

$$V_1 = 6V$$

$$G_{11} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_4} = \frac{7}{9} \text{ S}$$

$$G_{12} = G_{21} = \frac{1}{R_2} + \frac{1}{R_4} = \frac{4}{9} \text{ S}$$

$$G_{22} = \frac{1}{R_4} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_5} =$$

$$= \frac{17}{9} \text{ S} \quad I_{sc1} = \infty \rightarrow \text{open circuit}$$

$$I_{sc2} = -\frac{E_2}{R_2} + \frac{E_3}{R_3} = \frac{12}{3} - \frac{9}{9} = 3A$$

$$-G_{21}V_1 + G_{22}V_2 = I_{sc2} \quad -\frac{4}{9} \cdot 6 + \frac{17}{9} \cdot V_2 = 3$$

$$V_2 = 3V$$

$$I_{R1} = \frac{V_1}{R_1} = \frac{6}{3} = 2A$$

$$I_{R2} = \frac{E_2 - (V_1 - V_2)}{R_2} = \frac{6}{9} = \frac{2}{3}A$$

$$I_{R3} = \frac{E_3 - V_2}{R_3} = \frac{9}{3} = 3A$$

$$I_{R4} = \frac{V_1 - V_2}{R_4} = \frac{3}{3} = 1A \quad I_{R5} = \frac{V_2}{R_5} = \frac{3}{0.9} = \frac{10}{3}A$$

$$P_{R1} = I_{R1}^2 \cdot R_1 = 12W$$

$$P_{R2} = I_{R2}^2 \cdot R_2 = 4W$$

$$P_{R3} = I_{R3}^2 \cdot R_3 = 27W$$

$$P_{R4} = I_{R4}^2 \cdot R_4 = 3W$$

$$P_{R5} = I_{R5}^2 \cdot R_5 = 10W$$

$$\sum P_R = 56W$$

$$I_{E1} + I_{E2} = I_{R4} + 3A$$

$$I_{E1} = 1 + 3 - \frac{2}{3} = \frac{10}{3}A$$

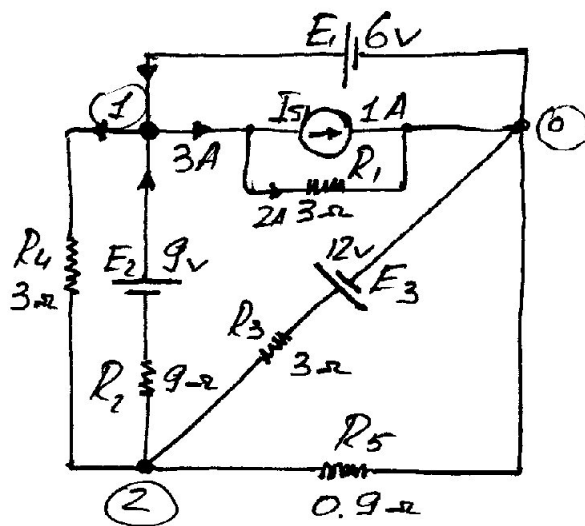
$$P_{E1} = E_1 \cdot I_{E1} = 6 \cdot \frac{10}{3} = 20W$$

$$P_{E2} = E_2 \cdot I_{R2} = 6W$$

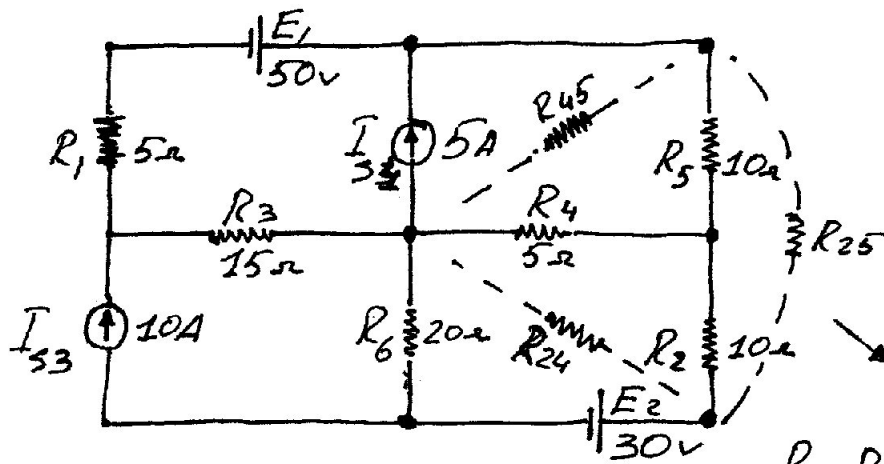
$$P_{E3} = E_3 \cdot I_{R3} = 12 \cdot 3 = 36W$$

$$P_{I_{S1}} = I_{S1} \cdot V_1 = 6W \text{ (1073)}$$

$$\sum P_S = 56W$$



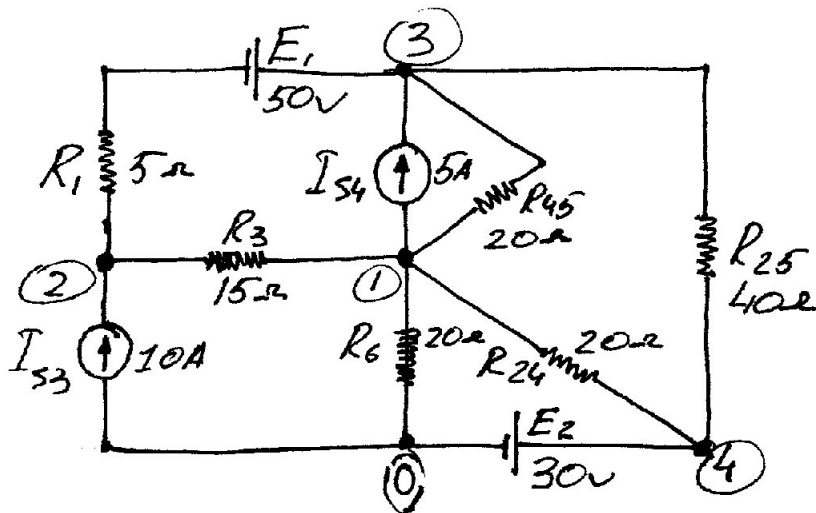
② 2/10



2010 7/17/7
 R_2, R_4, R_5 p'721
 R_{24}, R_{25}, R_{45} e'tien r

$$R_{24} = \frac{R_2 R_4 + R_4 R_5 + R_5 R_2}{R_5} = \frac{10 \cdot 5 + 5 \cdot 10 + 10 \cdot 10}{10} = \frac{200}{10} = 20 \Omega$$

$$R_{25} = \frac{200}{R_4} = 40 \Omega \quad R_{45} = \frac{200}{R_2} = 20 \Omega$$



$$\begin{cases} +G_{11}V_1 - G_{12}V_2 - G_{13}V_3 - G_{14}V_4 = \bar{I}_{sc1} \\ -G_{21}V_1 + G_{22}V_2 - G_{23}V_3 - G_{24}V_4 = \bar{I}_{sc2} \\ -G_{31}V_1 - G_{32}V_2 + G_{33}V_3 - G_{34}V_4 = \bar{I}_{sc3} \\ -G_{41}V_1 - G_{42}V_2 - G_{43}V_3 + G_{44}V_4 = \bar{I}_{sc4} = \infty \end{cases}$$

מחשבה דמיונית לא רלוונטית.

② nke pen

$$G_{11} = \frac{1}{R_3} + \frac{1}{R_6} + \frac{1}{R_{24}} + \frac{1}{R_{45}} = \frac{13}{60} S$$

$$G_{12} = G_{21} = \frac{1}{R_3} = \frac{1}{15} S \quad G_{14} = \frac{1}{20} S$$

$$G_{13} = G_{31} = \frac{1}{R_{45}} = 0.05 S \quad G_{24} = 0$$

$$G_{22} = \frac{1}{R_1} + \frac{1}{R_3} = \frac{4}{15} S \quad G_{34} = \frac{1}{40} S = G_{43}$$

$$G_{33} = \frac{1}{R_1} + \frac{1}{R_{45}} + \frac{1}{R_{25}} = 0.275 S$$

$$G_{32} = G_{23} = \frac{1}{R_1} = 0.2 S$$

$$I_{sc1} = -I_{s4} = -5 A$$

$$I_{sc2} = I_{s3} - \frac{E_1}{R_1} = 10 - 10 = 0 A$$

$$I_{sc3} = \frac{E_1}{R_1} + I_{s4} = 10 + 5 = 15 A$$

$$V_4 = E_2 = 30 V$$

$$\frac{13}{60} \cdot V_1 - \frac{1}{15} \cdot V_2 - 0.05 \cdot V_3 - \frac{1}{20} \cdot 30 = -5$$

$$-\frac{1}{15} \cdot V_1 + \frac{4}{15} \cdot V_2 - 0.2 \cdot V_3 = 0$$

$$-0.05 \cdot V_1 - 0.2 \cdot V_2 + 0.275 \cdot V_3 - \frac{1}{40} \cdot 30 = 15$$

$$\begin{cases} +\frac{13}{60} V_1 - \frac{1}{15} V_2 - 0.05 V_3 = -3.5 \\ -\frac{1}{15} V_1 + \frac{4}{15} V_2 - 0.2 V_3 = 0 \\ -0.05 V_1 - 0.2 V_2 + 0.275 V_3 = 15.75 \end{cases}$$

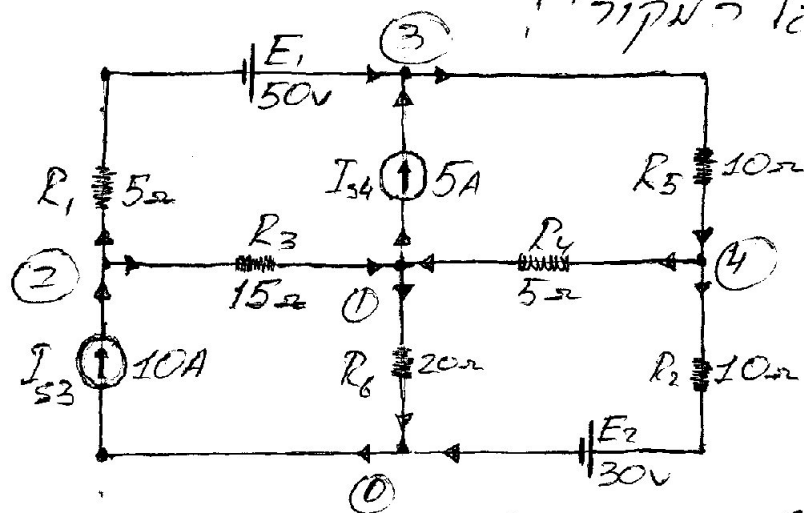
$$V_1 = \frac{455}{6} V = 75.833 V$$

$$V_2 = \frac{3815}{24} V = 158.958 V$$

$$V_3 = \frac{560}{3} V = 186.666 V$$

המשקע 2

חוקי קירכוף למעגל המקור:



$$V_1 = 75.833 \text{ V}$$

$$V_2 = 158.958 \text{ V}$$

$$V_3 = 186.666 \text{ V}$$

$$G_{41} = \frac{1}{R_1} = \frac{1}{5} \text{ S} = 0.2 \text{ S}$$

$$G_{43} = \frac{1}{R_5} = \frac{1}{10} \text{ S} = 0.1 \text{ S}$$

$$G_{42} = 0 \quad G_{44} = \frac{1}{R_5} + \frac{1}{R_4} + \frac{1}{R_2} = 0.4 \text{ S}$$

$$I_{s4} = \frac{E_2}{R_2} = 3 \text{ A} \quad \text{משקע 4 המקור}$$

$$-0.2 \cdot 75.833 - 0.1 \cdot 186.666 + 0.4 \cdot V_4 = 3$$

$$0.4 \cdot V_4 = 36.8332 \quad V_4 = 92.083 \text{ V}$$

$$I_{R1} = \frac{E_1 - (V_3 - V_2)}{R_1} = \frac{50 - 27.708}{5} = 4.458 \text{ A}$$

$$I_{R2} = \frac{V_4 - E_2}{R_2} = \frac{62.083}{10} = 6.208 \text{ A}$$

$$I_{R3} = \frac{V_2 - V_1}{R_3} = \frac{83.125}{15} = 5.542 \text{ A}$$

$$I_{R4} = \frac{V_4 - V_1}{R_4} = \frac{16.25}{5} = 3.25 \text{ A}$$

$$I_{R5} = \frac{V_3 - V_4}{R_5} = \frac{94.583}{10} = 9.458 \text{ A}$$

$$I_{R6} = \frac{V_1}{R_6} = \frac{75.833}{20} = 3.792 \text{ A}$$

מתק"ק חוק קירכוף למעגל
בכל המקור.

2 like pen

$$P_{R1} = I_{R1}^2 \cdot R_1 = 99.368 \text{ W}$$

$$P_{R2} = I_{R2}^2 \cdot R_2 = 385.392 \text{ W}$$

$$P_{R3} = I_{R3}^2 \cdot R_3 = 460.706 \text{ W}$$

$$P_{R4} = I_{R4}^2 \cdot R_4 = 52.812 \text{ W}$$

$$P_{R5} = I_{R5}^2 \cdot R_5 = 894.537 \text{ W} \quad \sum P_R = \underline{2180.4}$$

$$P_{R6} = I_{R6}^2 \cdot R_6 = 287.585 \text{ W}$$

$$P_{E1} = E_1 \cdot I_{R1} = 222.9 \text{ W}$$

$$P_{E2} = E_2 \cdot I_{R2} = 186.24 \text{ W (1.573)}$$

$$P_{I_{S3}} = I_{S3} \cdot V_2 = 1589.58 \text{ W}$$

$$P_{I_{S4}} = I_{S4} \cdot (V_3 - V_1) = 5 \cdot 110.833 = 554.165 \text{ W}$$

$$\sum P_S = \underline{2180.4}$$

הן פ'קטן פ'קטן פ'קטן





$$V_2 = -50V$$

$$I_{sc1} = I_{sc2} = \infty$$

$$V_1 = E_3 = 150\text{V}$$

$$V_2 = -E_1 = -50V$$

מחאה דאסער וועג - וועלכע

$$-\frac{1}{10} \cdot 150 - \frac{1}{10} (-50) + \frac{3}{10} \cdot V_3 = 0$$

$$V_3 = \frac{100}{3} \text{ V}$$

$$I_{R1} = \frac{V_3}{R_1} = \frac{10}{3} A$$

$$I_{R4} = \frac{E_2 - (V_1 - V_2)}{R_4} =$$

$$I_{R2} = \frac{V_1 - V_3}{R_2} = \frac{150 - \frac{100}{3}}{10} = \frac{35}{3} A$$

$$= \frac{100 - (150 + 50)}{10} =$$

$$I_{R3} = \frac{V_3 - V_2}{R_3} = \frac{\frac{100}{3} + 50}{10} = \frac{25}{3} A$$

$$= \frac{100}{10} = 10 \text{ A}$$

$$I_{E3} + I_{S1} = I_{R2} + I_{R4}$$

$$\hat{I}_{E1} + \hat{I}_{R1} = \hat{I}_{E3}$$

$$\underline{I_{E3}} = \frac{35}{3} + 10 - 10 = \frac{35}{3} A$$

$$\underline{I_{E1}} = \frac{35}{3} - \frac{10}{3} = \frac{25}{3} A$$

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83d

$$P_{R1} = I_{R1}^2 \cdot R_1 = 111.111 \text{ W}$$

$$P_{R2} = I_{R2}^2 \cdot R_2 = 1361.111 \text{ W}$$

$$P_{R3} = I_{R3}^2 \cdot R_3 = 694.444 \text{ W}$$

$$P_{R4} = I_{R4}^2 \cdot R_4 = 1000 \text{ W}$$

$$\underline{\Sigma P_R = 3166.666 \text{ W}}$$

$$P_{E1} = E_1 \cdot I_{E1} = 416.666 \text{ W}$$

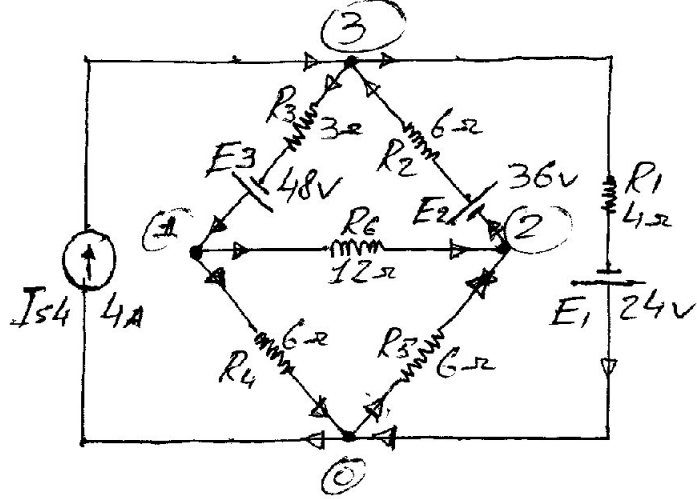
$$P_{E2} = E_2 \cdot I_{R4} = 1000 \text{ W (1073)}$$

$$P_{Is1} = I_{s1} \cdot (V_1 - V_2) = 10 \cdot (150 + 50) = 2000 \text{ W}$$

$$P_{E3} = E_3 \cdot I_{E3} = 1750 \text{ W}$$

$$\underline{\Sigma P_S = 3166.666 \text{ W}}$$

$P'_{p2007} / 15 \text{ kW}$ P'_{pPA}



(4) מילר

$$G_{11} = \frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_6} = \frac{7}{12} S$$

$$G_{12} = G_{21} = \frac{1}{R_6} = \frac{1}{12} S$$

$$G_{13} = G_{31} = \frac{1}{R_3} = \frac{1}{3} S$$

$$G_{22} = \frac{1}{R_2} + \frac{1}{R_5} + \frac{1}{R_6} = \frac{5}{12} S$$

$$G_{32} = G_{23} = \frac{1}{R_2} = \frac{1}{6} S$$

$$G_{33} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = 0.75 S$$

$$I_{sc1} = \frac{E_3}{R_3} = 16 A$$

$$I_{sc2} = -\frac{E_2}{R_2} = -6 A$$

$$I_{sc3} = I_{s4} - \frac{E_1}{R_1} + \frac{E_2}{R_2} - \frac{E_3}{R_3} = -12 A$$

$$\begin{cases} +\frac{7}{12} \cdot V_1 - \frac{1}{12} V_2 - \frac{1}{3} V_3 = 16, & V_1 = 19.121 V \\ -\frac{1}{12} \cdot V_1 + \frac{5}{12} \cdot V_2 - \frac{1}{6} V_3 = -6 & V_2 = -14.901 V \\ -\frac{1}{3} \cdot V_1 - \frac{1}{6} \cdot V_2 + 0.75 V_3 = -12 & V_3 = -10.813 V \end{cases}$$

$$I_{R1} = \frac{E_1 - V_3}{R_1} = \frac{24 - (-10.813)}{4} = 3.296 A$$

$$I_{R2} = \frac{E_2(V_3 - V_2)}{R_2} = \frac{36 - (-10.813 - (-14.901))}{6} = \frac{31.912}{6} = 5.318 A$$

$$I_{R3} = \frac{E_3 - (V_1 - V_3)}{R_3} = \frac{48 - (19.121 + 10.813)}{3} = \frac{18.066}{3} = 6.022 A$$

$$I_{R4} = \frac{V_1}{R_4} = \frac{19.121}{6} = 3.186 A$$

$$I_{R5} = \frac{V_0 - V_2}{R_5} = \frac{14.901}{6} = 2.483 A$$

$$I_{R6} = \frac{V_1 - V_2}{R_6} = \frac{19.121 + 14.901}{12} = 2.835 A$$

חוק קירכוף לזרמים
מנק' קרינה
מנק' קרינה

4 ארבע קצוות

$$P_{R1} = I_{R1}^2 \cdot R_1 = 43.454 \text{ W}$$

$$P_{R2} = I_{R2}^2 \cdot R_2 = 169.726 \text{ W}$$

$$P_{R3} = I_{R3}^2 \cdot R_3 = 108.793 \text{ W}$$

$$P_{R4} = I_{R4}^2 \cdot R_4 = 60.985 \text{ W} \quad \sum P_R = 516.372 \text{ W}$$

$$P_{R5} = I_{R5}^2 \cdot R_5 = 37.006 \text{ W}$$

$$P_{R6} = I_{R6}^2 \cdot R_6 = 96.458 \text{ W}$$

$$P_{E1} = I_{R1} \cdot E_1 = 79.104 \text{ W}$$

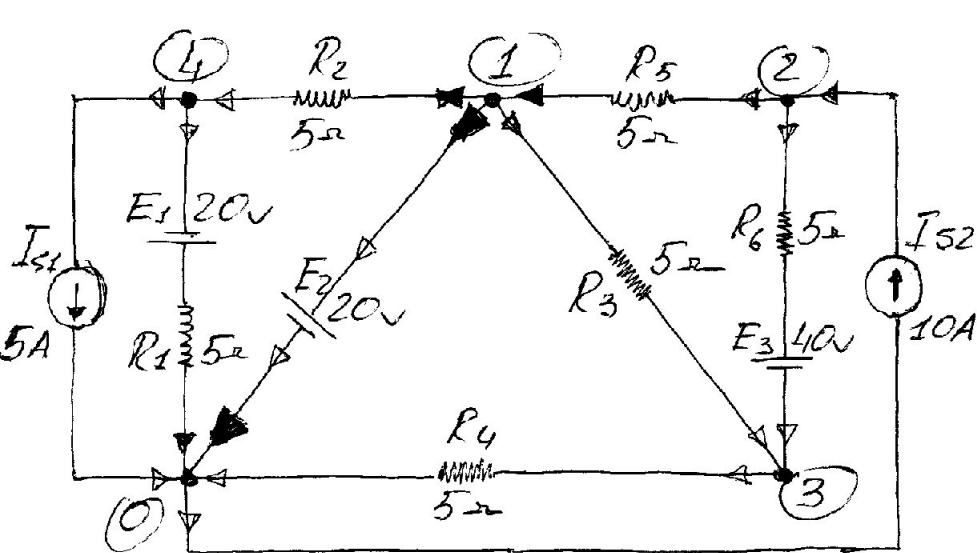
$$P_{E2} = I_{R2} \cdot E_2 = 191.448 \text{ W}$$

$$P_{E3} = I_{R3} \cdot E_3 = 289.056 \text{ W}$$

$$P_{I_{S4}} = I_{S4}(-V_3) = 43.252 \text{ W} (!) \underline{273})$$

$$\sum P_S = 516.356 \text{ W}$$





5) סכום

$$\begin{cases}
 +G_{11}V_1 - G_{12}V_2 - G_{13}V_3 - G_{14}V_4 = I_{sc1} = 0 \\
 -G_{21}V_1 + G_{22}V_2 - G_{23}V_3 - G_{24}V_4 = I_{sc2} \\
 -G_{31}V_1 - G_{32}V_2 + G_{33}V_3 - G_{34}V_4 = I_{sc3} \\
 -G_{41}V_1 - G_{42}V_2 - G_{43}V_3 + G_{44}V_4 = I_{sc4}
 \end{cases}$$

→ סכום
הקצות נפרד

$V_1 = 20V$

$$\begin{aligned}
 G_{11} &= \frac{1}{R_5} = \frac{1}{5} = 0.2S \\
 G_{22} &= \frac{1}{R_5} + \frac{1}{R_6} = 0.2 + 0.2 = 0.4S \\
 G_{23} &= \frac{1}{R_6} = 0.2S = G_{32} \\
 G_{24} &= 0 = G_{42} = G_{43} = G_{34} \\
 G_{31} &= \frac{1}{R_3} = 0.2S \quad G_{41} = 0.2S \\
 G_{33} &= \frac{1}{R_6} + \frac{1}{R_3} + \frac{1}{R_4} = 0.2 + 0.2 + 0.2 = 0.6S \\
 G_{44} &= \frac{1}{R_1} + \frac{1}{R_2} = 0.2 + 0.2 = 0.4S \\
 I_{sc2} &= I_{s2} + \frac{E_3}{R_6} = 10 + \frac{40}{5} = 18A \\
 I_{sc3} &= -\frac{E_3}{R_6} = -\frac{40}{5} = -8A \\
 I_{sc4} &= -I_{s1} - \frac{E_1}{R_1} = \\
 &= -5 - \frac{20}{5} = -9A
 \end{aligned}$$

$$\begin{cases}
 -0.2 \cdot 20 + 0.4V_2 - 0.2V_3 = 18 \\
 -0.2 \cdot 20 - 0.2V_2 + 0.6V_3 = -8 \\
 -0.2 \cdot 20 + 0.4V_4 = -9
 \end{cases}$$

$$\begin{cases}
 0.4V_2 - 0.2V_3 = 22 \\
 -0.2V_2 + 0.6V_3 = -4
 \end{cases}$$

$$\underline{V_2 = 62V}$$

$$\underline{V_3 = 14V}$$

$$0.4V_4 = -9$$

$$\underline{V_4 = -22.5V}$$

$$I_{R1} = \frac{E_1 - V_4}{R_1} = \frac{-20 + 12.5}{5} = -1.5 A$$

$$I_{R2} = \frac{V_1 - V_4}{R_2} = \frac{20 + 12.5}{5} = 6.5 A$$

$$I_{R3} = \frac{V_1 - V_3}{R_3} = \frac{20 - 14}{5} = 1.2 A$$

$$I_{R4} = \frac{V_3}{R_4} = \frac{14}{5} = 2.8 A$$

$$I_{R5} = \frac{V_2 - V_1}{R_5} = \frac{62 - 20}{5} = 8.4 A$$

$$I_{R6} = \frac{(V_2 - V_3) - E_3}{R_6} = \frac{48 - 40}{5} = 1.6 A$$

$$I_{E2} + I_{S2} = I_{S1} + I_{R4} + I_{R1}$$

$$I_{E2} = 5 + 2.8 + 1.5 - 10 = -0.7$$

$$P_{R1} = 1.5^2 \cdot 5 = 11.25 W$$

$$P_{E1} = 20 \cdot 1.5 = 30$$

$$P_{R2} = 6.5^2 \cdot 5 = 211.25 W$$

$$P_{E2} = 20 \cdot 0.7 = 14 \text{ (!/273)}$$

$$P_{R3} = 1.2^2 \cdot 5 = 7.2 W$$

$$P_{E3} = 40 \cdot 1.6 = 64 \text{ (!/273)}$$

$$P_{R4} = 2.8^2 \cdot 5 = 39.2 W$$

$$P_{I_{S1}} = 5 \cdot 12.5 = 62.5$$

$$P_{R5} = 8.4^2 \cdot 5 = 352.8 W$$

$$P_{I_{S2}} = 10 \cdot 62 = 620$$

$$P_{R6} = 1.6^2 \cdot 5 = 12.8 W$$

$$\sum P_R = 634.5 W$$

$$\sum P_S = 634.5 W$$

הספקים שווים