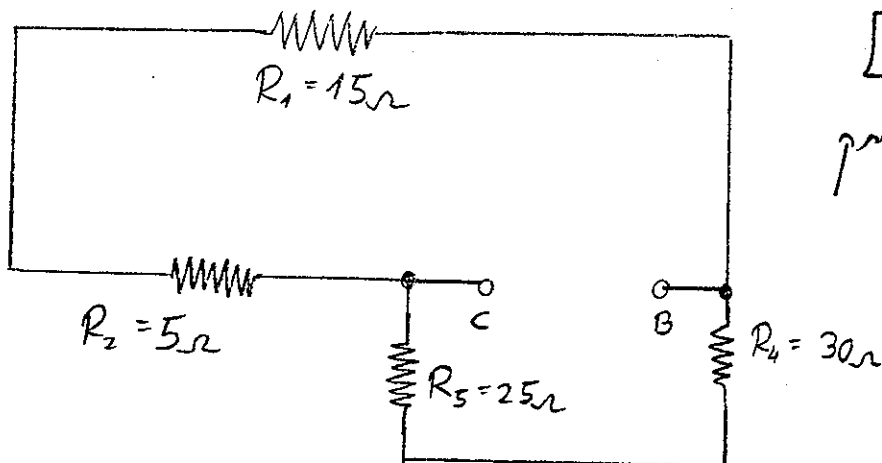


5

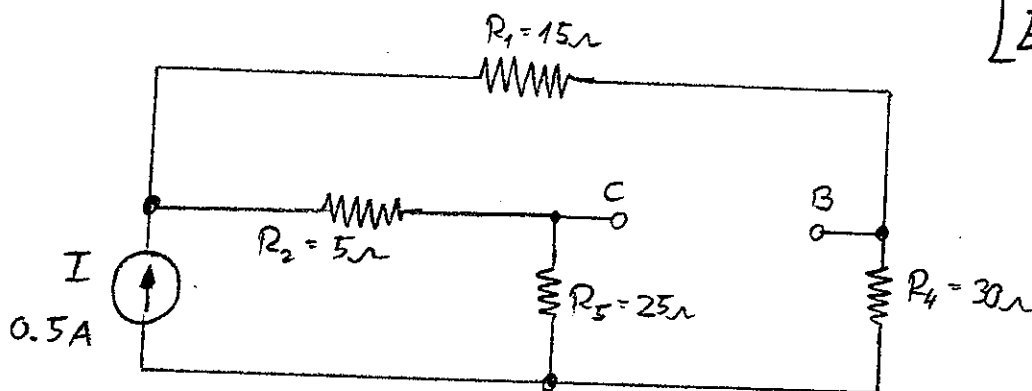


$[R_{TH} \text{ ב'ע'ר}]$

מקור מתח מוסר

$$R_{TH} = R_{BC} = (R_1 + R_2) \parallel (R_3 + R_4) = (5 + 15) \parallel (25 + 30) = 14.666\Omega$$

$[E_{TH} \text{ ב'ע'ר}]$



נניח שהתחבר במעגל מילמן ולו זרמי חוקים בקב' למעגל שר הידועים שלו

הזרם I , וכן I ח'ק מילמן - ו KVL למעגל שר U_{BC} , שר U ובהר במעגל

מילמן זרם במל:

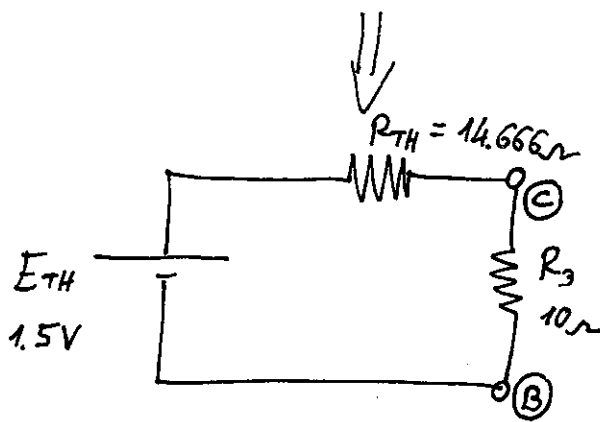
$$I_{R_5} = I \cdot \frac{(R_1 + R_4)}{(R_1 + R_4) + (R_2 + R_3)} = 0.5 \cdot \frac{45}{45 + 30} = 0.3A$$

$$I_{R_4} = I - I_{R_5} = 0.5 - 0.3 = 0.2A$$

$\Downarrow$

$$E_{TH} = U_{BC_0} = U_{R_4} - U_{R_5} = I_{R_4} \cdot R_4 - I_{R_5} \cdot R_5 = 0.2 \cdot 30 - 0.3 \cdot 25 = 6 - 7.5 = -1.5V$$

$\Downarrow$



$$I_{R_3} = \frac{E_{TH}}{R_{TH} + R_3} = \frac{1.5}{14.666 + 10} = 60.81 \mu A \quad [C \rightarrow B]$$

$$\begin{array}{l|l} \textcircled{A} = \textcircled{1} & +G_{11}V_1 - G_{12}V_2 - G_{13}V_3 = I_{sc1} \\ \textcircled{B} = \textcircled{2} & -G_{21}V_1 + G_{22}V_2 - G_{23}V_3 = I_{sc2} \\ \textcircled{C} = \textcircled{3} & -G_{31}V_1 - G_{32}V_2 + G_{33}V_3 = I_{sc3} \end{array}$$

$$G_{11} = \frac{1}{R_2} + \frac{1}{R_1} = \frac{1}{5} + \frac{1}{15} = \frac{4}{15} S$$

$$G_{22} = \frac{1}{R_3} + \frac{1}{R_1} + \frac{1}{R_4} = \frac{1}{10} + \frac{1}{15} + \frac{1}{30} = \frac{1}{5} S$$

$$G_{33} = \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_5} = \frac{1}{5} + \frac{1}{10} + \frac{1}{25} = \frac{17}{50} S$$

$$G_{12} = G_{21} = \frac{1}{R_1} = \frac{1}{15} S \quad I_{sc1} = I = 0.5 A$$

$$G_{13} = G_{31} = \frac{1}{R_2} = \frac{1}{5} S \quad I_{sc2} = 0 A$$

$$G_{23} = G_{32} = \frac{1}{R_3} = \frac{1}{10} S \quad I_{sc3} = 0 A$$

$$\begin{pmatrix} \frac{4}{15} & -\frac{1}{15} & -\frac{1}{5} \\ -\frac{1}{15} & \frac{1}{5} & -\frac{1}{10} \\ -\frac{1}{5} & -\frac{1}{10} & \frac{17}{50} \end{pmatrix} \begin{pmatrix} V_1 \\ V_2 \\ V_3 \end{pmatrix} = \begin{pmatrix} 0.5 \\ 0 \\ 0 \end{pmatrix} \Rightarrow$$

$$V_A = V_1 = 8.817 V$$

$$V_B = V_2 = 6.486 V$$

$$V_C = V_3 = 7.094 V$$

$Z_A = (50 + j50) \Omega$
 $Z_B = -j50 \Omega$
 $Z_C = (50 + j50) \Omega$
 $[T \text{ מ"ר}']$

$\textcircled{6} A = 1 + \frac{Z_A}{Z_B} = 1 + \frac{50 + j50}{-j50} = j$

$B = \frac{Z_A \cdot Z_C}{Z_B} + Z_A + Z_C =$

$= \frac{(50 + j50)^2}{-j50} + 2(50 + j50) = j100 \Omega$

$\begin{pmatrix} A & B \\ C & D \end{pmatrix} = \begin{pmatrix} j & j100 \\ j0.02 & j \end{pmatrix} \Leftarrow$

$C = \frac{1}{Z_B} = \frac{1}{-j50} = j0.02 \text{ S}$

$D = 1 + \frac{Z_C}{Z_B} = 1 + \frac{50 + j50}{-j50} = j$

$Z_o = \sqrt{\frac{B}{C}} = \sqrt{\frac{j100}{j0.02}} = \sqrt{5000} = 70.71 \Omega$

$\textcircled{7} \begin{pmatrix} A_1 & B_1 \\ C_1 & D_1 \end{pmatrix} \begin{pmatrix} A_2 & B_2 \\ C_2 & D_2 \end{pmatrix} = \begin{pmatrix} A_1 A_2 + B_1 C_2 & A_1 B_2 + B_1 D_2 \\ C_1 A_2 + D_1 C_2 & C_1 B_2 + D_1 D_2 \end{pmatrix} =$

$= \begin{pmatrix} j^2 + j100 \cdot j0.02 & j \cdot j100 + j100 \cdot j \\ j0.02 \cdot j + j \cdot j0.02 & j0.02 \cdot j100 + j^2 \end{pmatrix} = \begin{pmatrix} -3 & -200 \\ -0.04 & -3 \end{pmatrix}$

בפק'ה: רשת זו גם סמלית, וכנפ'ה הזכרה האופ'ית שלה נותרה 70.71Ω



בפיתוח נכון!

$$\textcircled{7} \quad \underline{U}_s = \frac{100}{\sqrt{2}} \angle 0^\circ = 70.71 \angle 0^\circ \text{ V}$$

$$\omega = 500 \frac{\text{rad}}{\text{sec}}$$

$\Downarrow$

$$\underline{Z}_L = jX_L = j\omega L = j500 \cdot 36 \cdot 10^{-3} = j18 \Omega$$

$$\underline{Z}_C = -jX_C = -j \frac{1}{\omega C} = -j \frac{1}{500 \cdot 200 \cdot 10^{-6}} = -j10 \Omega$$

$\Downarrow$

$$\textcircled{8} \quad \underline{Z}_{in} = \left[(\underline{Z}_L + \underline{Z}_C) \parallel \underline{Z}_2 \right] + \underline{Z}_1 = \left[\frac{1}{j18 - j10} + \frac{1}{8 - j8} \right]^{-1} + 5 \angle 30^\circ =$$

$$= 8 + j8 + 5 \angle 30^\circ = (12.33 + j10.5) \Omega = 16.195 \angle 40.4^\circ \Omega$$

$\Downarrow$

$$\textcircled{9} \quad \underline{I}_T = \frac{\underline{U}_s}{\underline{Z}_{in}} = \frac{70.71 \angle 0^\circ}{16.195 \angle 40.4^\circ} = (3.324 - j2.83) \text{ A} = 4.366 \angle -40.4^\circ \text{ A}$$

$\Downarrow$

$$\underline{U}_{Z_1} = \underline{I}_T \cdot \underline{Z}_1 = 4.366 \angle -40.4^\circ \cdot 5 \angle 30^\circ = (21.47 - j3.947) \text{ V} =$$

$$= 21.83 \angle -10.41^\circ \text{ V}$$

$$\underline{U}_{Z_2} = \underline{U} - \underline{U}_{Z_1} = 70.71 \angle 0^\circ - 21.83 \angle -10.41^\circ =$$

$$= (49.239 + j3.947) \text{ V} = 49.397 \angle 4.58^\circ \text{ V}$$

$$\textcircled{10} \quad \underline{S}_T = \underline{I}_T^* \cdot \underline{U}_s = 4.366 \angle +40.4^\circ \cdot 70.71 \angle 0^\circ =$$

$$= (\underline{235.05} + j\underline{200.162}) \text{ VA} = 308.729 \angle 40.41^\circ \text{ VA}$$

$$P_T [\text{W}]$$

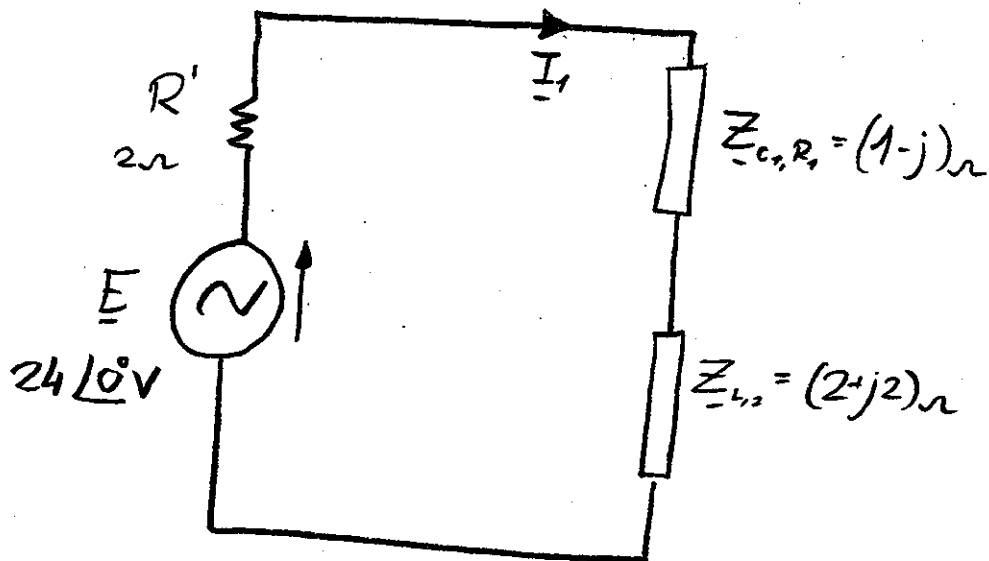
$$Q_T [\text{VAR}]$$

$$\boxed{P_T = 235 \text{ W}}$$

$$\textcircled{8} \textcircled{6} \underline{E} = \underline{I} \cdot R = 12 \angle 0^\circ \cdot 2 = 24 \angle 0^\circ \text{ V} \quad R' = R = 2 \Omega$$

$$\textcircled{2} \underline{Z}_{C,R_1} = \underline{X}_C \parallel R_1 = -j2 \parallel 2 = (1-j) = 1.414 \angle -45^\circ \Omega$$

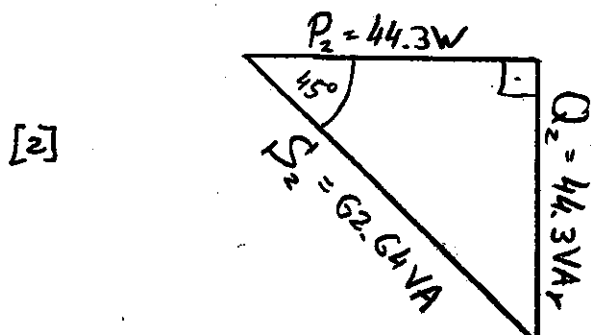
$$\underline{Z}_{L,2} = \underline{X}_L \parallel \underline{Z}_2 = j2 \parallel (2-j2) = (2+j2) = 2.828 \angle 45^\circ \Omega$$



$$\underline{I}_1 = \underline{I}_T = \frac{\underline{E}}{R' + \underline{Z}_{C,R_1} + \underline{Z}_{L,2}} = \frac{24 \angle 0^\circ}{2 + 1 - j + 2 + j2} = 4.706 \angle -11.3^\circ \text{ A}$$

$$\underline{I}_2 = \underline{I}_1 \cdot \frac{\underline{X}_L}{\underline{X}_L + \underline{Z}_2} = 4.706 \angle -11.3^\circ \cdot \frac{j2}{j2 + (2-j2)} = 4.706 \angle 78.7^\circ \text{ A}$$

$$\textcircled{1} \textcircled{7} \underline{S}_2 = \underline{I}_2^* \cdot \underline{Z}_2 = 4.706^2 \cdot (2-j2) = (\underbrace{44.3}_{P_2 [\text{W}]} - j \underbrace{44.3}_{Q_2 [\text{VAR}]}) \text{ VA} = 62.64 \angle -45^\circ \text{ VA}$$



[2]