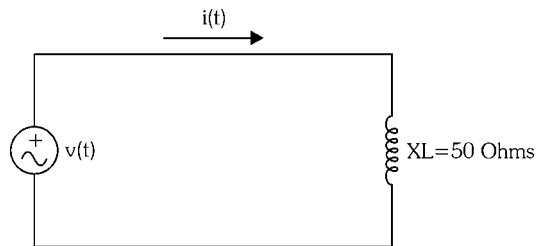


## Capítulo 4

4.1 - Dados: bobina ideal com  $X_L = 50 \Omega$  e  $v(t) = 20 \cdot \text{sen}(5 \cdot 10^2 \cdot t + 90^\circ) \text{ (V)}$



a)  $v = 20 \underline{90^\circ} \text{ (V}_P\text{)}$   $X_L = 50 \underline{90^\circ} \text{ (}\Omega\text{)}$

$$I = V/X_L = (20 \underline{90^\circ}) / (50 \underline{90^\circ}) = 0,4 \underline{0^\circ} \text{ (A}_P\text{)}$$

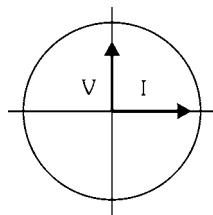
Logo:  $i(t) = 0,4 \cdot \text{sen}(5 \cdot 10^2 \cdot t) \text{ (A)}$

b)  $V_{RMS} = (20V) / (\sqrt{2}) = 14,14V$

$I_{RMS} = (0,4A) / (\sqrt{2}) = 0,28A$

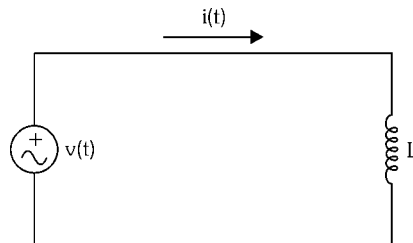
c)  $X_L = \omega \cdot L$  como  $\omega = 500 \text{rd/s}$   $\Rightarrow L = (50 \Omega) / (500 \text{rd/s}) = 0,1 \text{H} = 100 \text{mH}$

d)



4.2 - Dados  $i(t) = 100 \cdot \text{sen}(10^3 \cdot t + 45^\circ) \text{ (mA)}$

e  $X_L = 250 \underline{90^\circ} \text{ (}\Omega\text{)}$



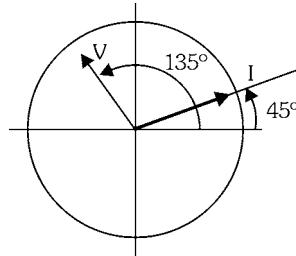
a)  $I = 100 \angle 45^\circ \text{ (mA}_P) = 0,1 \angle 45^\circ \text{ (mA}_P)$

$v = X_L \cdot I = 250 \angle 90^\circ \cdot 0,1 \angle 45^\circ = 25 \angle 135^\circ \text{ (V}_P)$

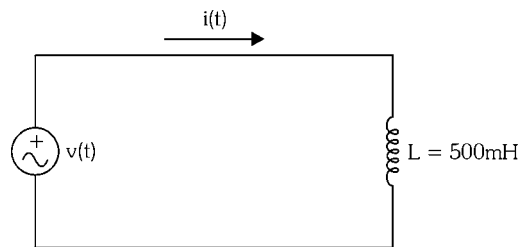
$v(t) = 25 \cdot \text{sen}(10^3 \cdot t + 135^\circ) \text{ (V)}$

b)  $V_{RMS} = (25V) / (\sqrt{2}) = 17,7V$  e  $I_{RMS} = (100\text{mA}) / (\sqrt{2}) = 70,7\text{mA}$

c)



4.3 - Dado o circuito e  $v(t) = 20 \cdot \text{sen}(10^4 \cdot t - 90^\circ) \text{ (V)} = 20 \angle -90^\circ \text{ (V}_P)$



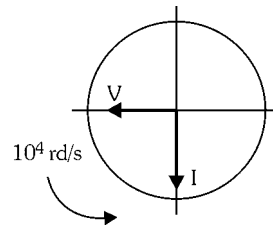
a)  $X_L = \omega \cdot L = 10^4 \cdot 0,5 = 5000\Omega = 5\text{k}\Omega = 5 \angle 90^\circ \text{ (k}\Omega)$

$I = U/X_L = (20 \angle -90^\circ) / (5 \angle 90^\circ) = 4 \angle -180^\circ \text{ (mA}_P)$  e  $i(t) = 4 \cdot \text{sen}(10^4 \cdot t - 180^\circ) \text{ (mA)}$

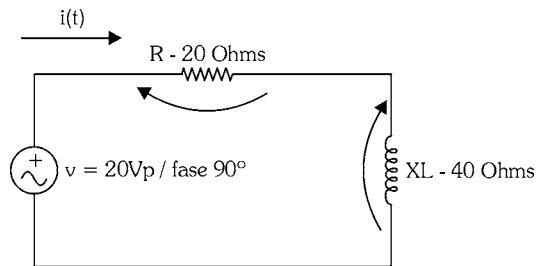
b)  $V_{RMS} = (20V) / \sqrt{2} = 14,14V$  e  $I_{RMS} = (4\text{mA}) / (\sqrt{2}) = 2,8\text{mA}$

c)  $X_L = 5\text{k}\Omega$

d)



4.4 - Dado o circuito



a)  $Z = R + j\omega L = 20 + j40 (\Omega)$  ou  $Z = 44,7 \angle 63,4^\circ (\Omega)$

$$|Z| = \sqrt{20^2 + 40^2} = 44,7 \quad \text{tg } \phi = (40/20) = 2 \quad \phi = 26,6^\circ$$

b)  $L = XL/\omega = 40 / 377 = 106\text{mH}$

c)  $I = U/Z = (20 \angle 90^\circ) / (44,7 \angle 63,4^\circ) = 0,447 \angle 26,6^\circ (\text{A}_p)$

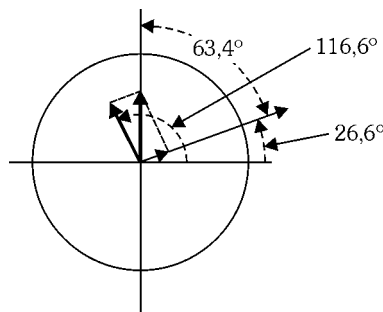
portanto:  $i(t) = 0,447 \cdot \text{sen}(377 \cdot t + 26,6^\circ) (\text{A})$

$$I_{\text{RMS}} = 0,447 / \sqrt{2} = 0,316\text{A}$$

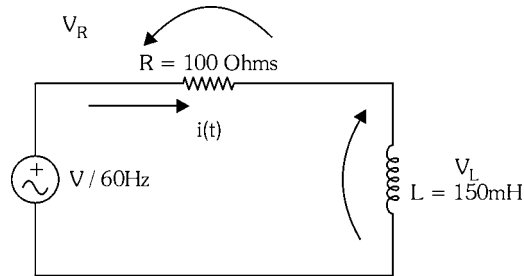
d)  $V_R = R \cdot I = 20 \angle 0^\circ \cdot 0,447 \angle 26,6^\circ = 8,94 \angle 26,6^\circ (\text{V})$

$$V_L = XL \cdot I = 40 \angle 90^\circ \cdot 0,447 \angle 26,6^\circ (\text{V}) = 17,9 \angle 116,6^\circ (\text{V})$$

e)



4.5 - Dado o circuito e  $v_R(t) = 10 \cdot \text{sen}(\omega \cdot t - 30^\circ)$  (V). Calcular:



a)  $V_R = 10 \angle -30^\circ$  (V<sub>P</sub>)     $\omega = 2 \cdot \pi \cdot 60 = 377 \text{ rad/s}$

$I = V_R / R = (10 \angle -30^\circ) / (100 \angle 0^\circ) = 0,1 \angle -30^\circ$  (A<sub>P</sub>)     $I_{\text{RMS}} = 70,7 \text{ mA}$

Logo:  $i(t) = 0,1 \cdot \text{sen}(377 \cdot t - 30^\circ)$  (A)

$X_L = \omega \cdot L = 377 \cdot 0,15 = 56,5 \Omega = 56,5 \angle 90^\circ$  (Ω) e portanto

$Z = R + j\omega \cdot L$  com  $|Z| = \sqrt{100^2 + 56,6^2} = 114,8 \Omega$  e fase

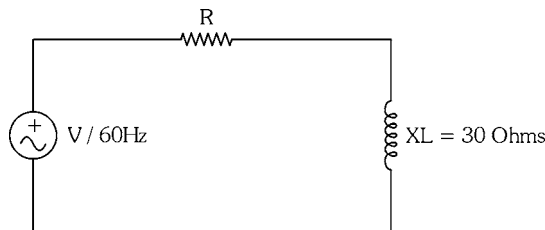
$\text{tg} \phi = 56,5 / 100 = 0,565$      $\phi = 29,5^\circ$

$Z = 114,8 \angle 29,5^\circ$  (Ω) e como  $v = Z \cdot I$  resulta:

$V = 114,8 \angle 29,5^\circ \cdot 0,1 \angle -30^\circ = 11,5 \angle -0,5^\circ$  (V<sub>P</sub>)

e  $v(t) = 11,5 \cdot \text{sen}(377 \cdot t - 0,5^\circ)$  (V)

4.6 - Dado o circuito e  $V = 42,4 \angle 0^\circ$  (V<sub>RMS</sub>)     $V_L = 30 \angle 45^\circ$  (V<sub>RMS</sub>)



a) Calcular Z,  $I = V_L / X_L = (30 \angle 45^\circ) / (30 \angle 90^\circ) = 1 \angle -45^\circ$  (A<sub>RMS</sub>)

sabemos que  $|V| = \sqrt{V_R^2 + V_L^2}$ , isto é,  $42,4 = \sqrt{V_R^2 + 30^2}$  então tiramos que:

$V_R = \sqrt{42,4^2 - 30^2} = 30 \text{ V}$  e  $V_R = 30 \angle -45^\circ$  (V<sub>RMS</sub>) e portanto

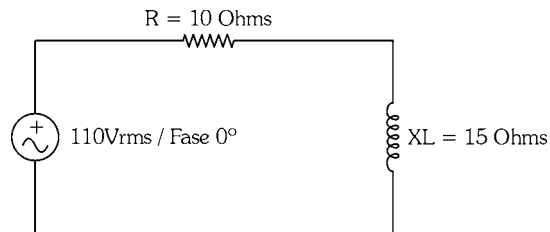
$$Z = U/I = (42,4 \angle 0^\circ) / (1 \angle -45^\circ) = 42,4 \angle 45^\circ (\Omega) = 30 + j30 (\Omega)$$

b) Como  $R = VR / I = (30 \angle -45^\circ) / (1 \angle -45^\circ) = 30 \angle 0^\circ (\Omega)$

$$R = 30 \Omega$$

$$L = 79,5\text{mH}$$

4.7 - Dado o circuito, calcular:



a) Calcular  $\phi$  (defasagem entre U e I)

Cálculo da impedância do circuito:  $Z = R + jXL = 10 + j15 (\Omega)$

$$|Z| = \sqrt{10^2 + 15^2} = 18\Omega \quad \text{tg}\phi = 15/10 = 1,5 \Rightarrow \phi = 56,3^\circ$$

Portanto,  $Z = 18 \angle 56,3^\circ \Rightarrow I = U/Z = (110 \angle 0^\circ) / (18 \angle 56,3^\circ) = 6,1 \angle -56,3^\circ (\text{A}_{\text{RMS}})$

Portanto, a defasagem entre U e I é  $\phi = 56,3^\circ$

$$L = 39,8\text{mH}$$

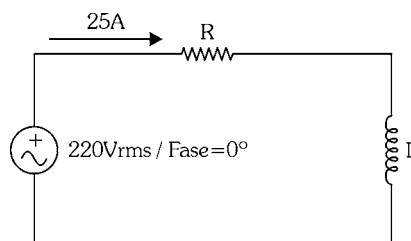
b)  $\text{Cos}\phi = \cos 56,3^\circ = 0,55$

c)  $P = V \cdot I \cdot \text{Cos}\phi = 110 \cdot 6,1 \cdot 0,55 = 369\text{W}$

$$P_R = V \cdot I \cdot \text{sen}\phi = 110 \cdot 6,1 \cdot 0,83 = 558\text{VAR}$$

$$P_{\text{Ap}} = V \cdot I = 110 \cdot 6,1 = 671\text{V}$$

4.8 - Dados do circuito  $I = 25\text{A}$   $f = 60\text{Hz}$   $\text{FP} = \cos\phi = 0,75$   $V = 220 \angle 0^\circ (\text{V}_{\text{RMS}})$ .



a)  $P_{AP} = V.I = 220.25 = 5500VA = 5,5KVA$

$P = V.I.\cos\phi = 220.25.0,75 = 4125W$

$P_R = V.I.\sen\phi = 220.25.0,66 = 3637VAR$

b)  $P_R = V_L.I = XL.I^2 \Rightarrow XL = 3637/(25)^2 = 5,81 \Omega$ , portanto  $L = 5,81/377 = 15,4mH$

e como  $P = R.I^2 \Rightarrow R = 4125W / 25^2 = 6,6 \Omega$

4.9 - Dados de uma instalação:  $P = 5KW$   $P_R = 3KVAR$   $U = 220 V_{RMS}$

a)  $F.P = \cos\phi = P / P_{AP}$  e  $P_{AP} = \sqrt{P^2 + P_R^2} = \sqrt{5^2 + 3^2} = 5,83KVA$

$FP = P/P_{AP} = 5KW / 5,83KVA = 0,857$

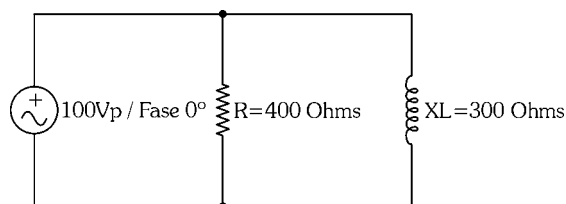
$L = 11,33mH$

$R = 7.12\Omega$

b) Como  $P_{AP} = U.I$ , então  $I = P_{AP} / U = 5830 / 220 = 26,5A$

## Circuito Paralelo

4.10 - Dado o circuito, calcular:



a) Impedância complexa (Z)

$Z = (XL.R) / (\sqrt{R^2 + X_L^2}) = (300.400) / (\sqrt{400^2 + 300^2}) = 240 \Omega$

$\phi = 90^\circ - \arctg(XL/R)$  ou  $\phi = \arctg(R/XL)$   $\phi = \arctg(400/300) = 53,1^\circ$

logo  $Z = 240 \angle 53,1^\circ (\Omega)$  ou  $Z = 144,1 + j192 (\Omega)$

b)  $I = U/Z = (100 \angle 0^\circ) / (240 \angle 53,1^\circ) = 0,416 \angle -53,1^\circ (A_P)$

logo:  $i(t) = 0,416 \cdot \text{sen}(377 \cdot t - 53,1^\circ) (A)$   $I_{RMS} = 294 \text{mA}$

$I_R = V_R / R = (100 \angle 0^\circ) / (400 \angle 0^\circ) = 0,25 \angle 0^\circ (A_P)$

Logo:  $i_R(t) = 0,25 \cdot \text{sen}(377 \cdot t) (A)$   $I_{Rms} = 176,7 \text{mA}$

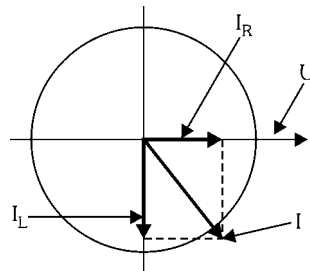
$I_L = V_L / X_L = (100 \angle 0^\circ) / (300 \angle 90^\circ) = 0,333 \angle -90^\circ (A_P)$

Logo:  $i_L(t) = 0,333 \cdot \text{sen}(377 \cdot t - 90^\circ) (A)$   $I_{Lrms} = 235,4 \text{mA}$

c) Como  $X_L = 300 \Omega = 377 \cdot L \Rightarrow L = 300/377 = 0,795 \text{H} = 795 \text{mH}$

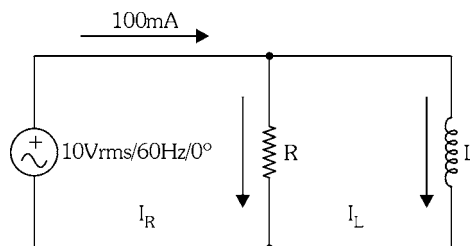
d)  $FP = \cos \phi = \cos 53,1^\circ = 0,6$   $P = 70,7 \cdot 0,29 \cdot 0,6 = 12,48 \text{W}$

e)



4.11 - De um circuito RL paralelo são fornecidas: defasagem entre U e I  $30^\circ$ ,

$U = 10 V_{RMS}$   $I_{RMS} = 100 \text{mA}$ , fase da tensão  $0^\circ$  e frequência  $60 \text{Hz}$ .



a)  $U = 10 \angle 0^\circ (V_{RMS})$  como a defasagem entre a tensão e a corrente é  $30^\circ$  e

o circuito é indutivo, podemos escrever  $I = 100 \angle -30^\circ (\text{mA}_{RMS})$ ,

$$i(t) = 100 \cdot \sqrt{2} \cdot \text{sen}(377 \cdot t - 30^\circ) \text{ (mA)}$$

portanto a impedância será dada por:

$$Z = U/I = (10 \angle 0^\circ) / (100 \angle -30^\circ) = 0,1 \angle 30^\circ \text{ (K}\Omega) = 100 \angle 30^\circ \text{ (}\Omega)$$

Mas  $\cos\phi = Z/R$  (veja página 91 livro Análise de Circuitos em Corrente Alternada) e como

$$\phi = 30^\circ \Rightarrow \cos\phi \ 30^\circ = 0,866 \text{ portanto } R = 100/0,86 = 116,27 \ \Omega$$

$$\text{Então } I_R = U/R = (10 \angle 0^\circ) / (116,27 \angle 0^\circ) = 86 \angle 0^\circ \text{ (mA}_{\text{RMS}})$$

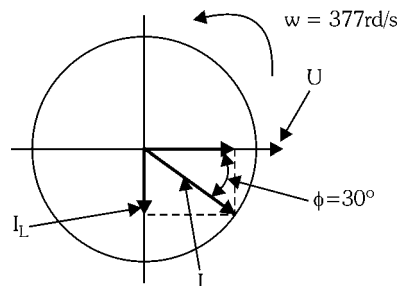
$$\text{Sabemos que } I^2 = I_R^2 + I_L^2, \text{ portanto } I_L = \sqrt{100^2 - 86^2} = 51 \text{ mA}_{\text{RMS}}$$

$$\text{Portanto: } i_L(t) = 51 \cdot \sqrt{2} \cdot \text{sen}(377 \cdot t - 90^\circ) \text{ (mA)}$$

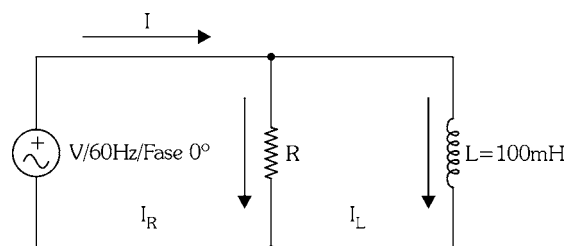
b)  $Z = 100 \angle 30^\circ \text{ (}\Omega)$      $R = 116,27 \ \Omega$

$$X_L = U/I_L = (10 \angle 0^\circ) / (51 \angle -90^\circ) = 196 \ \Omega \Rightarrow L = 196 / 377 = 520 \text{ mH}$$

c) Diagrama Fasorial



4.12 - Dado o circuito e  $I = 3,6 \angle -30^\circ \text{ (A}_{\text{RMS}})$



a) Se a fase inicial da tensão é nula e a fase da corrente é  $-30^\circ$ , significa que a defasagem ( $\phi$ ) entre a tensão e a corrente total é  $30^\circ$  e como:

$$\text{tg } \phi = R/X_L \Rightarrow \text{tg}30^\circ = 0,577 = R/X_L \quad R = X_L \cdot 0,577 \quad \text{e}$$

$$X_L = 2 \cdot \pi \cdot 60 \text{ Hz} \cdot 0,1 \text{ H} = 37,7 \ \Omega \Rightarrow R = 37,7 \cdot 0,577 = 21,8 \ \Omega$$



$$Z = (XL.R) / (\sqrt{R^2 + X_L^2}) = (37,7 \cdot 21,8) / \sqrt{21,8^2 + 37,7^2} = 18,87 \Omega$$

$$V = Z \cdot I = 18,87 \cdot 3,6 = 68 \text{ V}_{\text{RMS}}$$

$$V = 68 \angle 0^\circ \text{ (V}_{\text{RMS}})$$

b)  $P_{\text{AP}} = 68 \cdot 3,6 = 245 \text{ VA}$

$$P = V \cdot I \cdot \cos \phi = 245 \cdot 0,86 = 212 \text{ W}$$

$$P_{\text{R}} = V \cdot I \cdot \sin \phi = 245 \cdot 0,5 = 122,5 \text{ VAR}$$

$$I_{\text{Rms}} = 212 \text{ W} / 68 \text{ V} = 3,11 \text{ A}$$

c)  $\text{FP} = \cos \phi = 0,86$

$$I_{\text{LRMS}} = 122,5 \text{ VA} / 68 \text{ V} = 1,8 \text{ A}$$

d) Diagrama Fasorial: é igual ao do exercício anterior