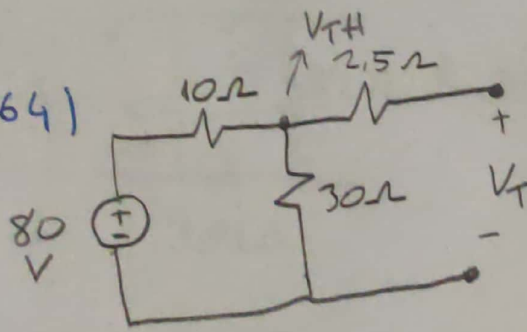
$50i = 75$

$i = 1,5mA$

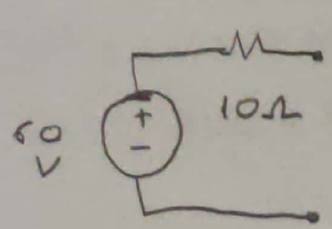
$(1,5-1) \cdot 25 = 12,5V$

(mA) (kΩ)

4.64)



$R_{TH} = (10 \| 30) + 2,5 = 10\Omega$



$\frac{V_{TH} - 80}{10} + \frac{V_{TH}}{30} = 0$

$4V_{TH} = 240V$

$V_{TH} = 60V$

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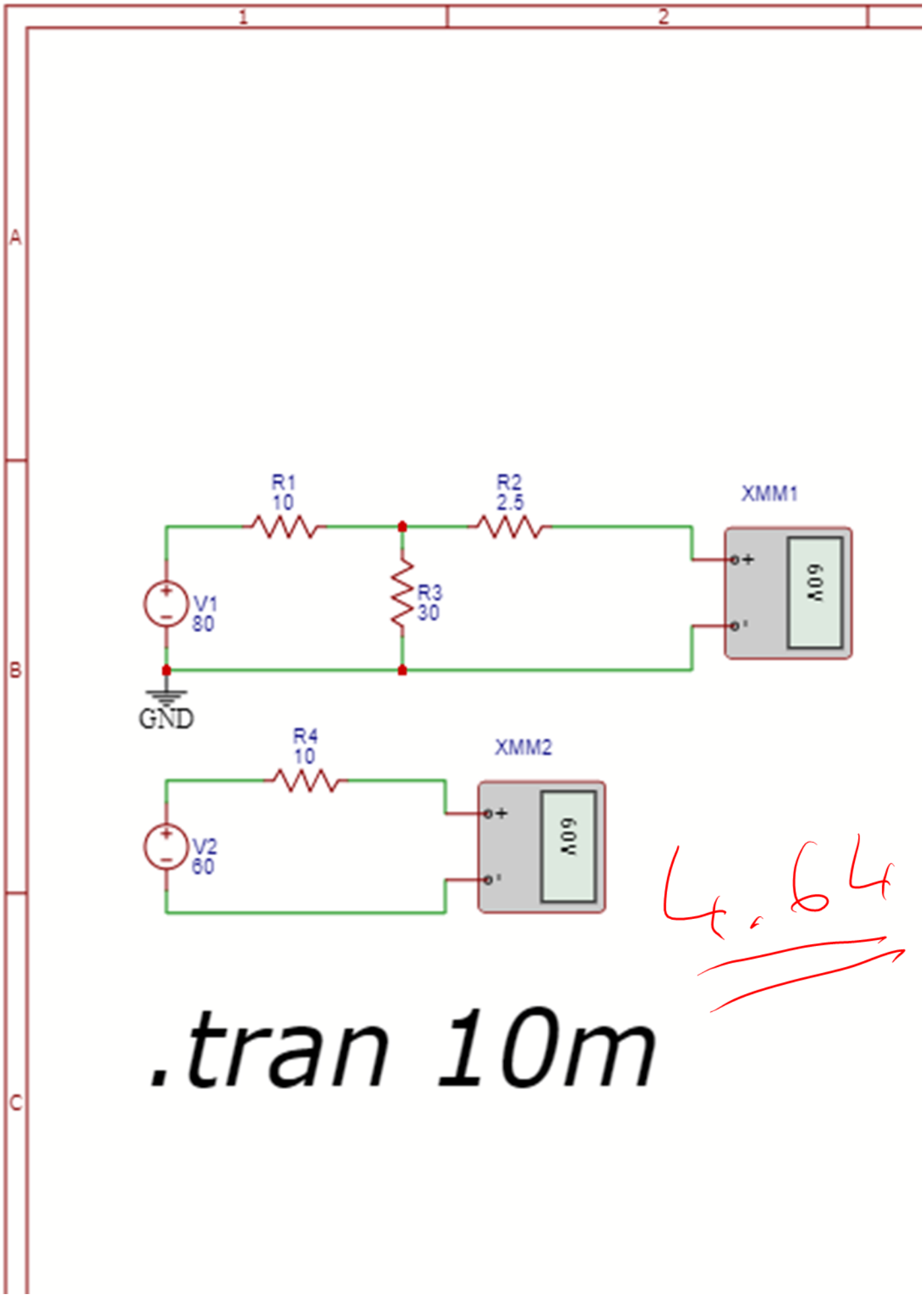
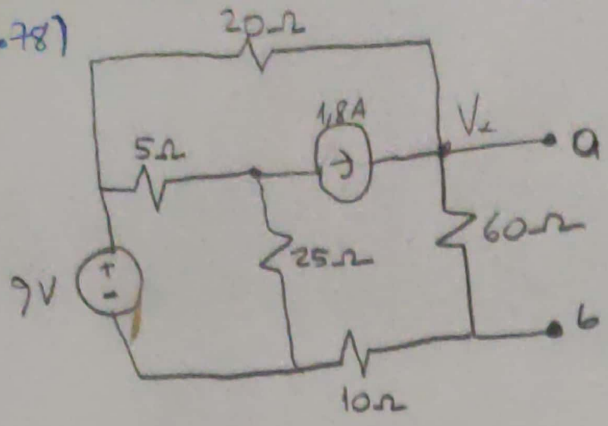


4.78)

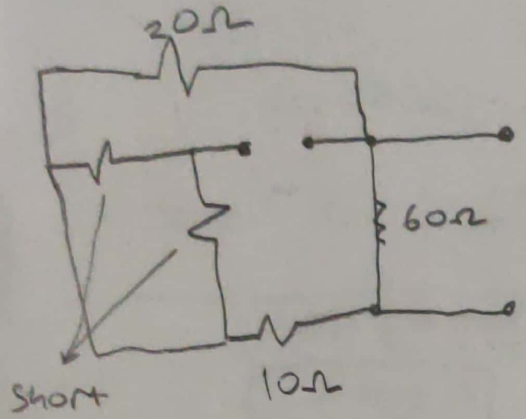


$$\frac{V_x}{70} - 1{,}8 + \frac{V_x - 9}{20} = 0$$

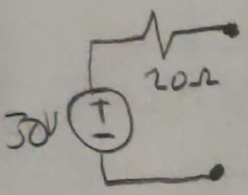
$$9V_x = 315$$

$$V_x = 35V$$

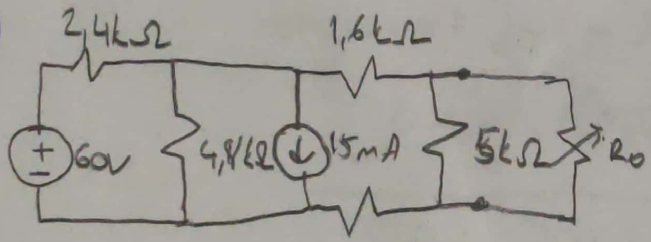
$$V_{TH} = 35.\frac{6\cancel{0}}{7\cancel{0}} = 30V$$

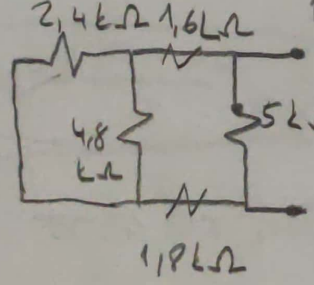


$R_{Th} = (20+10) \| 60 = 20\Omega$



4.82)





$R_{TH} = (((2{,}4 \| 4{,}8) + 1{,}6) + 1{,}8) \| 15 = 2500\Omega$

a) For max P R_o should be equal to R_{TH}

2500

$$-60 + i_1 \cdot 2400 + (i_1 - i_2)\,4800 = 0 \Rightarrow 7200 i_1 - 4800 i_2 = 60 \quad (1)$$

$$(i_2 - i_1) \cdot 4800 + i_3 \cdot 1600 + i_3 \cdot 5000 + i_3 \cdot 1800 = 0 \Rightarrow -4800 i_1 + 4800 i_2 + 8400 i_3 = 0 \quad (2)$$

$$i_1 = 19{,}4mA, \; i_2 = 16{,}6mA \quad i_3 = 1{,}6mA$$

$$i_2 - i_1 = 0{,}015 \quad (3)$$

$V_{TH} = 5000 \cdot 0{,}016 = 8V$

b) $P_{max} = \frac{V_{TH}^2}{4R_{TH}} = \frac{64}{4.2500} = 6{,}4mW$

c) $P_{2.7k} = \frac{V_{TH}}{R_o + R_{TH}} \cdot R_o = \underline{6{,}391mW}$

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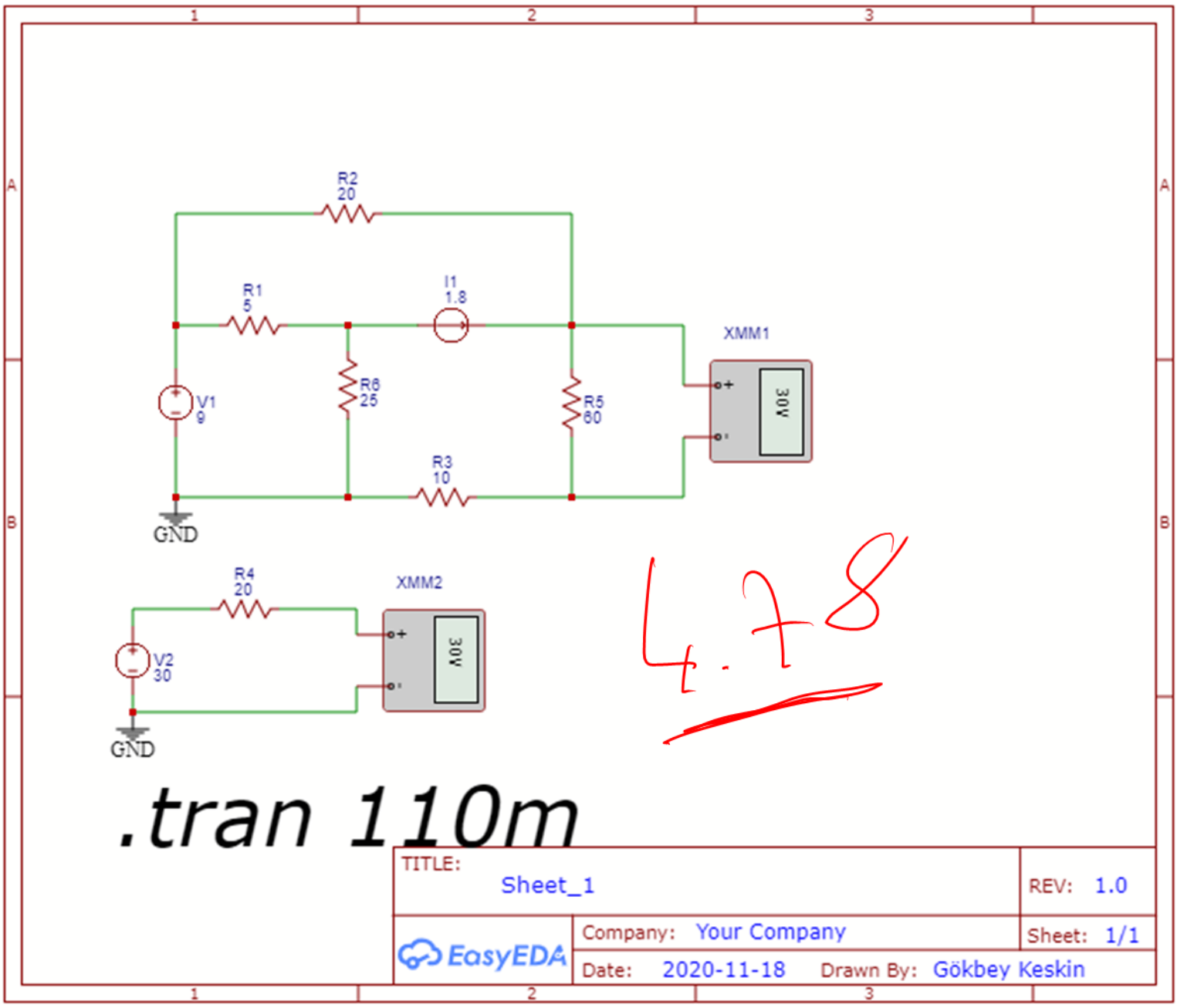

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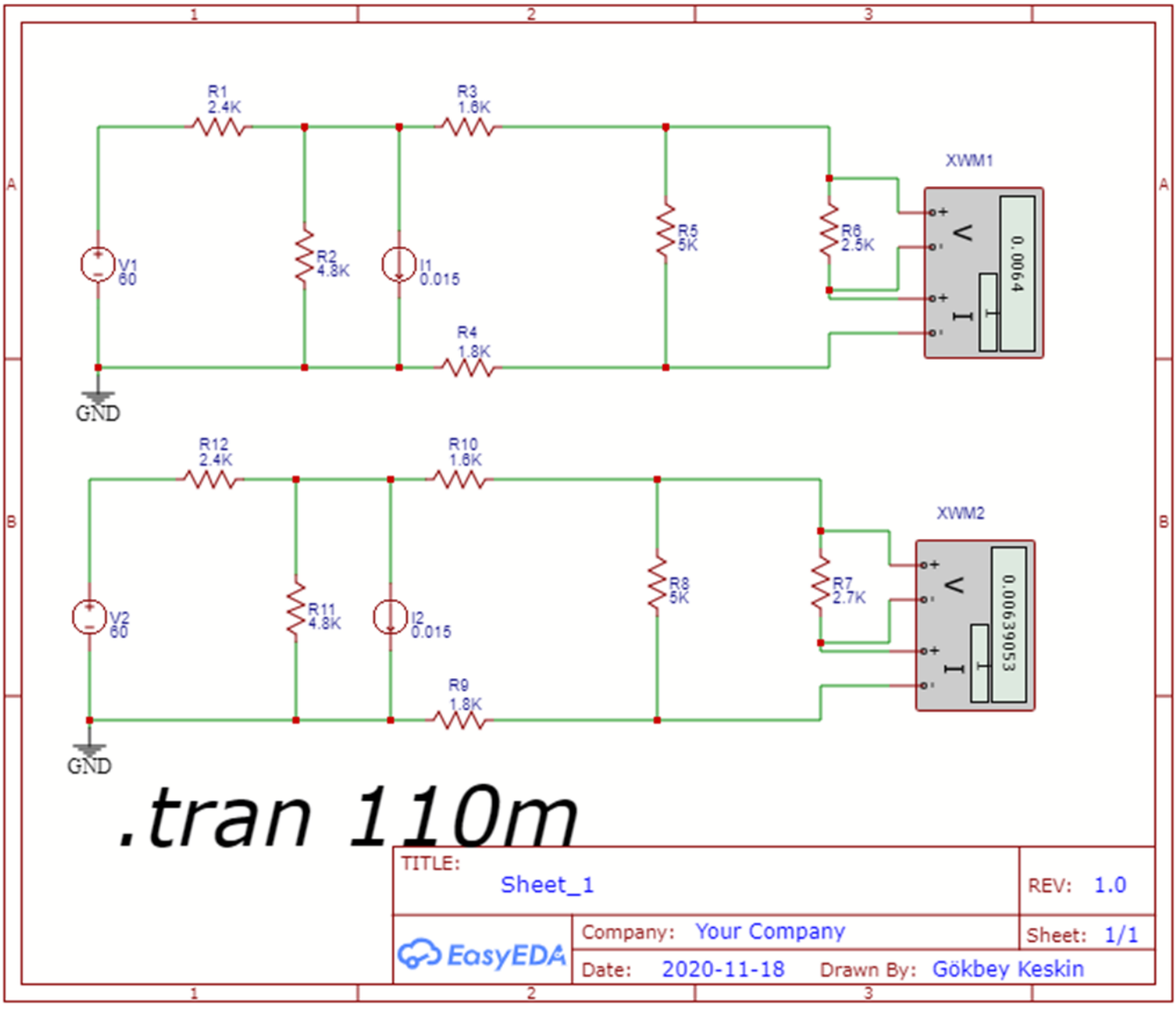
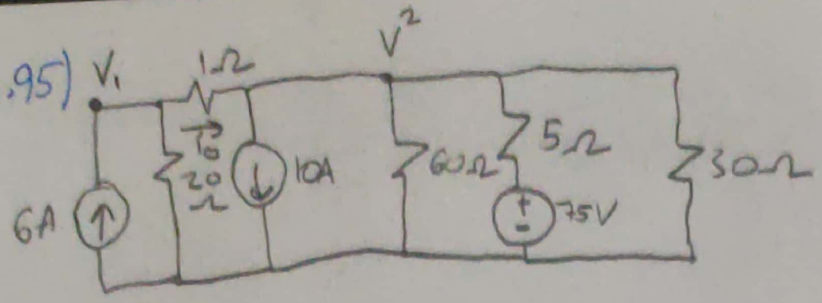


4.95)



for only 10A source:

$$\frac{V_2'-V_1'}{1}+10+\frac{V_2'}{60}+\frac{V_2'}{5}+\frac{V_2'}{30}=0 \Rightarrow 60V_2'-60V_1'+600+V_2'+12V_2'+2V_2'=0$$

$$75V_2'-60V_1'=-600$$

$$\frac{V_1'}{20}+\frac{V_1'-V_2'}{1}=0 \longrightarrow -20V_2'+21V_1'=0 \;/\times 3{,}75$$

$$18{,}75V_1'=-600$$

$V_1' = -32V$

$V_2' = -33{,}6V$

$$i_o'=\frac{-32-(-33{,}6)}{1}=1{,}6A$$

for only 6A source:

$$-6+\frac{V_1''}{20}+\frac{V_1''-V_2''}{1}=0 \longrightarrow 21V_1''-20V_2''=120 \;/\times 3{,}75$$

$$\frac{V_2''}{30}+\frac{V_2''}{5}+\frac{V_2''}{60}+\frac{V_2''-V_1''}{1}=0 \Rightarrow -60V_1''+75V_2''=0$$

$$18{,}75V_1''=450V$$

$V_1'' = 124V$

$V_2'' = 19.2V$

$$i_o''=\frac{24-19{,}2}{1}=4{,}8A$$

for only 75V source:

$$\frac{V_1'''}{20}+\frac{V_1'''-V_2'''}{1}=0 \longrightarrow 21V_1'''-20V_2'''=0 \;/\times 3{,}75$$

$$\frac{V_2'''}{30}+\frac{V_2'''-75}{5}+\frac{V_2'''}{60}+\frac{V_2'''-V_1'''}{1}=0 \Rightarrow 75V_2'''-60V_1'''=900$$

$$18{,}75V_1'''=900$$

$V_1''' = 48V$

$V_2''' = 50{,}4V$

$$i_o'''=\frac{48-50{,}4}{1}=-2{,}4A$$

$$i_o=i_o'+i_o''+i_o'''=1{,}6+4{,}8-2{,}4=\underline{\underline{4A}}$$

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4.95