

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

$$S = P + jQ$$

$$Z_T = Z_L + Z_C + Z_R$$

$Z_R = R$

$$Z_T = j\omega L + Z_C + R$$

$Z_C = -j \frac{1}{\omega C}$

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

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

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

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

$$Z_T = 45 + j65$$

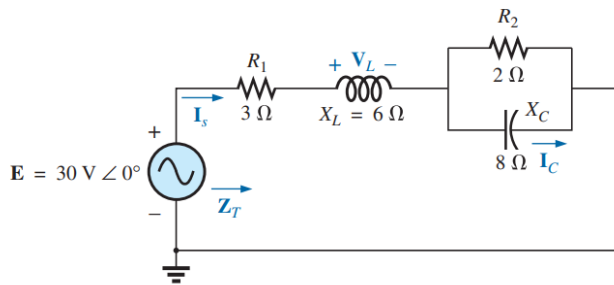
$$Z_T = 79,05 \angle 55,30^\circ$$

$$f_p = \cos(55,30^\circ) = 0,569$$

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

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

$$i = \frac{V}{Z_T} = \frac{380 \angle -28^\circ}{79,05 \angle 55,30^\circ} = \underline{4,807 \angle -83,3^\circ}$$



$$V = R i$$

$$V = 8 \angle 90^\circ \cdot 4,0672 \angle -48,55^\circ$$

$$Z_{R1} = 3 + 0j \text{ ou } 3 \angle 0^\circ$$

$$Z_L = 0 + 6j \text{ ou } 6 \angle 90^\circ$$

$$Z_{R2} = 2 + 0j \text{ ou } 2 \angle 0^\circ$$

$$Z_C = 0 - 8j \text{ ou } 8 \angle -90^\circ$$

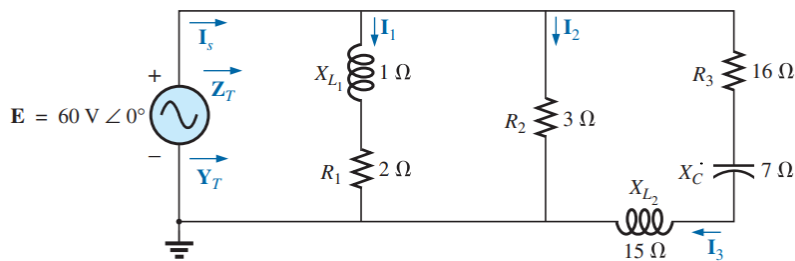
$$V_C = 32,53 \angle -138,55^\circ$$

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

$$Z_{\text{Total}} = 4,882 + 5,52j$$

$$I_s = \frac{V}{Z_{\text{Total}}} = \frac{30 \text{ V} \angle 0^\circ}{7,376 \angle 48,55^\circ} = 4,0672 \angle -48,55^\circ$$

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



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

$$Y_T = \frac{1}{Z_T} = 0,81 \angle -16,025^\circ$$

$$b) i_1 = \frac{V}{Z_{LR1}} = \frac{60 \angle 0^\circ}{(1 \angle 90^\circ + 2 \angle 0^\circ)} = 26,03 \angle -26,56^\circ$$

$$i_2 = \frac{V}{Z_{R2}} = \frac{60 \angle 0^\circ}{3 \angle 0^\circ} = 20 \angle 0^\circ$$

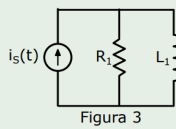
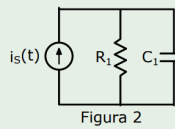
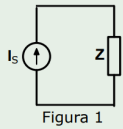
$$i_3 = \frac{V}{Z_{CL2R3}} = \frac{60 \angle 0^\circ}{\underline{\hspace{2cm}}} = 3,3541 \angle -26,56^\circ$$

$$I_s = i_1 + i_2 + i_3 =$$

$$f_p = \cos(16,025^\circ) = 0,9611 \text{ ATRASADO INDUCTIVO}$$

Cálculos de potência e impedância

A primeira figura mostra uma carga de impedância Z alimentada por uma fonte de corrente $i_s = 4 \cos(5t - 35^\circ)$ 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.



$$i = 4 \angle 35^\circ$$

$$a) i_s = 4 \cos(5t - 35^\circ)$$

$$S = 20 - j20 \text{ VA}$$

$$p = R \cdot \frac{i^2}{2} \rightarrow 16$$

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

$$Z = 2,5 - j2,5$$

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

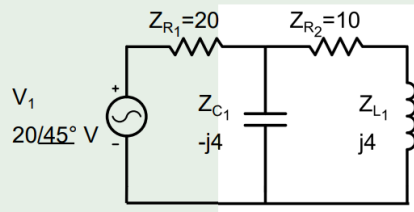
$$-20 = R \cdot \frac{4^2}{2}$$

$$R = -2,5$$

b)

Fator de potência

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



$$V = 20\angle 45^\circ$$

$$Z_{eq1} = Z_{R2} + Z_{L1}$$

$$Z_{eq1} = 10 + j4$$

$$Z_{eq2} = \frac{1}{\frac{1}{-j4} + \frac{1}{10 + j4}} = 1,6 - j4$$

$$Z_{eq} = 1,6 - j4 + 20$$

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

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

$$I = \frac{20\angle 45^\circ}{21,96 \angle -10,49^\circ} = 0,910 \angle 55,49^\circ$$

$$F_p = \cos(-10,49)$$

$$F_p = 0,9832$$

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

$$P = 21,96 \cdot 0,910^2$$

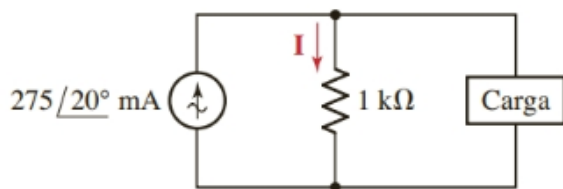
$$18,185 \, W$$

$$Ativa = 9,09 \, W$$

$$S = 9,09 - j1,6562$$

ou

$$S = 9,23 \angle -10,32^\circ$$



37. Calcule o fator de potência em que a fonte na Figura 11.40 está operando, se a carga é (a) puramente resistiva; (b) $1.000 + j900 \Omega$; (c) $500 \angle -5^\circ \Omega$.

$$275 \angle 20^\circ \quad Z_T = R \angle 0^\circ$$

a) $F_p = 1$

b) $Z_{eq} = \frac{1}{\frac{1}{1.10^3} + \frac{1}{1000 + j900}} = 584,195 + j187,11$

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

$$F_p = \cos(17,75)$$

$$F_p = 0,9523 \text{ indutivo (atrasado)}$$

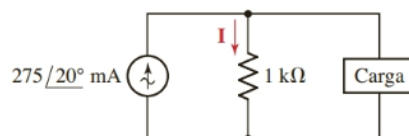
c) $Z_T = \frac{1}{\frac{1}{1000} + \frac{1}{498,09 - j43,57j}} = 333,04 - j19,397j$

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

$$F_p = \cos(-3,337) = 0,998 \text{ Adiantado Capacitivo}$$

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.

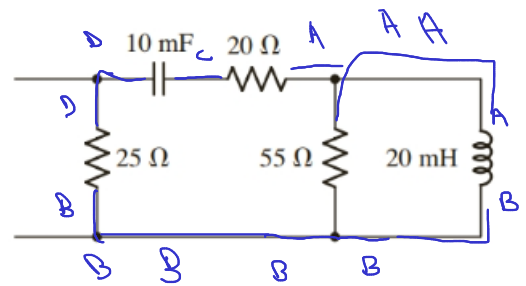
a) $\theta^\circ = -18,1948$



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

$$Z_C = \frac{1}{WC}$$

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



$$Z_{eq1} = \frac{1}{\frac{1}{25} + \frac{1}{20000}} i$$

$$Z_{eq1} = 7,2727 \cdot 10^{-6} + 0,1999 j$$

$$Z_L = +j 20 \cdot 10^{-3} \cdot 1$$

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

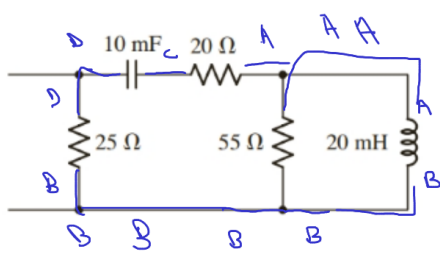
$$Z_{eq2} = 20,00 - 99,99 j$$

$$Z_C = -j \frac{1}{10 \cdot 10^{-3} \cdot 1}$$

$$Z_{eq} = \frac{1}{\frac{1}{20 - 99,99 j} + \frac{1}{25}} = 22,660 - 5,198 j \Omega$$

$$\text{ou } 23,24 \angle -12,91^\circ$$

b) $\omega = 10$



$$Z_{eq1} = \frac{1}{\frac{1}{20 \cdot 10^{-2}} + \frac{1}{99}} = 7,2726 \cdot 10^{-4} + 0,199 j$$

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

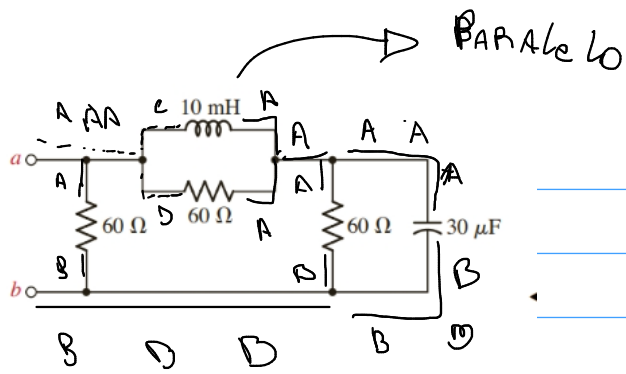
$$Z_{eq2} = 20 - 9,801 j$$

$$Z_{eq} = \frac{1}{\frac{1}{25} + \frac{1}{20 - 9,801 j}} = 11,74 - 2,88 j$$

$$\text{ou } 12,08 \angle -13,78^\circ$$

$$Z_L = 10 \cdot 20 \cdot 10^{-3} = 200$$

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



$$j\omega L = \frac{1}{2\pi f} = 0,1591 \text{ } \Omega$$

$$Z_L = \omega \cdot L \text{ } \Omega$$

$$Z_L = 0,1591 \cdot 10^{-3} \text{ } \Omega$$

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

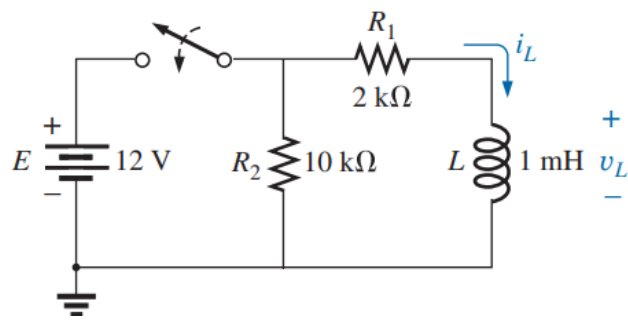
$$Z_{eq1} = \frac{1}{\frac{1}{1,591 \cdot 10^{-3}} + \frac{1}{60}} = 4,218 \cdot 10^{-8} + 1,5909 \cdot 10^{-3} \text{ } \Omega$$

$$Z_{eq2} = \frac{1}{\frac{1}{60} + \frac{1}{209,51 \text{ } \Omega}} = 55,4520 - 15,88 \text{ } \Omega$$

$$Z_{eq3} = 4,218 \cdot 10^{-8} + 1,5909 \cdot 10^{-3} \text{ } \Omega + 55,4520 - 15,88 \text{ } \Omega$$

$$= 55,45 - 15,878 \text{ } \Omega$$

$$Z_{eqtotal} = \frac{1}{55,45 - 15,878 \text{ } \Omega} + \frac{1}{60} = 29,39 - 4,208 \text{ } \Omega$$



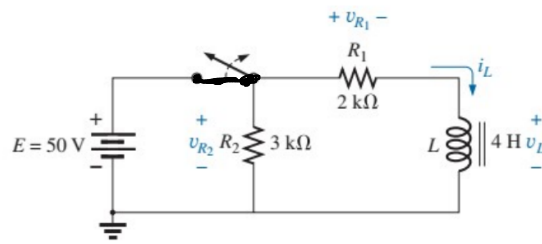
$$\tau = \frac{L}{R} = \frac{1 \cdot 10^{-3}}{2 \cdot 10^3} = 5 \cdot 10^{-7} \text{ s}$$

$$v_L = E \cdot e^{-t/\tau} = 12 \cdot e^{-t/5 \cdot 10^{-7} \text{ s}}$$

$$i_L = \frac{E}{R} (1 - e^{-t/\tau}) = \frac{12}{\underbrace{2 \cdot 10^3}_{6 \cdot 10^{-3}}} (1 - e^{-t/5 \cdot 10^{-7} \text{ s}})$$

Exercício 2 – Circuito RL

- Determine v_L e i_L para o armazenamento;
- Determine v_L e i_L para o decaimento;
- Esboçar as formas de onda de v_L e i_L .



• Armazenamento

$$\tau = \frac{L}{R} = \frac{4}{2 \cdot 10^3} = 2 \cdot 10^{-3}$$

$$i_L = \frac{E}{R} (1 - e^{-t/\tau}) = 0,025 \cdot (1 - e^{-t/2 \cdot 10^{-3}})$$

$$v_L = E \cdot e^{-t/\tau} = 50 \cdot e^{-t/2 \cdot 10^{-3}}$$

• decaimento $\tau = \frac{L}{R} = \frac{4}{5000} = 8 \cdot 10^{-4}$

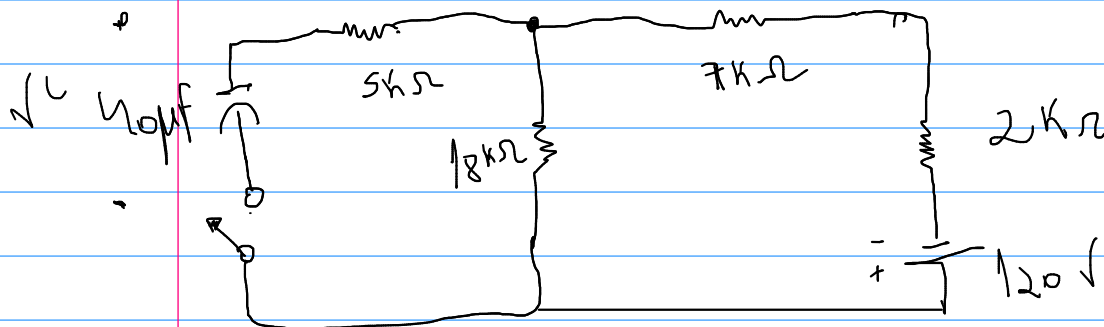
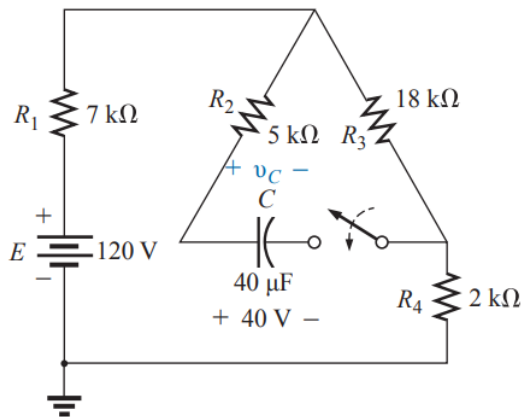
$$i_L = \frac{50}{1200} \cdot e^{-t/8 \cdot 10^{-4}}$$

$$i_L = 0,025 \cdot e^{-t/8 \cdot 10^{-4}}$$

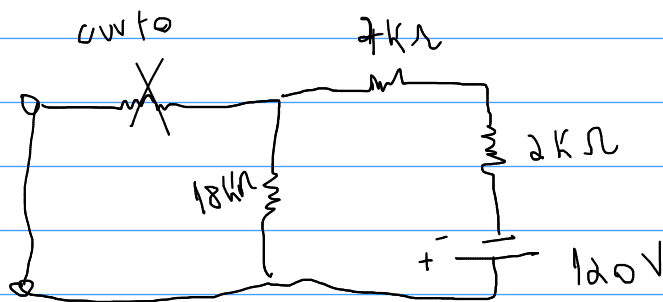
$$v_L = 125 \cdot e^{-t/8 \cdot 10^{-4}}$$

$$V_1 = 0,025 \cdot (2000 + 5000)$$

$$V_1 = 125$$



Thevenin



$$E_{th} = \frac{18 \cdot 10^3 \cdot 120}{18 \cdot 10^3 + 2 \cdot 10^3 + 7 \cdot 10^3} = 80 \text{ V}$$

$$R_{th} = 7 + 2 = 9 \text{ k}\Omega$$

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

$$\tau = R \cdot C = 11000 \cdot 40 \cdot 10^{-6} = 0,44 \text{ ms}$$

$$V_f = E_{th}$$

$$V_i = E_i$$

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

$$V_c = 80 + (40 - 80) \cdot e^{-t/0,44}$$

$$V_c = 80 - 40 \text{ V} \cdot e^{-t/0,44}$$

