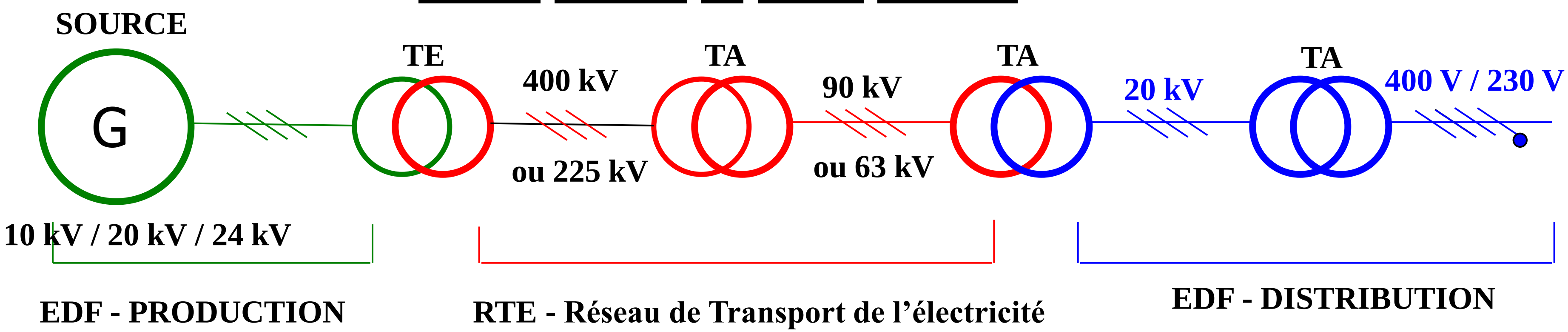
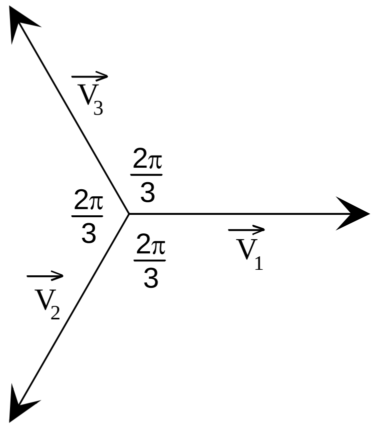
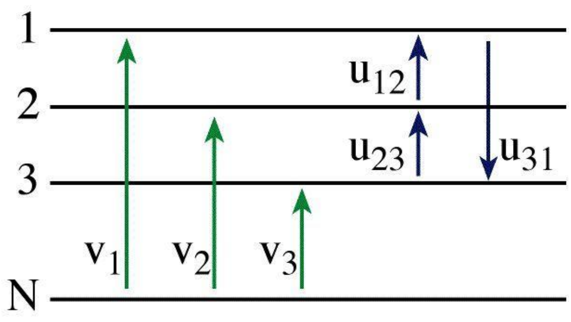
CHAPITRE 3–CIRCUIT TRIPHASÉ EN RÉGIME SINUSOÏDAL

SCHÉMA SIMPLIFIÉ DU RÉSEAU FRANÇAIS



Systèmes triphasés symétriques

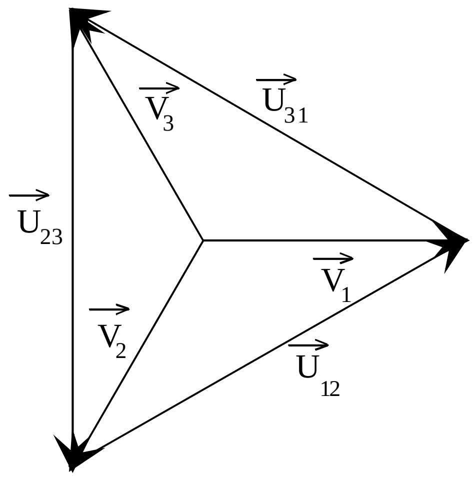


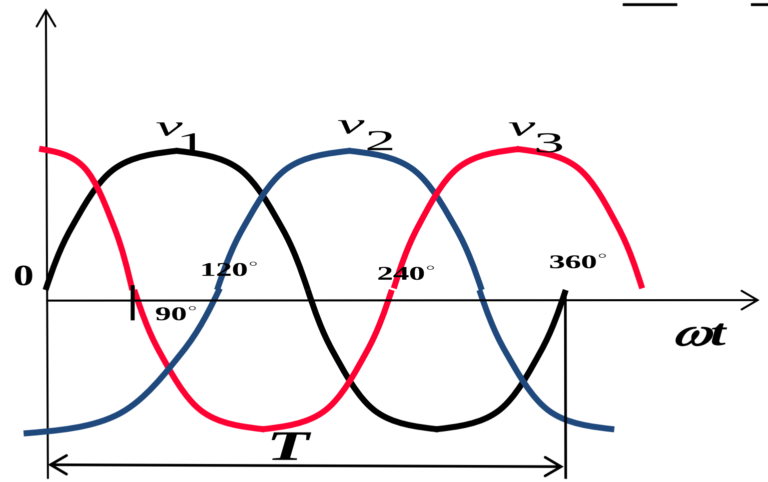


$$v_1 = V\sqrt{2}\sin(\omega t) \rightarrow v_2 = V\sqrt{2}\sin(\omega t - \frac{2\pi}{3}) \rightarrow v_3 = V\sqrt{2}\sin(\omega t - \frac{4\pi}{3})$$

Un circuit triphasé est équilibré quand la source et la charge sont toutes les deux équilibrées en tension et en courant.

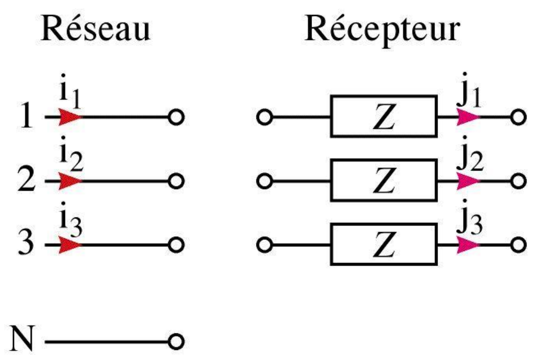
Le système est équilibré car la construction de Fresnel montre que $\underline{V}_1+\underline{V}_2+\underline{V}_3=0$



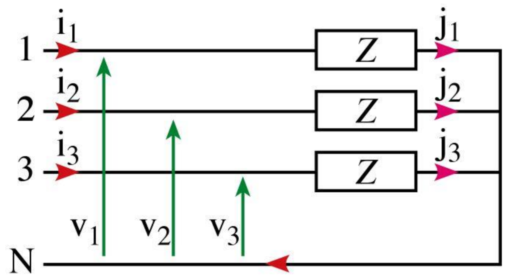


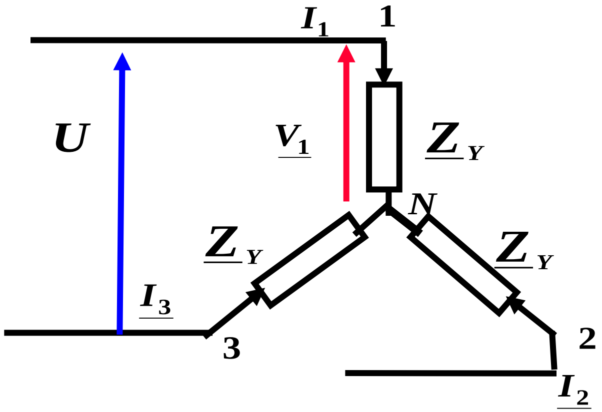
1- Couplage des trois phases

Il existe 2 manières de coupler 3 impédances



Couplage étoile





Relations entre les tensions

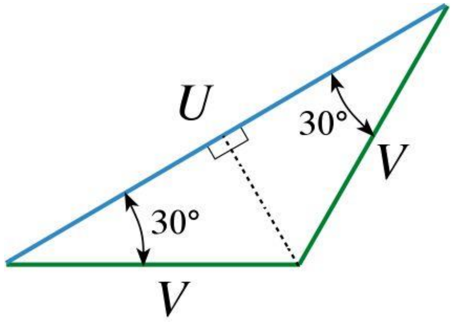
$$\boldsymbol{V_1 = V_2 = V_3 = V}$$ *Tension simple*

$$U = \sqrt{3} \times V$$ *Tension composée*

Relations entre les courants

$$I_1 = I_2 = I_3 = I = J$$

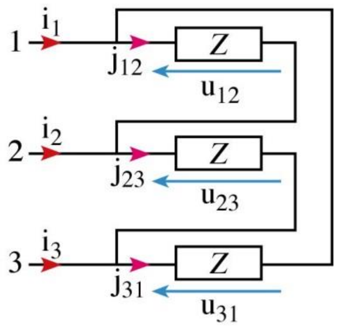
(I) courant en ligne

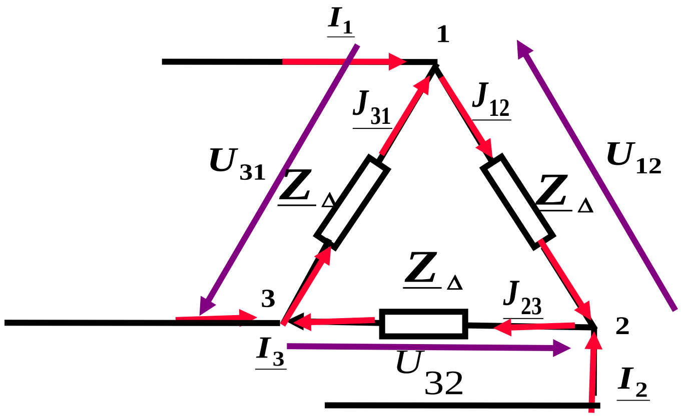


$$U = 2V\cos\frac{\pi}{3} = 2V\frac{\sqrt{3}}{2} = V\sqrt{3}$$

$$\underline{U}_{12} = \sqrt{3} * \underline{V}_1 * e^{j\frac{\pi}{6}}$$

Couplage triangle

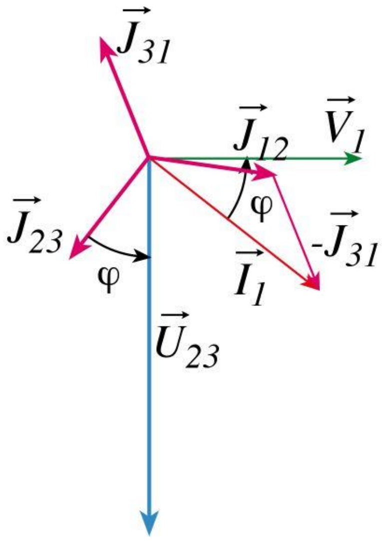




Relations entre les tensions

$$U_{31} = U_{23} = U_{12} = U$$

Tension composée



Relations entre les courants côté récepteur

$$I_1 = j_{12} - j_{31}$$
$$I_2 = j_{23} - j_{12}$$
$$I_3 = j_{31} - j_{23}$$

J *Courant de phase ou polygonal*

$$I = \sqrt{3} \times J$$

$$I = 2J\cos\frac{\pi}{3} = 2J\frac{\sqrt{3}}{2} = J \times \sqrt{3}$$

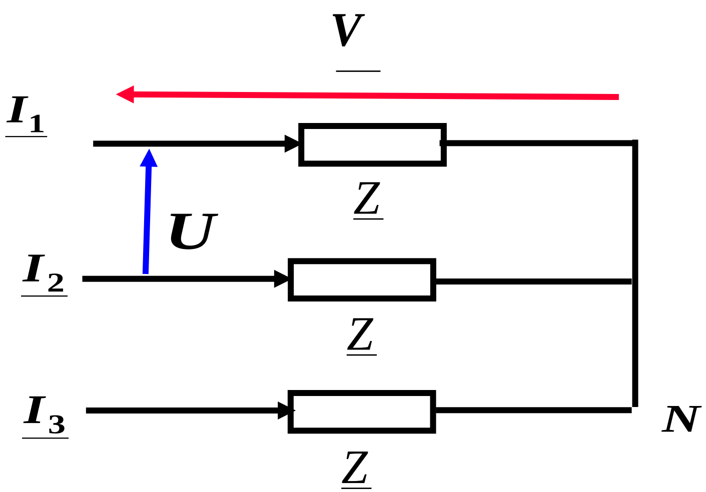
$$\underline{I} = \sqrt{3}Je^{-j\frac{\pi}{6}}$$

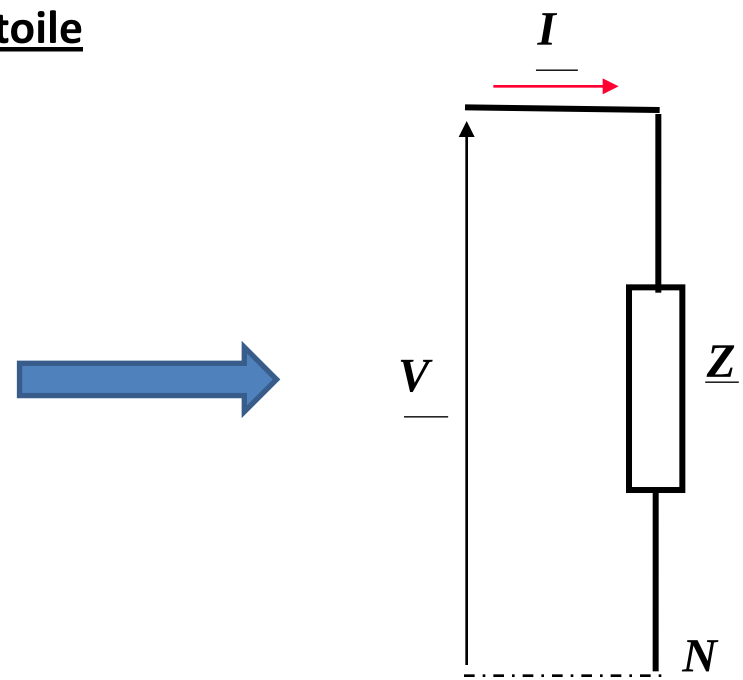
Traitement des réseaux en régime triphasé équilibré

L'étude peut se limiter à ce qui se passe sur une seule phase car les phénomènes sur les autres phases ne diffèrent que par un déphasage de $\frac{2\pi}{3}$

2- Schéma monophasé équivalent d'un récepteur triphasé

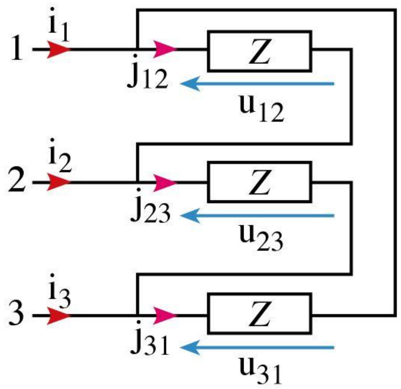
1. Si le couplage des impédances est en **étoile**



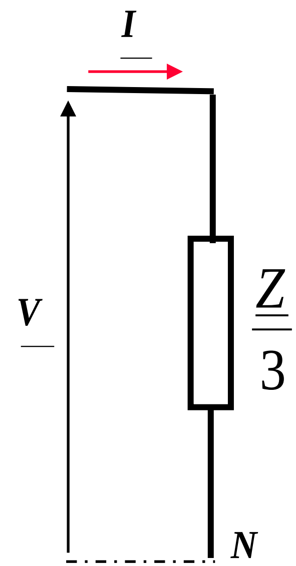


$$V = Z \times I$$

1. Si le couplage des impédances est en **triangle**

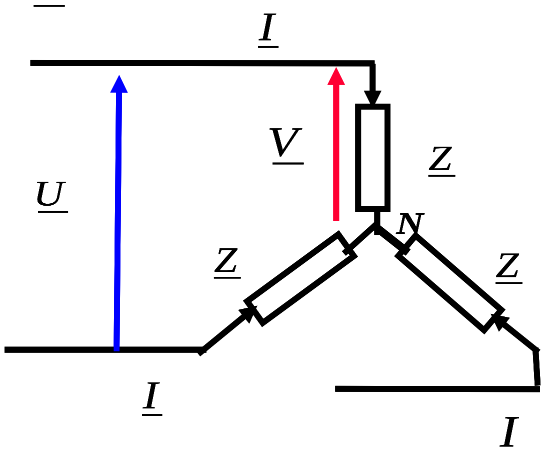


$$V = \frac{Z}{3} \times I$$



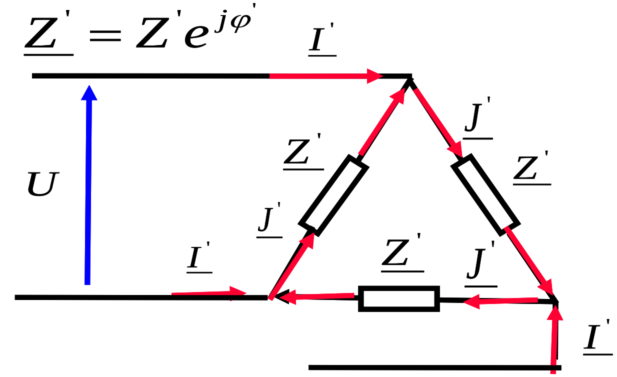
Exercice 1.3. On considère le circuit ci-dessous. Calculer la relation entre Z et Z' pour que ces deux charges soient équivalentes

$\underline{Z} = Ze^{j\varphi}$

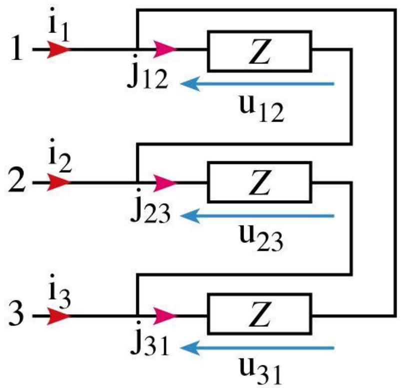


Exercice 1.3

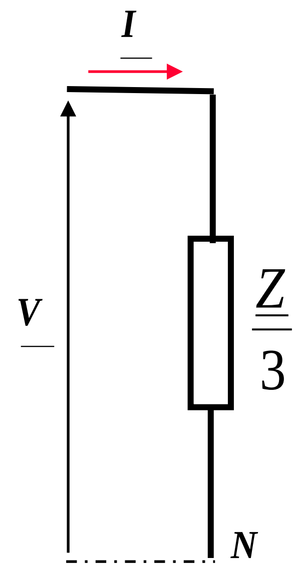
$\underline{Z'} = Z'e^{j\varphi'}$



1. Si le couplage des impédances est en **triangle**

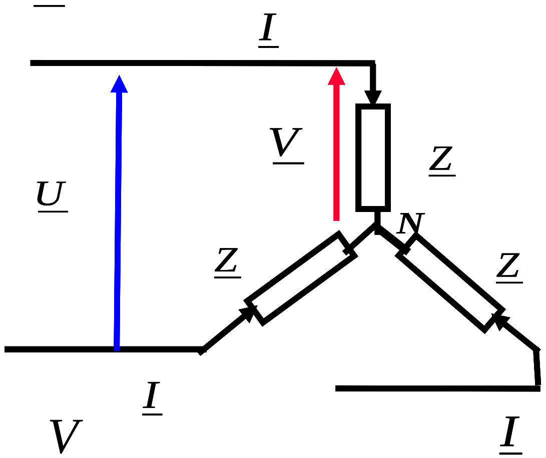


$$\underline{V} = \frac{\underline{Z}}{3} \times \underline{I}$$



Exercice 1.3. On considère le circuit ci-dessous. Calculer la relation entre Z et Z' pour que ces deux charges soient équivalentes

$$\underline{Z} = Ze^{j\varphi}$$



$$I = \frac{V}{Z}$$

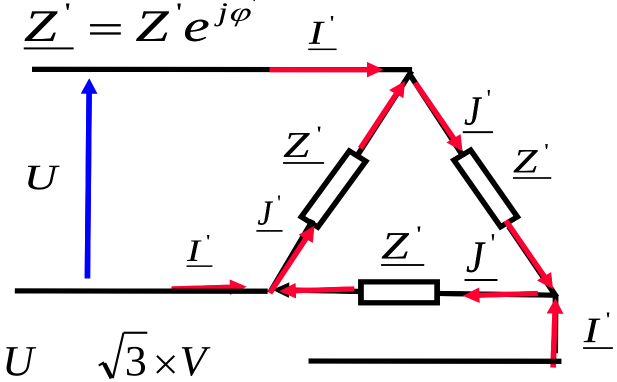
Exercice 1.3

$$\underline{I} = \underline{I}^{'}$$

$$I = I^{'} \rightarrow \frac{V}{Z} = \frac{3V}{Z^{'}}$$

$$Z^{'} = 3Z$$

$$\underline{Z}^{'} = Z^{'}e^{j\varphi^{'}}$$



$$J^{'} = \frac{U}{Z^{'}} = \frac{\sqrt{3} \times V}{Z^{'}}$$

$$I^{'} = J^{'}\sqrt{3}$$

$$I^{'} = \frac{3V}{Z^{'}}$$

;

3- PUISSANCES

L'application de la conservation des puissances actives et réactives permet d'écrire.

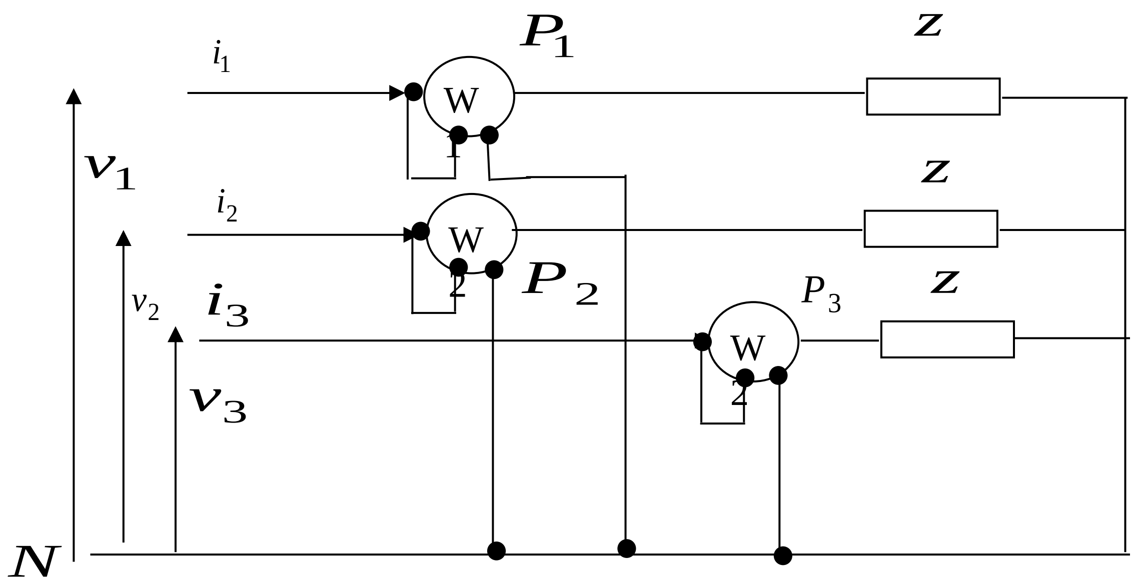
$$P = P_1 + P_2 + P_3 = 3VI\cos\varphi \qquad Q_1 = Q_2 = Q_3 = 3VI\sin\varphi \qquad S = 3VI$$

$$Q = \sqrt{3}UI\sin\varphi \qquad S = \sqrt{3}UI$$

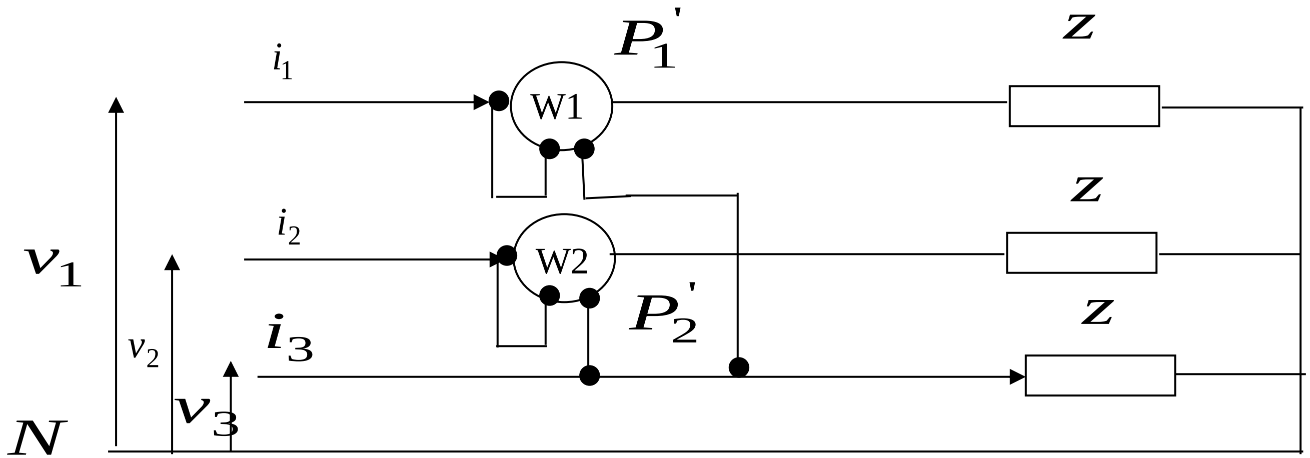
Mesures

$$P = \sqrt{3}UI\cos\varphi$$

La méthode des trois wattmètres



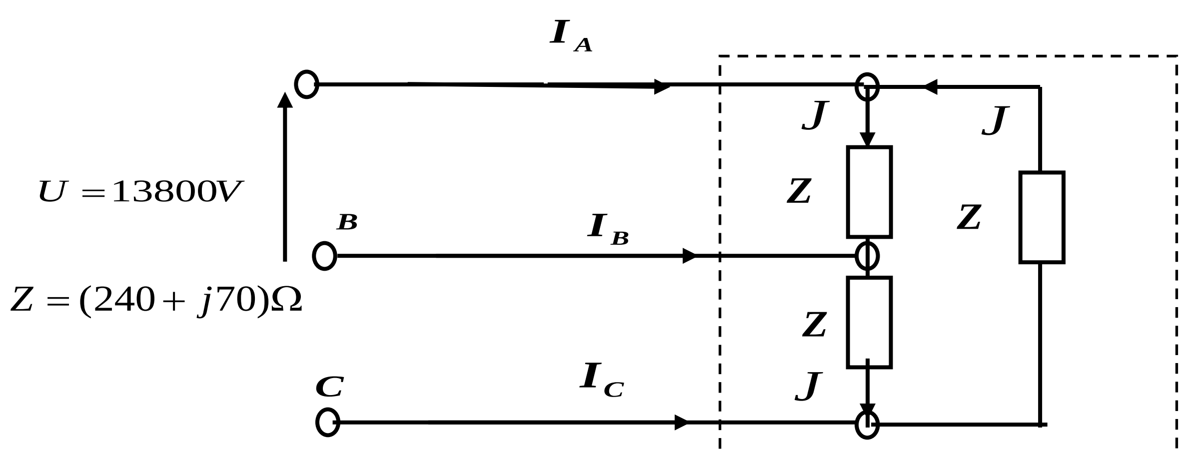
La méthode des deux wattmètres



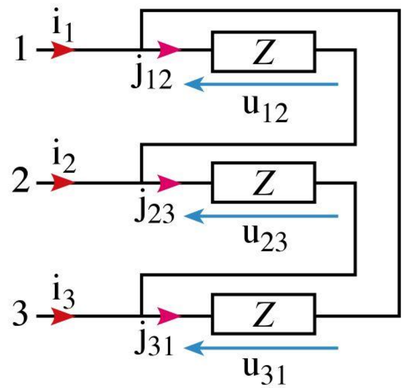
$$P = P_1' + P_2' \qquad Q = \sqrt{3}\left(P_1' - P_2'\right)$$

Exercice 2.3 Donner le schéma monophasé équivalent du circuit triphasé ci-dessus et calculer les puissances P, Q, S consommées par les impédances $\underline{Z} = (240 + j70)\Omega$ *; On donne* $U = 13800V$

Exercice 2.3

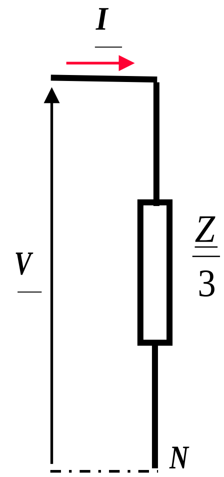


1.



$$V = \frac{Z}{3} \times I$$

$$V = \frac{U}{\sqrt{3}}$$



$$\frac{\underline{Z}}{3} = (80 + j23{,}33)\Omega$$

2.

$$P_m = R \times I^2 = R \times \frac{V^2}{\left(\frac{Z}{3}\right)^2} = 80 \times \frac{\left(\frac{13800}{\sqrt{3}}\right)^2}{80^2 + 23.33^2} = 731299.68W$$

$$Q_m = X \times I^2 = X \times \frac{V^2}{\left(\frac{Z}{3}\right)^2} = 23.33 \times \frac{\left(\frac{13800}{\sqrt{3}}\right)^2}{80^2 + 23.33^2} = 213265.27VAR$$

3.

$$P = 3 \times P_m \cong 2194kW \qquad S = \sqrt{\left(P^2 + Q^2\right)} \cong 2285kVA$$

$$Q = 3 \times Q_m \cong 640kVAR$$

FIN