



Sèrie 1

Exercici 1

Q1 b

Q2 b

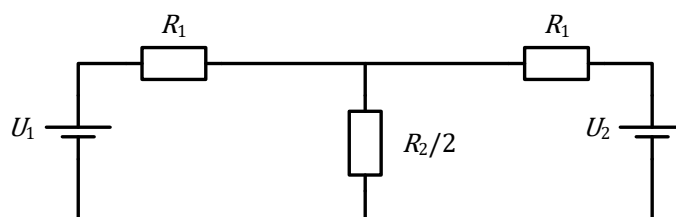
Q3 c

Q4 d

Q5 a

Exercici 2

a)



$$\begin{cases} U_1 = R_1 I_1 + \frac{R_2}{2} (I_1 + I_2) \\ U_2 = R_1 I_2 + \frac{R_2}{2} (I_1 + I_2) \end{cases} \rightarrow \begin{cases} U_1 = \left(R_1 + \frac{R_2}{2}\right) I_1 + \frac{R_2}{2} I_2 \\ U_2 = \frac{R_2}{2} I_1 + \left(R_1 + \frac{R_2}{2}\right) I_2 \end{cases}$$

$$\begin{bmatrix} \left(R_1 + \frac{R_2}{2}\right) & \frac{R_2}{2} \\ \frac{R_2}{2} & \left(R_1 + \frac{R_2}{2}\right) \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} U_1 \\ U_2 \end{bmatrix} \rightarrow \begin{bmatrix} 11 & 5 \\ 5 & 11 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 24 \\ 48 \end{bmatrix}$$

$$\begin{cases} I_1 = 0,25 \text{ A} \\ I_2 = 4,25 \text{ A} \end{cases}$$

$$P_{U1} = U_1 I_1 = 24 \cdot 0,25 = 6 \text{ W}$$

$$P_{U2} = U_2 I_2 = 48 \cdot 4,25 = 204 \text{ W}$$



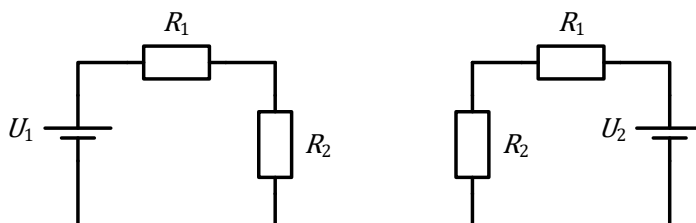
b)

$$P_{R2 \text{ Esquerra}} = P_{R2 \text{ Dreta}} = P_{R2} = \frac{U_{R2}^2}{R_2} = \frac{(U_1 - R_1 I_1)^2}{R_2} = \frac{(24 - 6 \cdot 0,25)^2}{10} = 50,625 \text{ W}$$

Alternativament:

$$P_{R2 \text{ Esquerra}} = P_{R2 \text{ Dreta}} = P_{R2} = \frac{U_{R2}^2}{R_2} = \frac{(U_2 - R_1 I_2)^2}{R_2} = \frac{(48 - 6 \cdot 4,25)^2}{10} = 50,625 \text{ W}$$

c)



$$P_{U1} = \frac{U_1^2}{R_1 + R_2} = \frac{24^2}{6 + 10} = 36 \text{ W}$$

$$P_{U2} = \frac{U_2^2}{R_1 + R_2} = \frac{48^2}{6 + 10} = 144 \text{ W}$$

d)

$$P_{R2 \text{ Esquerra}} = R_2 I_1^2 = R_2 \left(\frac{U_1}{R_1 + R_2} \right)^2 = 10 \left(\frac{24}{6 + 10} \right)^2 = 22,5 \text{ W}$$

$$P_{R2 \text{ Dreta}} = R_2 I_2^2 = R_2 \left(\frac{U_2}{R_1 + R_2} \right)^2 = 10 \left(\frac{48}{6 + 10} \right)^2 = 90 \text{ W}$$



Exercici 3

a)

$$S_a = \frac{U}{\sqrt{3}} I = \frac{400}{\sqrt{3}} 9 = 2078,5 \text{ VA}$$

$$Q_a = X_L I^2 = 5 \cdot 9^2 = 405 \text{ var}$$

$$W_3 = P_a = \sqrt{S_a^2 - Q_a^2} = \sqrt{2078,5^2 - 405^2} = 2038,7 \text{ W}$$

Alternativament:

$$Z = \frac{\frac{U}{\sqrt{3}}}{I} = \frac{\frac{400}{\sqrt{3}}}{9} = 25,66 \Omega$$

$$R = \sqrt{Z^2 - X_L^2} = \sqrt{25,66^2 - 5^2} = 25,17 \Omega$$

$$W_3 = P_a = R I^2 = 25,17 \cdot 9^2 = 2038,8 \text{ W}$$

b)

$$L = \frac{X_L}{\omega} = \frac{X_L}{2 \pi f} = \frac{5}{2 \pi 50} = 15,92 \text{ mH}$$

c)

$$P_a = R I^2 \rightarrow R = \frac{P_a}{I^2} = \frac{2038,7}{9^2} = 25,17 \Omega$$

d)

$$Q_c = Q_a = \frac{\left(\frac{U}{\sqrt{3}}\right)^2}{X_c} \rightarrow X_c = \frac{\left(\frac{U}{\sqrt{3}}\right)^2}{Q_a} = \frac{\left(\frac{400}{\sqrt{3}}\right)^2}{405} = 131,69 \Omega$$

$$X_c = \frac{1}{\omega C} \rightarrow C = \frac{1}{2 \pi f X_c} = \frac{1}{2 \pi 50 \cdot 131,69} = 24,17 \mu\text{F}$$



Exercici 4

a)

$$f = \frac{1}{T} = \frac{1}{6 \text{ div} \cdot 5 \frac{\text{ms}}{\text{div}} \frac{1 \text{ s}}{1000 \text{ ms}}} = 33,33 \text{ Hz}$$

b)

D_1 i D_4 . L'altra possibilitat, tot i que no hi ha l'opció d'escollir-la, seria D_2 i D_3 .

c)

$$U_{R2} = \frac{U_{\text{pic } R2}}{\sqrt{2}} = \frac{4 \text{ div} \frac{10 \text{ V}}{\text{div}}}{\sqrt{2}} = 28,284 \text{ V}$$

En ser les dues resistències iguals,

$$U = U_{R1} + U_{R2} = 2 U_{R2} = 2 \cdot 28,284 = 56,568 \text{ V}$$

d)

$$P = \frac{\frac{U^2}{R_1 + R_2}}{2} = \frac{\frac{56,568^2}{25 + 25}}{2} = 32 \text{ W}$$



Exercici 5

a)

$$\Gamma_N = \frac{P_N}{\omega_N} = \frac{50000}{2860 \cdot \frac{2\pi}{60}} = 166,95 \text{ N m}$$

b)

$$\eta_N(\%) = 100 \frac{P_N}{\sqrt{3} U I \cos \varphi_N} = 100 \frac{50000}{\sqrt{3} \cdot 400 \cdot 90 \cdot 0,85} = 94,34 \%$$

Alternativament:

$$\eta_N(\%) = 100 \frac{P_N}{\sqrt{3} U I \cos \varphi_N} = 100 \frac{50000}{\sqrt{3} \cdot 230 \cdot 156 \cdot 0,85} = 94,65 \%$$

c)

Com que $n_N = 2860 \text{ min}^{-1}$ i $f = 50 \text{ Hz}$, llavors $p = 1$.

d)

$$s(\%) = 100 \frac{n_s - n_N}{n_s} = 100 \frac{3000 - 2860}{3000} = 4,67 \%$$

e)

Agafant cada quadret de la gràfica com una divisió:

$$n = \frac{11,5 \text{ div}}{12 \text{ div}} n_s = \frac{11,5}{12} 3000 = 2875 \text{ min}^{-1}$$

Tot i que no es demana, es pot observar que en ser una velocitat (lleugerament) superior a la nominal, el parell al qual estarà funcionant (el requerit per la càrrega) serà (lleugerament) inferior al nominal.



Exercici 6

a)

$$W = R I^2 \quad \rightarrow \quad I = \sqrt{\frac{W}{R}} = \sqrt{\frac{250}{10}} = 5 \text{ A}$$

b)

$$I = \frac{U}{Z} = \frac{U}{\sqrt{R^2 + X_L^2}} \quad \rightarrow \quad X_L = \sqrt{\left(\frac{U}{I}\right)^2 - R^2} = \sqrt{\left(\frac{100}{5}\right)^2 - 10^2} = 17,32 \, \Omega$$

$$X_L = \omega L \quad \rightarrow \quad L = \frac{X_L}{2 \pi f} = \frac{17,32}{2 \pi 50} = 55,13 \text{ mH}$$

c)

$$Q_C = Q_L = X_L I^2 = 17,32 \cdot 5^2 = 433 \text{ var}$$

$$Q_C = \frac{U^2}{X_C} \quad \rightarrow \quad X_C = \frac{U^2}{Q_C} = \frac{100^2}{433} = 23,09 \, \Omega$$

$$X_C = \frac{1}{\omega C} \quad \rightarrow \quad C = \frac{1}{2 \pi f X_C} = \frac{1}{2 \pi 50 \cdot 23,09} = 137,86 \, \mu\text{F}$$

d)

$$I_C = \frac{U}{X_C} = \frac{100}{23,09} = 4,33 \text{ A}$$

e)

$$W = 250 \text{ W}$$



Sèrie 5

Exercici 1

Q1 d

Q2 c

Q3 b

Q4 c

Q5 a

Exercici 2

a)

$$A_1 = I_1 = \frac{U_1}{R_1 + \frac{R_3 (R_2 + R_4)}{R_2 + R_3 + R_4} + \frac{R_5 R_6}{R_5 + R_6}} = \frac{48}{5 + \frac{10 (5 + 10)}{5 + 10 + 10} + \frac{15 \cdot 15}{15 + 15}} = 2,595 \text{ A}$$

b)

$$P_{U1} = U_1 I_1 = 48 \cdot 2,595 = 124,56 \text{ W}$$

c)

$$W = P_{U1} - P_{R1} = P_{U1} - R_1 I_1^2 = 124,56 - 5 \cdot 2,595^2 = 90,89 \text{ W}$$

d)

$$U_{R3} = \frac{\frac{R_3 (R_2 + R_4)}{R_2 + R_3 + R_4}}{\frac{R_3 (R_2 + R_4)}{R_2 + R_3 + R_4} + \frac{R_5 R_6}{R_5 + R_6}} (U_1 - R_1 I_1)$$
$$U_{R3} = \frac{\frac{10 (5 + 10)}{5 + 10 + 10}}{\frac{10 (5 + 10)}{5 + 10 + 10} + \frac{15 \cdot 15}{15 + 15}} (48 - 5 \cdot 2,595) = 15,57 \text{ V}$$
$$A_2 = I_2 = \frac{U_{R3}}{R_3} = \frac{15,57}{10} = 1,557 \text{ A}$$



e)

$$U_{R6} = (U_1 - R_1 I_1) - U_{R3} = (48 - 5 \cdot 2,595) - 15,57 = 19,46 \text{ V}$$

$$I_{R5} = I_{R6} = \frac{U_{R6}}{R_6} = \frac{19,46}{15} = 1,297 \text{ A}$$

$$A_3 = I_3 = I_2 - I_{R6} = 1,557 - 1,297 = 0,26 \text{ A}$$

Alternativament,

$$I_{R2} = \frac{U_{R3}}{R_2 + R_4} = \frac{15,57}{5 + 10} = 1,038 \text{ A} \quad I_{R2} = I_1 - I_2 = 2,595 - 1,557 = 1,038 \text{ A}$$

$$A_3 = I_3 = I_{R5} - I_{R2} = 1,297 - 1,038 = 0,259 \text{ A}$$

Exercici 3

a)

$$A_n = 0 \text{ A}$$

b)

$$A_3 = \frac{U_{an}}{|Z|} = \frac{\frac{U}{\sqrt{3}}}{\sqrt{R_Z^2 + X^2}} = \frac{\frac{400}{\sqrt{3}}}{\sqrt{5^2 + 15^2}} = 14,61 \text{ A}$$

c)

$$A_2 = \frac{U_{an}}{R} = \frac{\frac{U}{\sqrt{3}}}{R} = \frac{\frac{400}{\sqrt{3}}}{40} = 5,77 \text{ A}$$

d)

$$P_{\text{Total}} = 3 R A_2^2 + 3 R_Z A_3^2 = 3 \cdot 40 \cdot 5,77^2 + 3 \cdot 5 \cdot 14,61^2 = 7,197 \text{ kW}$$

$$Q_{\text{Total}} = 3 X A_3^2 = 3 \cdot 15 \cdot 14,61^2 = 9,605 \text{ kvar}$$

$$S_{\text{Total}} = \sqrt{P_{\text{Total}}^2 + Q_{\text{Total}}^2} = \sqrt{7,197^2 + 9,605^2} = 12,002 \text{ kVA}$$

e)

$$S_{\text{Total}} = \sqrt{3} U I \rightarrow A_1 = I = \frac{S}{\sqrt{3} U} = \frac{12002}{\sqrt{3} \cdot 400} = 17,32 \text{ A}$$



Exercici 4

a)

$$P = \frac{t_{\text{Connectat}}}{T} (P_{\text{N Davantera}} + P_{\text{N Posterior}}) = \frac{0,5 T}{T} (10 + 10) = 10 \text{ W}$$

b)

$$R = \frac{U^2}{P_{\text{N Davantera}}} = \frac{12^2}{10} = 14,4 \Omega$$

c)

$$I_{\text{NL}} = \frac{12 - 5 \cdot U_{\text{ak}}}{R_{\text{NL}}} = \frac{12 - 5 \cdot 1,2}{240} = 25 \text{ mA}$$

d)

$$P_{\text{mitjana NL}} = \frac{t_{\text{Connectat}}}{T} (2 P_{\text{NL}}) = \frac{0,5 T}{T} (2 U I_{\text{NL}}) = 0,5 \cdot 2 \cdot 12 \cdot 0,025 = 0,3 \text{ W}$$

e)

$$P_{\text{mitjana R Consum}} = P - P_{\text{mitjana NL}} = 10 - 0,3 = 9,7 \text{ W}$$

$$R_{\text{Consum}} = \frac{U^2}{P_{\text{mitjana R Consum}}} = \frac{12^2}{9,7} = 14,85 \Omega$$



Exercici 5

a)

$$\Gamma_N = \Gamma_L = 0,0048744 \cdot \omega^2 = 0,0048744 \cdot \left(1750 \frac{2\pi}{60}\right)^2 = 163,7 \text{ N m}$$

b)

$$P_N = \Gamma_N \omega_N = 163,7 \cdot 1750 \frac{2\pi}{60} = 30 \text{ kW}$$

c)

$$E_N = \frac{P_N}{I_N} = \frac{30000}{69} = 434,8 \text{ V} \rightarrow R_i = \frac{U_N - E_N}{I_N} = \frac{500 - 434,8}{69} = 0,945 \Omega$$

d)

$$E' = \frac{n_s}{n_N} E_N = \frac{1200}{1750} 434,8 = 298,15 \text{ V}$$

$$P = \Gamma \omega_V = 0,0048744 \cdot \omega_V^2 \cdot \omega_V = 0,0048744 \left(1200 \frac{2\pi}{60}\right)^3 = 9672,8 \text{ W}$$

$$I = \frac{P}{E'} = \frac{9672,8}{298,15} = 32,44 \text{ A}$$

$$U = R_i I + E' = 0,945 \cdot 32,44 + 298,15 = 328,8 \text{ V}$$



Exercici 6

a)

$$I_R = \frac{U}{R} = \frac{120}{10} = 12 \text{ A}$$

b)

$$W = P_R = R I_R^2 = \frac{U^2}{R} = 10 \cdot 12^2 = \frac{120^2}{10} = 1440 \text{ W}$$

c) En ésser I_R igual a la mesura de l'amperímetre (A), el corrent consumit pel conjunt LC és nul, cosa que indica que estan en ressonància. Per tant,

$$f = \frac{1}{2 \pi \sqrt{L C}} = \frac{1}{2 \pi \sqrt{100 \cdot 10^{-3} \cdot 42 \cdot 10^{-6}}} = 77,66 \text{ Hz}$$

d)

$$X_L = \omega L = 2 \pi f L = 2 \pi 77,66 \cdot 100 \cdot 10^{-3} = 48,8 \Omega$$

$$Q = X_L I_L^2 = \frac{U^2}{X_L} = \frac{120^2}{48,8} = 295,1 \text{ var}$$

e) Com L i C estan en ressonància,

$$P = 1440 \text{ W}$$

$$S = 1440 \text{ VA}$$

$$Q = 0 \text{ var}$$