

בתכנון קצ'ה CW קצ'ה וולט
 קצ'ה - 2016

1.8.1

$$C_{4,5} = C_4 + C_5 = 20 + 20 = 40 \mu F$$

1K

$$C_{3,5} = \frac{C_3 \cdot C_{4,5}}{C_3 + C_{4,5}} = \frac{10 \cdot 40}{50} = 8 \mu F$$

הקצ'ה והקצ'ה
 הקצ'ה והקצ'ה

$$U_{C2} = U_{C3,5} = U_{AB} = 50V$$

$$Q_{C3,5} = U_{C3,5} \cdot C_{3,5} = 50 \cdot 8 \cdot 10^{-6} = 400 \mu C$$

$$Q_{C3,5} = Q_{C3} = Q_{C4,5} = 400 (\mu C)$$

$$U_{C3} = \frac{Q_{C3}}{C_3} = \frac{400 \cdot 10^{-6}}{10 \cdot 10^{-6}} = 40 [V]$$

$$Q_{C2} = U_{C2} \cdot C_2 = 50 \cdot 12 \cdot 10^{-6} = 600 \mu C$$

12

$$Q_T = Q_{C1} = Q_{C2} + Q_{C3} = 600 + 400 = 1 mC = 1000 \mu C$$

$$U_{C1} = \frac{Q_{C1}}{C_1} = \frac{1000}{5} = 200V$$

$$E = U_{C1} + U_{C2} = 200 + 50 = 250 [V]$$

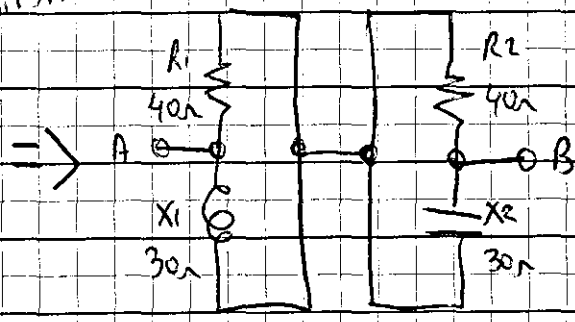
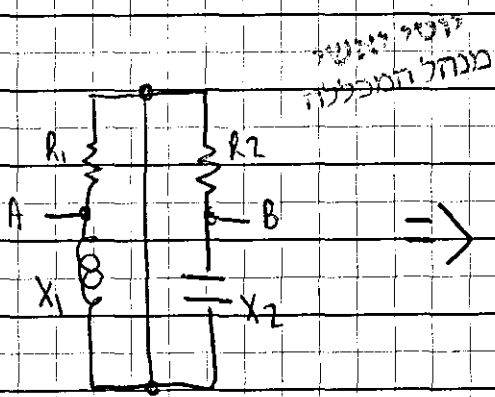
$$C_T = \frac{Q_T}{U_T} = \frac{1000 \cdot 10^{-6}}{250} = 4 \mu F$$

12

$$W_{C_T} = \frac{1}{2} \cdot C_T \cdot U_{C_T}^2 = 0.5 \cdot 4 \cdot 10^{-6} \cdot 250^2 = 0.125 (J)$$

2.10.8

$(\bar{Z}_{th}) \bar{Z}_{ab}$ $\sim 3N$ (R)



$$\bar{Z}_{ab} = R_1 \parallel jX_1 + R_2 \parallel (-jX_2)$$

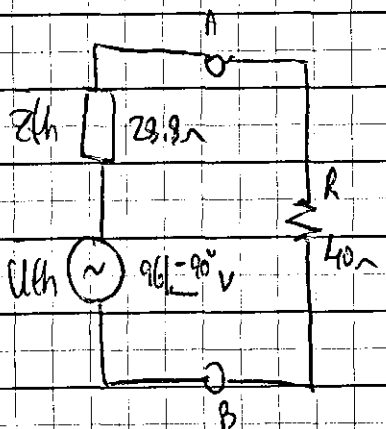
$$\bar{Z}_{ab} = \frac{40 \cdot j30}{40 + j30} + \frac{40 \cdot (-j30)}{40 - j30} = 28.8(\Omega)$$

$(\bar{U}_{th}) \bar{U}_{ab}$ $\sim 3N$

$$\bar{U}_{AB} = \bar{U}_{R1} - \bar{U}_{R2}$$

$$\bar{U}_{AB} = \frac{\bar{U} \cdot R_1}{R_1 + jX_1} - \frac{\bar{U} \cdot R_2}{R_2 - jX_2}$$

$$\bar{U}_{AB} = \frac{100 \cdot 40}{40 + j30} - \frac{100 \cdot 40}{40 - j30} = 96 \angle -90^\circ (V)$$



$$\bar{I}_T = \frac{\bar{U}_{th}}{\bar{Z}_{th} + R} = \frac{96 \angle -90^\circ}{68.8} \quad (?)$$

$$\bar{I}_T = 1.395 \angle -90^\circ A$$

$$P_R = |\bar{I}_T|^2 \cdot R = 1.395^2 \cdot 40 = 77.88 (W)$$

$$R = \frac{\Delta U}{\Delta I} = \frac{60}{24 \cdot 10^{-3}} = 2.5 \text{ (k}\Omega\text{)}$$

(K)

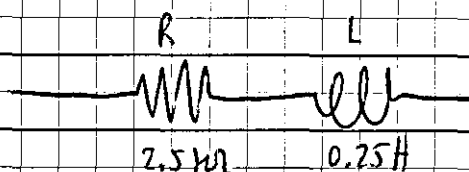
$$I(t) = \frac{e(t)}{R}$$

התנגדות
במודל המכני

(2)

$$I(t) = \sqrt{2} \cdot \frac{25}{2.5 \cdot 10^3} \sin(1000t) \text{ A}$$

$$I(t) = \sqrt{2} \cdot 10 \sin(1000t) \text{ (mA)}$$



(C)

$$X_L = 2\pi fL = \omega L = 1000 \cdot 0.25 = 250 \Omega$$

$$\bar{Z} = R + jX_L = (2500 + j250) = 2512.468 \angle 5.71^\circ \Omega$$

$$\bar{I}_T = \frac{\bar{U}_T}{\bar{Z}} = \frac{25 \angle 0^\circ}{2512.468 \angle 5.71^\circ} = 9.95 \angle -5.71^\circ \text{ mA}$$

$\frac{U_{\max}}{\sqrt{2}}$

$$I_T(t) = \underbrace{\sqrt{2} \cdot 9.95}_{I_{\max}} \sin(\underbrace{1000t}_{\omega} - \underbrace{5.71^\circ}_{\phi}) \text{ (mA)}$$

$$\phi (\text{deg}) = -\frac{5.71}{250} \pi (\text{rad})$$

התנגדות
במודל המכני
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$$\bar{Z}_{\text{eq}} = R + j(X_L - X_C) = 2.5 \text{ k}\Omega$$

(3)

התנאי הקבועים:

$$X_{C_0} = \frac{1}{\omega_0 C}$$

$$C = \frac{1}{\omega_0 X_{C_0}} = \frac{1}{1000 \cdot 250} = 4(\mu F)$$

התנאי הקבועים
מכאן המכשיר

4. שלב

התנאי הקבועים

$$\left. \begin{array}{l} l_{av} = l_1 + l_2 + l_3 = 440 \text{ mm} = 440 \cdot 10^{-3} \text{ m} \\ A = 800 \text{ mm}^2 = 800 \cdot 10^{-6} \text{ m}^2 \\ \mu_r = 2500 \end{array} \right\} \text{ (core)}$$

$$\left. \begin{array}{l} l_{av} = 120 \text{ mm} = 120 \cdot 10^{-3} \text{ m} \\ A = 800 \cdot 10^{-6} \text{ m}^2 \\ \mu_r = 500 \end{array} \right\} \text{ (yoke)}$$

$$\left. \begin{array}{l} l_{av} = 2 \cdot l_s = 4 \text{ mm} = 4 \cdot 10^{-3} \text{ m} \\ A = 800 \cdot 10^{-6} \text{ m}^2 \\ \mu_r = 1 \end{array} \right\} \text{ (gap)}$$

$$R_{mT} = R_{m(\text{core})} + R_{m(\text{yoke})} + R_g$$

(K)

$$R_m = \frac{l_{av}}{\mu_0 \mu_r A}$$

$$R_{m(\text{core})} = \frac{440 \cdot 10^{-3}}{4\pi \cdot 10^{-7} \cdot 2500 \cdot 800 \cdot 10^{-6}} = 135.07 \cdot 10^3 \frac{\text{At}}{\text{Wh}}$$

$$R_m(\text{yoke}) = \frac{120 \cdot 10^{-3}}{477 \cdot 10^{-3} \cdot 500 \cdot 800 \cdot 10^{-6}} = 238.732 \cdot 10^3 \frac{\text{AT}}{\text{Ab}}$$

$$R_g = \frac{4 \cdot 10^{-3}}{477 \cdot 10^{-3} \cdot 800 \cdot 10^{-6}} = 3978.833 \cdot 10^3 \frac{\text{AT}}{\text{Ab}}$$

$$R_{mT} = 4.374 \cdot 10^6 \left(\frac{\text{AT}}{\text{Ab}} \right)$$

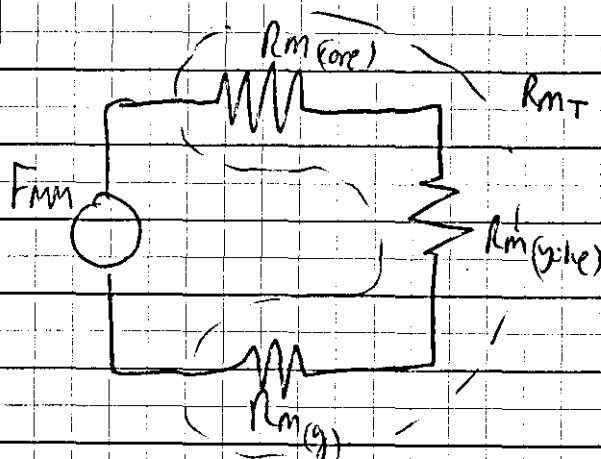
מחשבים את
הקבוצה

$$I = \frac{N^2}{R_{mT}} = \frac{2000^2}{4.374 \cdot 10^6} = 0.9144 (\text{Hy})$$

(2)

$$B(\text{const}) = 1.5 \text{ T}$$

(1)



$$\Phi_g = \Phi_{\text{core}} = \Phi_{\text{yoke}} = \Phi_T \quad \Rightarrow \quad B_g = B_{\text{core}} = B_{\text{yoke}} = B_T$$

$$\Phi_g = B_g A_g = 1.5 \cdot 800 \cdot 10^{-6}$$

(7 ms per dB)

$$\Phi_g = 1.2 \text{ mWb} = \Phi_T$$

$$F_{mm} = \Phi_T \cdot R_{mT} = 1.2 \cdot 10^{-3} \cdot 4.374 \cdot 10^6 = 5248.8 \text{ AT}$$

$$F_{mm} = NI$$

$$I = \frac{F_{mm}}{N} = \frac{5248.8}{2000} = 2.624 (\text{A})$$

DC 125

$$W_L = \frac{1}{2} L \cdot I_L^2 = 0.5 \cdot 0.9144 \cdot 2.6247$$

(3)

$$W_L = 3.148 \text{ (J)}$$

התוצאה נכונה
במקרה זה

5 אלקט

$$\bar{Z}_{AB} = (\bar{Z}_2 + \bar{Z}_3) \parallel (\bar{Z}_4 + \bar{Z}_5)$$

(1)

$$\bar{Z}_{AB} = (12 + j5 + 12 - j12) \parallel (6 + j10 + 6 - j5)$$

$$\bar{Z}_{AB} = \left(\frac{1}{24 - j7} + \frac{1}{12 + j5} \right)^{-1}$$

$$\bar{Z}_{AB} = (8.889 + j1.493) \Omega = 9.013 / 9.539^\circ (\Omega)$$

$$\bar{Z}_T = \bar{Z}_1 + \bar{Z}_{AB} = (15 + j10) + (8.889 + j1.493)$$

(2)

$$\bar{Z}_T = (23.889 + j11.493) \Omega = 26.51 / 25.693^\circ \Omega$$

$$\bar{I}_T = \frac{\bar{U}_T}{\bar{Z}_T} = \frac{200 \angle 0^\circ}{26.51 / 25.693^\circ} = 7.544 / -25.693^\circ (\text{A})$$

$$\bar{I}_{45} = \bar{I}_T \cdot \frac{\bar{Z}_{23}}{\bar{Z}_{23} + \bar{Z}_{45}}$$

(3)

$$= 7.544 / -25.693^\circ \cdot \frac{24 - j7}{24 - j7 + 12 + j5} = 5.23 / -38.333^\circ (\text{A})$$

$$P_{R(av)} = \frac{U_{rms}^2}{R} = \frac{8.66^2}{50} = 1.5 \text{ (W)}$$

הכוח הממוצע
המתפזר

7.10K1

$$|\bar{I}_{Z_1}| = \frac{|\bar{U}_{Z_1}|}{|\bar{Z}_1|} = \frac{65}{13} = 5 \text{ A}$$

(K)

5(A) 10W 11.1W

$$\phi_{Z_1} = \phi_{U_{Z_1}} - \phi_{I_{Z_1}} = 0 - 22.62^\circ = -22.62^\circ$$

$$\bar{U}_{Z_2} = 85 \angle -24.55^\circ$$

(P)

$$\bar{Z}_2 = \frac{\bar{U}_{Z_2}}{\bar{I}_{Z_2}} = \frac{85 \angle -24.55^\circ}{5 \angle -22.62^\circ} = 17 \angle -61.93^\circ \Omega$$

$$= (8 - j15) \Omega$$

$$\bar{U}_T = \bar{U}_{Z_1} + \bar{U}_{Z_2} = 65 \angle 0^\circ + 85 \angle -24.55^\circ =$$

(T)

$$= 111.80 \angle -49.186^\circ = (73.033 - j84.615) \text{ (V)}$$

$$\bar{S}_T = \bar{U}_T \cdot \bar{I}_T^* = 111.80 \angle -49.186^\circ \cdot 5 \angle 22.62^\circ =$$

(S)

$$= (499.983 - j250) \text{ (VA)}$$

8.10.1

$$|\bar{S}_1| = 10 \text{ kVA}; \cos\phi = 0.8; (\text{w.l.})$$

: מ'ו'ו'ו'

$$P_2 = 5 \text{ kW}; \cos\phi = 0.7; (\text{w.l.})$$

$$P_3 = 8 \text{ kW}; \cos\phi = 0.6; (\text{w.l.})$$

היחס בין
הכוח הפעיל
לכוח המכלול

$$\cos\phi = \frac{P}{|S|}$$

(K)

$$P_1 = \cos\phi_1 \cdot |\bar{S}_1| = 0.8 \cdot 10 = 8 \text{ kW}$$

$$\tan\phi = \frac{|Q|}{P}$$

$$|Q_1| = \tan\phi_1 \cdot P_1 = 0.75 \cdot 8 = 6 \text{ kVAR} (\text{w.l.})$$

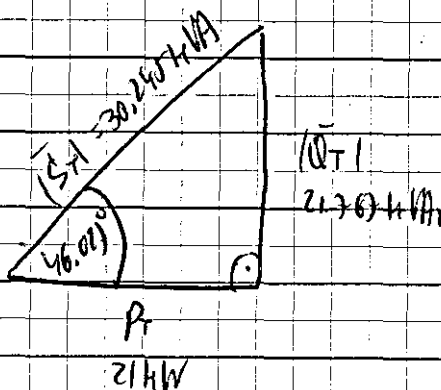
$$|Q_2| = \tan\phi_2 \cdot P_2 = 1.02 \cdot 5 = 5.101 \text{ kVAR} (\text{w.l.})$$

$$|Q_3| = \tan\phi_3 \cdot P_3 = 1.33 \cdot 8 = 10.666 \text{ kVAR} (\text{w.l.})$$

$$P_T = P_1 + P_2 + P_3 = 8 + 5 + 8 = 21 (\text{kW})$$

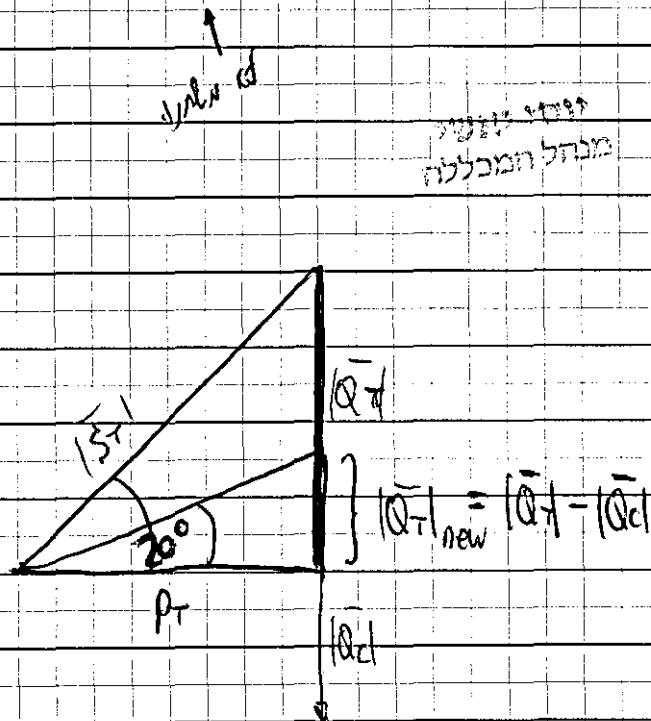
$$|Q_T| = |Q_1| + |Q_2| + |Q_3| = 21.767 (\text{kVAR})$$

$$\bar{S}_T = P_T + jQ_T = (21 + j21.767) \text{ VA} = 30.245 \angle 46.023^\circ (\text{kVA})$$



$$\phi_{\text{new}} = 20^\circ \Rightarrow \cos \phi_{\text{new}} = 0.939 \quad (P)$$

$$|\bar{Q}_T|_{\text{new}} = \tan \phi_{\text{new}} \cdot P_T = 0.363 \cdot 21 = 7.643 \text{ kVAR}$$



$$|\bar{Q}_C| = |\bar{Q}_T| - |\bar{Q}_T|_{\text{new}} = 21.767 - 7.643$$

$$|\bar{Q}_C| = 14.123 \text{ (kVAR)}$$

$$|\bar{Q}_C| = \frac{|\bar{U}_C|^2}{X_C} \quad (P)$$

$$X_C = \frac{|\bar{U}_C|^2}{|\bar{Q}_C|} = \frac{231^2}{14.123 \cdot 10^3} = 3.778 \Omega$$

$$X_C = \frac{1}{\omega C}$$

$$C = \frac{1}{2\pi f X_C} = \frac{1}{2\pi \cdot 50 \cdot 3.778} = 842.467 \text{ (}\mu\text{F)} //$$

