

**SÈRIE 1****Primera part****Exercici 1**

**Q1** d      **Q2** d      **Q3** b      **Q4** c      **Q5** b

**Exercici 2**

$$a) V_1 = \frac{U}{\sqrt{3}} = \frac{400}{\sqrt{3}} = 230,9 \text{ V}$$

$$b) A_1 = \frac{V_1}{R_1} = \frac{230,9}{20} = 11,55 \text{ A}$$

$$c) A_2 = \frac{V_1}{\sqrt{R_2^2 + X_{L2}^2}} = \frac{230,9}{\sqrt{10^2 + 10^2}} = 16,33 \text{ A}$$

$$d) V_2 = R_2 A_2 = 10 \cdot 16,33 = 163,3 \text{ V}$$

$$e) V_2 = X_{L2} A_2 = 10 \cdot 16,33 = 163,3 \text{ V}$$

**Segona part****OPCIÓ A****Exercici 3**

$$a) p = 3$$

$$b) \Gamma = \frac{P}{\omega} = \frac{90000}{948 \frac{2\pi}{60}} = 906,6 \text{ N m}$$

$$c) \eta_N = 0,9425 = \frac{P_N}{\sqrt{3} U_N I_N \cos \varphi_N} = \frac{90000}{\sqrt{3} \cdot 400 \cdot I_N \cdot 0,85} \rightarrow I_N = \frac{90000}{\sqrt{3} \cdot 400 \cdot 0,9425 \cdot 0,85} = 162,2 \text{ A}$$

$$d) P = \sqrt{3} U_N I_N \cos \varphi_N = \sqrt{3} \cdot 400 \cdot 162,2 \cdot 0,85 = 95,52 \text{ kW}$$

$$Q = \sqrt{3} U_N I_N \sin \varphi = \sqrt{3} \cdot 400 \cdot 162,2 \cdot \sqrt{1 - 0,85^2} = 59,2 \text{ kvar}$$

$$S = \sqrt{3} U_N I_N = \sqrt{3} \cdot 400 \cdot 162,2 = 112,38 \text{ kVA}$$

**Exercici 4**

$$a) R_{34} = \frac{R_3 R_4}{R_3 + R_4} = \frac{10 \cdot 15}{10 + 15} = 6 \Omega$$

$$U_1 = R_1 I_1 + R_{34} (I_1 + I_2) = (R_1 + R_{34}) I_1 + R_{34} I_2$$

$$I_1 = \frac{U_1 - R_{34} I_2}{R_1 + R_{34}} = \frac{48 - 6 \cdot 0,96}{10 + 6} = 2,64 \text{ A}$$

$$b) U_1 - R_1 I_1 = U_2 - R_2 I_2 \quad \rightarrow \quad R_2 = \frac{U_2 - U_1 + R_1 I_1}{I_2} = \frac{36 - 48 + 10 \cdot 2,64}{0,96} = 15 \Omega$$

$$c) P_{\text{Total}} = R_1 I_1^2 + R_2 I_2^2 + R_{34} (I_1 + I_2)^2$$

$$P_{\text{Total}} = 10 \cdot 2,64^2 + 15 \cdot 0,96^2 + 6 \cdot (2,64 + 0,96)^2 = 161,28 \text{ W}$$

Alternativament,

$$P_{\text{Total}} = U_1 I_1 + U_2 I_2 = 48 \cdot 2,64 + 36 \cdot 0,96 = 161,28 \text{ W}$$

**OPCIÓ B****Exercici 3**

$$a) W_1 = R A_1^2 = 500 \text{ W} = 10 A_1^2 \quad \rightarrow \quad A_1 = \sqrt{\frac{500}{10}} = 7,071 \text{ A}$$

$$b) U = Z I = I \sqrt{R^2 + (X_L - X_C)^2} = 7,071 \sqrt{10^2 + (10 - 20)^2} = 100 \text{ V}$$

$$c) Q_{\text{Consumida}} = X I^2 = (X_L - X_C) I^2 = (10 - 20) 7,071^2 = -500 \text{ var}$$

d) En resonància,  $X_L = X_C$  i, per tant,

$$W_1 = R A_1^2 = R \left(\frac{U}{Z}\right)^2 = \frac{U^2}{R} = \frac{100^2}{10} = 1000 \text{ W}$$

$$e) X_C = \frac{1}{\omega C} \quad \rightarrow \quad C = \frac{1}{2 \pi f X_C} = \frac{1}{2 \pi 50 \cdot 20} = 159,15 \mu\text{F}$$

$$X_L = \omega L \quad \rightarrow \quad L = \frac{X_L}{2 \pi f} = \frac{10}{2 \pi 50} = 31,83 \text{ mH}$$

$$f_r = \frac{1}{2 \pi \sqrt{LC}} = \frac{1}{2 \pi \sqrt{31,83 \cdot 10^{-3} \cdot 159,15 \cdot 10^{-6}}} = 70,71 \text{ Hz}$$

## Exercici 4

a)

$$R_{\text{cond.}} = 2 \frac{\Omega}{\text{km}} 0,2 \text{ km} = 0,4 \Omega$$

$$L_{\text{cond.}} = 5 \frac{\text{mH}}{\text{km}} 0,2 \text{ km} = 1 \text{ mH}$$

$$X_{L \text{ cond.}} = \omega L = 2 \pi f L_{\text{cond.}} = 2 \pi 50 \cdot 1 \cdot 10^{-3} = 0,314 \Omega$$

$$U_X = Z_{\text{Eq.}} I_N = \sqrt{(2 R_{\text{cond.}} + R_M)^2 + (2 X_{L \text{ cond.}} + X_M)^2} I_N$$

$$U_X = \sqrt{(2 \cdot 0,4 + 44)^2 + (2 \cdot 0,314 + 13)^2} \cdot 5 = 234,1 \text{ V}$$

b)

$$\Delta U(\%) = \frac{U_X - U_N}{U_N} 100 = \frac{234,1 - 230}{230} 100 = 1,78 \%$$

c)

$$\eta(\%) = 100 \frac{P_{\text{Consumida Motor}}}{P_{\text{Inici Línia}}} = 100 \frac{P_{\text{Consumida Motor}}}{P_{\text{Consumida Motor}} + 2 R I_N^2}$$

$$\eta(\%) = 100 \frac{U_N I_N \cos \varphi_N}{U_N I_N \cos \varphi_N + 2 R I_N^2} = 100 \frac{230 \cdot 5 \cdot 0,96}{230 \cdot 5 \cdot 0,96 + 2 \cdot 0,4 \cdot 5^2} = 98,22 \%$$

**SÈRIE 5****Primera part****Exercici 1**

Q1 a    Q2 b    Q3 c    Q4 c    Q5 b

**Exercici 2**

$$a) V_1 = \left( \sqrt{R_1^2 + X_C^2} \right) A_1 = 1,75 \sqrt{25^2 + 100^2} = 180,4 \text{ V}$$

$$b) W = R_1 A_1^2 + R_2 A_2^2 = 25 \cdot 1,75^2 + R_2 A_2^2 = 76,56 + R_2 A_2^2 = 205 \text{ W}$$

$$A_2 = \frac{V_1}{\sqrt{R_2^2 + X_L^2}} = \frac{180,4}{\sqrt{R_2^2 + 75^2}} \rightarrow A_2^2 = \frac{180,4^2}{R_2^2 + 75^2} \rightarrow 76,56 + R_2 \frac{180,4^2}{R_2^2 + 75^2} = 205$$

$$\frac{180,4^2 R_2}{R_2^2 + 75^2} = 128,44 \rightarrow 128,44 R_2^2 - 32544 R_2 + 722475 = 0$$

$$R_2 = \frac{32544 \pm \sqrt{(-32544)^2 - 4 \cdot 128,44 \cdot 722475}}{2 \cdot 128,44} = \begin{cases} 228,8 \Omega \text{ (No vàlida)} \\ 24,6 \Omega \text{ (Solució buscada)} \end{cases}$$

**OPCIÓ A****Exercici 3**

$$a) W = R A_1^2 = 100 \cdot 1,5^2 = 225 \text{ W}$$

$$b) X_L = \omega L = 2 \pi f L = 2 \pi 50 \cdot 100 \cdot 10^{-3} = 31,42 \Omega$$

$$U = Z A_1 = \left( \sqrt{R^2 + X_L^2} \right) A_1 = 1,5 \sqrt{100^2 + 31,42^2} = 157,2 \text{ V}$$

$$c) W = 225 \text{ W}$$

$$d) U = 157,2 \text{ V}$$

## Exercici 4

$$b) R_{\text{Conductor}} = \rho \frac{L}{S} = 0,01786 \cdot 10^{-6} \cdot \frac{27}{1,5 \cdot 10^{-6}} = 321,48 \text{ m}\Omega$$

$$I = \frac{P}{U \cos \varphi} = \frac{5000}{230 \cdot 1} = 21,74 \text{ A}$$

$$cdt_{\text{Cable}}(\%) = 100 \frac{U_{\text{Cable}}}{U} = 100 \frac{2 R_{\text{Conductor}} I}{U} = 100 \frac{2 \cdot 0,32148 \cdot 21,74}{230} = 6,08 \%$$

c) El cable d'1,5 mm<sup>2</sup> no és adient. Es prova, doncs, el conductor de 2,5 mm<sup>2</sup>:

$$R_{\text{Conductor}} = \rho \frac{L}{S} = 0,01786 \cdot 10^{-6} \cdot \frac{27}{2,5 \cdot 10^{-6}} = 192,9 \text{ m}\Omega$$

$$cdt_{\text{Cable}}(\%) = 100 \frac{U_{\text{Cable}}}{U} = 100 \frac{2 R_{\text{Conductor}} I}{U} = 100 \frac{2 \cdot 0,1929 \cdot 21,74}{230} = 3,65 \%$$

El cable de 2,5 mm<sup>2</sup> és correcte.

$$c) I_{\text{CC}} = \frac{U}{2 R_{\text{Conductor}}} = \frac{230}{2 \cdot 0,1929} = 596 \text{ A}$$

## OPCIÓ B

## Exercici 3

$$a) \eta(\%) = 100 \frac{P}{U_N I_N + \frac{U_{\text{Exc}}^2}{R_{\text{Exc}}}} = 100 \frac{147000}{750 \cdot 216 + \frac{450^2}{52}} = 88,61 \%$$

$$b) \Gamma = \frac{P}{\omega} = \frac{147000}{1161 \frac{2\pi}{60}} = 1209 \text{ Nm}$$

$$c) E = \frac{P}{I} = \frac{147000}{216} = 680,56 \text{ V} \quad R_i I = U - E = 750 - 680,56 = 69,44 \text{ V}$$

$$E' = U' - R_i I = 600 - 69,44 = 530,56 \text{ V}$$

$$n' = n \frac{E'}{E} = 1161 \frac{530,56}{680,56} = 905,1 \text{ min}^{-1}$$

**Exercici 4**

$$\text{a) } I_6 = 0 \rightarrow U_3 = U_2 + R_3 I_3 = 5 + 5 \cdot 1 = 10 \text{ V}$$

$$\text{b) } I_2 = I_3 + I_6 = I_3 = 1 \text{ A} \quad I_5 = I_4 + I_6 = I_4$$

$$R_2 I_2 = R_4 I_4 \rightarrow I_5 = I_4 = \frac{R_2 I_2}{R_4} = \frac{5 \cdot 1}{10} = 0,5 \text{ A}$$

$$I_1 = I_2 + I_4 = 1 + 0,5 = 1,5 \text{ A}$$

$$\text{d) } R_1 = \frac{U_1 - U_2 - R_3 I_3 - R_2 I_2}{I_1} = \frac{24 - 5 - 5 \cdot 1 - 5 \cdot 1}{1,5} = 6 \Omega$$

$$\text{e) } P_{U1} = U_1 I_1 = 24 \cdot 1,5 = 36 \text{ W} \quad P_{U2} = -U_2 I_3 = -5 \cdot 1 = -5 \text{ W}$$

$$P_{U3} = -U_3 I_5 = -10 \cdot 0,5 = -5 \text{ W}$$