MINISTÉRIO DA EDUCAÇÃO
SECRETARIA DE EDUCAÇÃO PROFISSIONAL E TECNOLÓGICA
INSTITUTO FEDERAL DE EDUCAÇÃO, CIÊNCIA E TECNOLOGIA DE SANTA CATARINA
Área de Conhecimento: Eletricidade
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LISTA DE EXERCÍCIOS RESOLVIDOS

Eletricidade em Corrente Alternada

(1) Dados: $I_{cc} = 7,5\,A$ $\quad V_{cc} = 120\,V$

$P_{cc} = P_{cA} \Rightarrow V_{cc} = V_{eficaz}$

$V_{máx} = \sqrt{2} \cdot 120 = 169,71\,V$

$P_{cA} = V_{ef} \cdot I_{ef} = 120 \cdot 7,5 = 900\,W$

(2.1) $v(t) = 50 \cdot \text{sen}(314,16\,t)\ [V]$

$V_{máx} = 50\,V$

$\omega = 314,16\ rad/s$

$f = \frac{\omega}{2\pi} = \frac{314,16}{2 \cdot \pi} = 50\,Hz$

$V_{ef} = \frac{V_{máx}}{\sqrt{2}} = 35,35\,V$

$I_{2ef} = \frac{V_{2ef}}{R_2} = \frac{35,35}{45} = 0,79\,A$

$I_{2máx} = \sqrt{2} \cdot I_{2ef} = 1,11\,A$

$R_{eq} = R_1 // R_2 = \frac{20 \cdot 45}{20+45} = 13,85\,\Omega$

$P_f = \frac{V_{ef}^2}{R_{eq}} = \frac{35,35^2}{13,85} = 90,28\,W$

$I_{fef} = \frac{V_{fef}}{R_{eq}} = \frac{35,35}{13,85} = 2,55\,A$

$I_{1ef} = \frac{V_{1ef}}{R_1} = \frac{35,35}{20} = 1,77\,A$

$I_{1máx} = \sqrt{2} \cdot I_{1ef} = 2,5\,A$

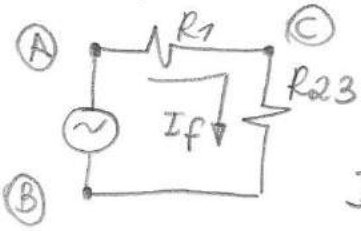
(2.2) $v(t) = 100 \cdot \text{sen}(377 \cdot t)\ [V]$

$V_{máx} = 100\,V$

$V_{fef} = \frac{V_{máx}}{\sqrt{2}} = 70,71\,V$

$\omega = 377\ rad/s$

$f = \frac{\omega}{2\pi} = 60\,Hz$



$R_{23} = \frac{10 \cdot 25}{10+25} = 7,14\,\Omega$

$R_{eq} = 20 + 7,14 = 27,14\,\Omega$

$I_{fef} = \frac{V_{fef}}{R_{eq}} = \frac{70,71}{27,14} = 2,60\,A$

$P_f = V_{fef} \cdot I_{fef} = 70,71 \cdot 2,60 = 184,21\,W$

$V_{CB} = V_2 = V_3 = R_{23} \cdot I_f = 7,14 \cdot 2,60 = 18,61\,V$

$I_{2ef} = \frac{V_{2ef}}{R_2} = \frac{18,61}{10} = 1,86\,A \Rightarrow I_{2máx} = \sqrt{2} \cdot I_{2ef} = 2,63\,A$

$I_{3ef} = \frac{V_{3ef}}{R_3} = \frac{18,61}{25} = 0,74\,A \Rightarrow I_{3máx} = \sqrt{2} \cdot I_{3ef} = 1,05\,A$

$I_{1ef} = I_{fef} = 2,60\,A \Rightarrow I_{1máx} = \sqrt{2} \cdot I_{1ef} = 3,68\,A$

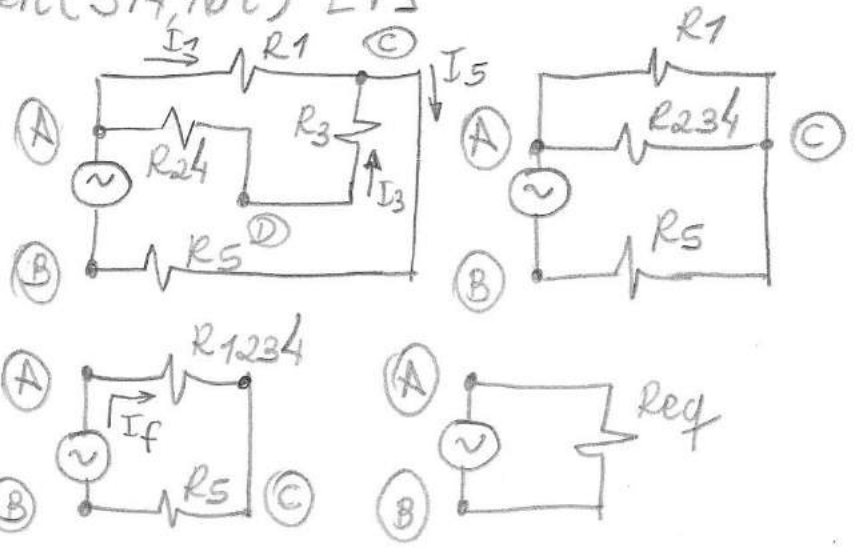
(2.3) $v(t) = 70{,}71 \cdot \operatorname{sen}(314{,}16t)$ [V]

$V_{máx} = 70{,}71\ V$

$V_{ef} = \frac{V_{máx}}{\sqrt{2}} = 50\ V$

$\omega = 314{,}16\ rad/s$

$f = \frac{\omega}{2\pi} = 50\ Hz$



$R_{24} = \frac{3k \cdot 2k}{3k + 2k} = 1{,}2\ k\Omega$

$R_{234} = 1{,}2k + 2k = 3{,}2\ k\Omega$

$R_{1234} = \frac{3{,}2k \cdot 4k}{3{,}2k + 4k} = 1{,}78\ k\Omega$

$Req = 8k + 1{,}78 = 9{,}78\ k\Omega$

$I_{fef} = \frac{V_{fef}}{Req} = \frac{50}{9{,}78k} = 5{,}11\ mA$

$P_f = V_{fef} \cdot I_{fef} = 255{,}68\ mW$

$I_{5ef} = I_{fef} = 5{,}11\ mA$

$I_{5máx} = \sqrt{2} \cdot I_{5ef} = 7{,}23\ mA$

$V_{AC} = R_{1234} \cdot I_f = 1{,}78 \cdot 10^3 \times 5{,}11 \cdot 10^{-3} = 9{,}09\ V \qquad V_{1ef} = V_{AC}$

$I_{1ef} = \frac{V_{1ef}}{R_1} = \frac{9{,}09}{4k} = 2{,}27\ mA \Rightarrow I_{1máx} = \sqrt{2} \cdot I_{1ef} = 3{,}21\ A$

Nó C: $I_1 + I_3 = I_5$

$I_{3ef} = I_{5ef} - I_{1ef} = 5{,}11m - 2{,}27m = 2{,}84\ mA$

$I_{3máx} = \sqrt{2} \cdot I_{3ef}$

$I_{3máx} = 4{,}02\ mA$

$V_{AD} = R_{24} \cdot I_3 = 1{,}2 \cdot 10^3 \times 2{,}84 \cdot 10^{-3} = 3{,}41\ V \qquad V_{2ef} = V_{4ef} = V_{AD}$

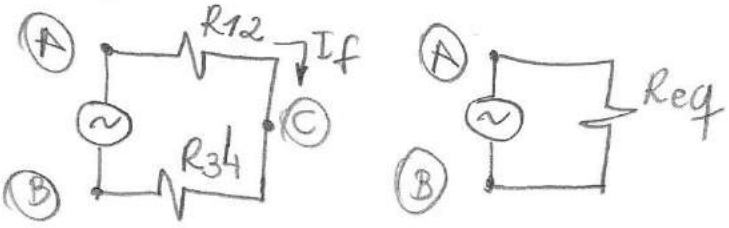
$I_{2ef} = \frac{V_{2ef}}{R_2} = \frac{3{,}41}{3k} = 1{,}14\ mA \Rightarrow I_{2máx} = \sqrt{2} \cdot I_{2ef} = 1{,}61\ mA$

$I_{4ef} = \frac{V_{4ef}}{R_4} = \frac{3{,}41}{2k} = 1{,}70\ mA \Rightarrow I_{4máx} = \sqrt{2} \cdot I_{4ef} = 2{,}41\ mA$

(24) $v(t) = 70,71 \cdot \text{Sen}(314,16t)$ [V]

$V_{máx} = 70,71\ V$ $\Rightarrow$ Resistor R_5 está em curto!

$V_{ef} = \frac{V_{máx}}{\sqrt{2}} = 50V$



$\omega = 314,16\ rad/s$

$f = \frac{\omega}{2\pi} = 50\ Hz$

$R_{12} = \frac{1k \cdot 2k}{1k + 2k} = 0,67\ k\Omega$

$R_{34} = \frac{2k \cdot 4k}{2k + 4k} = 1,33\ k\Omega$

$Req = 0,67k + 1,33k = 2\ k\Omega$

$I_{fef} = \frac{V_{fef}}{Req} = \frac{50}{2k} = 25\ mA$

$P_f = V_{fef} \cdot I_{fef} = 1,25\ W$

$V_{AC} = R_{12} \cdot I_f = 0,67 \cdot 10^3 \times 25 \cdot 10^{-3}$

$V_{AC} = 16,67\ V = V_{1ef} = V_{2ef}$

$I_{1ef} = \frac{V_{1ef}}{R_1} = \frac{16,67}{1k} = 16,67\ mA$

$I_{1máx} = \sqrt{2} \cdot I_{1ef} = 23,57\ mA$

$V_{CB} = R_{34} \cdot I_f = 1,33 \cdot 10^3 \times 25 \cdot 10^{-3}$

$V_{CB} = 33,33\ V = V_3 = V_4$

$I_{2ef} = \frac{V_{2ef}}{R_2} = \frac{16,67}{2k} = 8,33\ mA$

$I_{2máx} = \sqrt{2} \cdot I_{2ef} = 11,78\ mA$

$I_{3ef} = \frac{V_{3ef}}{R_3} = \frac{33,33}{2k} = 16,67\ mA$

$I_{3máx} = \sqrt{2} \cdot I_{3ef} = 23,57\ mA$

$I_{4ef} = \frac{V_{4ef}}{R_4} = \frac{33,33}{4k} = 8,33\ mA$

$I_{4máx} = \sqrt{2} \cdot I_{4ef} = 11,78\ mA$

$V_5 = 0\ V$

$I_5 = 0\ A$

(3) $v(t) = 311,13 \cdot \text{sen}(377t)$ [V] $\quad f = \frac{\omega}{2\pi} = 60\,Hz$

$V_{ef} = \frac{311,13}{\sqrt{2}} = 220\,V \quad \omega = 377\,rad/s$

(3.1) $R = 1\,\Omega \quad I = \frac{V}{Z} = \frac{220}{1} = 220\,A$

$Z = 1\,\Omega \quad P = \frac{V^2}{R} = \frac{220^2}{1} = 48,4\,kW$

$Q = 0 \Rightarrow$ Resistor não armazena energia.

$S = \sqrt{P^2 + Q^2} = 48,4\,kVA$ (Q = 0)

(3.2) $L = 2\,mH$

$X_L = 2 \cdot \pi \cdot f \cdot L = 2 \cdot \pi \cdot 60 \cdot 2 \cdot 10^{-3} = 0,75\,\Omega$

$Z = X_L = 0,75\,\Omega \quad I = \frac{V}{Z} = \frac{220}{0,75} = 291,78\,A$

$P = 0 \Rightarrow$ indutor não dissipa potência ativa

$Q = \frac{V^2}{X} = \frac{220^2}{0,75} = 64,53\,kVAr$

$S = \sqrt{P^2 + Q^2} = 64,53\,kVA$ (P = 0)

(3.3) $C = 2\,mF$

$X_C = \frac{1}{2 \cdot \pi \cdot f \cdot C} = \frac{1}{2 \cdot \pi \cdot 60 \cdot 2 \cdot 10^{-3}} = 1,33\,\Omega$

$Z = X_C = 1,33\,\Omega \quad I = \frac{V}{Z} = \frac{220}{1,33} = 165,88\,A$

$P = 0 \Rightarrow$ capacitor não dissipa pot. ativa

$Q = \frac{V^2}{X} = \frac{220^2}{1,33} = 36,49\,kVAr$

$S = \sqrt{P^2 + Q^2} = 36,49\,kVA$ (P = 0)

(4) Utilizando os valores calculados na questão anterior:

$P_t = P_R + \cancel{P_L}^{0} + \cancel{P_C}^{0} = 48,4\,kW$

$Q_t = \cancel{Q_R}^{0} + Q_L - Q_C = 64,53k - 36,49k = 28,04\,kVAr$

$S_t = \sqrt{P_t^2 + Q_t^2} = 55,93\,kVA \quad I_t = \frac{S_t}{V_f} = \frac{55,93k}{220} = 254,25\,A$

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(5) $V = 220\,V$

$P = 10\,kW$

$\cos\varphi = 0,5$

$S = \frac{P}{\cos\varphi} = \frac{10k}{0,5}$

$S = 20\,kVA$

$I = \frac{S}{V} = \frac{20k}{220} = 90,91\,A$

$\cos\varphi = 1$

$S = \frac{P}{\cos\varphi} = \frac{10k}{1}$

$S = 10\,kVA$

$I = \frac{S}{V} = \frac{10k}{220} = 45,45\,A$

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(6) $V = 220\,V$

$\cos\varphi = 0,92$

$I = 0,72$

$S = V \cdot I = 220 \cdot 0,72 = 158,4\,VA$

$P = S \cdot \cos\varphi = 158,4 \cdot 0,92 = 145,73\,W$

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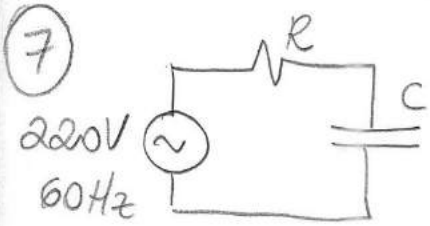
(7)



$P = 1.200\,W \quad \cos\varphi = 0,8$

$S = \frac{P}{\cos\varphi} = \frac{1.200}{0,8} = 1.500\,VA$

$S = V \cdot I \Rightarrow I = \frac{S}{V} = \frac{1500}{220} = 6,82\,A$

$Q = \sqrt{S^2 - P^2} = 900\,VAr$ circuito série!

$R = \frac{P}{I^2} = \frac{1.200}{6,82^2} = 25,80\,\Omega$

$X_C = \frac{Q_C}{I^2} = \frac{900}{6,82^2} = 19,35\,\Omega$

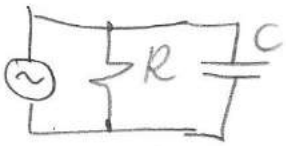
$X_C = \frac{1}{2 \cdot \pi \cdot f \cdot C} \Rightarrow C = \frac{1}{2\pi \cdot f \cdot X_C} = \frac{1}{2 \cdot \pi \cdot 60 \cdot 19,35} = 137\,\mu F$

(8) $V = 220V$
$f = 60Hz$
$P = 560\ W$
$\cos\varphi = 0,85$

$$S = \frac{P}{\cos\varphi} = \frac{560}{0,85} = 658,82\ VA$$

$$I = \frac{S}{V} = \frac{658,82}{220} = 2,99\ A$$

$$Q = \sqrt{S^2 - P^2} = 347,06\ VAr$$



$$R = \frac{V^2}{P} = \frac{220^2}{560} = 86,43\ \Omega$$

$$X_C = \frac{V^2}{Q} = \frac{220^2}{347,06} = 139,46\ \Omega$$

$$C = \frac{1}{2 \cdot \pi \cdot f \cdot X_C} = \frac{1}{2 \cdot \pi \cdot 60 \cdot 139,46} = 19,02\ \mu F$$

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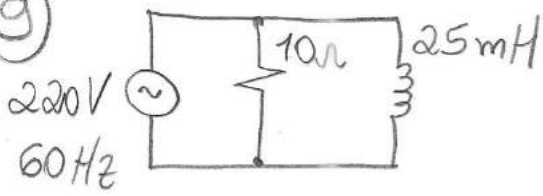
(9)



$$P = \frac{V^2}{R} = \frac{220^2}{10} = 4.840\ W$$

$$X_L = 2 \cdot \pi \cdot f \cdot L = 2 \cdot \pi \cdot 60 \cdot 25 \cdot 10^{-3} = 9,42\ \Omega$$

$$Q = \frac{V^2}{X_L} = \frac{220^2}{9,42} = 5.135,40\ VAr$$

$$S = \sqrt{P^2 + Q^2}$$

$$S = 7.056,76\ VA$$

$$I = \frac{S}{V} = \frac{7.056,76}{220} = 32,08\ A$$

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(10) $S = 15\ kVA$
$\cos\varphi = 0,85$
R$ 0,35 kWh

$$P = S \cdot \cos\varphi = 15k \cdot 0,85 = 12,75\ kW$$

$$E = P \cdot t = 12,75 \cdot 24h \cdot 30d = 9.180\ kWh$$

$$Custo = E \cdot tarifa = 9.180 \cdot 0,35 \Rightarrow R\$\ 3.213,00$$

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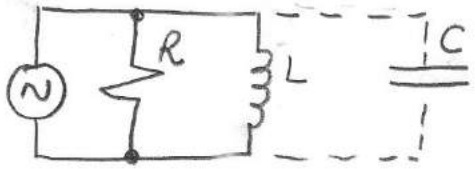
(11) $V = 220V$
$I = 55\ A$
$P = 10\ kW$

$$S = V \cdot I = 220 \cdot 55 = 12,1\ kVA$$

$$\cos\varphi = \frac{P}{S} = \frac{10k}{12,1k} = 0,83$$

(12)



$V = 220\ V$ $\quad S = 300\ VA$

$f = 60\ Hz$ $\quad \cos\varphi = 0{,}8\ ind$

$\cos\varphi = 1 \Rightarrow Q_L = Q_C \Rightarrow X_L = X_C$

Circuito RL: $P = S \cdot \cos\varphi = 300 \cdot 0{,}8 = 240\ W$

$Q = \sqrt{S^2 - P^2} = 180\ VAr$

$X_L = \frac{V^2}{Q_L} = \frac{220^2}{180} = 268{,}89\ \Omega \quad X_L = X_C$

$C = \frac{1}{2 \cdot \pi \cdot f \cdot X_C} = \frac{1}{2 \cdot \pi \cdot 60 \cdot 268{,}89} = 9{,}86\ \mu F$

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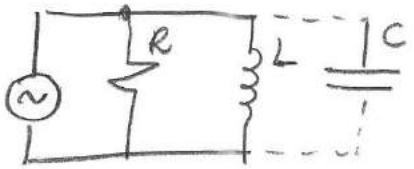
(13)



$V = 115\ V$ $\quad \cos\varphi = 0{,}8\ ind.$

$f = 60\ Hz$ $\quad C = ? \Rightarrow \cos\varphi = 0{,}92\ ind.$

$P = 3\ kW$

Circuito RL:

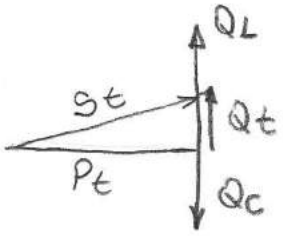
$S_L = \frac{P}{\cos\varphi} = \frac{3k}{0{,}8} = 3{,}75\ kVA$

$Q_L = \sqrt{S^2 - P^2} = 2{,}25\ kVAr$

Circuito RLC

$S_t = \frac{P}{\cos\varphi} = \frac{3k}{0{,}92} = 3{,}26\ kVA$

$Q_t = \sqrt{S^2 - P^2} = 1{,}28\ kVAr$



$Q_t = Q_L - Q_C$

$Q_C = Q_L - Q_t$

$Q_C = 2{,}25k - 1{,}88k$

$Q_C = 972\ VAr$

$X_C = \frac{V^2}{Q_C} = \frac{115^2}{972}$

$X_C = 13{,}60\ \Omega$

$C = \frac{1}{2\pi \cdot f \cdot X_C} = \frac{1}{2\pi \cdot 60 \cdot 13{,}60}$

$C = 194{,}96\ \mu F$