Exercice n°1 :

1) $W_a = P_a \times t \Rightarrow P_a = \frac{W_a}{t} = \frac{39600}{360} = 110\ kW$

$W_r = Q_a \times t \Rightarrow Q_a = \frac{W_r}{t} = \frac{32666{,}4}{360} = 90{,}74\ kVAR$

$\tan(\varphi) = \frac{Q_a}{P_a} = \frac{90{,}74}{110} = 0{,}825.$

$\varphi = 39{,}5° \Rightarrow \cos(\varphi) = 0{,}77.$

$P_a = 3VI\cos(\varphi) = \sqrt{3}\,UI\cos(\varphi)$

$I = \frac{P_a}{\sqrt{3}.U.\cos(\varphi)} = \frac{110 \times 10^3}{\sqrt{3} \times 400 \times 0{,}77} = 206\ A$

2) $\cos(\varphi') = 0{,}707 = \frac{\sqrt{2}}{2}$

$P_t = \sqrt{3}.U'.I.\cos(\varphi') = \sqrt{3}.470.206.0{,}707 = 118{,}6\ kW$

$W_t = P_t.\underbrace{\tan(\varphi')}_{=1} = 118{,}6\ kVAR$

$P_t = P_A + 3RI^2 \iff R = \frac{P_t - P_a}{3.I^2} = \frac{8{,}6 \times 10^3}{3 \times 206^2} = 67{,}5\ m\Omega$

$Q_t = Q_a + 3.L\omega.I^2 \iff L\omega = \frac{Q_t - Q_a}{3.I^2} = \frac{(118{,}6 - 90{,}74) \times 10^3}{3 \times 206^2} = 0{,}22\ \Omega.$

3) Pertes en ligne : $P_t - P_a = 8{,}6\ kW$

Pertes : $\frac{8{,}6}{118{,}6} = 0{,}0725$ soit $7{,}25\ \%$

4) $P_a = P_a'$

$Q_a' = Q_c + Q_a = P_a' \tan(\varphi') = P_a \tan(\varphi')$

$Q_a = P_a \tan(\varphi)$

$Q_c = Q_a' - Q_a = P_a(\tan(\varphi') - \tan(\varphi))$

$\cos(\varphi') = 0{,}9 \Rightarrow \tan(\varphi') = 0{,}484 \Rightarrow \varphi' = 25{,}8°$

$\tan(\varphi) = 0{,}825$

$Q_c = 110(0{,}484 - 0{,}825) = -37{,}5\ kVAR$ Energie reactive fournie par les condensateurs

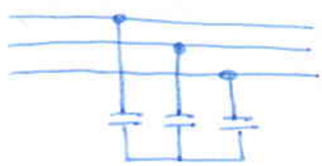
Pour 1 condensateur,

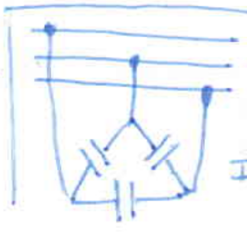
$I = \frac{V}{1/C\omega} = VC\omega$

$Q = VI.\underbrace{\sin(\varphi)}_{=1} = V.VC\omega = V^2C\omega$

$Q_c = 3.V^2C\omega$

$Q = \frac{Q_c}{3V^2C\omega} = \frac{37500}{3 \times 230^2 \times 2\pi 50} \iff C_\lambda = 752{,}15\ \mu F$ En etoile.





$C_\Delta = \frac{C_\lambda}{3} = 248{,}7\ \mu F$ en triangle

Courant en ligne I'

$I' = \frac{P'_a}{\sqrt{3}.V.\cos(\varphi')} = \frac{110.10^3}{\sqrt{3} \times 400 \times 0{,}9} = 176\ VA$

5) Pertes : $3 \cdot R I^2 = 3 \times 0{,}0675 \times 176^2 = 6{,}3\ kW$

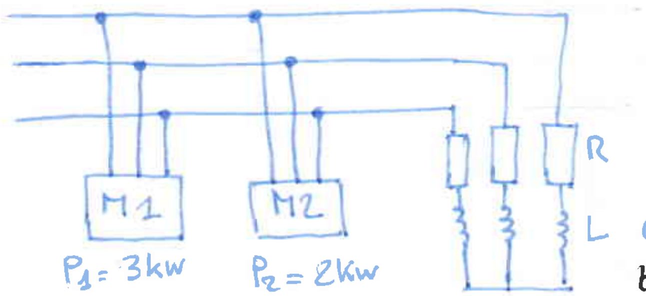
$P_t' = P_a' + \text{Pertes} = 110 + 6{,}3 = 116{,}3\ kW$

$\text{Pertes} = \dfrac{6{,}3}{116{,}3} = 0{,}053 = 5{,}3\ \%$

6) Volume : $125 \times 250 \times 462 = 14\,437\,500\ mm^2 = 0{,}014\ m^2$
$(420 + 42)$

Exercice n° 2 :

$\varphi_1 = 45{,}5$ $\varphi_2 = 53{,}13$ $\varphi_3 = 60$



$P_1 = 3\ kW$ $P_2 = 2\ kW$ $P_3 = 1\ kW$

$\cos(\varphi_1) = 0{,}7$ $\cos(\varphi_2) = 0{,}6$ $\cos(\varphi_3) = 0{,}5$

$\tan(\varphi_1) = 1{,}02$ $\tan(\varphi_2) = 1{,}33$ $\tan(\varphi_3) = 1{,}73$

1) $v_1(t) = \hat{V}\cos(\omega t) = V\sqrt{2}\cdot\cos(\omega t)$

$v_2(t) = V\sqrt{2}\cos(\omega t - \frac{2\pi}{3})$

$v_3(t) = V\sqrt{2}\cos(\omega t - \frac{4\pi}{3})$

$\underline{V}_1 = V$

$\underline{V}_2 = V e^{j240°}$

$\underline{V}_3 = V e^{j120°}$

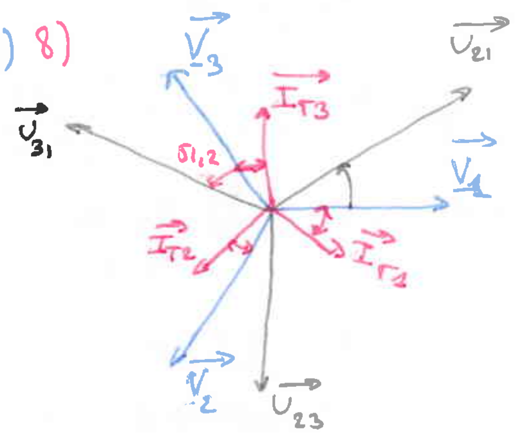
3) $\underline{U}_{12} = \underline{V}_1 - \underline{V}_2 = V(1 - e^{j240°})$

$\underline{U}_{12} = V(1 + \frac{1}{2} + \frac{\sqrt{3}}{2}j) = V\sqrt{3}\, e^{j\frac{\pi}{6}}$

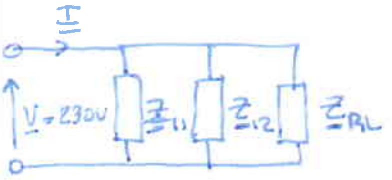
$\underline{U}_{23} = \underline{V}_2 - \underline{V}_3 = V(e^{j240°} - e^{j120°}) = V\cdot\sqrt{3}\, e^{-j\frac{\pi}{2}}$

$\underline{U}_{31} = \underline{V}_3 - \underline{V}_1 = V(e^{j120} - 1) = V\cdot\sqrt{3}\cdot e^{j\frac{5\pi}{6}}$

2) 8)



4) Schéma monophasé équivalent.



$P_t = P_1 + P_2 + P_3 = 6\ kW$

5)

$P_t = P_1 + P_2 + P_3 = 6\ kW$

$Q_t = P_1 \tan(\varphi_1) + P_2 \tan(\varphi_2) + P_3 \tan(\varphi_3)$

$Q_t = 3 \times 1{,}02 + 2 \times 1{,}33 + 1 \times 1{,}73 = 7459{,}3\ VAR.$

$S_t = \sqrt{P^2 + Q_t^2} = 9572{,}9\ VA.$

6) $\cos(\varphi_T) = \dfrac{P_t}{S_t} = \dfrac{6}{9{,}57} = 0{,}63$

$\varphi_T = 51{,}2°$

7) $I_T = \dfrac{S_T}{3V} = \dfrac{9572{,}9}{3 \times 230} = 13{,}9\ A \Leftrightarrow \underline{I}_T = 13{,}9\, e^{-j51{,}2°}$

9) $\begin{cases} P_T = P^1_{AC} + P^2_{BC} \\ Q_T = \sqrt{3}\,(P^1_{AC} - P^2_{BC}) \end{cases} \Leftrightarrow \begin{cases} P_T = P^1_{AC} + P^2_{BC} \\ \frac{Q_T}{\sqrt{3}} = P^1_{AC} - P^2_{BC} \end{cases} \Rightarrow$

$P^1_{AC} = \frac{1}{2}\left(P_t + \frac{Q_t}{\sqrt{3}}\right) = 5153\ W$

$P^2_{BC} = P_t - P^2_{AC} = 848\ W.$

11) $Q_c = P_T(\tan(\varphi') - \tan(\varphi)) = 6(0{,}4 - 1{,}24) -$

$Q_c = -5{,}04\ kVAR$

$C = \dfrac{Q_c}{3U^2\omega} = \dfrac{5040}{3 \times 400^2 \times 2\pi \times 50} = 33{,}7\ mF.$

12) $P_t' = P_t = 6\ kW \Rightarrow I_t' = \dfrac{P_t'}{\sqrt{3}\cdot U \cdot \cos(\varphi')}$

$Q_t' = Q_t + Q_c \Rightarrow$

$I_t' = \dfrac{6 \times 10^3}{\sqrt{3}\cdot 400 \times 0{,}93} = 9{,}35\ A$

$\underline{I}_t' = 9{,}35\, e^{-j21{,}5°}$