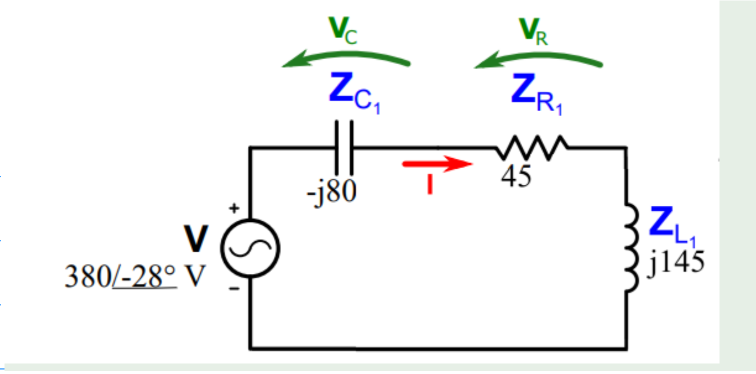


↳ Potência Complexa S, Reativa (Q) e Ativa (P)

$$S = P + jQ$$

$$Z_T = Z_L + Z_C + Z_R \rightarrow Z_R = R$$

$$Z_T = \quad \hookrightarrow Z_L = j\omega L \quad \hookrightarrow Z_C = -j\frac{1}{\omega C}$$

$$P = R \cdot i^2$$

$$P = 45 \cdot 4{,}807^2 / 2$$

$$P = 519{,}9 \text{ W}$$

$$Z_t = j145 + 45 + (-j80)$$

$$Z_t = 45 + j65$$

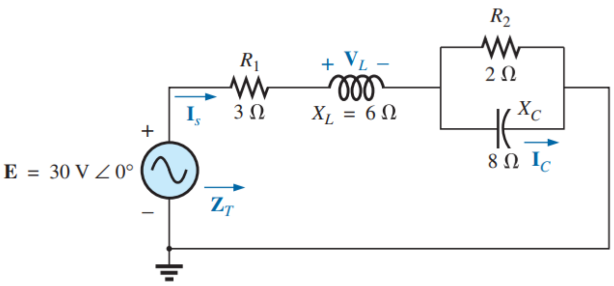
$$Z_t = 79{,}05 \angle 55{,}30°$$

$$fp = \cos(55{,}30) = 0{,}569$$

$$Q = 65 \cdot 4{,}807^2 / 2$$

$$Q = 750{,}98 \text{ VAR}$$

$$i = \frac{V}{Z_t} = \frac{380 \angle -28}{79{,}05 \angle 55{,}30°} = \underbrace{4{,}807 \angle -83{,}3°}_{i}$$



$V = R\,i$

$V = 8\angle 90° \cdot 4{,}0672 \angle -48{,}55°$

$V_C = 32{,}53 \angle -138{,}55°$

$Z_{R_1} = 3 + 0J$ ou $3\angle 0°$

$Z_L = 0 + 6J$ ou $6\angle 90°$

$Z_{R_2} = 2 + 0J$ ou $2\angle 0°$

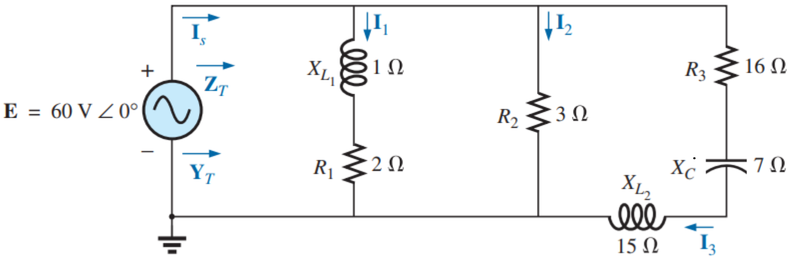
$Z_C = 0 - 8J$ ou $8\angle -90°$

$$Z_{Total} = \left(\frac{1}{\frac{1}{2} + \frac{1}{-8J}} \right) + 6J + 3$$

$Z_{total} = 4{,}882 + 5{,}52J$

$$I_S = \frac{V}{Z_{Total}} = \frac{30V\angle 0°}{7{,}376\angle 48{,}55°} = 4{,}0672\angle -48{,}55°$$

$$I_C = \frac{V_C}{Z_C} = \frac{32{,}537\angle -138{,}55°}{8\angle -90°} = 0{,}5084\angle -48{,}55°$$



a) $Z_T = \dfrac{1}{\dfrac{1}{1j+2} + \dfrac{1}{3} + \dfrac{1}{16+8j}} = 1{,}2269 \angle 16{,}025^\circ$

$Y_T = \dfrac{1}{Z_T} = 0{,}81 \angle -16{,}025$

b) $i_1 = \dfrac{V}{Z_{LR_1}} = \dfrac{60 \angle 0^\circ}{(1\angle 90^\circ + 2\angle 0)} = 26{,}83 \angle -26{,}56$

$i_2 = \dfrac{V}{Z_{R_2}} = \dfrac{60 \angle 0^\circ}{3 \angle 0^\circ} = 20 \angle 0^\circ$

$i_3 = \dfrac{V}{Z_{L_2R_3}} = \dfrac{60 \angle 0^\circ}{\;} = 3{,}3541 \angle -26{,}56^\circ$

$I_s = i_1 + I_2 + I_3 =$

$f_p = \cos(16{,}025^\circ) = 0{,}9611$ atrasado
indutivo

Cálculos de potência e impedância

A primeira figura mostra uma carga de impedância **Z** alimentada por uma fonte de corrente $i_s = 4\cos(5t - 35°)$ A. A fonte fornece à carga uma potência 20 - j20 VA. **(a)** determine a impedância da carga, **Z**; **(b)** Sabendo que a carga é composta por uma associação **em paralelo** de dois elementos (Figura 2 ou Figura 3), determine os valores dos dois componentes.

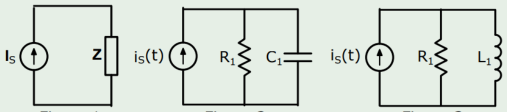


Figura 1 Figura 2 Figura 3

$i = 4 \angle 35°$

a) $i_s = 4\cos(5t - 35°)$

$S = 20 - j20$ VA

$P = R \cdot \dfrac{i^2}{2} \rightarrow 16$

$\dfrac{40}{16}$ $\cancel{20} = R \cdot \dfrac{4^2}{\cancel{2}}$ $R = 2{,}5$

$Q = R \dfrac{i^2}{2}$

$-\cancel{20} = R \cdot \dfrac{4^2}{\cancel{2}}$

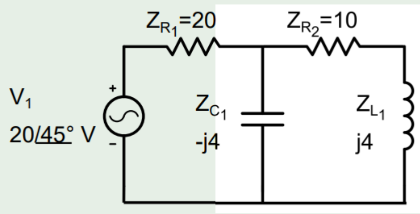
$R = -2{,}5$

$Z = 2{,}5 - j\,2{,}5$

b)

Fator de potência

No circuito a seguir, determine o fator de potência da associação vista pela fonte.



$V = 20\angle 45°$

$Z_{eq_1} = Z_{R_2} + Z_{L_1}$

$Z_{eq_1} = 10 + j4$

$Z_{eq_2} = \dfrac{1}{\dfrac{1}{-j4} + \dfrac{1}{10+j4}} = \underline{1{,}6 - 4j}$

$Z_{eq} = 1{,}6 - 4j + 20$

$Z_{eq} = 21{,}6 - j4 \ \Omega$

$Z_{eq} = 21{,}96 \angle -10{,}49$

$I = \dfrac{20\angle 45°}{21{,}96 \angle -10{,}49} = \underline{0{,}910 \angle 55{,}49°}$

$Fp = \cos(-10{,}49)$

$Fp = 0{,}9832$

$S = P + jQ \longrightarrow \dfrac{-4 \cdot 0{,}910^2}{2} = -1{,}6562$

$\hookrightarrow \dfrac{21{,}96 \cdot 0{,}910^2}{2}$

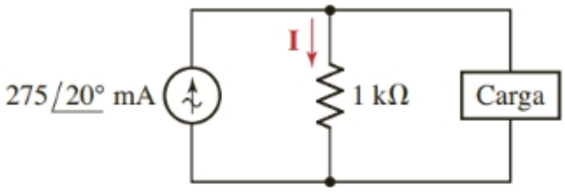
$18{,}185 \ W$

Ativa $= 9{,}09 \ W$

$S = 9{,}09 - j\,1{,}6562$

ou

$S = 9{,}23 \angle -10{,}32$



37. Calcule o fator de potência em que a fonte na Figura 11.40 está operando, se a carga é (*a*) puramente resistiva; (*b*) 1.000 + j900 Ω; (*c*) 500/–5° Ω.

$275\angle 20^\circ$ $\qquad Z_t = R\angle 0^\circ$

a) $fp = 1$

b) $Z_{Eq} = \dfrac{1}{\dfrac{1}{1.10^3} + \dfrac{1}{1000 + j900}} = 584{,}195 + j\,187{,}11$

$613{,}42\angle 17{,}75$

$fp = \cos(17{,}75)$

$fp = 0{,}9523$ indutiva (atrasada)

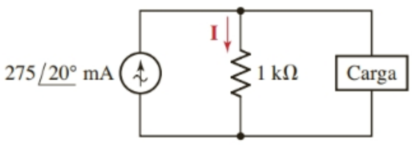
c) $Z_T = \dfrac{1}{\dfrac{1}{1000} + \dfrac{1}{498{,}09 - 43{,}57j}} = 333{,}04 - 19{,}397j$

ou

$333{,}60\angle -3{,}333$

$fp = \cos(-3{,}333) = 0{,}998$ adiantado capacitivo

38. Determine a impedância de carga para o circuito ilustrado na Figura 11.40 se a fonte está operando com um PF de (*a*) 0,95 adiantado; (*b*) unitário; (*c*) 0,45 atrasado.

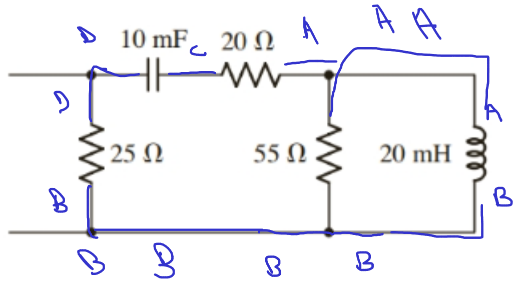


a) $\theta^\circ = -18{,}1948$

$wC = \dfrac{1}{R} \cdot \tan(\cos^{-1}(PF)) = 3{,}1756 \cdot 10^{-3}$

$Z_C = \dfrac{1}{wCj}$

40. Considere o circuito da Figura 10.54, e determine a impedância equivalente vista a partir dos terminais abertos, se (a) $\omega = 1$ rad/s; (b) $\omega = 10$ rad/s, (c) $\omega = 100$ rad/s.



$$Z_{eq1} = \frac{1}{\frac{1}{55} + \frac{1}{20000}\, i}$$

$$Z_{eq1} = 7,2727\cdot10^{-6} + 0,0199\, J$$

$$Z_L = +j\, 20\cdot10^{-3}\cdot 1$$

$$Z_{eq2} = Z_{eq1} + 20 + 10\cdot10^{-3}$$

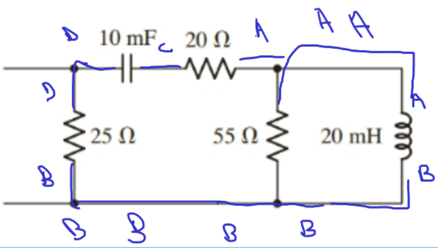
$$Z_C = -J\, \frac{1}{10\cdot10^{-3}\cdot 1}$$

$$Z_{eq2} = 20,00 - 99,98\, J$$

$$Z_{eq} = \frac{1}{\frac{1}{20 - 99,98J} + \frac{1}{25}} = 22,660 - 5,1981\, J$$

ou $23,24 \angle -12,91$

b) $\omega = 10$



$Z_L = \cancel{10}\cdot 20\cdot 10^{-\cancel{3}\,2}$

$Z_C = \frac{1}{10^{-2}}$

$$Z_{eq1} = \frac{1}{\frac{1}{20\cdot10^{-2}J} + \frac{1}{55}} = 7,2726\cdot10^{-4} + 0,199\, J$$

$$Z_{eq2} = 20 - 10J + 7,2726\cdot10^{-4} + 0,199\, J$$

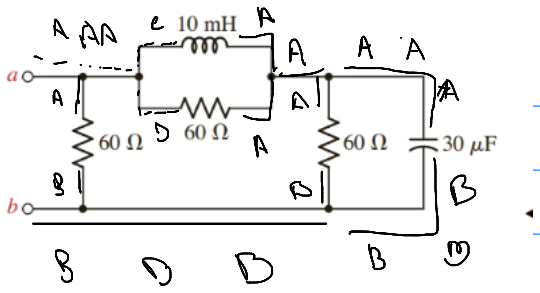
$$Z_{eq2} = 20 - 9,801\, J$$

$$Z_{eqt} = \frac{1}{\frac{1}{25} + \frac{1}{20 - 9,801J}} = 11,74 - 2,88\, i$$

ou $12,08 \angle -13,78$

PARALELO

$$1\,Hz = \frac{1}{2\pi} = 0{,}1591\ Rad$$



$$Z_L = \omega . L\, j$$

$$Z_L = 0{,}1591 . 10^{-3}\, j$$

$$Z_L = j\, 1{,}591 . 10^{-3}$$

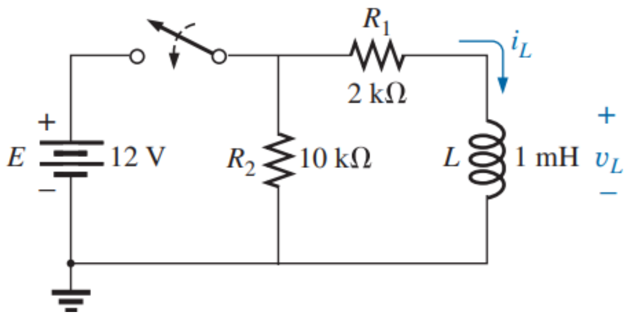
$$Z_{eq_1} = \frac{1}{\frac{1}{1{,}591 . 10^{-3} j} + \frac{1}{60}} = 4{,}218 . 10^{-8} + 1{,}5909 . 10^{-3} j$$

$$Z_{eq_2} = \frac{1}{\frac{1}{60} + \frac{1}{-209{,}51 j}} = 55{,}4520 - 15{,}88 j$$

$$Z_{eq_3} = 4{,}218 . 10^{-8} + 1{,}5909 . 10^{-3} j + 55{,}4520 - 15{,}88 j$$

$$= 55{,}45 - 15{,}878 j$$

$$Z_{eq\,total} = \frac{1}{\frac{1}{55{,}45 - 15{,}878 j} + \frac{1}{60}} = 29{,}39 - 4{,}208 j$$



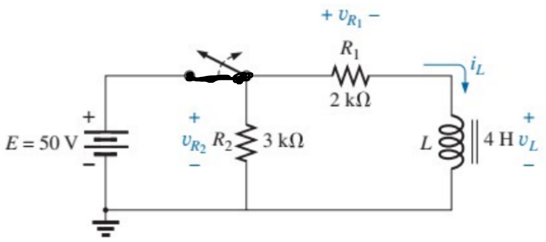
$$\tau = \frac{L}{R} = \frac{1.10^{-3}}{2.10^{3}} = 5.10^{-7}\,s$$

$$v_L = E.e^{-t/\tau} = 12.e^{-t/5.10^{-7}s}$$

$$I_L = \frac{E}{R}\left(1-e^{-t/\tau}\right) = \frac{12}{\underbrace{2.10^{3}}_{6.10^{-3}}}\left(1-e^{-t/5.10^{-7}s}\right)$$

Exercício 2 – Circuito RL

- Determine vL e iL para o armazenamento;
- Determine vL e iL para o decaimento;
- Esboçar as formas de onda de vL e iL.



- Armazenamento

$$\tau = \frac{L}{R} = \frac{4}{2.10^3} = 2.10^{-3}$$

$$I_L = \frac{E}{R}\left(1 - e^{-T/\tau}\right) = 0{,}025.\left(1 - e^{-T/2.10^{-3}}\right)$$

$E = 50$, $R = 2.10^3$

$$V_L = E.e^{-T/\tau} = 50.e^{-T/2.10^{-3}}$$

- decaimento $\quad \tau = \frac{4}{5000} = 8.10^{-4}$

curto na fonte

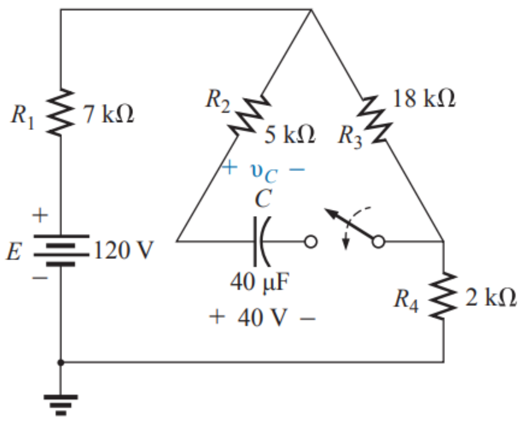
$$I_L = \frac{50}{1200} . e^{-T/3{,}33.10^{-3}}$$

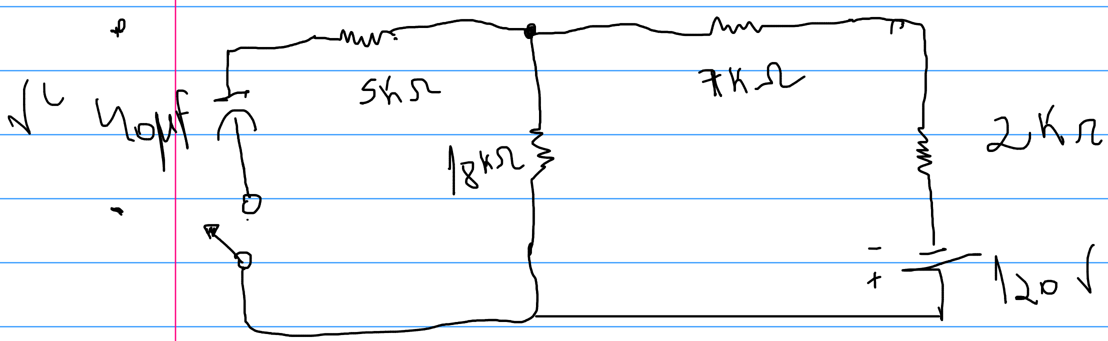
$$I_L = 0{,}025 . e^{-T/8.10^{-4}}$$

$$V_1 = 0{,}025.(2000 + 5000)$$

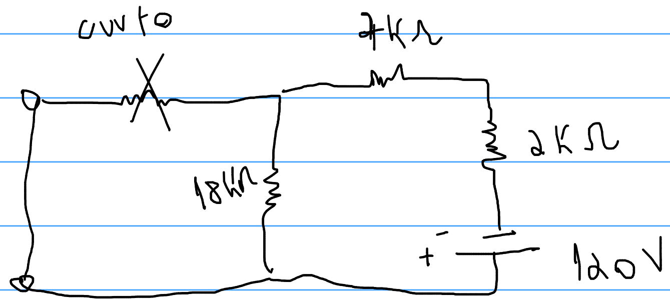
$$V_1 = 125$$

$$V_L = 125\, e^{-T/8.10^{-4}}$$





Thevenin



$$E_{th} = \frac{18.10^3 . 120}{18.10^3 + 2.10^3 + 7.10^3} = 80\,V$$

$$R_{th} = 7+2 = 9K$$

$$R_{th} = \left(\frac{1}{\frac{1}{9K} + \frac{1}{18K}} \right) + 5k\Omega = 11000\,\Omega$$

$$\tau = R.C = 11000 . 40.10^{-6} = 0,44\,s$$

$V_f = E_{th}$
$V_i = E_i$

$$V_c = V_f + (V_i - V_f) . e^{-T/\tau}$$

$$V_c = 80 + (40 - 80) . e^{-T/\tau}$$

$$V_c = 80 - 40V . e^{-T/0,44s}$$