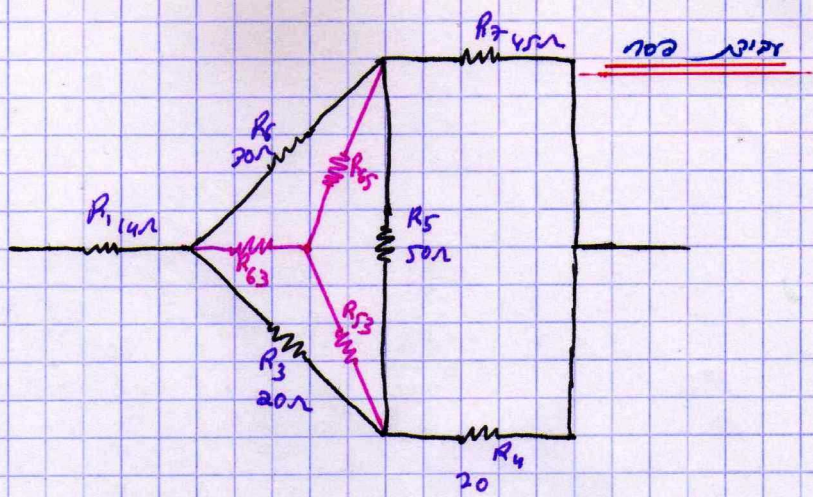


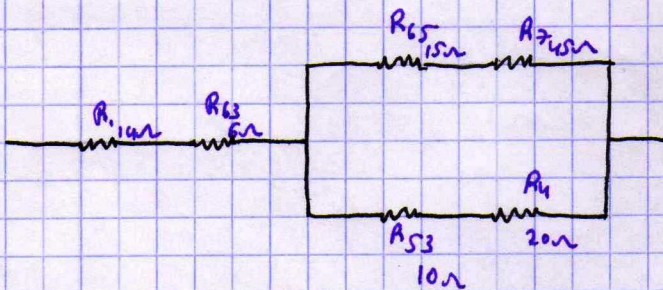


1. 2/10

$$R_{63} = \frac{R_2 \cdot R_3}{R_2 + R_3 + R_5} = \frac{30 \cdot 20}{30 + 20 + 50} = 6 \Omega$$

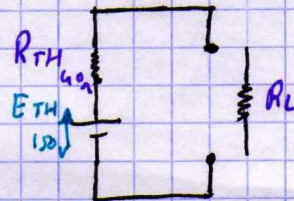
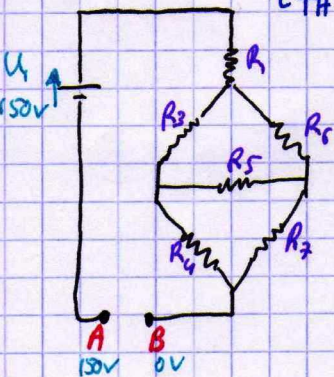
$$R_{65} = \frac{30 \cdot 50}{100} = 15 \Omega$$

$$R_{53} = \frac{50 \cdot 20}{100} = 10 \Omega$$



$$R_{TH} = R_1 + R_{63} + \left[(R_{65} + R_7) \parallel (R_{53} + R_4) \right] = 14 + 6 + \left[\frac{1}{15 + 45} + \frac{1}{10 + 20} \right]^{-1} = 40 \Omega$$

$$E_{TH} = U_{AB} = 150V$$



$$P_{RL} = I_R^2 \cdot R_L = \left(\frac{E_{TH}}{R_{TH} + R_L} \right)^2 \cdot R_L = \left(\frac{150}{40 + 35} \right)^2 \cdot 35 = \boxed{140W}$$

✓

$$R_{L,max} = R_{TH} = \boxed{40 \Omega}$$

✓

$$P_{AL} = \left(\frac{150}{40 + 40} \right)^2 \cdot 40 = \boxed{140.625W}$$

$$\begin{cases} R_1 \cdot \hat{I}_1 - R_{12} \cdot \hat{I}_2 = E_1 \\ -R_{21} \cdot \hat{I}_1 + R_{22} \cdot \hat{I}_2 = E_2 \end{cases}$$

$$\begin{cases} (R+2) \cdot \hat{I}_1 - 2 \cdot \hat{I}_2 = 20 \\ -2 \hat{I}_1 + (R+2) \cdot \hat{I}_2 = -14 \end{cases}$$

$$\hat{I}_1 = 2 \cdot \hat{I}_2 \Rightarrow$$

$$\begin{cases} (R+2)(2 \cdot \hat{I}_2) - 2 \hat{I}_2 = 20 \\ -2(2 \hat{I}_2) + (R+2) \cdot \hat{I}_2 = -14 \end{cases}$$

$$\Downarrow$$

$$\begin{cases} 2 \hat{I}_2 R + 4 \hat{I}_2 - 2 \hat{I}_2 = 20 \\ -4 \hat{I}_2 + R \hat{I}_2 + 2 \hat{I}_2 = -14 \end{cases}$$

$$\Downarrow$$

$$\begin{cases} 2 \hat{I}_2 (R+1) = 20 \\ \hat{I}_2 (R-2) = -14 \Rightarrow \hat{I}_2 = \frac{-14}{R-2} \end{cases}$$

$$\Downarrow$$

$$2 \cdot \left(\frac{-14}{R-2} \right) (R+1) = 20$$

$$\Downarrow$$

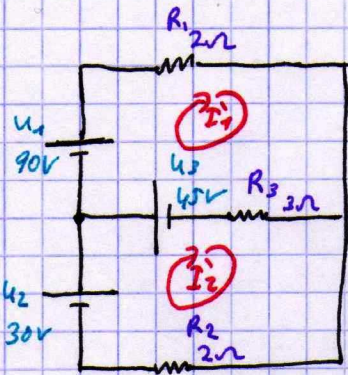
$$-28R - 28 = 20R - 40$$

$$\Downarrow$$

$$12 = 48R$$

$$\boxed{0.25 \Omega} = \frac{1}{4} = \frac{12}{48} = R$$

$$//$$



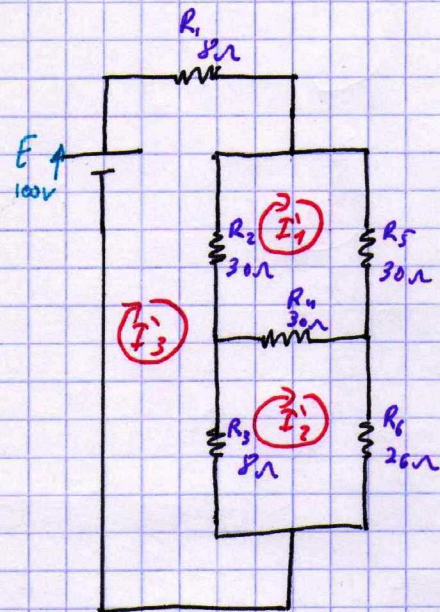
$$\begin{cases} R_{11} \cdot I_1 - R_{12} \cdot I_2 = E_1 \\ -R_{21} \cdot I_1 + R_{22} \cdot I_2 = E_2 \end{cases}$$

$$\begin{cases} 5 \cdot I_1 - 3 \cdot I_2 = 135 \\ -3 \cdot I_1 + 5 \cdot I_2 = -15 \end{cases}$$

$$I_1 = 39.375$$

$$I_2 = 20.625$$

$$P_{R_2} = I_{R_2}^2 \cdot R_2 = I_2^2 \cdot R_2 = 20.625^2 \cdot 2 = \boxed{850.78 \text{ W}}$$

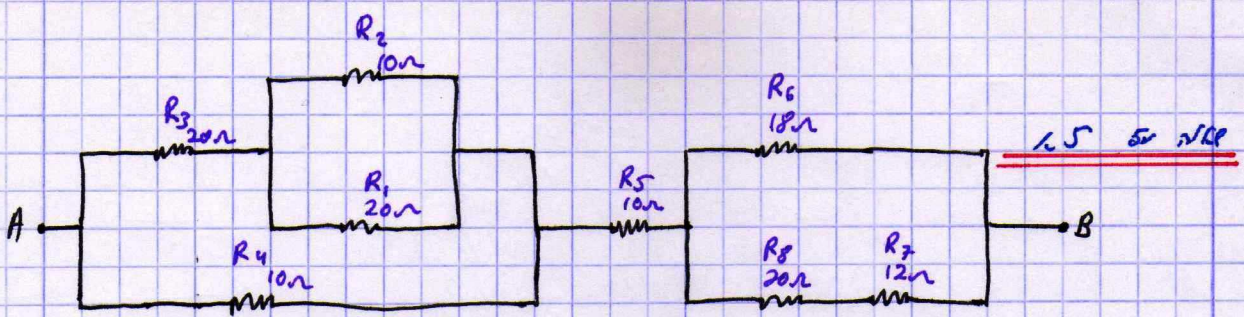


$$\begin{cases} R_{11} \cdot \dot{I}_1 - R_{12} \cdot \dot{I}_2 - R_{13} \cdot \dot{I}_3 = E_1 \\ -R_{21} \cdot \dot{I}_1 + R_{22} \cdot \dot{I}_2 - R_{23} \cdot \dot{I}_3 = E_2 \\ -R_{31} \cdot \dot{I}_1 - R_{32} \cdot \dot{I}_2 + R_{33} \cdot \dot{I}_3 = E_3 \end{cases}$$

$$\begin{cases} 90 \cdot \dot{I}_1 - 30 \cdot \dot{I}_2 - 30 \cdot \dot{I}_3 = 0 \\ -30 \cdot \dot{I}_1 + 64 \cdot \dot{I}_2 - 8 \cdot \dot{I}_3 = 0 \\ -30 \cdot \dot{I}_1 - 8 \cdot \dot{I}_2 + 46 \cdot \dot{I}_3 = 100 \end{cases}$$

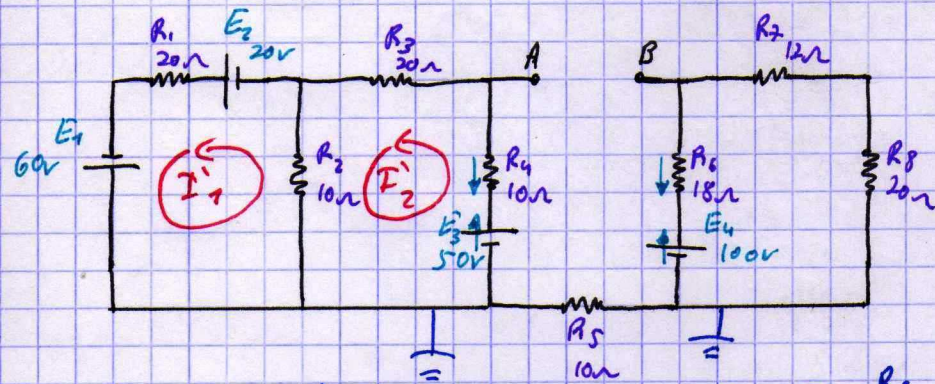
$$\dot{I}_1 = \frac{40}{27} \quad \dot{I}_2 = \frac{10}{9} \quad \dot{I}_3 = \frac{10}{3}$$

$$R_{TH} = \frac{E}{I} = \frac{100}{\frac{10}{3}} = \boxed{30\Omega}$$



$$R_{TH} = \left[R_4 \parallel (R_3 + [R_2 \parallel R_1]) \right] + R_5 + \left[R_6 \parallel (R_8 + R_7) \right]$$

$$= \left[\frac{1}{10} + \frac{1}{20 + \left(\frac{1}{10} + \frac{1}{20} \right)^{-1}} \right]^{-1} + 10 + \left[\frac{1}{18} + \frac{1}{20 + 12} \right]^{-1} = \boxed{28.79\Omega}$$



$$\begin{cases} R_1 \cdot I_1 - R_{12} \cdot I_2 = E_1 \\ -R_{21} \cdot I_1 + R_{22} \cdot I_2 = E_2 \end{cases}$$

$$\begin{cases} 30 \cdot I_1 - 10 \cdot I_2 = 80 \\ -10 \cdot I_1 + 40 \cdot I_2 = 50 \end{cases}$$

$$I_1 = \frac{32}{11}, \quad I_2 = \frac{23}{11}$$

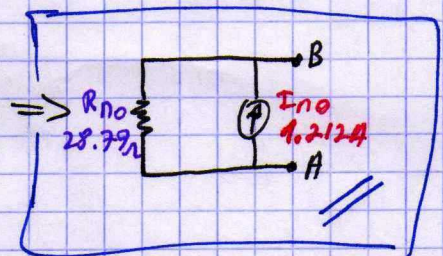
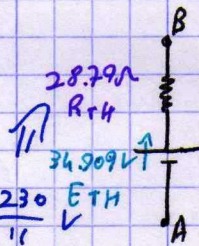
↓

$$U_{A_4} = I_{R_4} \cdot R_4 = I_2 \cdot R_4 = \frac{23}{11} \cdot 10 = \frac{230}{11} \text{ V}_{TH}$$

$$U_{R_6} = E_4 \cdot \frac{R_6}{R_6 + R_7 + R_8} = 100 \cdot \frac{18}{18 + 12 + 20} = 36 \text{ V}$$

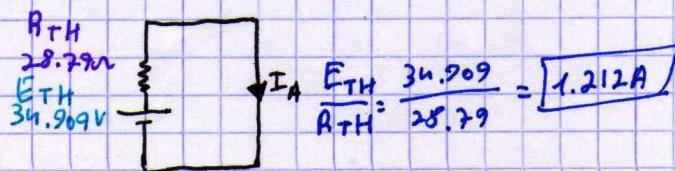
↓

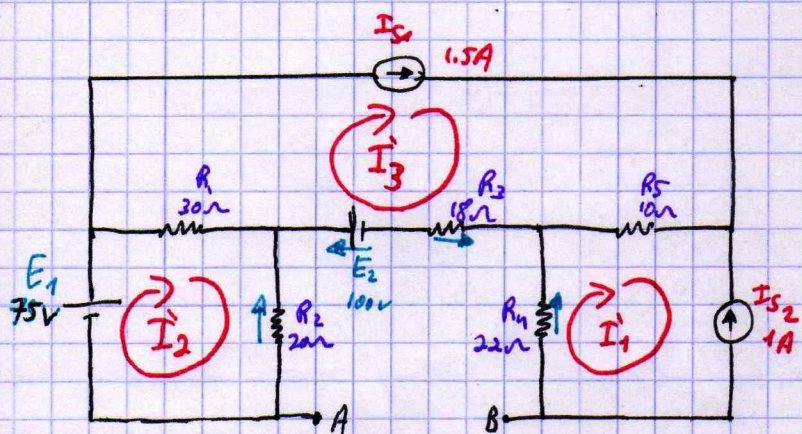
$$U_{AB} = -R_4 \cdot I_2 - E_3 + E_4 + R_6 = -\frac{230}{11} + 50 - 100 + 36 = -34.909 \text{ V}$$



$$R_{L_{max}} = R_{NO} = \boxed{28.79\Omega}$$

$$P_{A_{L_{max}}} = \frac{\left(\frac{E_{TH}}{2} \right)^2}{R_{L_{max}}} = \frac{\left(\frac{34.909}{2} \right)^2}{28.79} = \boxed{10.58 \text{ W}}$$





$$\begin{cases} R_{11}I_1 - R_{12}I_2 - R_{13}I_3 = E_1 \\ -R_{21}I_1 + R_{22}I_2 - R_{23}I_3 = E_2 \\ -R_{31}I_1 - R_{32}I_2 + R_{33}I_3 = E_3 \end{cases}$$

$$I_1 = -1A$$

$$I_3 = 1.5A$$

$$0 + 50 \cdot I_2 - 30 \cdot 1.5 = 75$$

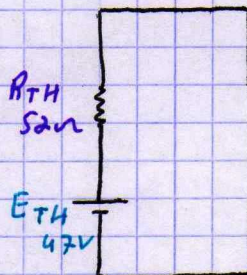
$$50 \cdot I_2 = 120$$

$$I_2 = 2.4A$$

$$E_{TH} = U_{AB} = -U_{R_2} + E_2 - U_{R_3} + U_{R_4}$$

$$= -(2.4 \cdot 20) + 100 - (18 \cdot 1.5) + (22 \cdot 1) = 47V$$

$$R_{TH} = R_4 + R_3 + (R_1 || R_2) = 22 + 18 + \left(\frac{1}{20} + \frac{1}{30}\right)^{-1} = 52\Omega$$



$$R_{20} = 45 \left[1 + 0.0026(20 - 40) \right] = 42.66$$

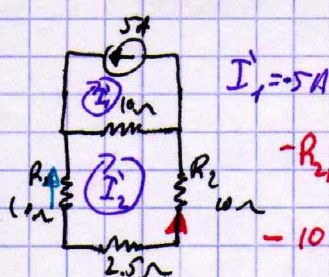
$$P_{R_{20}} = I_{R_{20}}^2 \cdot R_{20} = \left(\frac{E_{TH}}{R_{TH} + R_{20}} \right)^2 \cdot R_{20} = \left(\frac{47}{52 + 42.66} \right)^2 \cdot 42.66 = 10.516W$$

$$R_{0max} = R_{TH} = 52 = 45 \left[1 + 0.0026(\theta - 40) \right]$$

solve ↓

$$\boxed{99.829^\circ C}$$

$$P_{A_{0max}} = I_{A_{0max}}^2 \cdot R_{0max} = \left(\frac{47}{52 + 52} \right)^2 \cdot 52 = 10.62W$$



$$I_1 = 5A$$

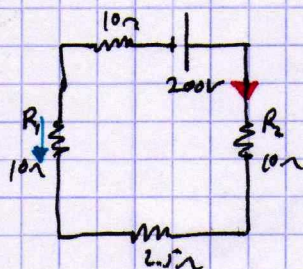
$$-R_1 I_1 + R_2 I_2 = E_2$$

$$-10 \cdot (-5) + 32.5 I_2 = 0 \Rightarrow I_2 = -\frac{20}{13}$$

$$I_{R_2} = \frac{20}{13} A \uparrow$$

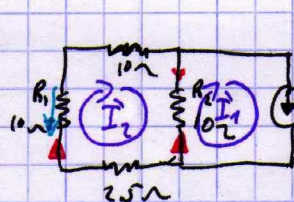
$$\frac{20}{13} \cdot 10 = \boxed{\frac{200}{13} V \uparrow}$$

6. en 2ke



$$\frac{200}{32.5} = \boxed{\frac{80}{13} A \downarrow}$$

$$\frac{80}{13} \cdot 10 = \boxed{\frac{800}{13} V \downarrow}$$

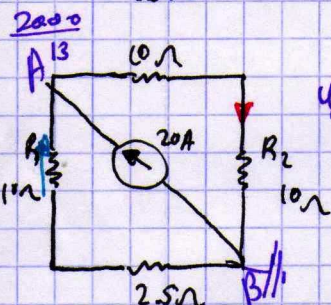


$$I_1 = 5A$$

$$-10 \cdot 5 + 32.5 I_2 = 0 \Rightarrow I_2 = \frac{20}{13}$$

$$I_{R_2} = 5 - \frac{20}{13} = \boxed{\frac{45}{13} A \uparrow}$$

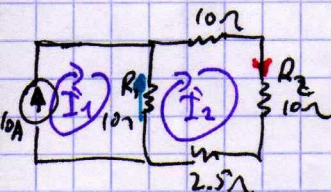
$$U_{R_1} = \frac{20}{13} \cdot 10 = \boxed{\frac{200}{13} V \downarrow}$$



$$U_{AB} = \frac{20}{\frac{1}{12.5} + \frac{1}{20}} = \frac{2000}{13}$$

$$I_{R_2} = \frac{2000}{13} \cdot \frac{10}{20} = \boxed{\frac{100}{13} A \downarrow}$$

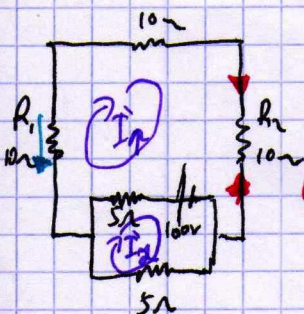
$$U_{R_1} = \frac{2000}{13} \cdot \frac{10}{10+2.5} = \boxed{\frac{1600}{13} V \uparrow}$$



$$I_1 = 10A$$

$$-10 \cdot 10 + 32.5 I_2 = 0 \Rightarrow I_2 = \frac{40}{13} A \downarrow$$

$$U_R = \left(10 - \frac{40}{13}\right) \cdot R_1 = \boxed{\frac{900}{13} V \uparrow}$$

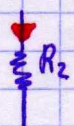


$$\begin{cases} 35 I_1 - 5 I_2 = 100 \\ -5 I_1 + 10 I_2 = -100 \end{cases}$$

$$I_1 = \frac{20}{13} \downarrow$$

$$I_2 = -\frac{120}{13}$$

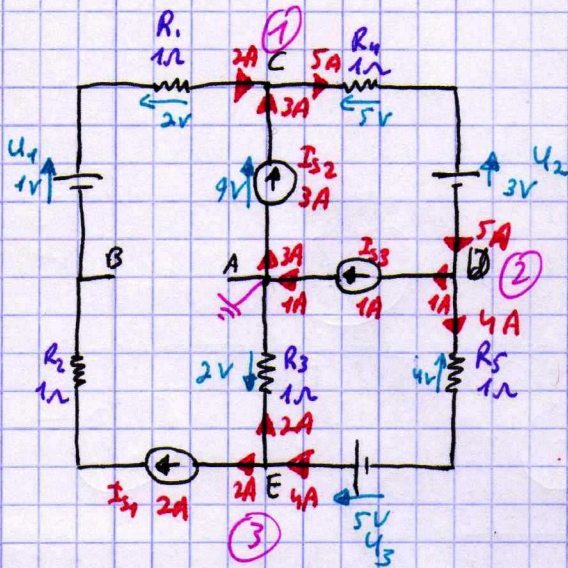
$$U_R = \frac{20}{13} \cdot 10 = \boxed{\frac{200}{13} V \downarrow}$$



$$+\frac{20}{13} - \frac{80}{13} + \frac{45}{13} - \frac{100}{13} - \frac{40}{13} - \frac{20}{13} = \boxed{-13.461 A}$$

$$\frac{200}{13} - \frac{800}{13} - \frac{200}{13} + \frac{1600}{13} + \frac{900}{13} - \frac{200}{13} = \boxed{115.384 V}$$





$$\sum_{i=1}^n I_i = 0 \text{ [KCL]}$$

$$0 = I_{R_1} + I_{I_{S_2}} - I_{R_4} = 2 + 3 - I_{R_4} \Rightarrow I_{R_4} = 5A$$

$$0 = I_{R_4} - I_{I_{S_3}} - I_{R_5} = 5 - 1 - I_{R_5} \Rightarrow I_{R_5} = 4A$$

$$0 = I_{R_5} - I_{I_{S_4}} - I_{R_3} = 4 - 2 - I_{R_3} \Rightarrow I_{R_3} = 2A$$

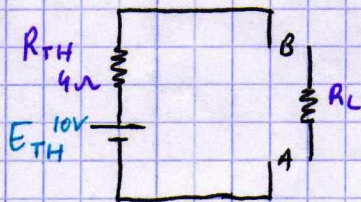
$$U_{I_{S_2}} = U_{R_4} + U_2 + U_{R_5} - U_3 + U_{R_3} = R_4 \cdot I_{R_4} + U_2 + R_5 \cdot I_{R_5} - U_3 + R_3 \cdot I_{R_3} \\ = 5 + 3 + 4 - 5 + 2 = 9V$$

$$U_{AB} = -U_{I_{S_2}} - U_{R_1} + U_1 = -9 - 2 + 1 = -10V \Rightarrow E_{TH} = 10V$$

$$R_{TH} = R_3 + R_5 + R_4 + R_1 = 1 + 1 + 1 + 1 = 4\Omega$$

$$I_{R_L} = \frac{E_{TH}}{R_{TH} + R_L} = \frac{10}{4 + 1} = 2A //$$

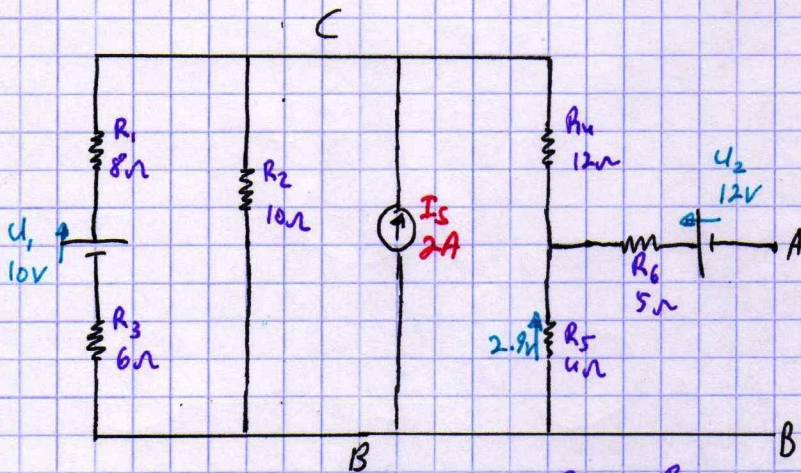
$$I_{R_{L_{min}}} = \frac{10}{4 + 4} = 1.25A //$$



نوع السطح

$$\begin{cases} 1 - 1 - 0 = 8 \\ -1 + 2 - 1 = -9 \\ -0 - 1 + 2 = 3 \end{cases}$$

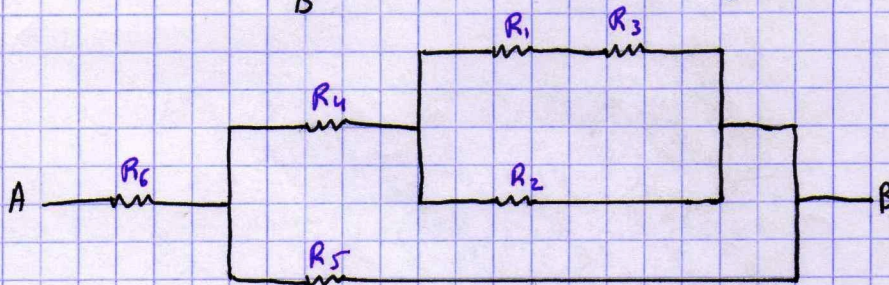
$$V_1 = 9V, V_2 = 1V, V_3 = 2V$$



$$U_{CB} = \frac{10}{14} + 2 = \frac{1}{\frac{1}{14} + \frac{1}{10} + \frac{1}{16}} = 11.603$$

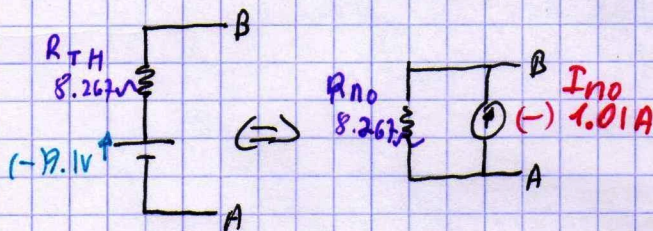
$$E_{TH} = U_{AB} = U_{R5} - U_2 = 2.9 - 12 = -9.1$$

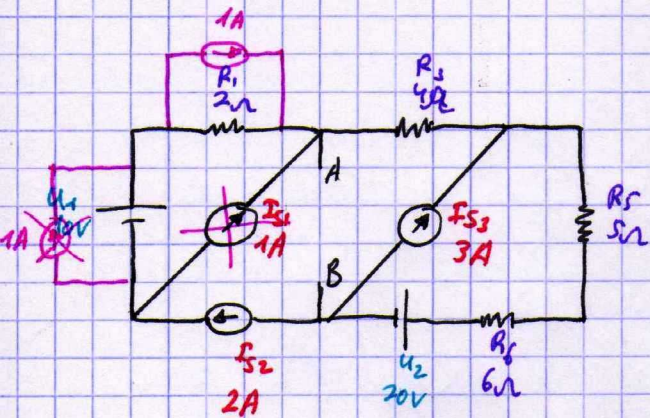
$$U_{R5} = U_{CB} \cdot \frac{R5}{R5 + R_N} = 11.603 \cdot \frac{4}{12 + 4} = 2.9$$



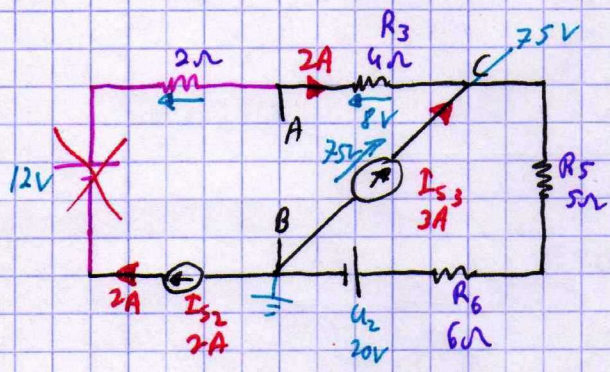
$$R_{TH} = R_6 + \left(R_5 \parallel \left[R_4 + \left(R_2 \parallel [R_1 + R_3] \right) \right] \right)$$

$$= 5 + \left(\frac{1}{4} + \left[\frac{1}{12 + \left(\frac{1}{10} + \left[\frac{1}{8 + 6} \right] \right)} \right]^{-1} \right)^{-1} = 8.267 \Omega$$





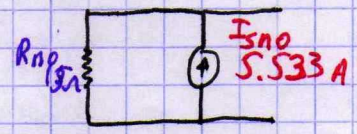
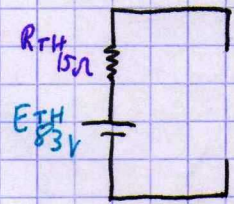
$$U_{CD} = \frac{I_{S2} + I_{S3} + \frac{U_2}{R_6 + R_7}}{\frac{1}{R_6 + R_7}} = \frac{2 + 3 + \frac{20}{11}}{\frac{1}{11}} = 75V$$



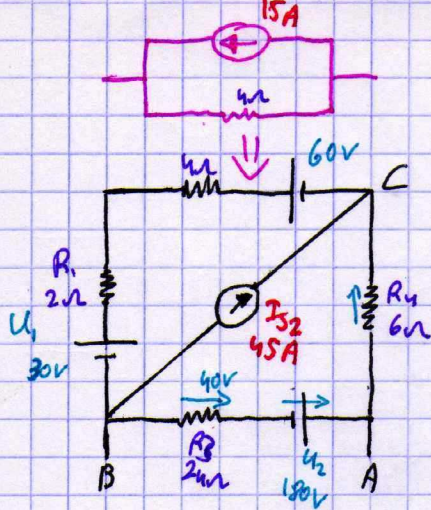
$$U_{AB} = U_{R3} + U_{I_{S3}} = 8 + 75 = 83V$$

$$R_{TH} = R_3 + R_5 + R_6 = 4 + 5 + 6 = 15\Omega$$

$$I_{no} = \frac{E_{TH}}{R_{TH}} = \frac{83}{15} = 5.533A$$



$$I_{A2} = I_{no} \cdot \frac{R_{no}}{R_{no} + R_2} = 5.533 \cdot \frac{15}{15 + 3} = 4.611A$$

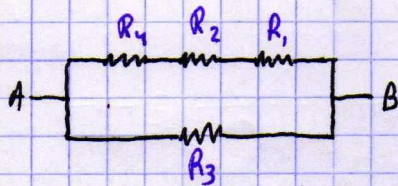


10.5W SEP

$$U_{CB} = \frac{45 + \frac{30-60}{4+2} + \frac{180}{30}}{\frac{1}{6} + \frac{1}{30}} = 230V$$

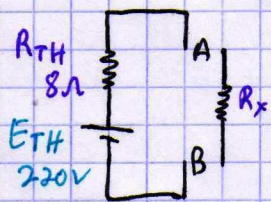
$$U_{R_3} = \frac{(U_{CB} - U_2) \cdot R_3}{R_3 + R_4} = \frac{(230 - 180) \cdot 24}{24 + 6} = 40V$$

$$U_{AB} = U_2 + U_{R_3} = 180 + 40 = 220V$$



$$R_{TH} = \left[R_3 \parallel (R_4 + R_2 + R_1) \right] = \left(\frac{1}{24} + \frac{1}{6+4+2} \right) = 8\Omega$$

$$R_{xmax} = R_{TH} = \boxed{8\Omega}$$



$$P_{R_{xmax}} = \frac{\left(\frac{220}{2} \right)^2}{8} = 1512.5W$$

$$P_{R_x} = \frac{1}{2} P_{R_{xmax}} = 756.25W$$

$$= I_{R_x}^2 \cdot R_x = \left(\frac{E_{TH}}{R_{TH} + R_x} \right)^2 \cdot R_x = \left(\frac{220}{8 + R_x} \right)^2 \cdot R_x$$

$\Downarrow$

$$\frac{48400 \cdot R_x}{(R_x + 8)^2} = 756.25$$

$\Downarrow$

$$64 \cdot R_x = (R_x + 8)^2$$

$\Downarrow$

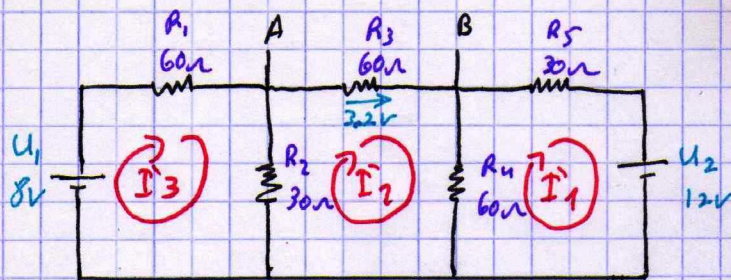
$$64 \cdot R_x = R_x^2 + 16R_x + 64$$

$\Downarrow$

$$R_x^2 - 48 \cdot R_x + 64 = 0$$

$$R_{x1} = \boxed{46.627\Omega}$$

$$R_{x2} = \boxed{1.3725\Omega}$$



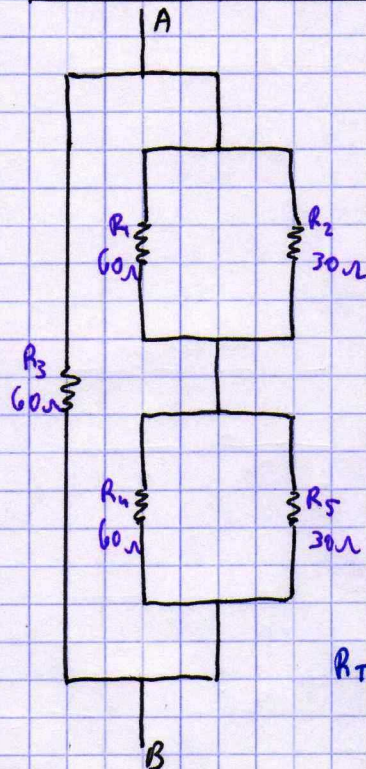
11. 02. 2018

$$\begin{cases} R_{11} \cdot \vec{I}_1 - R_{12} \cdot \vec{I}_2 - R_{13} \cdot \vec{I}_3 = \vec{E}_1 \\ -R_{21} \cdot \vec{I}_1 + R_{22} \cdot \vec{I}_2 - R_{23} \cdot \vec{I}_3 = \vec{E}_2 \\ -R_{31} \cdot \vec{I}_1 - R_{32} \cdot \vec{I}_2 + R_{33} \cdot \vec{I}_3 = \vec{E}_3 \end{cases}$$

$$\begin{cases} 90 \cdot \vec{I}_1 - 60 \cdot \vec{I}_2 - 0 = -12 \\ -60 \cdot \vec{I}_1 + 150 \cdot \vec{I}_2 - 30 \cdot \vec{I}_3 = 0 \\ 0 - 30 \cdot \vec{I}_2 + 90 \cdot \vec{I}_3 = 8 \end{cases}$$

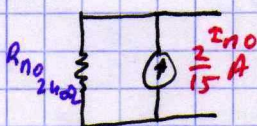
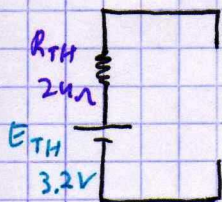
$$\vec{I}_1 = -\frac{38}{225}, \vec{I}_2 = -\frac{4}{75}, \vec{I}_3 = \frac{16}{225}$$

$$E_{TH} = U_{BA} = U_{A_3} = I_{A_3} \cdot R_3 = \frac{4}{75} \cdot 60 = \boxed{3.2V}$$



$$R_{TH} = \left(R_3 \parallel \left[(R_1 \parallel R_2) + (R_5 \parallel R_4) \right] \right)$$

$$= \left(60 \parallel \left(\frac{20}{60 \parallel 30} + \frac{20}{60 \parallel 30} \right) \right) = \boxed{24\Omega}$$

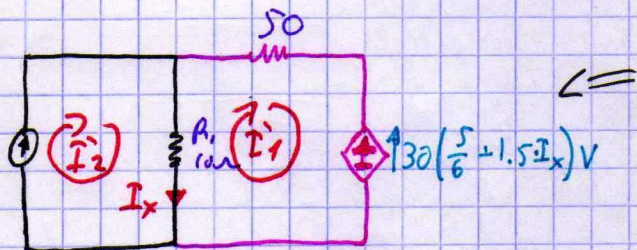
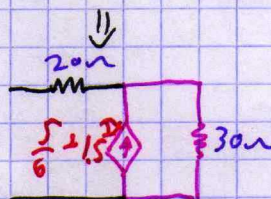
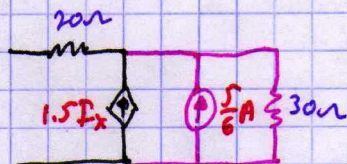
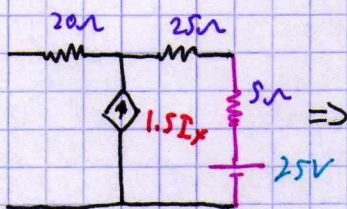
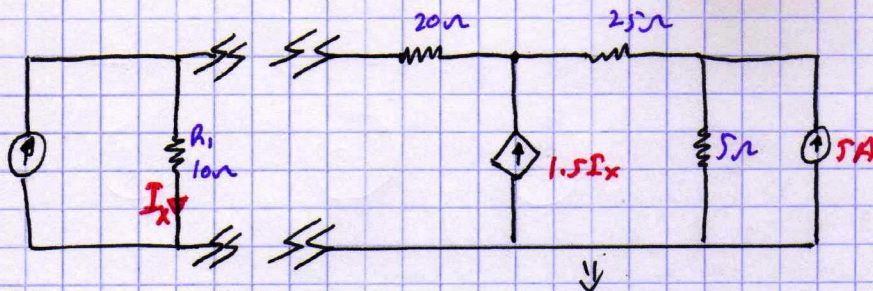


$$I_{no} = \frac{E_{TH}}{R_{TH}} = \frac{3.2}{24} = \frac{2}{15} = \boxed{0.133A}$$

$$R_{L_{max}} = R_{TH} = \boxed{24\Omega}$$

$$P_{R_{L_{max}}} = \frac{\left(\frac{E_{TH}}{2} \right)^2}{R_{L_{max}}} = \frac{\left(\frac{3.2}{2} \right)^2}{24} = \boxed{0.1066V}$$

R_1 also



$$I_2 = 2A$$

$$R_1 \cdot I_1 - R_2 \cdot I_2 = E_1$$

$$60 \cdot I_1 - 10 \cdot 2 = -30 \left(\frac{5}{6} + 1.5I_x \right)$$

$$60 \cdot I_1 = 20 - 30 \left(\frac{5}{6} + 1.5I_x \right)$$

$$I_1 = -\frac{1}{2} \left(\frac{5}{6} + 1.5I_x \right) + \frac{1}{3}$$

$$I_x = I_{R_1} = I_2 - I_1$$

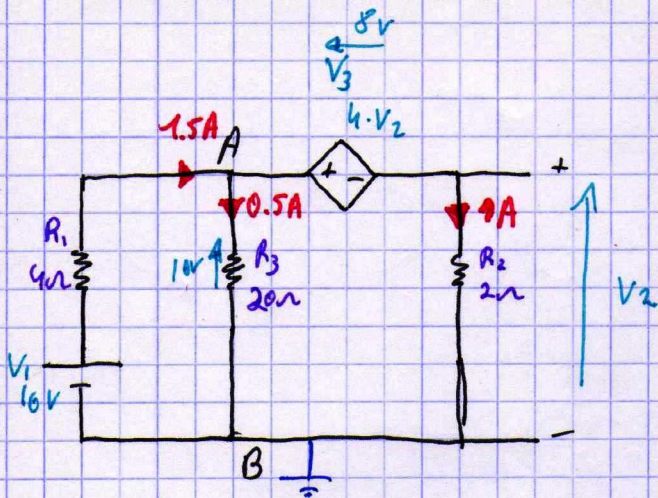
$$= 2 - \left(-\frac{1}{2} \left(\frac{5}{6} + 1.5I_x \right) + \frac{1}{3} \right)$$

$$= 2 - \left(-\frac{5}{12} - \frac{3}{4}I_x + \frac{1}{3} \right)$$

$$I_x = \frac{25}{12} + \frac{3}{4}I_x$$

$\Downarrow$

$$\frac{1}{4}I_x = \frac{25}{12} \Rightarrow I_x = \frac{25}{3} = \boxed{8.333A}$$



B₂ NLP

$$U_{AB} = \frac{\frac{16}{4} + \frac{4 \cdot V_2}{2}}{\frac{1}{4} + \frac{1}{20} + \frac{1}{2}} = \frac{16 + 8V_2}{\frac{4}{5}}$$

$$= \frac{5 \cdot 4 \cdot 2 (2 + V_2)}{4 \cdot 2 \cdot 2} = \frac{5}{2} (2 + V_2)$$

$$V_2 = U_{R_2} = U_{AB} - V_3 = \frac{5}{2} (2 + V_2) - 4V_2 = 5 + \frac{5}{2} V_2 - 4V_2$$

⇓

$$V_2 = 5 + \frac{5}{2} V_2 - 4V_2$$

⇓

$$V_2 - \frac{5}{2} V_2 + 4V_2 = 5$$

⇓

$$\frac{5}{2} V_2 = 5 \Rightarrow \boxed{V_2 = 2V} \Rightarrow I_{R_2} = \frac{U_{R_2}}{R_2} = \frac{2}{2} = \boxed{1A}$$

$$V_3 = 4 \cdot V_2 = 4 \cdot 2 = 8V$$

$$I_{R_3} = \frac{U_{R_3}}{R_3} = \frac{R_2 + V_3}{R_3} = \frac{2 + 8}{20} = \boxed{0.5A}$$

$$I_{R_1} = I_{R_3} + I_{R_2} [KCL] = 0.5 + 1 = \boxed{1.5A}$$

$$P_{V_1} = 16 \cdot 1.5 = \boxed{24W}$$

$$P_{V_3} = 8 \cdot 1 = \boxed{8W}$$

