4. domača naloga iz Osnov elektrotehnike II

1. Transformator z nazivno močjo S_{nT}=500 kVA je trenutno polno obremenjen z bremenom, ki ima cosφ=0,6. Na transformator želimo priključiti še dodatno breme z delovno močjo P_d=100 kW in cosφ$_d$=0,9. Določite potrebno velikost kompenzacije Q_c, da bo transformator po kompenzaciji deloval s cosφ$_2$=0,95.

2. Transformator z nazivno močjo S_{nT}=200 kVA je trenutno polno obremenjen z bremenom, ki ima cosφ=0,6. Na transformator želimo priključiti še dodatno breme , ki ima navidezno moč S_Δ=60 kVA in cosφ$_\Delta$=0,8. Določite najmanjšo potrebno velikost kompenzacije Q_c, da transformator ne bo preobremenjen.

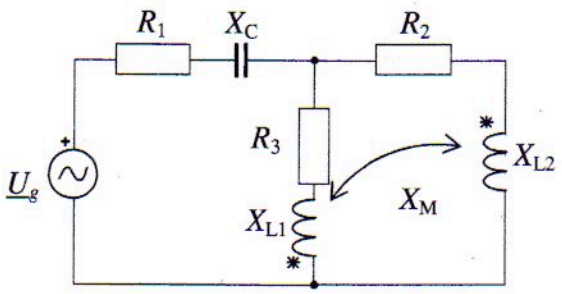
3. Izračunajte ekvivalentne elemente za zaporedno nadomestno vezavo realnega kondenzatorja s podatki: U = 400 V, Q_C=4·10^3 var, tgδ = 10^{-4}, ω = 2,5·10^4 rad/s.

4. Na realnem kondenzatorju smo pri napetosti U = 250 V in frekvenci 50 Hz izmerili tok I = 0,1 A ter izgube P = 12,5 mW. Določite elemente nadomestne vzporedne vezave (R_{vz}, C in tgδ).

5. V realni tuljavi z železnim jedrom smo pri napetosti U = 20 V izmerili tok I = 2 A in moč (izgube) P = 4 W. Jedro odstranimo in izgube se pri istem toku zmanjšajo na 1 W. Določite elemente nadomestne vezave (z in brez jedra), če zanemarimo stresanje in je frekvenca 100 Hz.

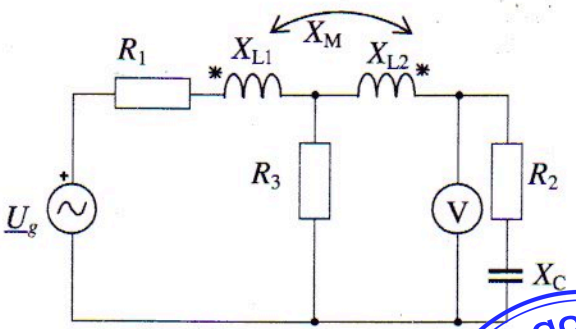
6. Na realni tuljavi (brez stresanja) smo pri napetosti U_1=80 V izmerili tok I_1=6 A in cosφ$_1$=0,7. Nato v tuljavo vstavimo železno jedro in ponovimo meritve pri enaki napetosti. Izmerimo tok I_2=4 A in cosφ$_2$=0,9. Izračunajte izgube v bakru in železu ter reaktanco X_L.

7. Določite toke v vezju na sliki. $\underline{U}_g$ = 70 – j110 V, R_1 = 14 Ω, R_2 = 4 Ω, R_3 = 8 Ω, X_{L1} = 18 Ω, X_{L2} = 6 Ω, X_C = 12 Ω in X_M = 6 Ω.

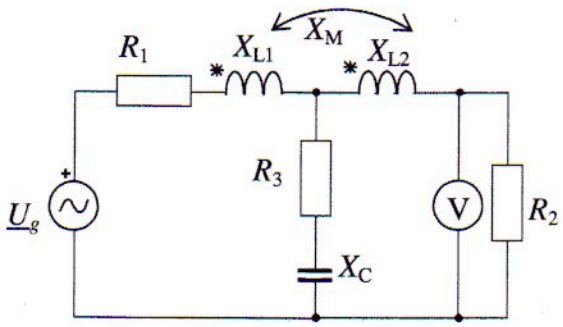


8. Kakšen bi moral biti X_c v vezju iz prejšnje naloge, da bi bilo vezje v napetostni resonanci.

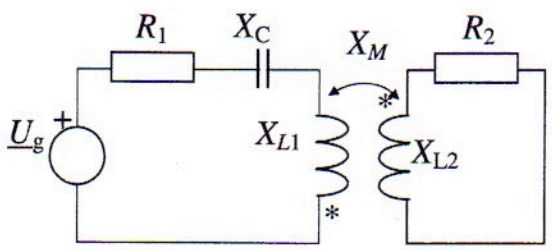
9. Določite napetost, ki jo meri voltmeter v vezavi na sliki . $\underline{U}_g$ = 100 + j100 V, R_1 = 5 Ω, R_2 = 5 Ω, R_3 = 10 Ω, X_{L1} = 15 Ω, X_{L2} = 20 Ω, X_C = 5 Ω in X_M = 10 Ω. (Voltmeter meri efektivno vrednost napetosti!)



10. Določite napetost, ki jo meri voltmeter v vezavi na sliki 1. $\underline{U}_g = 100 + j200$ V, $R_1 = 5\ \Omega$, $R_2 = 10\ \Omega$, $R_3 = 5\ \Omega$, $X_{L1} = 20\ \Omega$, $X_{L2} = 15\ \Omega$, $X_C = 5\ \Omega$ in $X_M = 5\ \Omega$. (Voltmeter meri efektivno vrednost napetosti!)



11. V vezju na sliki določite X_c tako, da bo vezje v napetostni resonanci. Podatki elementov so: $R_1 = 8\ \Omega$, $R_2 = 4\ \Omega$, $X_{L1} = 30\ \Omega$, $X_{L2} = 4\ \Omega$, $X_M = 3\ \Omega$.



Rešitve:

1. $Q_C = 316{,}96$ kvar
2. $Q_{C,min} = 87{,}48$ kvar
3. $R_z = 4 \cdot 10^{-3}\ \Omega$, $C = 1\ \mu$F
4. $R_{vz} = 5\ M\Omega$, $C = 1{,}27\ \mu$F, $\text{tg}\delta = 5 \cdot 10^{-4}$
5. $R_{Cu} = 0{,}25\ \Omega$, $R_{Fe} = 0{,}75\ \Omega$, $L_0 = 15{,}8$ mH
6. $P_{Cu1} = 336$ W, $P_{Cu2} = 149{,}28$ W, $P_{Fe} = 139{,}2$ W, $R_{Cu} = 9{,}3\ \Omega$, $R_{Fe} = 8{,}7\ \Omega$, $X_L = 8{,}72\ \Omega$
7. $I_1 = 6 - j3$ A, $I_2 = 4 - j2$ A, $I_3 = 2 - j1$ A
8. $X_C = 2\ \Omega$
9. $\underline{U}_V = 40 - j40$ V ($U_V = 56{,}57$ V)
10. $\underline{U}_V = 10{,}07 - j57{,}05$ V ($U_V = 57{,}93$ V)
11. $X_C = 28{,}875\ \Omega$

4 DN / [1. rok]

$S_{nT} = 500\ kVA = S_1$

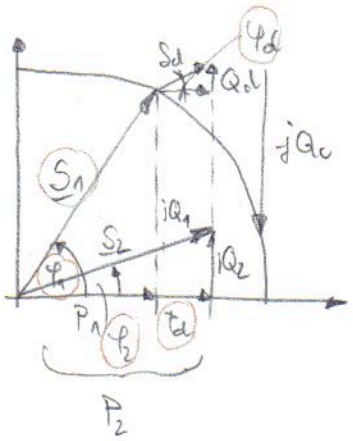
$\cos\varphi_1 = 0,6$

$P_d = 100\ kVA$

$\cos\varphi_d = 0,9$

$\cos\varphi_2 = 0,95$

$Q_c = ?$ da bo



$Q_c = Q_1 + Q_d - Q_2$

$\sin\varphi_1 = 0,8$

$P_1 = S_1 \cdot \cos\varphi_1 = 500 \cdot 0,6 = \boxed{300\ kW}$

$P_2 = P_1 + P_d = 300 + 100 = \boxed{400\ kW}$

$Q_1 = \sin\varphi_1 \cdot S_1 = 0,8 \cdot 500 = \boxed{400\ k var}$

$Q_d = tg\,\varphi_d \cdot P_d = \boxed{48,432\ k var}$

$Q_2 = tg\,\varphi_2 \cdot P_2 = \boxed{131,474\ k var}$

$Q_c = Q_1 + Q_d - Q_2$

$Q_c = 400 + 48,432 - 131,474 = \boxed{316,96\ k var}$

2.

POLNO OBR.

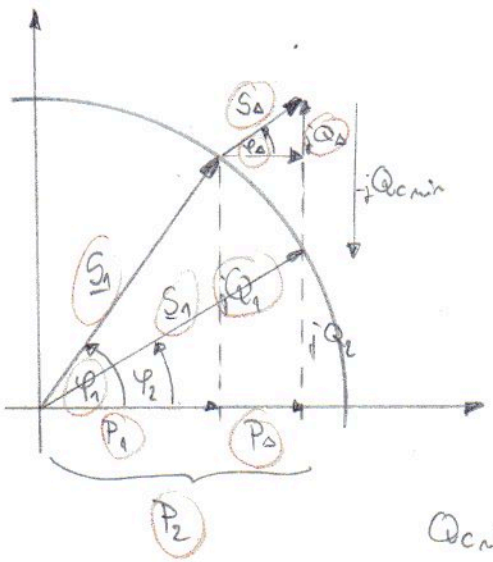
$S_{nT} = 200\ kVA = S_n$

$\cos\varphi_1 = 0{,}6$

$S_\Delta = 60\ kVA$

$\cos\varphi_\Delta = 0{,}8$

$Q_{c\,min} = ?$



$$Q_{c\,min} = Q_1 + Q_\Delta - Q_2$$

$$P_1 = \cos\varphi_1 \cdot S_1 = \boxed{120\ kW}$$

$$Q_{c\,min} = \boxed{87{,}48\ kvar}$$

$$Q_1 = \sin\varphi_1 \cdot S_1 = \boxed{160\ kvar}$$

$$Q_\Delta = \sin\varphi_\Delta \cdot S_\Delta = \boxed{36\ kvar}$$

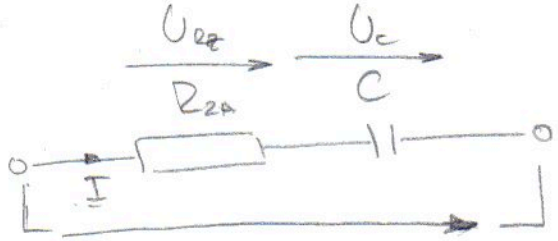
$$P_\Delta = \cos\varphi_\Delta \cdot S_\Delta = \boxed{48\ kW}$$

$$Q_2 = \sqrt{S_1^2 - P_2^2}$$

$$P_2 = P_1 + P_\Delta = \boxed{168\ kW}$$

$$Q_2 = \boxed{108{,}52\ kvar}$$

(3.)



$U = 400\,V$

$Q_c = 4 \cdot 10^8$ var

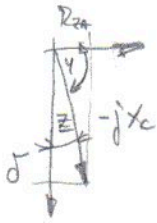
$tg\,\delta = 1 \cdot 10^{-4}$

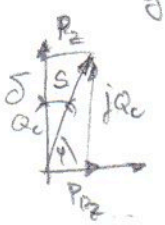
$\omega = 2{,}5 \cdot 10^4$ rad/s

$R_{ZA} C = 2$

$U \approx U_c$

$S \approx Q_c$





$tg\,\delta = \frac{P_Z}{Q_c}$

$Q_c = U_c \cdot I$

$X_c = \frac{U_c}{I} = \frac{400\,\Omega}{1\,\Phi} = \boxed{40\,\Omega}$

$I = \frac{Q_c}{U_c} = \frac{4 \cdot 10^8}{4 \cdot 10^8\,\Omega} = \boxed{10\,A}$

$C = \frac{1}{\omega X_c} = \frac{1}{2{,}5 \cdot 10^4 \cdot 40} = 1 \cdot 10^{-6}\,F = \boxed{1\,\mu F}$

$P_{ZA} = tg\,\delta \cdot Q_c = \boxed{0{,}4\,W}$

$P_{ZA} = U \cdot I = I^2 \cdot R_{ZA} \Rightarrow R_{ZA} = \frac{P_{ZA}}{I^2} = \frac{4 \cdot 10^{-1}}{100} = \boxed{4 \cdot 10^{-3}\,\Omega}$

(4.)

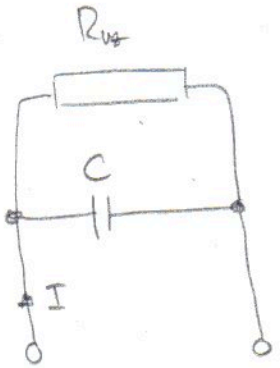
$U = 250\,V$

$f = 50\,Hz$

$I = 0{,}1\,A$

$P = 12{,}5\,mW$

$R_{vz}, C, tg\gamma = ?$



$I \approx I_c$

$S \approx Q$

$$X_c = \frac{U_c}{I_c} = \frac{250}{1 \cdot 10^{-1}} = \boxed{2500\,\Omega}$$

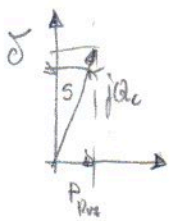
$$C = \frac{1}{\omega X_c} = \frac{1}{50 \cdot 2\pi \cdot 2{,}5 \cdot 10^3} = \boxed{1{,}273\,\mu F}$$

$$P = U \cdot I = \frac{U^2}{R_{vz}} \Rightarrow R_{vz} = \frac{U^2}{P} = \frac{250^2}{12{,}5 \cdot 10^{-3}} = \boxed{5\,M\Omega}$$

$$tg\gamma = \frac{12{,}5 \cdot 10^{-3}}{25} = \boxed{5 \cdot 10^{-4}}$$

$$S = U \cdot I = 250 \cdot 0{,}1$$

$$S = \boxed{25\,VA} \approx Q$$



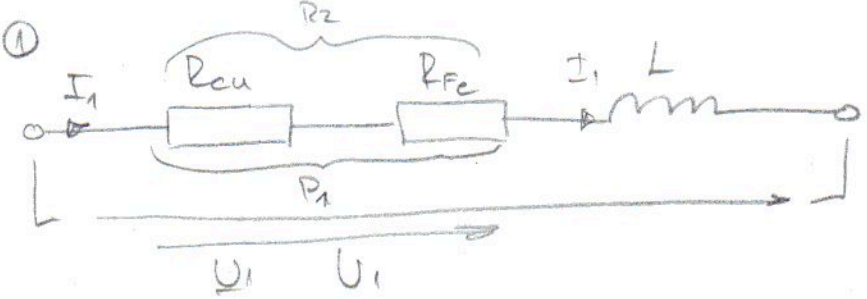
$$tg\gamma = \frac{P}{Q_c}$$

5.

① Z, Fe	② Brez Fe
$U_1 = 20V$	
$I_1 = 2A$	$I_2 = 2A$
$P_1 = 4W$	$P_2 = 1W$

$f = 1000\,Hz$

R_{Cu}, L, R_{Fe}

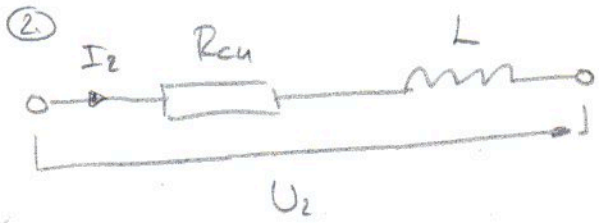


$P_{Fe} = P_1 - P_2 = \boxed{3W}$

$P_1 = U \cdot I = I_1^2 \cdot R_2$

$R_2 = \frac{P_1}{I_1^2} = \boxed{1\Omega}$

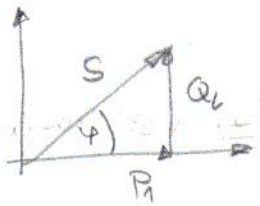
$R_{Cu} = R_2 - R_{Fe} = \boxed{0{,}25\Omega}$



$S = U \cdot I = \boxed{40VA}$

$P_{Fe} = I_2 U = I_2^2 R_{Fe}$

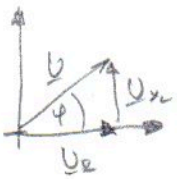
$\Rightarrow R_{Fe} = \frac{P_{Cu}}{I_2^2} = \frac{3}{2^2} = \boxed{0{,}75\Omega}$



$\cos\varphi = \frac{P_1}{S} \Rightarrow \varphi = \boxed{84{,}26^\circ}$

$Q_L = \sin\varphi \cdot S = \boxed{39{,}8\ var}$

$X_L = \frac{U_{R_2}}{I_2} = \boxed{9{,}949\Omega}$



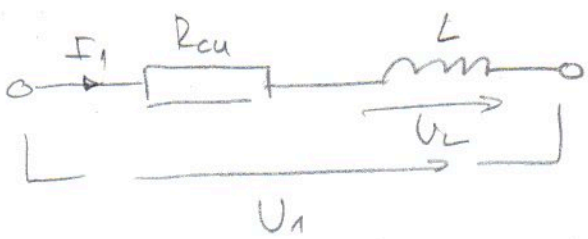
$L = \frac{X_L}{\omega} = \boxed{15{,}835\,mH}$

$U_{X_L} = \sin\varphi \cdot U$

$U_{X_L} = \boxed{19{,}899V}$

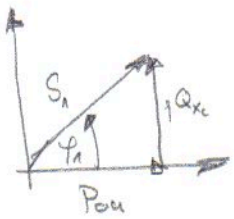
6.

Bez Fe	Sa Fe
$U_1 = 80V$	$U_2 = 80V$
$I_1 = 6A$	$I_2 = 4A$
$\cos\varphi_1 = 0,7$	$\cos\varphi_2 = 0,9$



$P_{cu}, P_{Fe}, X_L = ?$

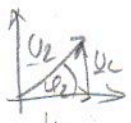
$S_1 = U \cdot I_1 = \boxed{480\,VA}$



$P_{cu} = \cos\varphi_1 \cdot S$

$P_{cu} = \boxed{336\,W}$

$U_L = \sin\varphi_2 \cdot U_2 = \boxed{34,87V}$

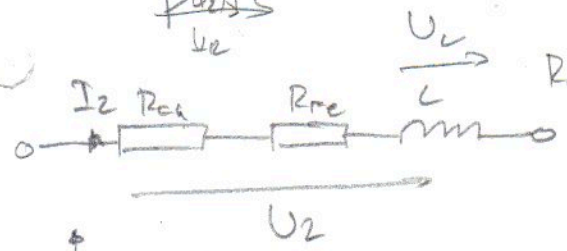


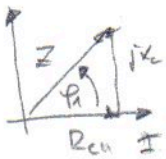
$Q_{xL} = \sin\varphi_1 \cdot S$

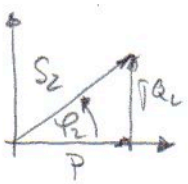
$Q_{xL} = \boxed{342,79\,var}$

$P_{cu} = U_{cu} \cdot I_{cu} = I_{cu}^2 R_{cu}$

$R_{cu} = \dfrac{P_{cu}}{I_{cu}^2} = \boxed{9,33\,\Omega}$







$P_{cu_2} = U_{cu_2} \cdot I_{cu_2} = I_{cu_2}^2 \cdot R_{cu}$

$S_2 = U_2 \cdot I_2 = \boxed{320\,VA}$

$P_{cu_2} = \boxed{149,33\,W}$

$P = P_{cu_2} + P_{Fe}$

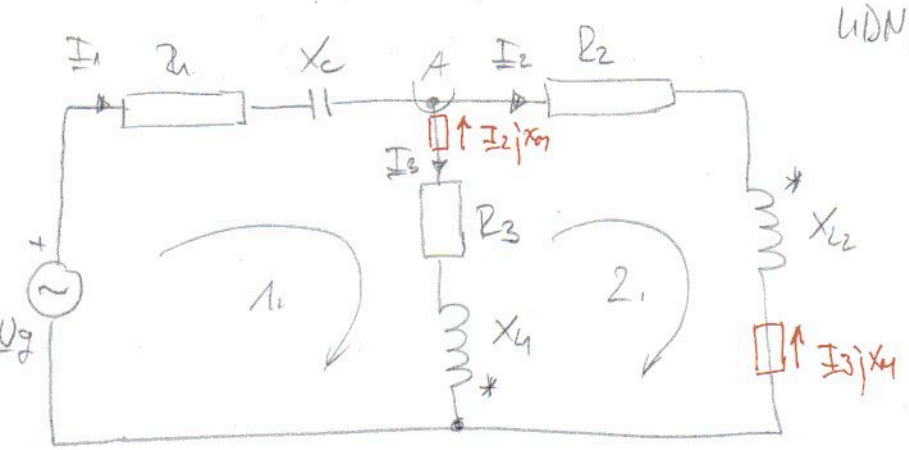
$P = \cos\varphi_2 \cdot S_2 = \boxed{288\,W}$

$P_{Fe} = P - P_{cu_2} = \boxed{138,67\,W}$

$P_{Fe} = I_{Fe}^2 \cdot R_{Fe} \Rightarrow R_{Fe} = \dfrac{P_{Fe}}{I_{Fe}^2} = \boxed{8,67\,\Omega}$

$X_L = \dfrac{U_L}{I_L} = \boxed{8,72\,\Omega}$

UDN/(7)rad



$\underline{U}_g = 70 - j110\ V$

$R_1 = 14\ \Omega$ $X_{L1} = 18\ \Omega$

$R_2 = 4\ \Omega$ $X_{L2} = 6\ \Omega$

$R_3 = 8\ \Omega$

$X_C = 12\ \Omega$

$X_M = 6\ \Omega$

1.) $\underline{I}_1(R_1 - jX_C) - \underline{I}_2 jX_M + \underline{I}_3(R_3 + jX_4) = \underline{U}_g$

2.) $\underline{I}_2(R_2 + jX_{L2} + jX_M) - \underline{I}_3(jX_M + jX_4 + R_3) = 0$

$$\underline{I}_3 = \frac{\underline{I}_2(R_2 + jX_{L2} + jX_M)}{jX_M + jX_{L1} + R_3}$$

A: $\underline{I}_1 = \underline{I}_2 + \underline{I}_3$

$$\underline{I}_1 = \underline{I}_2\left(1 + \frac{R_2 + jX_{L2} + jX_M}{jX_M + jX_4 + R_3}\right)$$

$$\underline{I}_1 = \underline{I}_2\left(1 + \frac{4 + j12}{8 + j24}\right)$$

$$\underline{I}_1 = \underline{I}_2\left(\frac{3 + j3}{2 + j2}\right) = \underline{I}_2\left(\frac{3}{2}\right)$$

$\underline{I}_1 = \frac{3}{2}\underline{I}_2$

$$\underline{I}_2\,\frac{3(R_1 - jX_C)}{2} - \underline{I}_2 jX_M + \underline{I}_2\,\frac{(R_2 + jX_{L2} + jX_M)(R_3 + jX_4)}{jX_M + jX_4 + R_3} = \underline{U}_g$$

$$\underline{I}_2\left(\frac{42 - j36}{2} - j6 + \frac{(4 + j12)(8 + j18)}{8 + j24}\right) = 70 - j110\ V$$

$$\underline{I}_2\left(21 - j18 - j6 + \frac{32 + j72 + j96 - 216}{8 + j24}\right) = 70 - j110\ V$$

$$\underline{I}_2\left(21 - j24 + \underbrace{\frac{2560 + j5760}{640}}_{4 + j9}\right) = 70 - j110\ V$$

$$\underline{I}_2 = \frac{70 - j110}{25 - j15} = \boxed{4 - j2\ A}$$

$$I_1 = \frac{3 \cdot (4 - j2)}{2}$$

$$= \frac{12 - j6}{2} = \boxed{6 - j3\ A}$$

$\underline{I}_3 = \underline{I}_1 - \underline{I}_2$

$\underline{I}_3 = 6 - j3 - 4 + j2 = \boxed{2 - j1\ A}$

(8.) 4DN

1) $\underline{I}_1(R_1 - jX_C) - \underline{I}_2 jX_M + \underline{I}_3(R_3 + jX_{L1}) = \underline{U}_g$

2) $\underline{I}_2(R_2 + jX_{L2} + jX_M) - \underline{I}_3(jX_M + jX_{L1} + R_3) = 0$

$\underline{I}_1 = \underline{I}_2 + \underline{I}_3$

$\underline{I}_3 = \underline{I}_1 - \frac{2}{3}\underline{I}_1$

$\underline{I}_3 = \frac{1}{3}\underline{I}_1$

$\operatorname{Im}\left(\frac{\underline{U}_g}{\underline{I}_1}\right) = 0$

$\underline{I}_1 = \frac{3}{2}\underline{I}_2 \Rightarrow \underline{I}_2 = \frac{2}{3}\underline{I}_1$

$$\underline{I}_1(R_1 - jX_C) - \frac{2}{3}\underline{I}_1 jX_M + \frac{1}{3}\underline{I}_1(R_3 + jX_{L1}) = \underline{U}_g$$

$$\frac{\underline{U}_g}{\underline{I}_1} = R_1 - jX_C - \frac{2jX_M}{3} + \frac{R_3 + jX_{L1}}{3}$$

$$\frac{\underline{U}_g}{\underline{I}_1} = 14 - jX_C - j4 + \frac{8 + j18}{3}$$

$\operatorname{Im}\left(\frac{\underline{U}_g}{\underline{I}_1}\right) = 0$

$$-X_C - 4 + \frac{18}{3} = 0$$

$$X_C = \frac{18}{3} - \frac{12}{3}$$

$$\boxed{X_C = 2\ \Omega}$$

9.

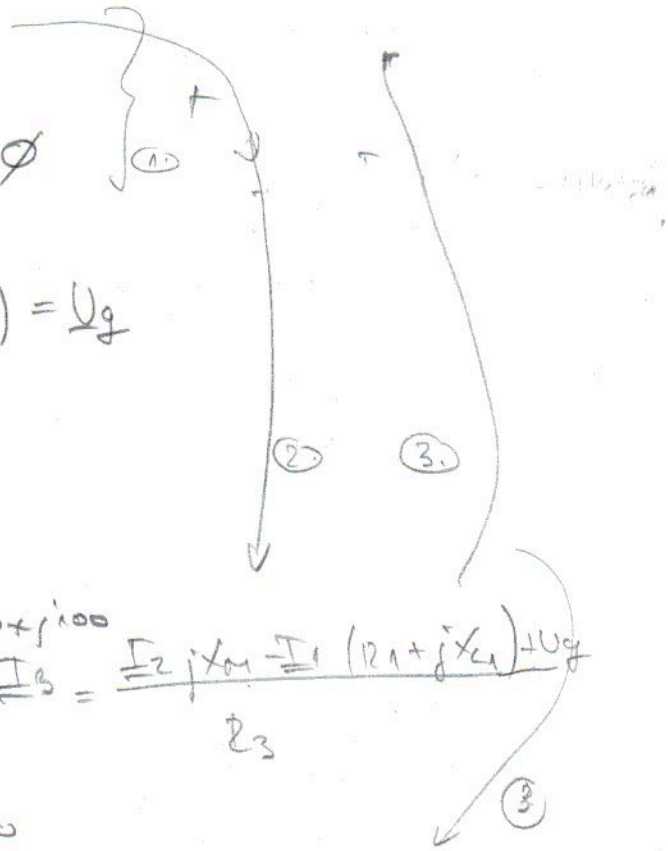
A) $\underline{I}_1 = \underline{I}_2 + \underline{I}_3$

1) $\underline{I}_1(R_1 + jX_{L1}) - \underline{I}_2 jX_M + \underline{I}_3 R_3 = \underline{U}_g$

2) $-\underline{I}_1 jX_M + \underline{I}_2(jX_{L2} + R_2 - jX_C) - \underline{I}_3 R_3 = 0$

$\underline{I}_1(\overset{5}{R_1} + j\overset{15}{X_{L1}} - j\overset{10}{X_M}) + \underline{I}_2(j\overset{20}{X_{L2}} + \overset{5}{R_2} - j\overset{5}{X_C} - j\overset{10}{X_M}) = \underline{U}_g$

$\underline{I}_1(5 + j5) + \underline{I}_2(5 + j5) = 100 + j100$



$$\frac{(5+j5)\cdot(\underline{I}_2(10+j10)+(100+j100))}{15+j15} + \underline{I}_2(5+j5) = 100+j100$$

$$\underline{I}_3 = \frac{\underline{I}_2 jX_M - \underline{I}_1(R_1 + jX_{L1}) + \underline{U}_g}{R_3}$$

$$(5+j5)(\underline{I}_2(10+j10)+(100+j100)) + \underline{I}_2 j150 = j3000$$

$$\underline{I}_2 j100 + j1000 + \underline{I}_2 j150 = j3000$$

$$\underline{I}_1 = \underline{I}_2 + \frac{\underline{I}_2 jX_M - \underline{I}_1(R_1 + jX_{L1}) + \underline{U}_g}{R_3}$$

$$\underline{I}_2(j100 + j150) = j2000$$

$$\boxed{\underline{I}_2 = 8\,A}$$

$$\underline{I}_1 R_3 + \underline{I}_1(R_1 + jX_{L1}) = \underline{I}_2(R_3 + jX_M) + \underline{U}_g$$

$$\underline{I}_1 = \frac{\underline{I}_2(R_3 + jX_M) + \underline{U}_g}{R_3 + R_1 + jX_{L1}}$$

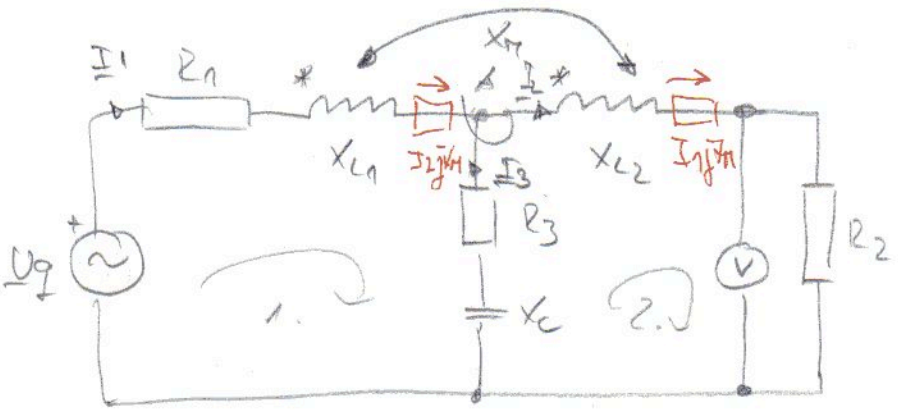
$$\underline{U}_v = \underline{I}_2 \cdot (R_2 - jX_C)$$

$$\underline{I}_1 = \frac{\underline{I}_2(10+j10) + \underline{U}_g}{15 + j15}$$

$$\underline{U}_v = 8\cdot(5-5) = \boxed{40 - j40\,V}$$

$$\underline{I}_1 = \frac{\underline{I}_2(10+j10) + (100+j\cdots)}{15+j15}$$

$$U_v = 40\cdot\sqrt{2}\,V \doteq \boxed{56{,}57\,V}$$



10.

$\underline{U}_g = 100 + j200$

$R_1 = 5\,\Omega$

$R_2 = 10\,\Omega$

$R_3 = 5\,\Omega$

$X_{L1} = 20\,\Omega$

$X_{L2} = 15\,\Omega$

$X_C = 5\,\Omega$

$X_M = 5\,\Omega$

$U_v = ?$

A: $\underline{I}_1 = \underline{I}_2 + \underline{I}_3$

1) $\underline{I}_1(R_1 + jX_{L1}) + \underline{I}_2 jX_M + \underline{I}_3(R_3 - jX_C) = \underline{U}_g$

2) $\underline{I}_1 jX_M + \underline{I}_2(R_2 + jX_{L2}) - \underline{I}_3(R_3 - jX_C) = 0$

$+ \Rightarrow$ (2.) $\underline{I}_3 = \dfrac{\underline{I}_1 jX_M + \underline{I}_2(R_2 + jX_{L2})}{R_3 - jX_C}$

$\underline{I}_1\left(\overset{5}{R_1} + j\overset{20}{X_{L1}} + j\overset{5}{X_M}\right) + \underline{I}_2\left(\overset{10}{R_2} + j\overset{15}{X_{L2}} + j\overset{5}{X_M}\right) = \overset{100+j200}{U_g}$ (1.)

(3.) $\underline{I}_1 = \underline{I}_2 + \underline{I}_3$

$\dfrac{\underline{I}_2(-1+j3)\cdot(5+j25)}{5} + \underline{I}_2(10+j20) = 100+j200$

$\underline{I}_1 = \underline{I}_2 + \dfrac{\underline{I}_1 jX_M + \underline{I}_2(R_2 + jX_{L2})}{R_3 - jX_C}$

$\underline{I}_2(-11 + j3 + 10 + j20) = 100 + j200$

$\underline{I}_1\left(R_3 - jX_C - jX_M\right) = \underline{I}_2\left(R_2 + jX_{L2} + R_3 - jX_C\right)$

$\underline{I}_2 = \dfrac{100 + j200}{-31 + j23} = \boxed{1{,}0067 + j5{,}705\,A}$

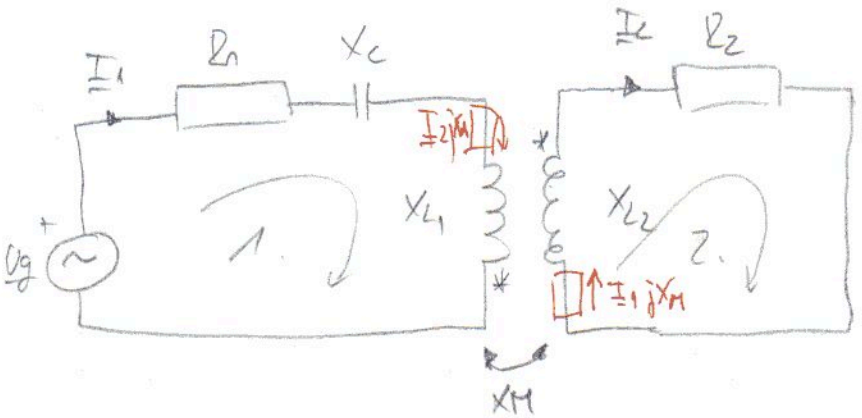
$\underline{I}_1 = \dfrac{\left(\overset{10}{R_2} + j\overset{15}{X_{L2}} + \overset{5}{R_3} - j\overset{5}{X_C}\right)\underline{I}_2}{R_3 - jX_C - j\overset{5}{X_M}}$

$\underline{I}_1 = \dfrac{\underline{I}_2(15 + j10)}{5 - j10} = \dfrac{\underline{I}_2(-1+j3)}{5}$ (4.)

$\underline{U}_v = \underline{I}_2 \cdot R_2 = \boxed{10{,}067 - j57{,}047\,V}$

$U_v = \boxed{57{,}93\,V}$

$$\underbrace{\begin{bmatrix} (5,20) & (0,5) & (5,-5) \\ (0,5) & (10,15) & (-5,5) \\ (-1,0) & (1,0) & (1,0) \end{bmatrix}}_{A} \quad \underbrace{\begin{bmatrix} (100,200) \\ (0,0) \\ (0,0) \end{bmatrix}}_{B}$$



$R_1 = 8\,\Omega$

$R_2 = 4\,\Omega$

$X_{L1} = 30\,\Omega$

$X_{L2} = 4\,\Omega$

$X_M = 3\,\Omega$

$$\operatorname{Im}\left(\frac{\underline{U}_g}{\underline{I}_1}\right) = \emptyset$$

1.) $\underline{I}_1(R_1 + jX_c + jX_{L1}) + \underline{I}_2 jX_M = \underline{U}_g$

2.) $\underline{I}_2(R_2 + jX_{L2}) + \underline{I}_1 jX_M = \emptyset \rightarrow \underline{I}_2 = \dfrac{-\underline{I}_1 jX_M}{R_2 + jX_{L2}}$

$$\underline{I}_1\left(R_1 - jX_c + jX_{L1} + \frac{X_M^2}{R_2 + jX_{L2}}\right) = \underline{U}_g$$

Drugi način →

$$\underline{I}_1\left(R_1 - jX_c + jX_{L1} + \frac{X_M^2}{R_2 + jX_{L2}}\right) = \underline{U}_g$$

$$\frac{\underline{U}_g}{\underline{I}_1} = R_1 - jX_c + jX_{L1} + \frac{X_M^2}{R_2 + jX_{L2}}$$

$$\operatorname{Im}\left(\frac{\underline{U}_g}{\underline{I}_1}\right) = \emptyset$$

$$-jX_c + jX_{L1} + \frac{X_M^2}{R_2 + jX_{L2}} = \emptyset$$

$$X_c = X_{L1} + \frac{X_M^2}{R_2 + X_{L2}}$$

1.) $\underline{I}_1\left(R_1 - jX_C + jX_{L1}\right) + \underline{I}_2 jX_M = \underline{U}_g$

2.) $\underline{I}_1 jX_M + \underline{I}_2\left(R_2 + jX_{L2}\right) = \emptyset \Rightarrow \underline{I}_2 = \dfrac{-\underline{I}_1 jX_M}{R_2 + jX_{L2}}$

$$\underline{I}_1\left(R_1 - jX_C + jX_{L1}\right) + jX_M \cdot \frac{-\underline{I}_1 jX_M}{R_2 + jX_{L2}} = \underline{U}_g$$

$$\underline{I}_1\left(R_1 - jX_C + jX_{L1}\right) + \frac{\underline{I}_1 X_M^2}{R_2 + jX_{L2}} = \underline{U}_g$$

$$\underline{I}_1 \cdot \left(R_1 - jX_C + jX_{L1} + \frac{X_M^2}{R_2 + jX_{L2}}\right) = \underline{U}_g$$

$$\frac{\underline{U}_g}{\underline{I}_1} = R_1 - jX_C + jX_{L1} + \frac{X_M^2\left(R_2 - jX_{L2}\right)}{R_2^2 + X_{L2}^2}$$

$$\mathrm{Im}\left(\frac{\underline{U}_g}{\underline{I}_1}\right) = \emptyset$$

$$-jX_C + jX_{L1} + \frac{-jX_{L2}X_M^2}{R_2^2 + jX_{L2}^2} = \emptyset$$

$$X_C = X_{L1} + \frac{-X_{L2} \cdot X_M^2}{R_2^2 + X_{L2}^2}$$

$$X_C = 30 + \frac{-4 \cdot 3^2}{4^2 + 4^2} = 30 + \frac{-36}{32} = \boxed{28{,}875\ \Omega}$$