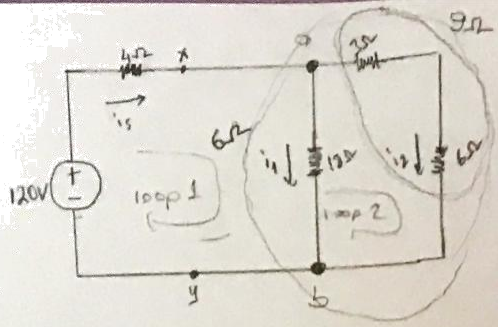
3.1)

a) $120 = i_s \cdot 10$

$i_s = 12\ A$, $i_1 = 4\ A$, $i_2 = 8\ A$



for point a ;

$i_s - i_2 - i_1 = 12 - 4 - 8$

$i_s - i_2 - i_1 = 0$ (The circuit satisfied KCL for point a)

for point b;

$i_1 + i_2 - i_s = 4 + 8 - 12 = 0$ (The circuit satisfied for point b)

$\frac{1}{R_{eq}} = \frac{1}{18} + \frac{1}{9} \Rightarrow R_{eq} = 6\Omega$

$V_1 = 12 \cdot 6 = 72V$

$i_1 = \frac{72}{18} = 4A$, $i_2 = \frac{72}{9} = 8A$

b) for loop 1 $\Rightarrow$

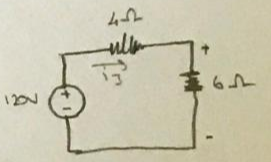
$-120 + (4 \times i_3) + (18 \times i_1) = -120 + (4 \times 12) + (18 \times 4) = 0$

for loop 2 $\Rightarrow$ $-(18 \times i_1) + (3 \times i_2) + (6 \times i_2) = -(4 \times 18) + (8 \times 3) + (8 \times 6) = 0$

The circuit satisfied KVL at every loop

3.2)

a) $\frac{1}{R_{eq}} = \frac{1}{9} + \frac{1}{18} \Rightarrow R_{eq} = 6\Omega$



KVL for loop 1;

$-120 + i_3 \times (4 + 6) = 0$

$i_3 = 12A$

$V = 12 + 6 = 72V$

By applying current dividing

$i_2 = \frac{i_3}{12} \times \frac{18}{27} \Rightarrow 8A$

$P_{6\Omega} = (i_2)^2 \times 6 \Rightarrow 384\ W$

$P_{3\Omega} = (i_2)^2 \times 3 = 192\ W$

$P_{18\Omega} = \frac{V^2}{18} = \frac{(72)^2}{18} = 288\ W$

$P_{4\Omega} = (i_3)^2 \times 4 = 576\ W$

b) $P_{deliv} = 120 \times i_3$

$P_{deliv} = 120 \times 12 \Rightarrow 1440\ W$

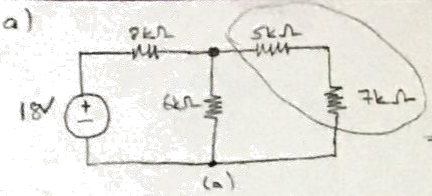
c) $P_{dissipated} = P_{4\Omega} + P_{18\Omega} + P_{3\Omega} + P_{6\Omega}$

$= 576 + 288 + 192 + 384$

$= 1440\ W$

$\Rightarrow P_{delivered} = P_{dissipated}$

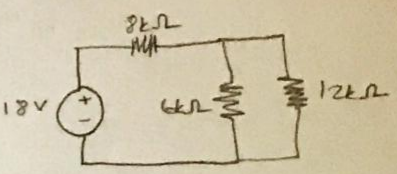
3.3 a)



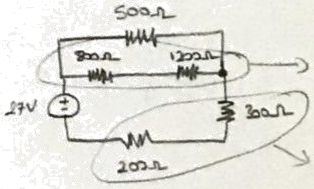
(a)

They are in a series

$12\,\Omega$



b)

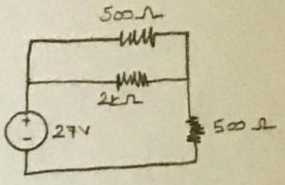


$R_{eq} = 800 + 1200 = 2000\,\Omega$

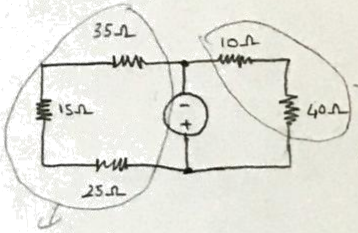
They are in a series

$R_{eq} = 300 + 200 = 500\,\Omega$

They are in a series



c)

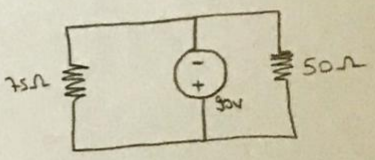


They are in a series.

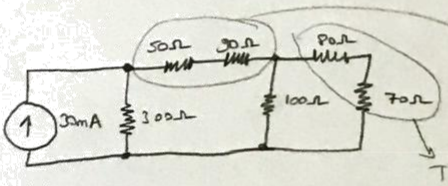
$R_{eq} = 10 + 40 = 50\,\Omega$

They are in a series

$R_{eq} = 35 + 15 + 25 = 75\,\Omega$



d)

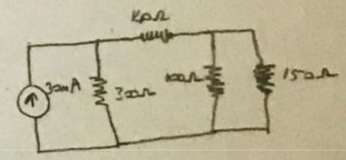


They are in a series

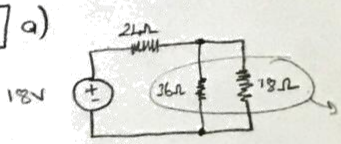
$R_{eq} = 50 + 90 = 140\,\Omega$

They are in a series

$R_{eq} = 80 + 70 = 150\,\Omega$

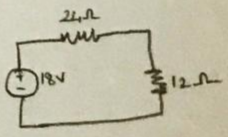


3.4 a)

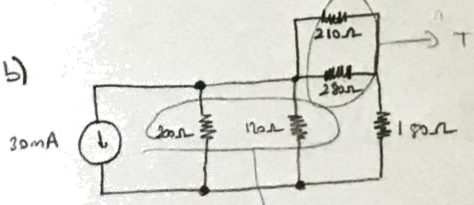


They are in a parallel.

$\frac{1}{R_{eq}} = \frac{1}{36} + \frac{1}{18}$ (Ω)



b)

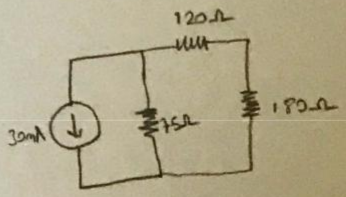


They are in a parallel.

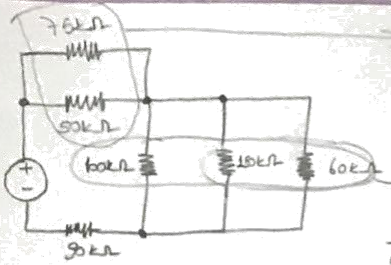
$\frac{1}{R_{eq}} = \frac{1}{210} + \frac{1}{280} \Rightarrow 120\,\Omega = R_{eq}$

They are in a parallel

$\frac{1}{R_{eq}} = \frac{1}{200} + \frac{1}{120} \Rightarrow R_{eq} = 75\,\Omega$



c)

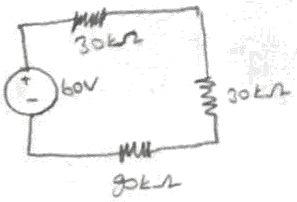


They are in a parallel.

$\frac{1}{Req} = \frac{1}{75} + \frac{1}{50} \Rightarrow Req = 30k\Omega$

They are in a parallel.

$\frac{1}{Req} = \frac{1}{60} + \frac{1}{150} + \frac{1}{100} \Rightarrow Req = 30k\Omega$



d)

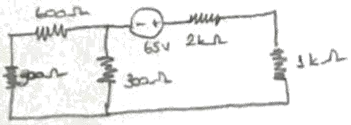
They are in a parallel.

$\frac{1}{Req} = \frac{1}{1.5k} + \frac{1}{3k}$

$Req = 1k\Omega$

They are in a parallel.

$\frac{1}{Req} = \frac{1}{750} + \frac{1}{550} \Rightarrow Req = 300\Omega$



3.5

a)

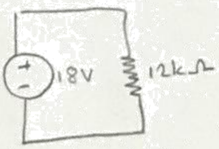
$Req = 5k\Omega + 7k\Omega = 12k\Omega$

$\frac{1}{Req} = \frac{1}{12k} + \frac{1}{6k} \Rightarrow Req = 4k\Omega$

$Req = 8+4 = \boxed{12k\Omega}$

$i = \frac{18V}{12k\Omega} = 1.5\,mA$

$P = i.v = 1.5mA \times 18V = 27mW$



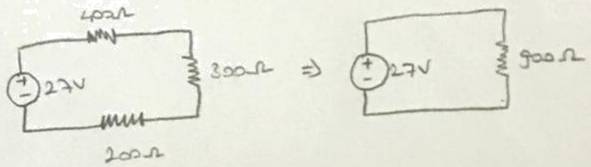
b) $R = 800\Omega + 1200\Omega = 2000\Omega$

$\frac{1}{Req} = \frac{1}{2000} + \frac{1}{500} \Rightarrow Req = 400\Omega$

$Req = 400 + 300 + 200\Omega \Rightarrow \boxed{Req = 900\Omega}$

$i = \frac{27V}{900\Omega} = 30\,mA$

$P = i.V = 30mA \times 27V = \boxed{810\,mW}$

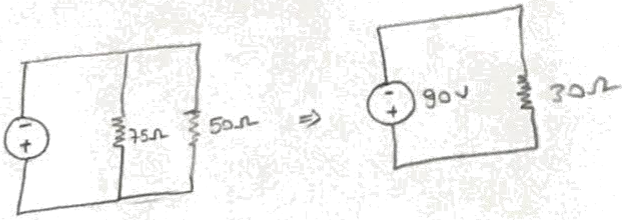


c)

$R_{eq} = 35\Omega + 15\Omega + 25\Omega = 75\Omega$

$R_{eq} = 10\Omega + 40\Omega = 50\Omega$

$R_{eq} = \frac{1}{50} + \frac{1}{75} \Rightarrow \boxed{30\Omega = R_{eq}}$



$i = \frac{90V}{30\Omega} = 3A$

$P = 3A \cdot 90V = \boxed{270\ mW}$

d)

$R_{eq} = 50 + 90 = 140\Omega$

$R_{eq} = 80 + 70 = 150\Omega$

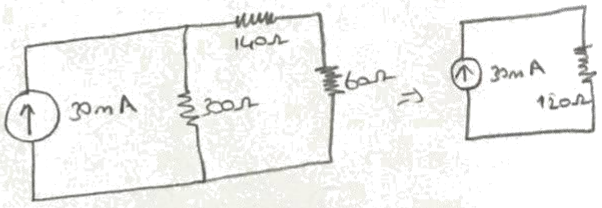
$\frac{1}{R_{eq}} = \frac{1}{100} + \frac{1}{150} \Rightarrow R_{eq} = 60\Omega$

(3) (2)

$R_{eq} = 140 + 60\Omega = 200\Omega$

$\frac{1}{R_{eq}} = \frac{1}{200} + \frac{1}{300} = \boxed{120\Omega = R_{eq}}$

(1)



$V = i \cdot R \Rightarrow 30mA \cdot 120 = \boxed{V = 3.6V}$

$P = i \cdot V = 30mA \cdot (3,6V) \Rightarrow \boxed{108\ mW}$

3.8

a) $R_{ab} = 24 + (90 \| 60) + 12 = 24 + 36 + 12 = 72\Omega$

$\frac{1}{R} = \frac{1}{90} + \frac{1}{60}$ (2) (3) $R = 36\Omega$

b) $R_{ab} = [(4k + 6k + 2k) \| 8k] + 5.2k = 4.8k + 5.2k = 10k\Omega$

$12k \| 8k$ $\frac{1}{R} = \frac{1}{12} + \frac{1}{8} \Rightarrow R = 4.8k$ (2) (3)

c) $R_{ab} = 1200 \| 1720 \| (320 + 480) = 288\Omega$

$320 + 480 = 800$

$\frac{1}{R} = \frac{1}{1200} + \frac{1}{720} + \frac{1}{800}$ (6) (10) (8)

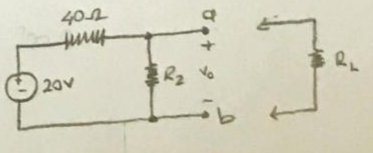
$R = \frac{7200}{25} = 288\Omega$

3.13

$4 = \frac{20R_2}{R_2 + 40} \Rightarrow R_2 = 10\Omega$

$3 = \frac{20R_e}{40 + R_e} \Rightarrow R_e = \frac{120}{17}\Omega$

$17R_e = 120$

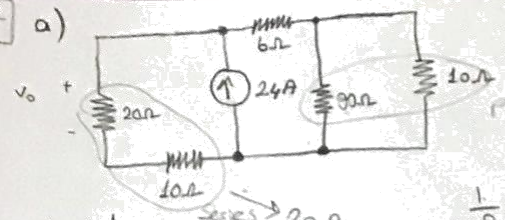


$\Rightarrow \frac{120}{17} = \frac{10R_L}{10 + R_L} \Rightarrow 170R_L = 1200 + 120R_L$

$50R_L = 1200$

$R_L = 24\Omega$

3.17 a)



parallel

$\frac{1}{R} = \frac{1}{10} + \frac{1}{90}$

$R = 9\Omega + 6\Omega$

$R = 15\Omega$

series → 30Ω

$\frac{1}{R_{eq}} = \frac{1}{15} + \frac{1}{30}$

$R_{eq} = 10\Omega$

$V_A = 2.4 \times 10$

$V = 24V$

$V_o = V_{20\Omega} = \frac{20}{10+20}(24) = 16V$

$V_{90\Omega} = \frac{9}{6+9} \cdot 24 = 14.4\,V$

$i_o = \frac{14.4}{90} = 0.16\,A$

b) $P_{6\Omega} = \frac{(V_o - V_{90\Omega})^2}{6} = \frac{(24-14.4)^2}{6} = 15.36\,W$

c) $P_{2.4A} = (2.4)(24) = 57.6\,W$

3.18

We can write KCL for main node

$i_g = i_1 + i_2 + i_3 + i_4$

$i_g = 0.6 i_2 + i_2 + 2 i_2 + 4.0.6 i_2$

$6 i_2 = i_g = 50mA$

$i_2 = 8.33\,mA$

$i_1 = (0.6) i_2 \Rightarrow 5mA$

$i_3 = 2 i_2 \Rightarrow 16,67\,mA$

$i_4 = 4 i_1 = 20mA$

$\Rightarrow$

$R_1 = \frac{25V}{i_1} = \frac{25V}{5} \Rightarrow R_1 = 5k\Omega$

$R_2 = \frac{25V}{i_2} = \frac{25V}{0,00833} = 3000 = 3k\Omega = R_2$

$R_3 = \frac{25V}{i_3} = \frac{25V}{0,01667} = 1500 = 1.5k\Omega = R_3$

$R_4 = \frac{25}{i_4} = \frac{25}{20} \Rightarrow R_4 = 1.25k\Omega$

3.19

$P = i \cdot V$

$i = \frac{P}{V} \Rightarrow \frac{80W}{24V} = 3.33A$

$R_2 = \frac{V_2}{i} \Rightarrow \frac{5V}{3.33A} = 1.5\Omega$

$R_1 = \frac{V_1 - V_2}{i} \Rightarrow \frac{12V - 5V}{3.33A} = 2.1\Omega$

$R_3 = \frac{-V_3}{i} = \frac{12V}{3.33A} = 3.6\Omega$

We use Ohm's Law to calculate the resistors

3.22

a)

$i_g = V_o G_1 + V_o G_2 + V_o G_3 + \dots + V_o G_n$

$i_g = V_o (G_1 + G_2 + \dots + G_n)$

$V_o = \frac{i_g}{(G_1 + G_2 + \dots + G_n)}$ $\quad (i_k = V_o G_k)$

ok $\frac{i_k}{G_k} = \frac{i_g}{(G_1 + G_2 + G_3 + \dots + G_n)} \cdot G_k \Rightarrow$ $\boxed{i_k = \frac{i_g G_k}{(G_1 + G_2 + \dots + G_n)}}$

b)

$i_5 = \frac{40 \cdot \frac{1}{5}}{\frac{1}{0.5} + \frac{1}{5} + \frac{1}{8} + \frac{1}{10} + \frac{1}{20} + \frac{1}{40}} \Rightarrow i_5 = \frac{8}{\frac{5}{2}}$

$2 + \frac{1}{2} = \frac{5}{2}$

$i_5 = \frac{16}{5} = \boxed{3.2A}$

3.28

a) $V_{6k} = \frac{6}{6+2} \cdot (18) = \frac{27}{2} = 13.5V$

$V_{3k} = \frac{3}{3+9} \cdot 18 = \frac{9}{2} = 4.5V$

$\Rightarrow V_x = V_{6k} - V_{3k}$

$= 13.5 - 4.5$

$\boxed{V_x = 9V}$

b) $V_{6k} = \frac{6}{8} \cdot (V_s) \Rightarrow V_{6k} = 0,75(V_s)$

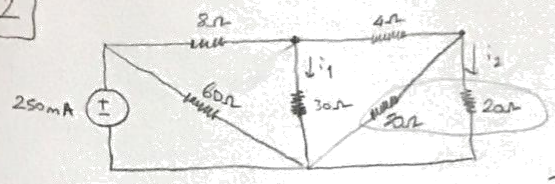
$V_{3k} = \frac{3}{12}(V_s) \Rightarrow V_{3k} = 0,25(V_s)$

$V_x = V_{6k} - V_{3k}$

$= 0,75(V_s) - 0,25(V_s)$

$\boxed{V_x = 0.5(V_s)}$

3.32



parallel

$\frac{1}{R} = \frac{1}{20} + \frac{1}{80}$ (4) $\Rightarrow R = 16\Omega$

$R = 16 + 4 = 20\Omega$

$\frac{1}{R} = \frac{1}{20} + \frac{1}{30}$ (3) (2) $\Rightarrow R = 12\Omega$

$R = 12\Omega + 8\Omega = \underline{20\Omega}$

$\frac{1}{R} = \frac{1}{60} + \frac{1}{20} \Rightarrow R = 15\Omega$

We find current division in 8Ω resistor

$i_{8\Omega} = \frac{15\Omega}{20} \cdot (0.25)$

$i_{8\Omega} = 0.1875 = \underline{187.5\,mA}$

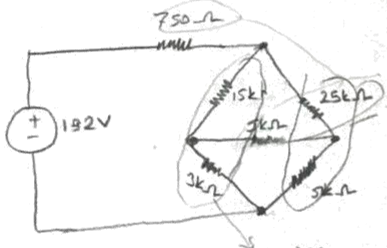
We use current division to find i_1 from i_8

$i_1 = \frac{30||20}{30} \cdot (i_8) \Rightarrow \frac{12}{36} \cdot (0.1875) = 0.075 = 75mA$

$i_{4\Omega} = \frac{12}{20} \cdot (0.1875) = 0.1125 = \underline{112.5\,mA}$

$i_2 = \frac{80||20}{20} \cdot (0.1125) = 0.09 = \underline{90\,mA}$

3.52



series 30Ω kΩ

parallel

series 18kΩ

$\frac{1}{R} = \frac{1}{18} + \frac{1}{30}$

$R = 11,25\,k\Omega$

$R = 11,25 + 750\Omega$

$R = 12\,k\Omega$

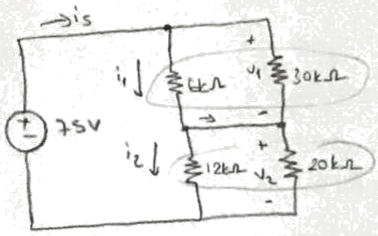
$V = iR$

$i = \frac{V}{R} \Rightarrow \frac{192}{12000} = 16mA$

$i_{3k} = \frac{11,250}{18000}(0.016) \Rightarrow \underline{10\,mA}$

$P_{3k} = 3000 \cdot (0.1)^2 = \underline{0.3\,W}$

3.53



$$\frac{1}{R} = \frac{1}{6} + \frac{1}{30}$$

$$R = 5k\Omega$$

$$\frac{1}{R} = \frac{1}{12} + \frac{1}{20} \quad \Big\} \; 12{,}5k\Omega$$

$$R = 7.5k\Omega$$

$$i_s = \frac{75}{12500} = 6mA$$

$$v_1 = (0.006)(5000) = 30V$$

$$v_2 = (0.006)(7500) = 45V$$

$$i_1 = \frac{30}{6000} = 5mA$$

$$i_2 = \frac{45}{12000} = 3.75mA$$

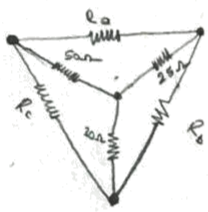
$$i_d = i_1 - i_2$$

$$i_d = 5 - 3.75$$

$$\boxed{i_d = 1.25mA}$$

3.58

a)



$$R_a = \frac{(25)(30) + (25)(50) + (30)(50)}{30} = \frac{3500}{30} = 116.67\Omega$$

$$R_b = \frac{(25)(30) + (25)(50) + (30)(50)}{50} = \frac{3500}{50} = 70\Omega$$

$$R_c = \frac{(25)(30) + (25)(50) + (30)(50)}{25} = \frac{3500}{25} = 140\Omega$$

$$70 \,||\, [(50 \,||\, 116.67) + (20 \,||\, 140)] = 30\Omega$$

$$R_{ab} = 13 + 7 + 30 = 50\Omega$$

b)

$$R_1 = \frac{(50)(20)}{50+20+30} = 10\Omega$$

$$R_2 = \frac{(50)(30)}{50+20+30} = 15\Omega$$

$$R_3 = \frac{(20)(30)}{50+20+30} = 6\Omega$$

$$R_{ab} = 50\Omega$$

3.62

$R = 8 + 12 = 20\,\Omega$

$\Rightarrow \frac{1}{R} = \frac{1}{20} + \frac{1}{60} \Rightarrow R = 15\,\Omega$

$\Rightarrow 15 + 20 = 35\,\Omega$

$\Rightarrow \frac{1}{R} = \frac{1}{35} + \frac{1}{140} \Rightarrow R = 28\,\Omega$

$\Rightarrow 28 + 22 = 50\,\Omega$

$\frac{1}{R} = \frac{1}{50} + \frac{1}{75} \Rightarrow R = 30\,\Omega + 10 = \underline{40\,\Omega}$

$i_g = \frac{240}{40} = \underline{6\,A}$

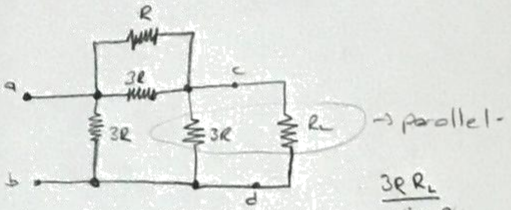
$i_o = \frac{(6)(50)}{125} = \underline{2.4\,A}$

$i_{140\Omega} = \frac{(6 - 2.4)(35)}{175} = \underline{0.72\,A}$

$P_{140\Omega} = (0.72)^2 \cdot (140) = \underline{72.576\,W}$

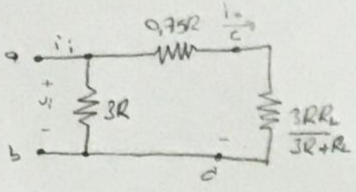
3.67

a)



→ parallel

$\frac{3RR_L}{3R+R_L}$



$\Rightarrow 0.75R + \frac{3RR_L}{3R+R_L} = \frac{2.25R^2 + 3.75RR_L}{3R+R_L}$

$\Rightarrow R_{ab} = \frac{3R\left(\frac{2.25R^2 + 3.75RR_L}{3R+R_L}\right)}{3R + \left(\frac{2.25R^2 + 3.75RR_L}{3R+R_L}\right)} = \frac{3R(3R+5R_L)}{15R+9R_L}$

If $R = R_L$, we have $R_{ab} = \frac{3R_L \cdot 8R_L}{24R_L} = R_L$

$\Rightarrow R_{ab} = R_L$

b)

$i_o = \frac{i_i(3R_L)}{4.5R_L} = \frac{1}{1.5} i_i = \frac{1}{1.5} \cdot \frac{v_i}{R_L} \Rightarrow v_o = 0.75R_L i_o = \frac{1}{2} v_i$

$\frac{v_o}{v_i} = 0.5$

3.73 a)

$V_x = \alpha V_s$ $\qquad \alpha = \frac{V_x}{V_s} = \frac{1}{5} = 0.2$

$V_y = \beta V_s$ $\qquad \beta = \frac{V_y}{V_s} = \frac{3.75}{5} = 0.75$

b) $x = (1-\alpha) p_x = (1-0.2)(480) = 384$

$y = (1-\beta) p_y = (1-0.75)(800) = 200$

Right corner

3.74

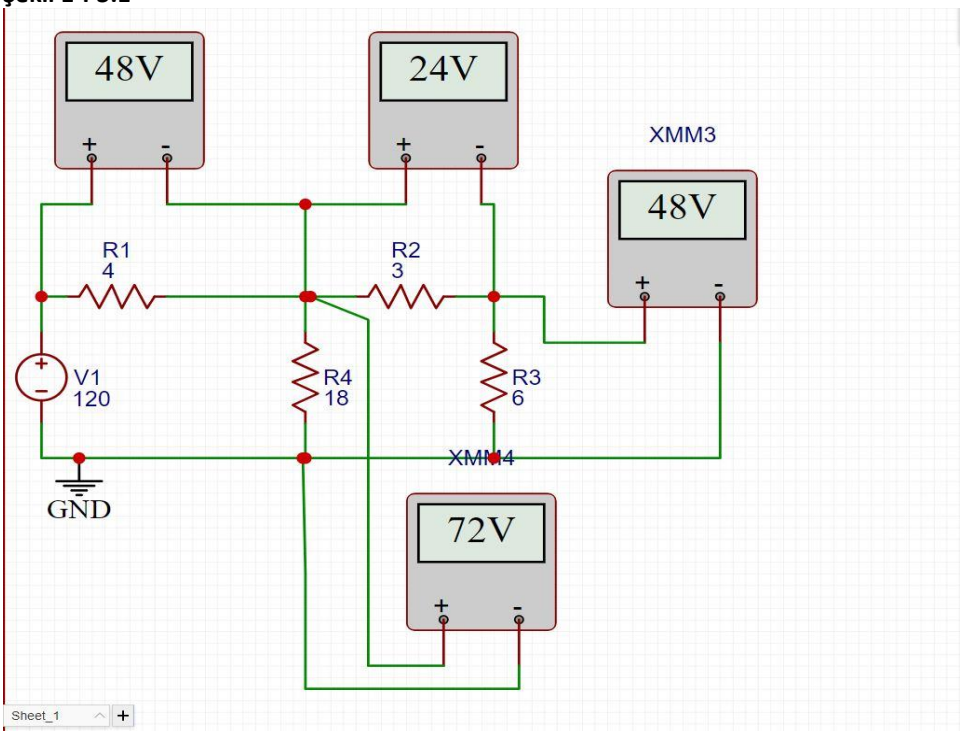
$x = (1-\alpha) p_x \Rightarrow \alpha = 1 - \frac{x}{p_x} = 1 - \frac{480}{640} = 0.25$

$V_x = \alpha V_s = (0.25)(8) = 2V$

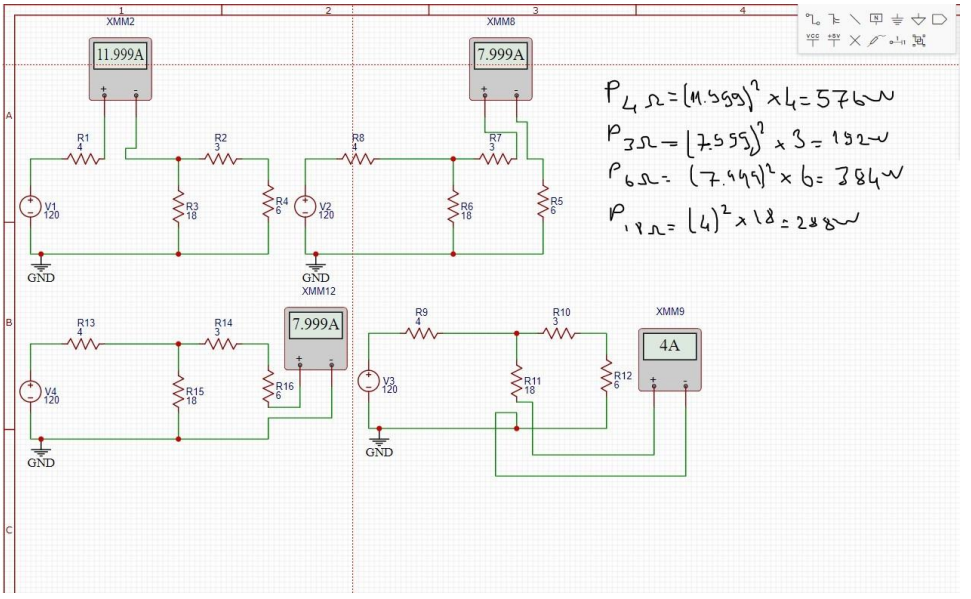
$y = (1-\beta) p_y$ so $\beta = 1 - \frac{y}{p_y} = 1 - \frac{192}{1024} = 0.8125$

$V_y = \beta V_s = (0.8125)(8) = 6.5V$

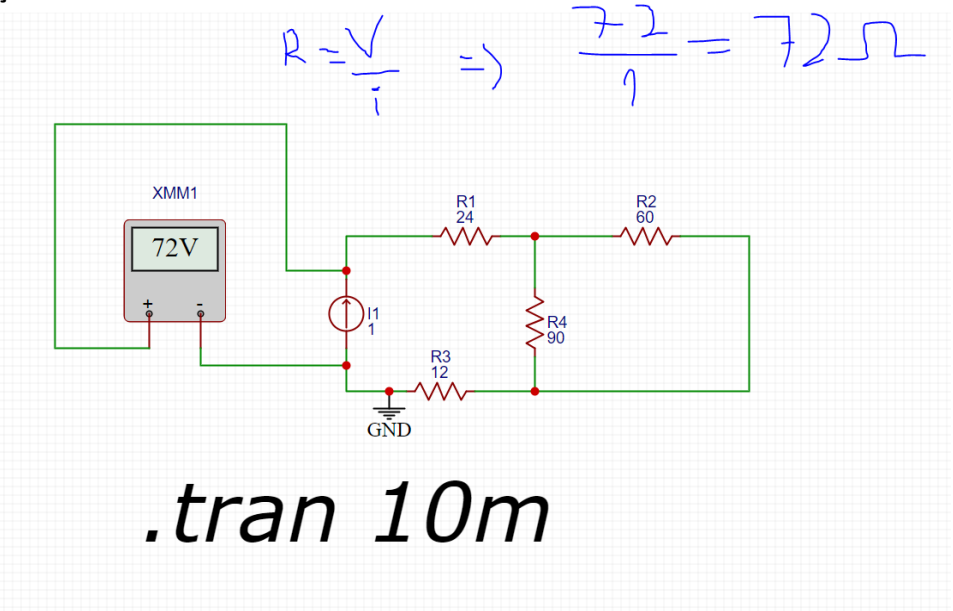
Şekil 1-P3.1



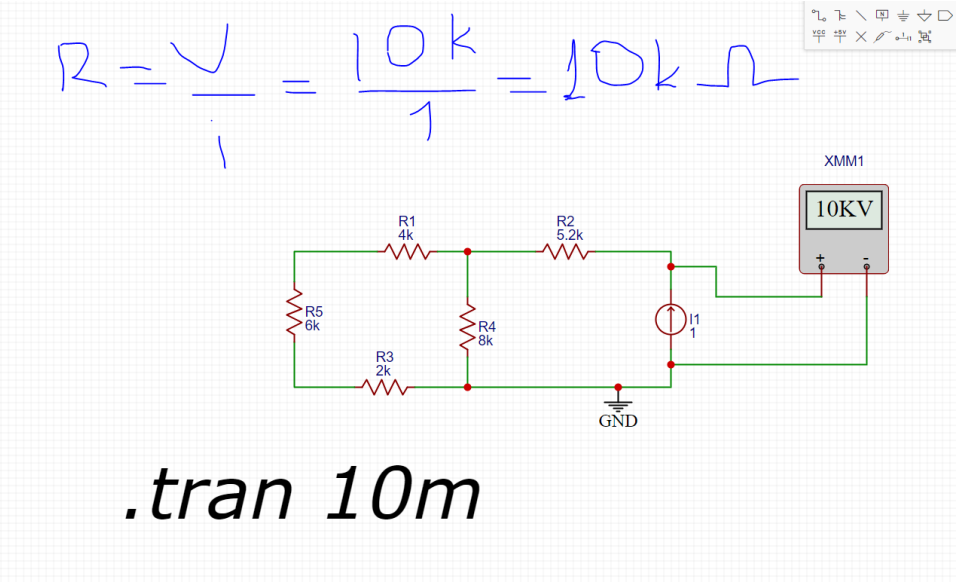
Şekil 2-P3.2



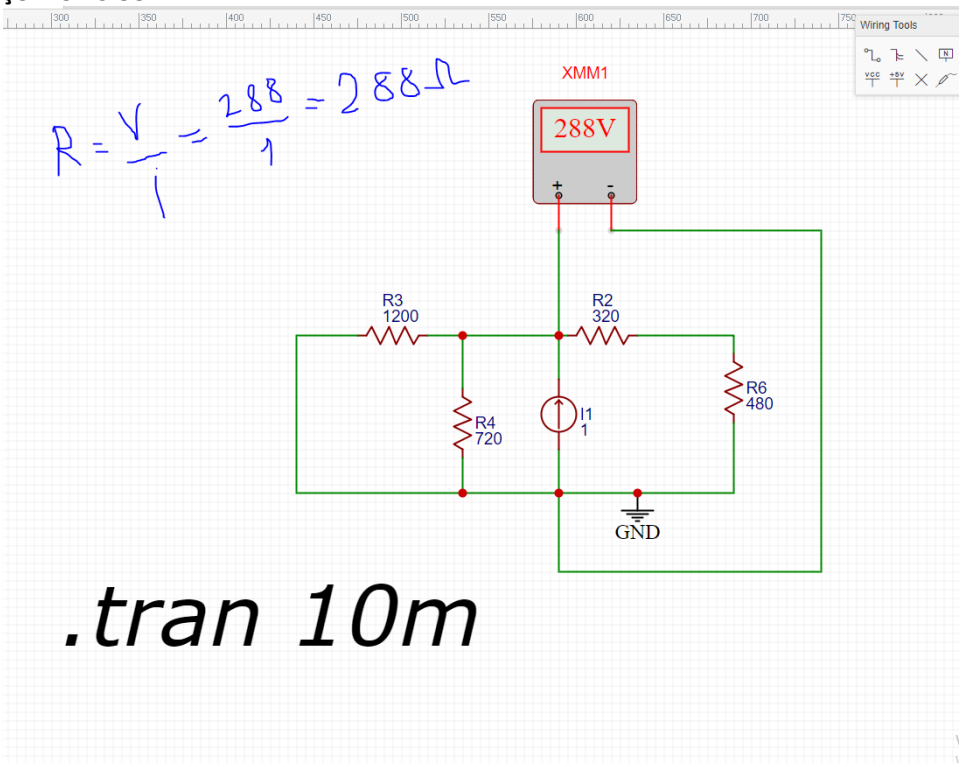
Şekil 3-P3.8A



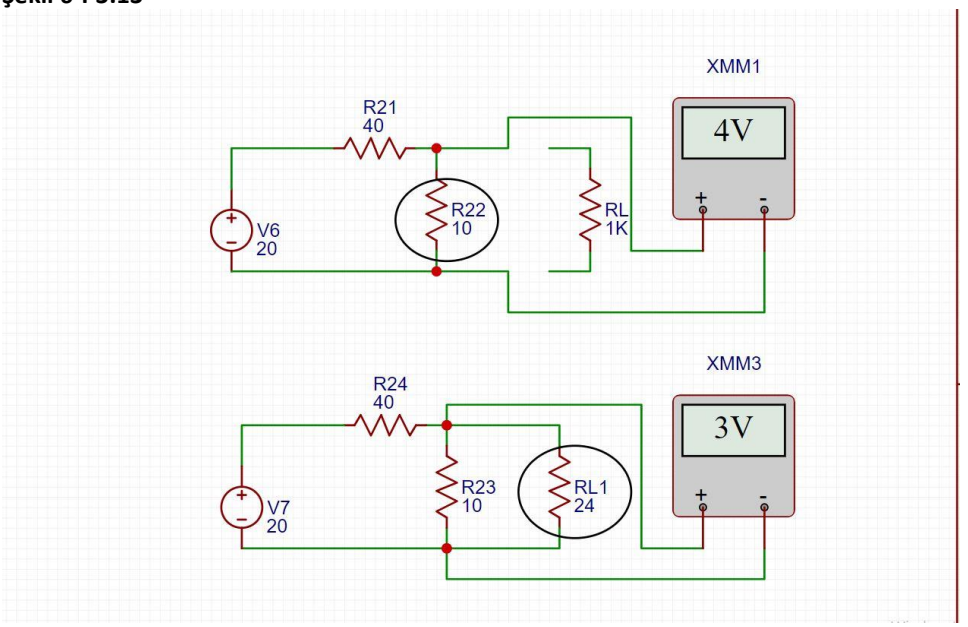
Şekil 4-P3.8B



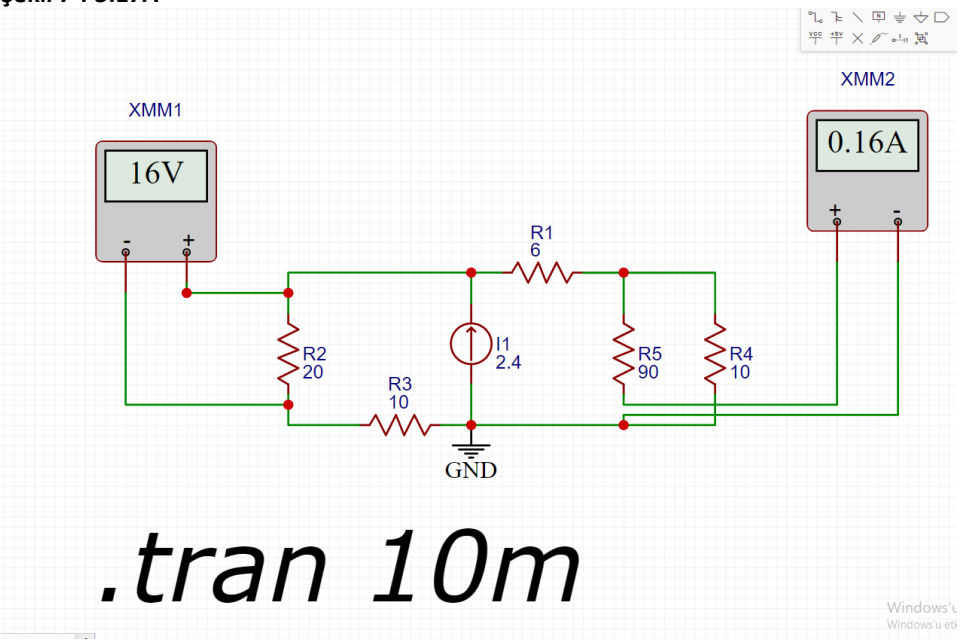
Şekil 5-P3.8C



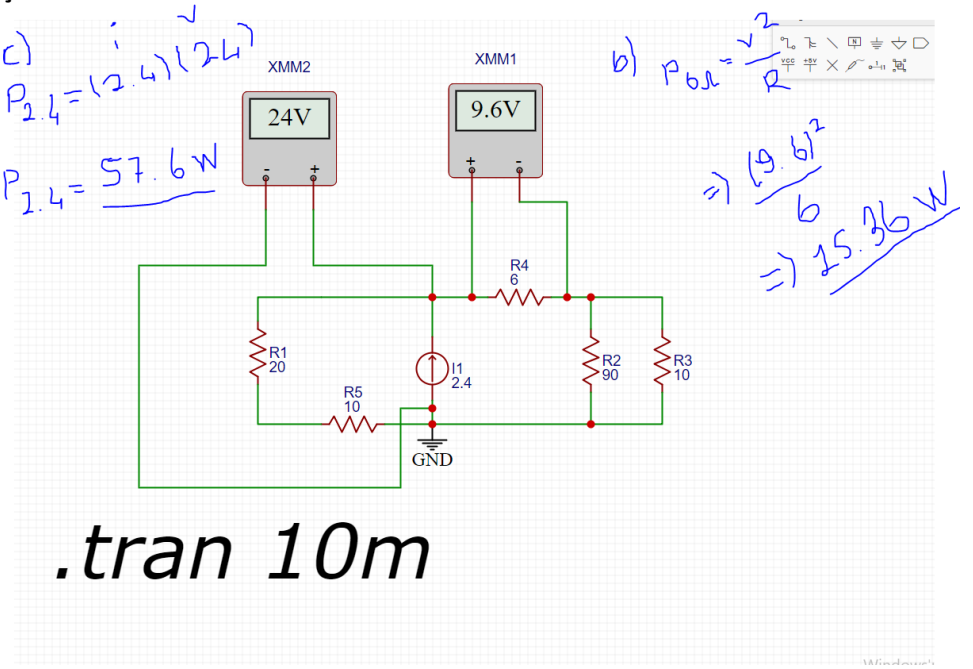
Şekil 6-P3.13



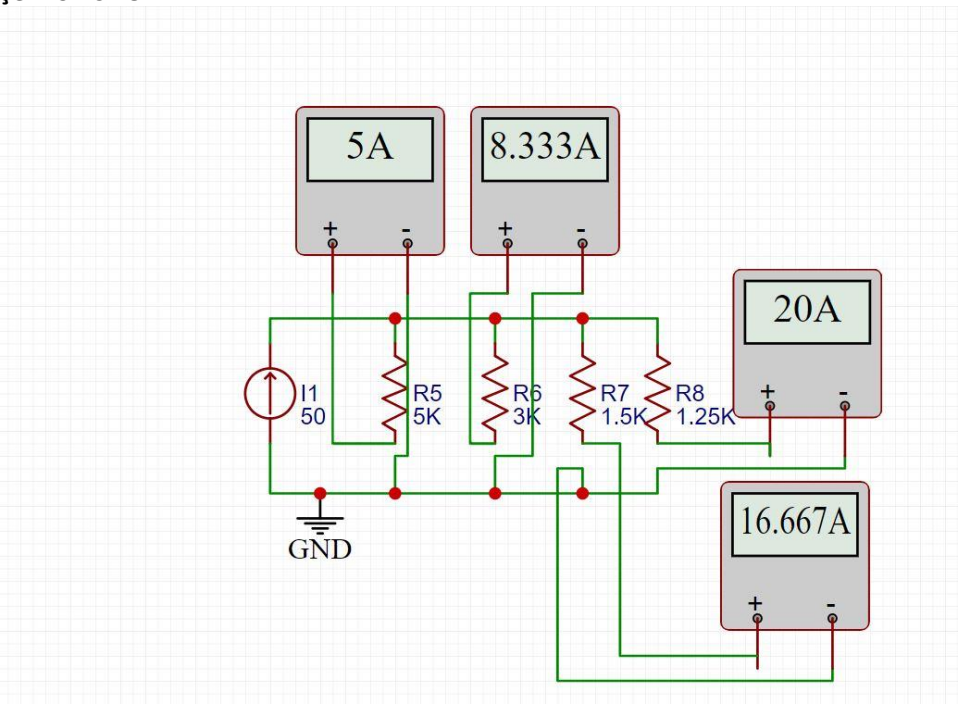
Şekil 7-P3.17A



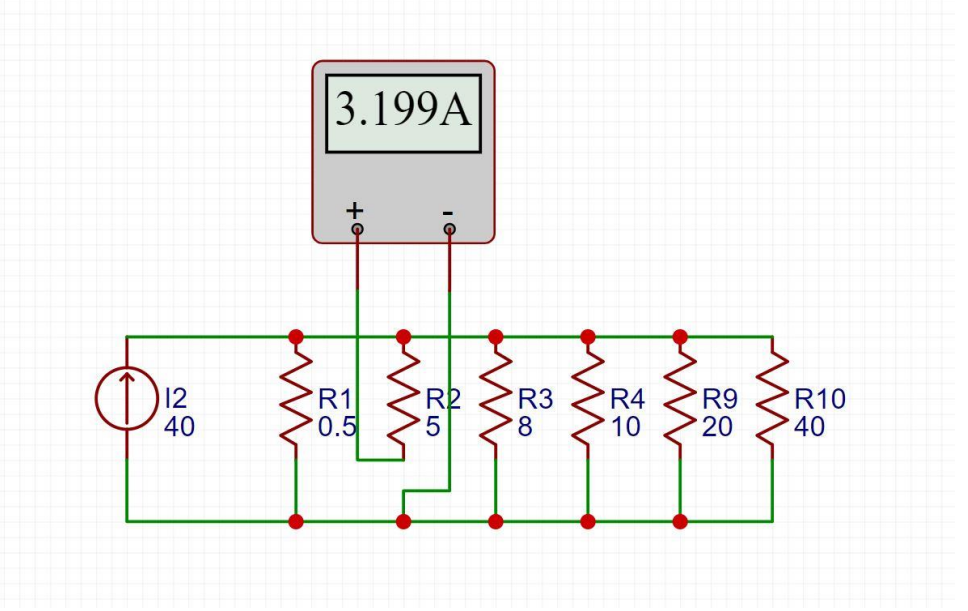
Şekil 8-P3.17B-C



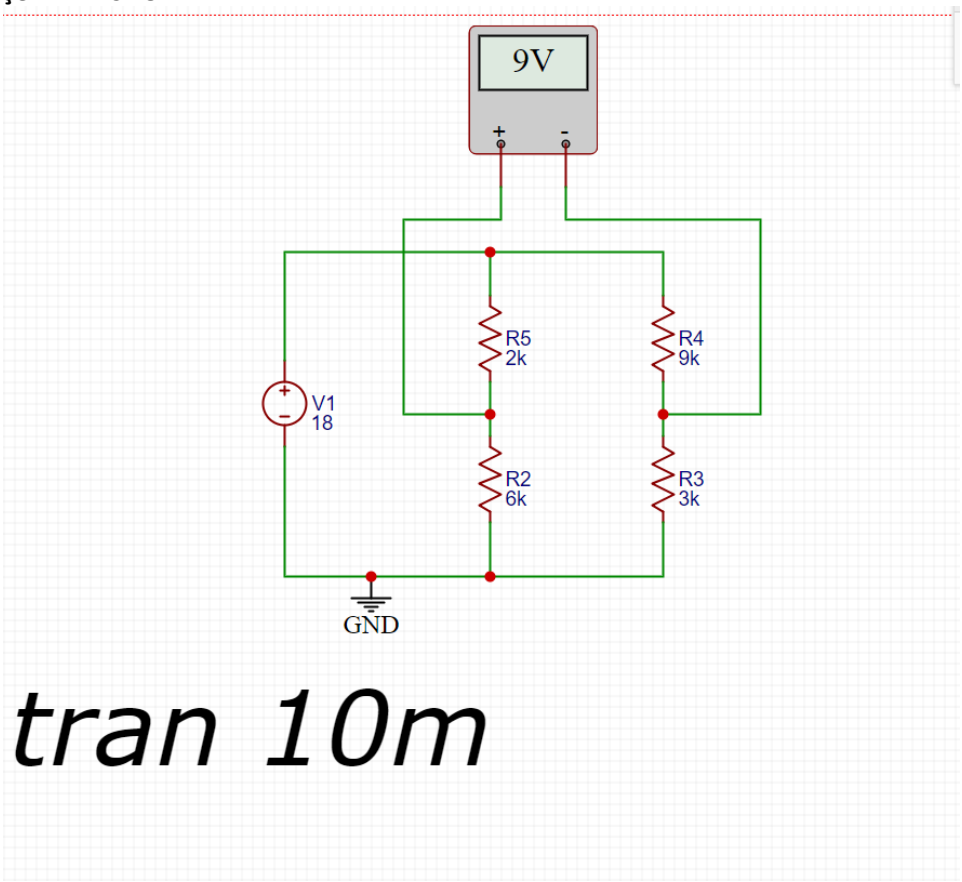
Şekil 9-P3.18



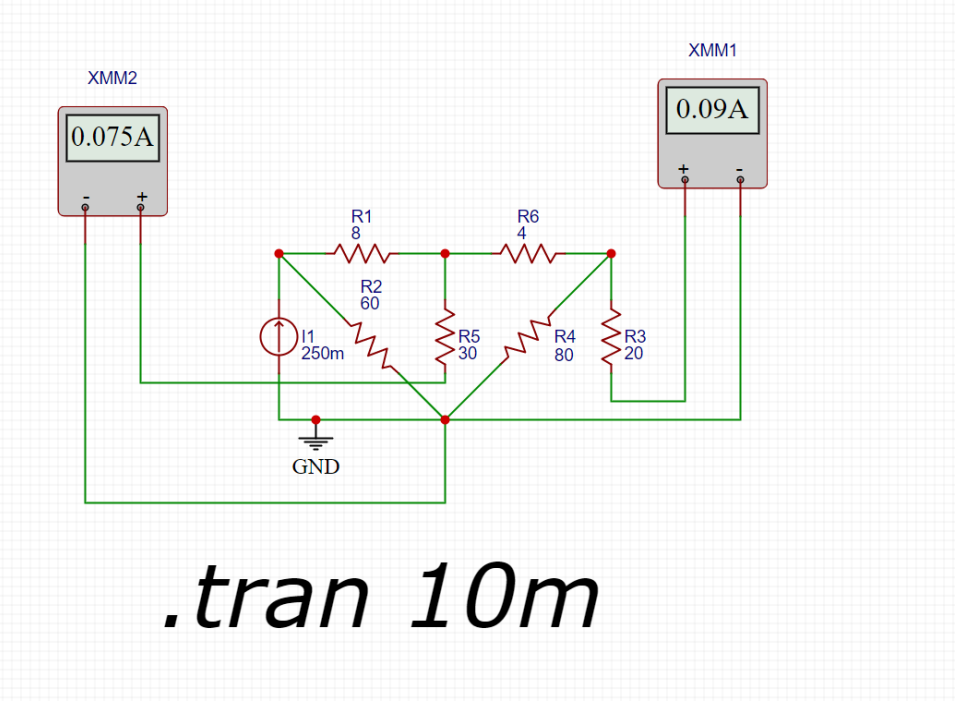
Şekil 10-P3.22



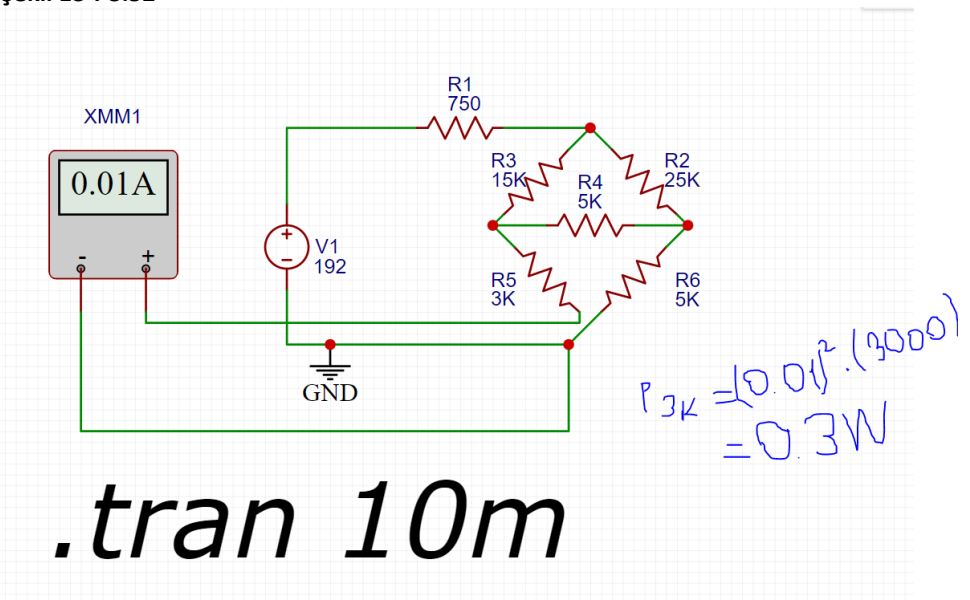
Şekil 11-P3.28



Şekil 12-P3.32



Şekil 13-P3.52



$P_{3K} = (0.01)^2 \cdot (3000)$

$= 0.3W$

Şekil 14-P3.62