Université Mohamed Boudiaf–M'sila
Faculté de Technologie

1ère Année Energies Renouvelables & Environnement, **Electricité**
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Exercice 1.

1°/

$$U_{\text{eff}} = 220V, \qquad f = 50Hz,$$
$$I_{\text{eff}} = 150mA, \qquad P = 20W.$$

$$P = U_{\text{eff}}\, I_{\text{eff}}\, cos\varphi \longrightarrow f_p = cos\varphi = \frac{P}{U_{\text{eff}}\, I_{\text{eff}}}$$

$$f_p = cos\varphi = \frac{20}{220 \times 0.15} = \mathbf{0.61}$$

2°/
Ampoule basse consommation:

$$W_{bc} = 3 \times 6 \times 365 \times 0.02 = \mathbf{131.4\ KWh}$$

3°/
Ampoule classique :

$$W_{class} = 3 \times 6 \times 365 \times 0.1 = 657.0\ KWh$$

La différence de consommation est :

$$W_{class} - W_{bc} = 525.6\ KWh$$

Soit :

$$525.6 \times 4 = \mathbf{2102.4\ DA}$$

Exercice 2.

1°/

$$P = U_{\text{eff}}\, I_{\text{eff}}\, cos\varphi = \boldsymbol{I_{\text{eff}}^2\, R}$$

$$Q = U_{\text{eff}}\, I_{\text{eff}}\, sin\varphi = \boldsymbol{I_{\text{eff}}^2\, L\omega}$$

2°/

$$S = \sqrt{P^2 + Q^2} = \boldsymbol{I_{\text{eff}}^2 \sqrt{R^2 + L^2\omega^2}}$$

$$f_P = cos\varphi = \frac{\boldsymbol{R}}{\boldsymbol{\sqrt{R^2 + L^2\omega^2}}}$$

3°/

$$S = U_{\text{eff}}\, I_{\text{eff}} \longrightarrow U_{\text{eff}} = \frac{S}{I_{\text{eff}}} = \boldsymbol{I_{\text{eff}} \sqrt{R^2 + L^2\omega^2}}$$

$$f_P = cos\varphi \longrightarrow \varphi = \boldsymbol{arc(cosf_P)}$$

A.N :

$$P = \mathbf{129.6\ W}, \quad Q = \mathbf{813.89\ VAR}$$
$$S = \mathbf{824.14\ VA}, \quad f_P = \mathbf{0.16}$$
$$U = \mathbf{228.93\ V}, \quad \varphi = \mathbf{81°}.$$

Exercice 3.

1. Expressions des puissances : active (P), réactive (Q) et apparente (S) :

$$\boldsymbol{P = U_{\text{eff}}\, I_{\text{eff}}\, cos\varphi}$$
$$\boldsymbol{Q = U_{\text{eff}}\, I_{\text{eff}}\, sin\varphi}$$
$$\boldsymbol{S = \sqrt{P^2 + Q^2} = U_{\text{eff}}\, I_{\text{eff}}}$$

2. Calcul de P et Q pour chaque élément

Pour les trois lampes : $f_P = cos\varphi = 1 \rightarrow \varphi = 0$

$$P_1 = 3 \times 75 = \mathbf{225\ W}$$
$$Q_1 = 3 \times U_{\text{eff}}\, I_{\text{eff}}\, sin\varphi = \mathbf{0\ VAR}$$

Pour le radiateur : $f_P = cos\varphi = 1 \rightarrow \varphi = 0$

$$P_2 = \mathbf{2000\ W}$$
$$Q_2 = U_{\text{eff}}\, I_{\text{eff}}\, sin\varphi = U_{\text{eff}}\, I_{\text{eff}} \times 0 = \mathbf{0\ VAR}$$

Pour le moteur : $f_P = cos\varphi = 0.80$
$\rightarrow \varphi = 36.89°$

$$P_3 = \mathbf{1500\ W}$$

$$\frac{Q_3}{P_3} = \frac{U_{\text{eff}}\, I_{\text{eff}}\, sin\varphi}{U_{\text{eff}}\, I_{\text{eff}}\, cos\varphi} = tan\varphi$$

$$Q_3 = P_3\, tan\varphi = 1500 \times 0.75 = \mathbf{1125\ VAR}$$

3. Calcul de P et Q pour toute l'installation

$$P_T = \sum_{i=1}^{3} P_i = P_1 + P_2 + P_3 = \mathbf{3725\ W}$$

$$Q_T = \sum_{i=1}^{3} Q_i = Q_1 + Q_2 + Q_3 = \mathbf{1125\ VAR}$$

4. Calcul de f_P pour toute l'installation

$$S = \sqrt{P_T^2 + Q_T^2} = U_{\text{eff}}\, I_{\text{eff}} = \frac{P_T}{cos\varphi} = \frac{P_T}{f_P}$$

$$f_P = \frac{P_T}{\sqrt{P_T^2 + Q_T^2}} = \frac{3725}{\sqrt{3725^2 + 1125^2}}$$

$$f_P = \mathbf{0.96}$$

5. Calcul de l'intensité du courant totale :

$$S = U_{\text{eff}}\, I_{\text{eff}} \longrightarrow I_{\text{eff}} = \frac{S}{U_{\text{eff}}}$$

$$I_{\text{eff}} = \frac{P_T}{f_P\, U_{\text{eff}}} = \frac{3725}{0.96 \times 220} = \mathbf{17.64\ A}$$

Exercice 4.

1.

$$Z^* = Z_R^* + Z_L^* + Z_C^* = R + jL\omega - \frac{1}{C\omega}j$$

$$Z^* = \boldsymbol{R + j\left(L\omega - \frac{1}{C\omega}\right)}$$

2. La réactance représente la partie imaginaire de Z^*, soit :

$$X = Im\{Z^*\} = \boldsymbol{L\omega - \frac{1}{C\omega}}$$

3.

$$P = Re\{Z^*\}\,\boldsymbol{I^2} = R\,\boldsymbol{I^2}$$

$$Q = Im\{Z^*\}\,\boldsymbol{I^2} = \boldsymbol{\left(L\omega - \frac{1}{C\omega}\right)\,I^2}$$

$$S = \sqrt{P^2 + Q^2} = \boldsymbol{I^2\sqrt{R^2 + \left(L\omega - \frac{1}{C\omega}\right)^2}}$$

4.

$u(t)$ et $i(t)$ sont en phase si $X = 0$.

D'où :

$$L\omega - \frac{1}{C\omega} = 0 \longrightarrow \boldsymbol{Q = 0}$$

$$L\omega = \frac{1}{C\omega} \longrightarrow LC\omega^2 = 1 \longrightarrow \omega = \frac{1}{\sqrt{LC}}$$

5.

$$\omega = 2\pi f \longrightarrow f = \boldsymbol{\frac{1}{2\pi\sqrt{LC}}}$$

Exercice 5.

1.

$$\varphi = 0 \longrightarrow P_R = V_{\text{eff}}\,I_{\text{eff}} = I_{\text{eff}}^2\,R = \boldsymbol{\frac{V_{\text{eff}}^2}{R}}$$

$$P_R = \frac{230^2}{1600} = \boldsymbol{33\ W}$$

2.

$$Q_L = \boldsymbol{\frac{V_{\text{eff}}^2}{L\omega}} = \frac{230^2}{1.25 \times 2\pi \times 50} = \boldsymbol{134.7\ VAR}$$

3.

$$S = \sqrt{P_R^2 + Q_L^2} = \boldsymbol{V_{\text{eff}}^2\sqrt{\frac{1}{R^2} + \frac{1}{L^2\omega^2}}}$$

$$S = 230^2\sqrt{\boldsymbol{\frac{1}{1600^2} + \frac{1}{1.25^2 \times 2\pi^2 \times 50^2}}}$$

$$S = \boldsymbol{138.7\ VA}$$

4.

$$S = \sqrt{P_R^2 + Q_L^2} = V_{\text{eff}}\,I_{\text{eff}}$$

$$I_{\text{eff}} = \frac{S}{V_{\text{eff}}} = \frac{138.7}{230} = \boldsymbol{0.60\ A}$$

$$f_P = cos\varphi = \frac{P_R}{\boldsymbol{S}} = \boldsymbol{\frac{33}{138.7}} = \boldsymbol{0.24}$$

5.

$$cos\varphi = \boldsymbol{0.24} \longrightarrow \varphi = \boldsymbol{76.1°}$$

6. Nous avons obtenu :

$$S = \sqrt{P_R^2 + Q_L^2} = \boldsymbol{V_{\text{eff}}^2\sqrt{\frac{1}{R^2} + \frac{1}{L^2\omega^2}}}$$

et sachant que :

$$S = \sqrt{P_R^2 + Q_L^2} = V_{\text{eff}}\,I_{\text{eff}}$$

$$Z = |Z^*| = \frac{V_{\text{eff}}}{I_{\text{eff}}} = \frac{\boldsymbol{V_{\text{eff}}^2}}{S} = \frac{1}{\sqrt{\boldsymbol{\frac{1}{R^2} + \frac{1}{L^2\omega^2}}}}$$

En posant : $X = L\omega$, on obtient :

$$Z = \boldsymbol{\frac{1}{\sqrt{\frac{1}{R^2} + \frac{1}{X^2}}}}$$

$$cos\varphi_{v/i} = \frac{P_R}{S} = \frac{\frac{V_{\text{eff}}^2}{R}}{V_{\text{eff}}^2\sqrt{\frac{1}{R^2} + \frac{1}{L^2\omega^2}}}$$

$$cos\varphi_{v/i} = \boldsymbol{\frac{1}{R\sqrt{\frac{1}{R^2} + \frac{1}{X^2}}}}$$

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