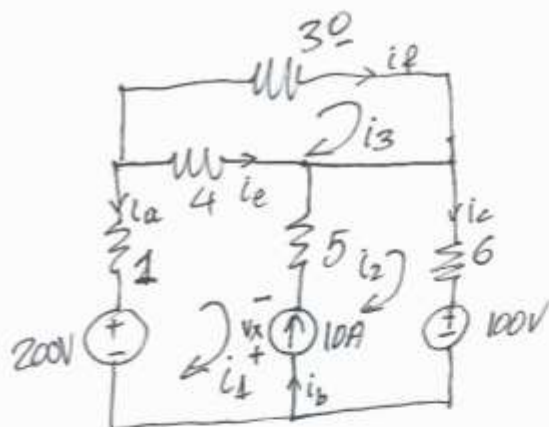


ΗΛΕΚΤΡΟΤΕΧΝΙΑ
ΑΣΚΗΣΕΙΣ Μ.Α.Β.

Επιλύστε το κύκλωμα με την Μ.Α.Β.



$$\begin{bmatrix} 10 & -5 & -4 \\ -5 & 11 & 0 \\ -4 & 0 & 7 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} v_x + 200 \\ -v_x - 100 \\ 0 \end{bmatrix} \Rightarrow 10A = i_2 - i_1$$

$$\begin{bmatrix} -1 & 1 & 0 \\ 5 & 6 & -4 \\ -4 & 0 & 7 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 10 \\ 100 \\ 0 \end{bmatrix}$$

$$i_1 = \frac{-280}{-61} = \frac{280}{61} = 4,59 \text{ A}$$

$$i_2 = \frac{290}{61} = 4,75 \text{ A}$$

$$i_3 = \frac{160}{61} = 2,62 \text{ A}$$

$$|A| = -4(-4-0) + 7(-6-5) = 16 + 7 \cdot 11 = -61$$

$$|A_1| = \begin{vmatrix} 10 & 1 & 0 \\ 100 & 6 & -4 \\ 0 & 0 & 7 \end{vmatrix} = 7(60-100) = -280$$

$$|A_2| = \begin{vmatrix} -1 & 10 & 0 \\ 5 & 100 & -4 \\ -4 & 0 & 7 \end{vmatrix} = +4 \cdot 40 + 7(-100-50) = 160 - 1050 = -890$$

$$|A_3| = \begin{vmatrix} -1 & 1 & 10 \\ 5 & 6 & 100 \\ -4 & 0 & 0 \end{vmatrix} = -4(100-60) = -160$$

$$i_a = -i_1 = -4,59 \text{ A} \quad i_e = i_1 - i_3 = 1,97$$

$$i_b = 10 \text{ A} = 10 \text{ A} \quad i_f = i_3 = 2,62$$

$$i_c = i_2 = 4,75$$

$$P_{ANT} = i_a^2 \cdot 1 + i_b^2 \cdot 5 + i_c^2 \cdot 6 + i_e^2 \cdot 4 = 1834,43$$

$$P_{200V} = 200V \cdot 4,59A = 918 \text{ W напоротем}$$

$$P_{10A} = 10A \cdot V_x = 2375,41 \text{ W напоротем}$$

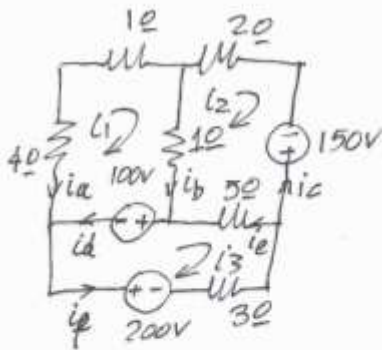
$$10i_4 - 5i_2 - 4i_3 = V_x + 200 \Rightarrow V_x = -237,541$$

$$P_{100V} = 100V \cdot i_c = 100V \cdot 14,99A = 1499 \text{ W напоротем}$$

$$P_{kaz} = P_{ANT} + P_{100V} = 3293,44 \text{ W}$$

$$P_{напоротем} = P_{200V} + P_{10A} = 3293,44 \text{ W}$$

Εξετάστε το κύκλωμα με Μ.Α.Β. Καίστε 100Ω, 200Ω, 150V



$$\begin{bmatrix} 6 & -1 & 0 \\ -1 & 8 & -5 \\ 0 & -5 & 8 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} -100 \\ 150 \\ 200+100 \end{bmatrix} = \begin{bmatrix} -100 \\ 150 \\ 300 \end{bmatrix}$$

$$i_1 = \frac{A_{11}}{|A|} = -5,31$$

$$i_2 = \frac{A_{21}}{|A|} = 68,14$$

$$i_3 = \frac{A_{31}}{|A|} = 80,09$$

$$|A| = \begin{vmatrix} 6 & -1 & 0 \\ -1 & 8 & -5 \\ 0 & -5 & 8 \end{vmatrix} \quad |A_{11}| = \begin{vmatrix} -100 & -1 & 0 \\ 150 & 8 & -5 \\ 300 & -5 & 8 \end{vmatrix} = -1200 \quad |A| = 226$$

$$|A_{21}| = \begin{vmatrix} 6 & -100 & 0 \\ -1 & 150 & -5 \\ 0 & 300 & 8 \end{vmatrix} \quad |A_{31}| = \begin{vmatrix} 6 & -1 & -100 \\ -1 & 8 & 150 \\ 0 & -5 & 300 \end{vmatrix} = 18100 \quad |A_{21}| = 15400$$

$$i_a = -i_1 = 5,31 \quad i_d = i_1 - i_3 = -85,3982$$

$$i_b = i_1 - i_2 = -73,45 \quad i_e = i_2 - i_3 = -11,947$$

$$i_c = -i_2 = -68,1416 \quad i_f = -i_3 = -80,0885$$

$$P_{100V} = 100V \cdot i_d = 100 \cdot (-85,3982)W = 8539,82W$$

$$P_{200V} = 200V \cdot i_f = 200 \cdot (-80,0885)W = 16017,7W$$

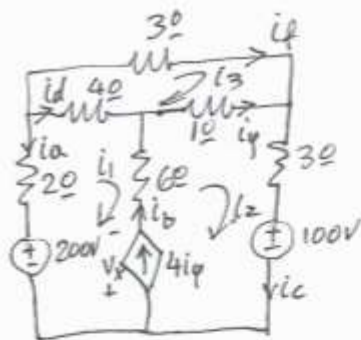
$$P_{150V} = 150V \cdot i_e = 150 \cdot (-11,947)W = 10221,2W$$

$$P_{ANT} = i_a^2 \cdot 5 + i_b^2 \cdot 1 + i_c^2 \cdot 2 + i_e^2 \cdot 5 + i_f^2 \cdot 3 = 34778,76W$$

$$P_{KAT} = 34778,76W = P_{ANT}$$

$$P_{PAPAY} = P_{100V} + P_{150V} + P_{200V} = 34778,76W$$

Επιλύσατε το κύκλωμα με την ΜΑΒ



$$\begin{bmatrix} 12 & -6 & -4 \\ -6 & 10 & -1 \\ -4 & -1 & 8 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} V_x + 200 \\ -V_x - 100 \\ 0 \end{bmatrix} \Rightarrow \begin{bmatrix} -1 & 1 & 0 \\ 6 & 4 & -5 \\ -4 & -1 & 8 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 4i_q \\ 100 \\ 0 \end{bmatrix} \Rightarrow$$

$$\Rightarrow \begin{bmatrix} -1 & 1 & 0 \\ 6 & 4 & -5 \\ -4 & -1 & 8 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 4(i_2 - i_3) \\ 100 \\ 0 \end{bmatrix} \Rightarrow \begin{bmatrix} -1 & -3 & 4 \\ 6 & 4 & -5 \\ -4 & -1 & 8 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 100 \\ 0 \end{bmatrix}$$

$$i_1 = +20,618 \text{ A}$$

$$i_2 = 8,247 \text{ A}$$

$$i_3 = 11,34 \text{ A}$$

$$i_a = -i_1 = -20,618 \text{ A} \quad i_d = i_1 - i_3 = 9,278 \text{ A}$$

$$i_b = 4i_q = i_2 - i_1 = -13,371 \text{ A} \quad i_e = i_q = i_2 - i_3 = -3,09 \text{ A}$$

$$i_c = i_2 = 8,247 \text{ A} \quad i_f = i_3 = 11,34 \text{ A}$$

$$P_{\text{ANT}} = i_a^2 2 + i_b^2 6 + 3i_c^2 + i_d^2 4 + i_e^2 1 + i_f^2 3 = 2712,297 \text{ W}$$

$$P_{200\text{V}} = 200\text{V} \cdot i_a = 200\text{V} \cdot (-20,618) = 4123,71 \text{ W} \text{ καταρ.}$$

$$P_{100\text{V}} = 100\text{V} \cdot i_c = 824,74 \text{ W} \text{ καταρ. πλεονέκτημα}$$

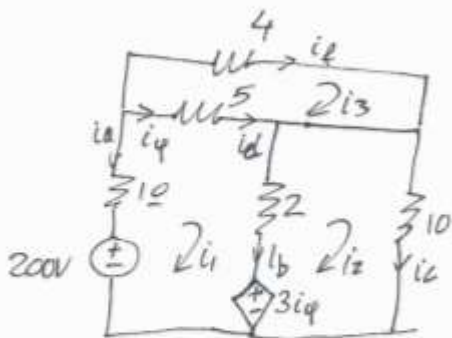
$$P_{4i_q} = 4i_q \cdot V_x = \underline{\underline{4(-3,09)(-47,42) = 586,74 \text{ W}}} \text{ καταρ.}$$

$$-6i_1 + 10i_2 - 1i_3 = -V_x - 100 \Rightarrow V_x = -47,42$$

$$P_{\text{κατ}} = P_{\text{ANT}} + P_{4i_q} + P_{100\text{V}} = 4123,71 \text{ W}$$

$$P_{\text{παραρ.}} = P_{200\text{V}} = 4123,71 \text{ W}$$

Επιλύσατε το κύκλωμα με την Μ.Α.Β



$$\begin{bmatrix} 9 & -2 & -5 \\ -2 & 12 & 0 \\ -5 & 0 & 9 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 200 - 3i_\phi \\ 3i_\phi \\ 0 \end{bmatrix} \xrightarrow{i_\phi = i_1 - i_2} \begin{bmatrix} 9 & -2 & -5 \\ -2 & 12 & 0 \\ -5 & 0 & 9 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 200 - 3i_1 + 3i_2 \\ 3i_1 - 3i_2 \\ 0 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} 11 & -2 & -8 \\ 5 & 12 & 3 \\ -5 & 0 & 9 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 200 \\ 0 \\ 0 \end{bmatrix} \quad \begin{array}{l} i_1 = 33,33 \\ i_2 = 9,26 \\ i_3 = 18,52 \end{array}$$

$$i_a = -i_1 = -33,33 \quad i_d = i_\phi = i_1 - i_2 = 14,815$$

$$i_b = -i_2 + i_1 = 24,074 \quad i_\phi = i_3 = 18,52$$

$$i_c = i_2 = 9,26$$

$$P_{\text{ANT}} = i_a^2 1 + i_b^2 2 + i_c^2 10 + i_d^2 5 + i_\phi^2 4 = 5596,7 \text{ W}$$

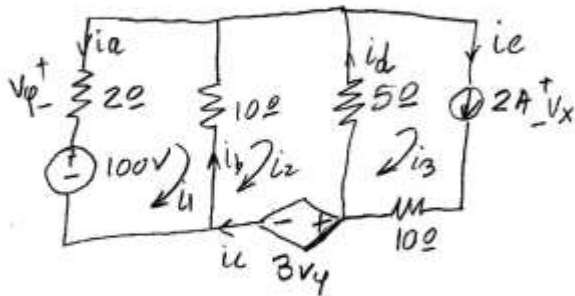
$$P_{200V} = 200V \cdot i_a = 200V(-33,33) = 6666,67 \text{ W παραγόμενον}$$

$$P_{3i_\phi} = 3i_\phi \cdot i_b = (3 \cdot i_d)V \cdot i_b = 3 \cdot 14,815 \cdot 24,074 \text{ W κατανάλωση} \\ 1069,959 \text{ W}$$

$$P_{\text{κέρ}} = P_{\text{ANT}} + P_{3i_\phi} = 5596,7 + 1069,959 = 6666,67 \text{ W}$$

$$P_{\text{παραγ}} = P_{200V} = 6666,67 \text{ W}$$

Na crtanju se vidi krugovna:



$$\begin{bmatrix} 12 & -10 & 0 \\ -10 & 15 & -5 \\ 0 & -5 & 15 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 100 \\ -3V_x \\ -V_x \end{bmatrix} \Rightarrow$$

$$\begin{bmatrix} 12 & -10 & 0 \\ -10 & 15 & -5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 100 \\ -3(-i_3) \\ 2 \end{bmatrix} \Rightarrow$$

$$\begin{bmatrix} 12 & -10 & 0 \\ -16 & 15 & -5 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 100 \\ 0 \\ 2 \end{bmatrix} \quad \begin{array}{l} i_1 = 80 \text{ A} \\ i_2 = 86 \text{ A} \\ i_3 = 2 \text{ A} \end{array}$$

$$i_a = -i_1 = -80 \text{ A}$$

$$i_b = i_2 - i_1 = 6$$

$$i_c = i_2 = 86$$

$$i_d = i_3 - i_2 = -84$$

$$i_e = i_3 = 2 \text{ A}$$

$$-V_x = -5i_2 + 15i_3 \Rightarrow 5i_2 - 15i_3 = V_x = 400 \text{ V}$$

$$P_{100V} = 100V \cdot i_a = 8000 \text{ W (out)}$$

$$P_{3V} = 3 \cdot 2 \cdot i_a \cdot i_c = 41280 \text{ W}$$

$$P_{2A} = 2A \cdot V_x = 800 \text{ W}$$

$$P_{\text{ANT}} = 2i_a^2 + 10i_b^2 + 5i_d^2 + 10i_e^2 = 48480$$

$$P_{\text{KAT}} = P_{\text{ANT}} + P_{2A} = 49280 \text{ W} = P_{\text{out}}$$