2.1)

$V = I \cdot R$

$I = \frac{16V}{5K\Omega} = \underline{3{,}2\,A} \cdot 10^{-3}$

2,2)

$P = I^2 \cdot R$

$60W = V I \Rightarrow 60W = 120V \cdot I$

$I = 0{,}5A \Rightarrow \frac{120V}{0{,}5A} = \underline{240\,\Omega}$

2,3)

$V = I \cdot R$

$120V = 2{,}5mA \cdot R$

$48 \cdot 10^{-3}\Omega = R \Rightarrow S = \frac{1}{48 \cdot 10^{-3}}$ Siemens

2,7)

$n = 5$ $n = 4$

$b = 7$ $b = 6$

$l = b - n + 1 = 3$

2,8)

$I_1 \Rightarrow 8 \equiv I_1 + 12mA \Rightarrow I_1 = \underline{-4mA}$

(reverse direction of the diagram shown)

$I_2 = 9 - 8 = \underline{1mA}$

$I_3 = \frac{-3mA}{4\uparrow}$

1 ?

2,4)

a) $R = 100$

$I = \frac{3}{100} \Rightarrow \underline{0{,}03A}$

b) $I = \frac{3}{150} \Rightarrow \underline{0{,}02A}$

2,5)

$n = 9$

$b = 15$

$l = b - n + 1 \Rightarrow l = 15 - 9 + 1 = 7$

2.6) $n = 14$, $n = 12$

$b = 21$ branch = 19

2,9) $I_1 = 10A + (-1A) + 2A = \underline{11A}$

$I_2 = 3A + I_3 = \underline{4A}$

$I_3 = 11A - 10A = \underline{1A}$

2.10) $I_1 = 4A + 3A = 7A$

$I_2 = -2A - 3A = -5A$

2.11)

$8V - V_1 - 12V = 0$

$V_1 = -4V$

$V_2 - 6V + 12V = 0$

$V_2 = -6V$

$V_3 - 10V + 6V = 0$

$V_3 = 4V$

$V_4 - 8V + 10V = 0$

$V_4 = -2V$

2.12)

$20V + 25V - 10V - V_1 = 0$

$V_1 = 35V$

$V_2 + 10V - 35V = 0$

$V_2 = 5V$

$V_3 + V_2 - V_1 = 0$

$V_3 + 5 - 35 = 0$

$V_3 = 30V$

2.13) $6V - 2V_3 + 22V = 0 \Rightarrow V_3 = 14V$

$V_2 - 22V = 0 \Rightarrow V_2 = 22V$

2.14) $24V - V_3 - 10V - 12V = 0$

$V_3 = 2V$

$24V - V_3 + V_2 = 0$

$V_2 = -22V$

$10V - V_3 = 0$

$V_3 = 10V$

2.15) $10V - 5I - 8V + 36V - 3I = 0$

$32V = 8I$

$4A = I$

$V_{ab} = 20V + 8V = 28V$

2.16)

$V_T = -8V + 12V + (-10V)$

$V_T = -6V$

$V = I\,R \Rightarrow I = \frac{V}{R} = \frac{-6V}{3\Omega} = -2A$

$P_R = I^2 R$

$= 4 \cdot 3 = 12W$

$P_{12V} = V I = +24W$

$P_{10V} = 10 \cdot -2 = -20W$

$P_{20V} = 16W$

2.17)

$R = 4\Omega$

$0 = 36V - 4I_0 - 5I_0$

$9I_0 = 36V$

$I_0 = 4A$

2.18)

$0 = 45V - V_0 + 3V_0 - 5I_0$

$V_0 = 6I_0 \cdot 2\Omega = V_0$

$I_0 = 15A$

$3V_0 = 45V \Rightarrow V_0 = 15V$

$P = I^2R \Rightarrow 225 \cdot 5 = 1125W$

2.19)

$I_T = 10A + 2V_0\,A$

$R_T = 10\Omega$

$4 \cdot (10A + 2V_0) = -V_0$

$40A + 8V_0 = -V_0$

$40A = -9V_0$

$V_0 = \frac{40}{9} = -4,4\,V$

$V_T = (-3,8A + 10A) \cdot 10 = 62V$

$P = IV$

$3,8 \cdot 62 = 106,65\,W$

2.20)

$V_S = I_0 (R_1 + R_2)$

$V_0 = I_4 \cdot R_4$

we will find I_4 by current divider rule

$I_4 = -\alpha I_0 \frac{R_3}{(R_3 + R_4)}$

$V_0 = -\alpha I_0 \frac{R_3}{(R_3 + R_4)} \times R_4$

$\frac{V_0}{V_S} = \frac{-\alpha I_0 \frac{R_3}{R_3+R_4} \cdot R_4}{I_0 (R_1 + R_2)} = \frac{-\alpha I_0 R_3 R_4}{(R_3+R_4)(R_1+R_2)}$

$\frac{V_0}{V_S} = \frac{-\alpha R_3 R_4}{(R_3+R_4)(R_1+R_2)}$

if $\left|\frac{V_0}{V_S}\right| = 10$, and $R_1 = R_2 = R_3 = R_4 = 1k\Omega$,

$\left|\frac{V_0}{V_S}\right| = \frac{-\alpha R^2}{(2R)\|(2R)} = \left|\frac{-\alpha R^2}{4R}\right| = 10 = |-\alpha| = 40$

2.21)

$V_0 = 5mA \cdot 10k\Omega$

$V_0 = 50V$

$P = I^2 \cdot R$

$P = \left(0,1A \cdot \frac{1}{25}\right)^2 \cdot 20k\Omega$

$P = 0,01A \cdot 20\Omega \cdot b^3$

$P = 0,2 \cdot 10^3\,W$

2,22)

$i_1 = 20mA \cdot \frac{4k\Omega}{10k\Omega} \Rightarrow$ 8 mA

$i_2 = 20mA \cdot \frac{6k\Omega}{10k\Omega} \Rightarrow$ 12 mA

2,23)

$V = 1.k$

$I = \frac{24V}{12k\Omega} = 2\,mA$

$V_1 = 2mA \cdot 3k\Omega = 6V$

$V_2 = 2mA \cdot 9k\Omega = 18V$

2,24)

$V = IR$

$V_T = 40V$

$R_T = 14\Omega + \left(\frac{1}{\frac{1}{15}+\frac{1}{10}}\right)\Omega = 20\Omega$

$I = \frac{40V}{20\Omega} = 2A$

$V_1 = 2A \cdot 14\Omega = 28V$

$V_2 = V_3 = 12V$

2,25)

$V = IR$

$\frac{12V}{4\Omega} = 3A$

$V_3 = 4\Omega \cdot 3A = 12V$

$I_1 = 3A$ short circuit

$I_2 = 0A$ / $V_2 = 0V$

2,26)

$I = 9A$

$i = 9A \cdot \frac{12}{18} = 6A$

$P = I^2 \cdot R$

$P = (6A)^2 \cdot 6$

$P = 36 \cdot 6 = 216W$

2,27)

$I = \frac{V_T}{R_T} \Rightarrow R_T = 5\Omega + \left(\frac{1}{\frac{1}{10}+\frac{1}{10}}\right)\Omega = 10\Omega$

$I = \frac{20V}{10\Omega} = 2A$

$V = 1A \cdot 10\Omega = 10V$

$i = 2A - 1A = 1A$

$P = i^2 \cdot R \Rightarrow (1A)^2 \cdot 4\Omega = 4W$

2,28)

$R_1 = \frac{1}{\frac{1}{10}+\frac{1}{40}} = 8\Omega$ / $R_2 = \frac{1}{\frac{1}{30}+\frac{1}{20}} = 12$

$i_3 + i_4 = \left(\frac{12}{20}\right)(20A) = 12A$ / $i_3 + i_2 = 20A -$

$i_3 + i_2 = 8A$

$i_3 = \frac{1}{5} \cdot 12A$ 2,4A

$i_4 = \frac{4}{5} \cdot 12A$ 9,6A

$i_2 = 8A \cdot \frac{2}{5}$ 3,2A

$i_2 = 8A \cdot \frac{3}{5}$ 4,8A

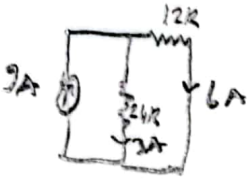
2.29)

$1S = 24K$

$6S = 4K$

$R_x = 12K$
$R_y = 12K$)) parallel

$R_x + R_y = 6K$
$R_z = 6K$)) Series

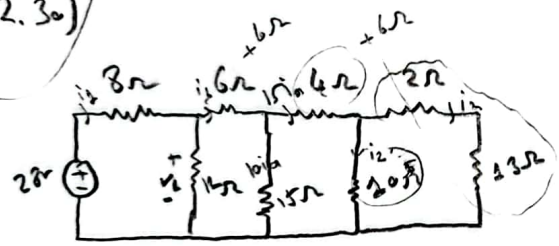


Current divider

$1S = 1\mho = 1$ Siemens $= \frac{1}{1\Omega}$ $i = 6A$

$v = 3A \cdot 1\Omega = 3V$

2.30)



$\frac{1}{15} + \frac{1}{10}$

$5i_a = 3 \cdot 2i_a = i_2$

$3 \cdot 5i_a = i_b \cdot \frac{15}{2}$

$25i_a + 25i_a = i_1$

$R_T = 6\Omega$
$V = 28V$

$I_1 = \frac{28V}{6\Omega} = \boxed{\frac{14}{3}A} = 50i_a$

$\frac{14}{150}A = i_a$

$i_2 = 6i_a$

$I_2 = \boxed{\frac{14}{25}A}$

$V_1 = \frac{14}{6}A \cdot 12\Omega = 28V$

$V_2 = \frac{14}{25}A \cdot 13\Omega = 7{,}28V$

2,31)

$$R_T = \underbrace{\left(\frac{1}{\frac{1}{70}+\frac{1}{30}}\right)}_{2,1\Omega}\Omega + \underbrace{\left(\frac{1}{\frac{1}{20}+\frac{1}{5}}\right)}_{4\Omega}\Omega \Rightarrow 6,1\Omega$$

$V_T = 50V$

$I_T = \frac{50V}{6,1\Omega} = 8,2\,A$

$I_0 = 8,2A \cdot \left(\frac{20}{25}\right) = 8,2A \cdot \frac{4}{5} = 6,56\,A$

$V_0 = 6,56A \cdot 5\Omega = 32,8\,V$

2,32)

$$R_T = \underbrace{\left(\frac{1}{\frac{1}{3}+\frac{1}{6}}\right)}_{2\Omega}\Omega + 2\Omega = 4\Omega$$

$I_T = \frac{4V}{4\Omega} = 1A$

$I_0 = 1A$

$\left.\begin{array}{l} V_{0+} = 0 \\ V_{0-} = 2V \end{array}\right) V_0 = 2V$

2,33)

$V_0 = I_0 \cdot R = 4V$

$20 - I_T \cdot 16 - 4 = 0$

$I_T = 1A$

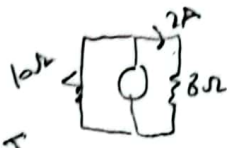
$I_0 = 1A \cdot \left(\frac{6}{6+R}\right) = \frac{4V}{R}$

$\frac{6}{6+R} = \frac{4V}{R}$

$6R = 24 + 4R$

$2R = 24 \Rightarrow R = 12\Omega$

2,34)



$I_T = 2A + 1A + I$

$R_T = \frac{1}{\frac{1}{10}+\frac{1}{8}} = \frac{20}{9}$

$I = \frac{8}{18} \cdot I_T = 2,4\,A$

$3A = \frac{10}{18} \cdot I_T$

$27/5 = I_T = 5,4\,A$

$V_S = I_T \cdot R_T = 12V$

2,35)

a) 0Ω, b) R, c) R

d) $\frac{1}{\frac{1}{\frac{3R}{2}}+\frac{1}{3R}} = R$, e) $\frac{1}{\frac{1}{R}+\frac{1}{2R}+\frac{1}{3R}} = \frac{6}{11}R$

(6) (3) (2)

2,36)

$R_{eq} = 2\Omega + 3\Omega = 5\Omega$

$I_T = \frac{10V}{5\Omega} = 2A$

2,37)

$R_{eq} = 50\Omega$

$R_{eq} = \left(\frac{1}{\frac{1}{14+R}+\frac{1}{60}}\right)\Omega + 30\Omega = 42\Omega$

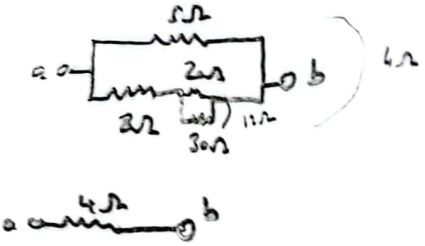
$R = \frac{60 \cdot (14+R)}{60+14+R} \Rightarrow 12(74+R) = 60(14+R)$

$74 + R = 70 + 5R$

$4 = 4R$

$R = 1\Omega$

2,33)



2,39)

a)

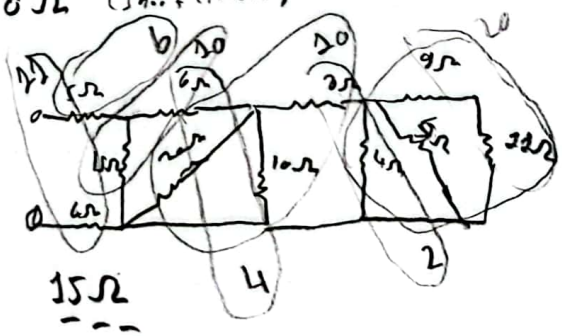
$3\Omega + 4\Omega = 12\Omega$

b) $\dfrac{1}{\frac{1}{10+1\Omega} + \frac{1}{80}} = 16\Omega$

2,40)

a) 0Ω (Short circuit)

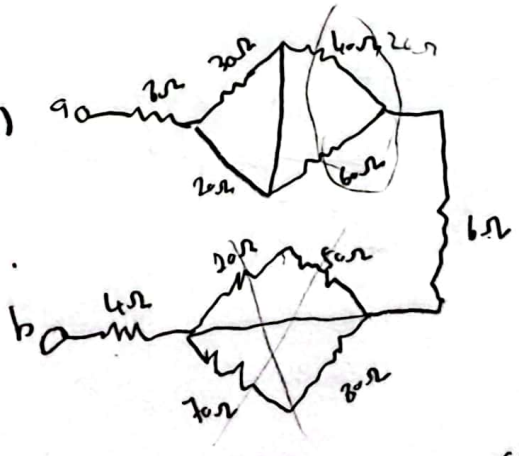
b)



2,41)

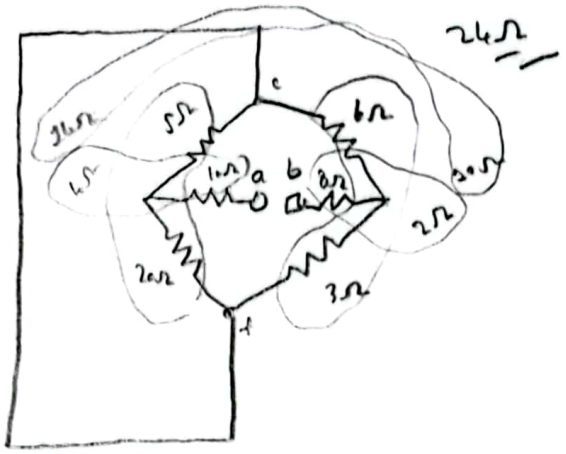
a) $21\Omega + 40\Omega + 15\Omega = 76\Omega$

b)



$R_{ges} = 4\Omega + 6\Omega + 24\Omega + 12\Omega + 8\Omega = 54\Omega$

2,42)

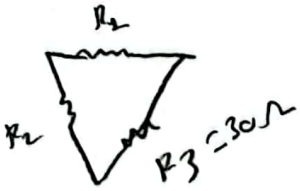


2,43)

a) $10 = \dfrac{R_1 \cdot R_2}{R_1 + R_2 + R_3}$ $\quad R_2 = R_3 = R_1 = 30\Omega$

$10 = \dfrac{R_1 \cdot R_3}{R_1 + R_2 + R_3}$

$10 = \dfrac{R_2 \cdot R_3}{R_1 + R_2 + R_3}$



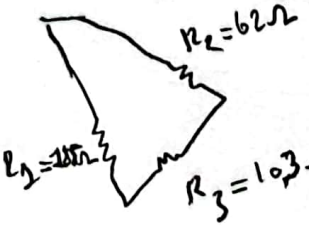
b)

$30 = \dfrac{R_1 \cdot R_2}{R_1 + R_2 + R_3}$

$50 = \dfrac{R_1 \cdot R_3}{R_1 + R_2 + R_3}$

$\frac{3}{5} = \frac{R_2}{R_3}$ $\quad \frac{3}{2} = \frac{R_1}{R_3}$ $\quad 20 = \dfrac{R_2 \cdot R_3}{R_1 + R_2 + R_3}$

$\frac{5}{2} = \frac{R_1}{R_2}$



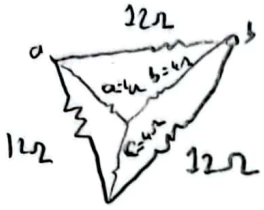
$R_1 = 10{,}\bar{3} \cdot 15 = 155\Omega$

$R_2 = 10{,}\bar{3} \cdot 6 = 62\Omega$

$R_3 = 10{,}\bar{3} \cdot 10 = 103\Omega$

2,44)

a)



$a = \frac{12 \cdot 12}{36}\Omega$, $b = \frac{12 \cdot 12}{36}\Omega$

$c = \frac{12 \cdot 12}{36}\Omega$

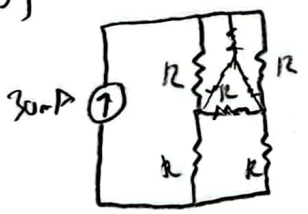
b)

$a = \frac{60 \cdot 30}{100} = 18\Omega$

$b = \frac{60 \cdot 10}{100} = 6\Omega$

$c = \frac{30 \cdot 10}{100} = 3\Omega$

2,45)



$P = IV = 800mW$

$30mA \cdot V = 800mW$

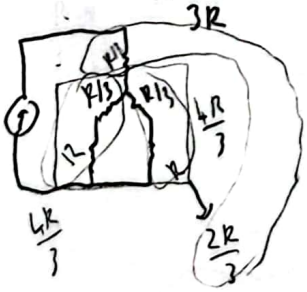
$V_{eq} = 26,\bar{6}V$

$V_{eq} = I_{eq} \cdot R_{eq}$

$\frac{26,\bar{6}}{30 \cdot 10^{-3}} = R = 888\Omega$

$\frac{2R}{3} + \frac{R}{3} = R = R_{eq}$

$= \frac{R \cdot R}{3R}$



$\frac{1}{\frac{1}{\frac{4R}{3}} + \frac{1}{\frac{4R}{3}}} = \frac{4R}{3}$

2,46)

$a_R = \frac{10 \cdot 20}{40}\Omega = 5\Omega$

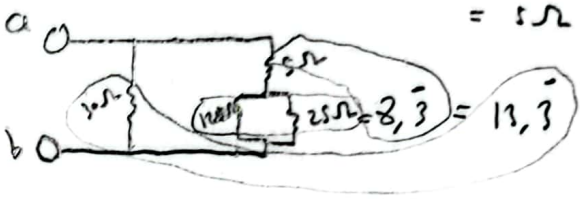
$b_R = \frac{10 \cdot 10}{40}\Omega = 2,5\Omega$

$c_R = \frac{10 \cdot 20}{40} = 5\Omega$

$b_R + 10\Omega = 12,5\Omega$

|| Parallel

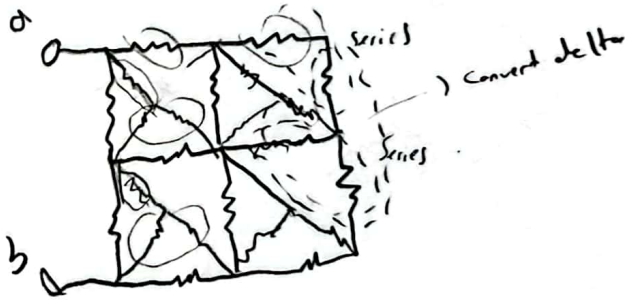
$c_R + 20\Omega = 25\Omega$

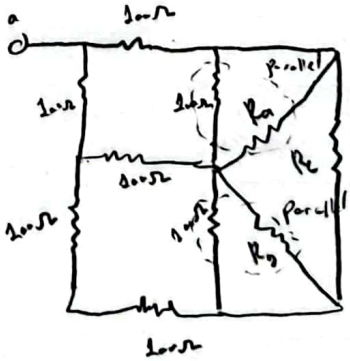


$= 8,\bar{3} = 13,\bar{3}$

$\frac{1}{\frac{1}{30} + \frac{1}{13,\bar{3}}} = 9,23\Omega$

2,47)



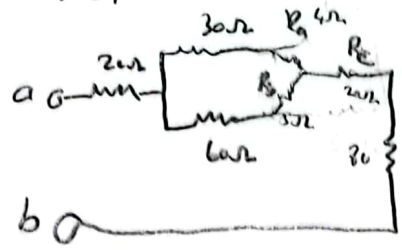


$R_b = R_a = \frac{100 \cdot 200 + 100 \cdot 200 + 200 \cdot 100}{200}$

$R_a = R_b = 400\Omega$

$R_c = 800\Omega$

2.48) a)



a)

$R_a = \frac{40 \cdot 10}{100} = 4\Omega$

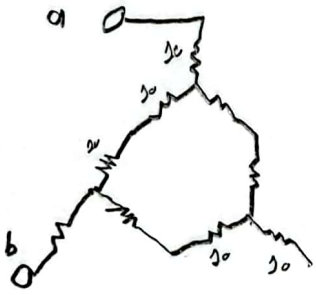
$R_b = \frac{10 \cdot 50}{100} = 5\Omega$

$R_c = \frac{50 \cdot 40}{100} = 20\Omega$

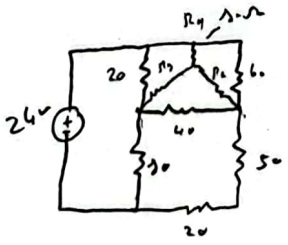
$$R_{eq} = 20\Omega + \frac{1}{\underbrace{\frac{1}{34} + \frac{1}{65}}_{22,\overline{32}}} + 200\Omega$$

$= 142,\overline{32}$

b)



2.49)

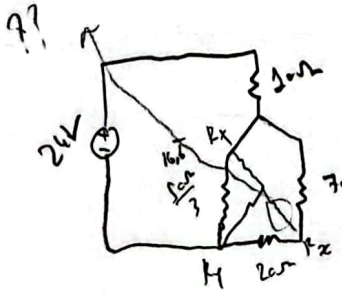


$R_a = \frac{60 \cdot 20}{120} = 10\Omega$

$R_b = \frac{40 \cdot 20}{120} = \frac{20}{3}\Omega$

$R_c = \frac{60 \cdot 40}{120} = 20\Omega$

??



$R_x = \frac{50/3 \cdot 70}{106,\overline{6}}$ 10,94, $R_y = \frac{50/3 \cdot 20}{106,\overline{6}}$ 3,12

$R_z = \frac{70 \cdot 20}{106,\overline{6}}$ 13,13

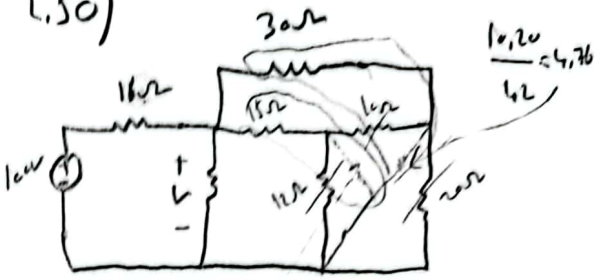
$R_{eq} = 10\Omega + 10,94\Omega + 3,12\Omega =$

$= 24,06\Omega$

$V = I \cdot R$

$24V / 24\Omega = 1A$

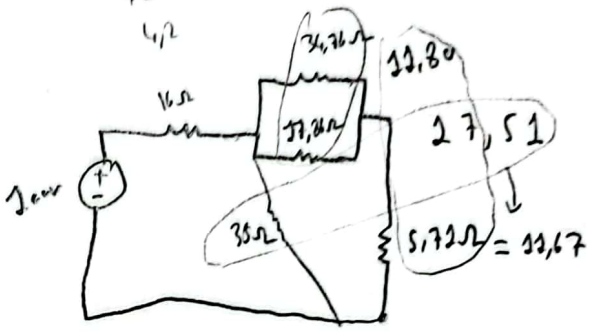
2.50)



$\frac{10 \cdot 20}{42} = 4,76$

$\frac{14 \cdot 12}{42} = 2,86$

$\frac{12 \cdot 20}{42} = 5,71$



$R_{eq} = 16\Omega + 11,67\Omega$

$= 27,67\Omega$

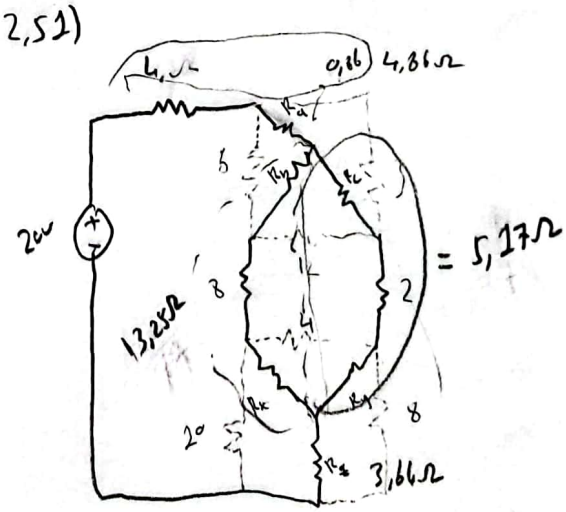
$V = I R$

$\frac{100V}{27,67} = 3,61A$

$V_o = 3,61A \cdot \left(\frac{17,51}{52,51}\right) \cdot 35\Omega$

$= 42,13V$

2.51)



$= 5,17\Omega$

$13,25 \parallel 5,17\Omega = 3,72\Omega$

$R_{eq} = 4,86\Omega + 3,72\Omega + 3,64\Omega = 12,22$

$I = \frac{V}{R_{eq}} = \frac{20V}{12,22\Omega} = 1,64A$

2,52)

$R = \frac{V}{I} = \frac{120V}{0,75A}$

$R = 160\Omega$

$R_T = 40\Omega + \frac{1}{\frac{1}{160} + \frac{1}{80}} = 93,3\Omega$

$53,3$

$V_S = I_T \cdot R_T$

$I_T \cdot \frac{80}{240} = 0,75A$

$I_T = 2,25A$

$V_S = 209,9V$

2,53)

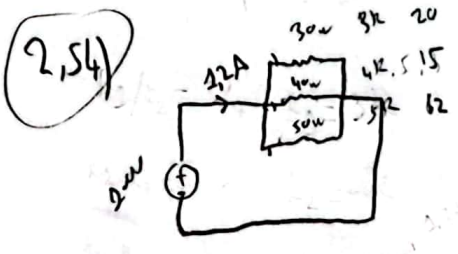
$V_T = 100V$

$P_T = 120W$

$VI = 120W$

$I = 1,2A$

2,54)



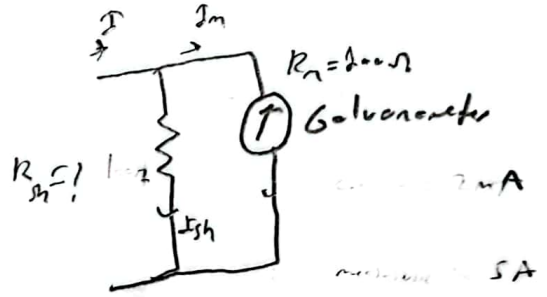
$P = IV$

$i_1 = \frac{30}{100}$, $i_2 = \frac{40}{100}$ / $i_3 = \frac{50}{100}$

0,3A 0,4A 0,5A

2,55)

2,56)



$I = I_m + I_{sh}$

$I_{sh} = I - I_m$

$R_m = 100\Omega$, $I_m = 2mA$

$I = 5A$, $R_{sh} = ?$

$I_m \cdot R_m = I_{sh} \cdot R_{sh}$

$I_{sh} = (I - I_m)$

$I_m R_m = (I - I_m) R_{sh}$

$R_{sh} = \frac{I_m \cdot R_m}{I - I_m} = \frac{2mA \cdot 100\Omega}{5A - 2mA}$

$40 \cdot 10^{-3}\Omega$

$P = I^2 \cdot R = 25 \cdot 40 \cdot 10^{-3}$

$= 1W$