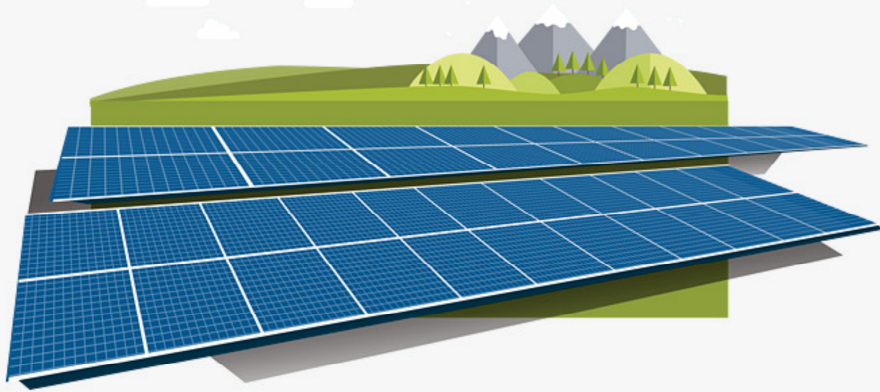




Sistemas Elétricos de Potência

Aula 01-P4 – Mudança de base Valores por unidade (pu)

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Introdução

- Se os equipamentos estão em base diferentes, como padronizar a base?



Potência 10000/12500 kVA

Tensão nominal AT 138 kV

Tensão nominal BT 13.8 kV

Impedância 10.0 %



Potência 150 kVA

Tensão nominal AT 13.2 kV

Tensão nominal BT 0.22 kV

Impedância 3.5%

Mudança de Base

- Caso 1: Tensão e potência em bases diferentes

$$Z_{B1} = \frac{V_{B1}^2}{S_{B1}} \quad Z_{B2} = \frac{V_{B2}^2}{S_{B2}}$$

- Impedância em pu

$$z_{pu1} = \frac{Z_{\Omega}}{\frac{V_{B1}^2}{S_{B1}}} = \frac{Z_{\Omega} S_{B1}}{V_{B1}^2}$$

$$\frac{z_{pu2}}{z_{pu1}} = \frac{\frac{Z_{\Omega} S_{B2}}{V_{B2}^2}}{\frac{Z_{\Omega} S_{B1}}{V_{B1}^2}} = \frac{V_{B1}^2 S_{B2}}{V_{B2}^2 S_{B1}}$$

$$z_{pu2} = \frac{Z_{\Omega}}{\frac{V_{B2}^2}{S_{B2}}} = \frac{Z_{\Omega} S_{B2}}{V_{B2}^2}$$

$$z_{pu2} = z_{pu1} \frac{V_{B1}^2 S_{B2}}{V_{B2}^2 S_{B1}}$$

Mudança de Base

- Caso 2: Tensão em bases diferentes

$$Z_{B1} = \frac{V_{B1}^2}{S_B} \quad Z_{B2} = \frac{V_{B2}^2}{S_B}$$

- Impedância em pu

$$z_{pu1} = \frac{Z_{\Omega}}{\frac{V_{B1}^2}{S_B}} = \frac{Z_{\Omega} S_B}{V_{B1}^2}$$
$$z_{pu2} = \frac{Z_{\Omega}}{\frac{V_{B2}^2}{S_B}} = \frac{Z_{\Omega} S_B}{V_{B2}^2}$$
$$\frac{z_{pu2}}{z_{pu1}} = \frac{\frac{Z_{\Omega} S_B}{V_{B2}^2}}{\frac{Z_{\Omega} S_B}{V_{B1}^2}} = \frac{V_{B1}^2}{V_{B2}^2}$$

$$z_{pu2} = z_{pu1} \frac{V_{B1}^2}{V_{B2}^2}$$

Mudança de Base

- Caso 3: Potência em bases diferentes

$$Z_{B1} = \frac{V_B^2}{S_{B1}} \quad Z_{B2} = \frac{V_B^2}{S_{B2}}$$

- Impedância em pu

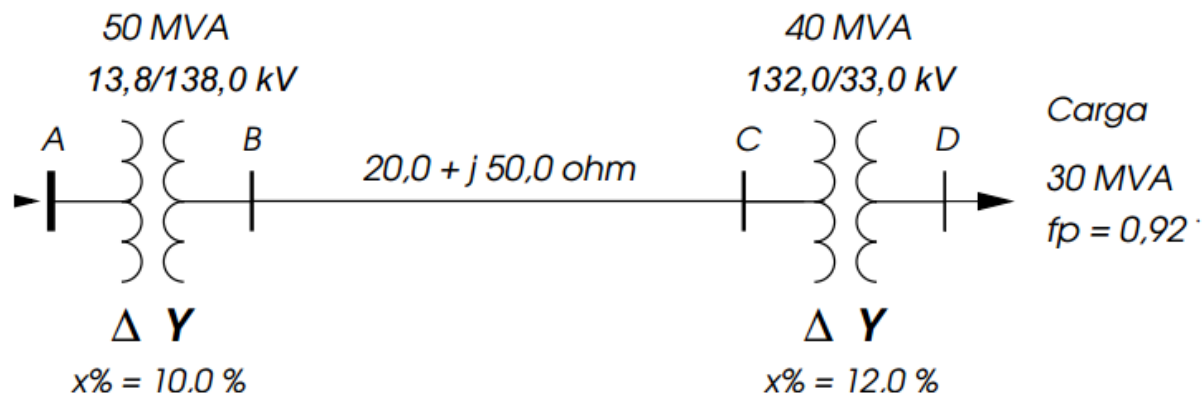
$$z_{pu1} = \frac{Z_{\Omega}}{\frac{V_B^2}{S_{B1}}} = \frac{Z_{\Omega} S_{B1}}{V_B^2}$$

$$\frac{z_{pu2}}{z_{pu1}} = \frac{\frac{Z_{\Omega} S_{B2}}{V_B^2}}{\frac{Z_{\Omega} S_{B1}}{V_B^2}} = \frac{S_{B2}}{S_{B1}}$$

$$z_{pu2} = \frac{Z_{\Omega}}{\frac{V_B^2}{S_{B2}}} = \frac{Z_{\Omega} S_{B2}}{V_B^2}$$

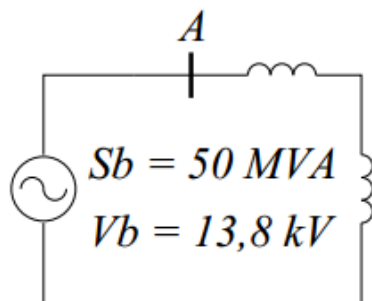
$$z_{pu2} = z_{pu1} \frac{S_{B2}}{S_{B1}}$$

A tensão na carga (barra D) é mantida em 30,0 kV. Qual o valor da tensão na fonte (barra A)?



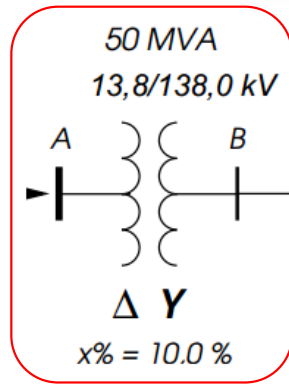
$$\frac{132}{33} = \frac{138}{V_{base}}$$

$$V_{base} = 34,5 \text{ kV}$$

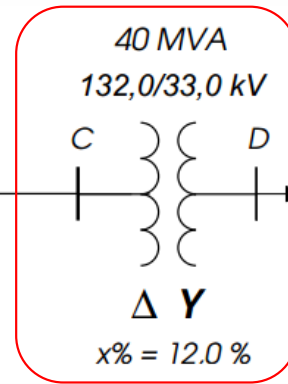


$$z_l\% = \frac{(20,0 + j50,0)}{\frac{138^2}{50,0}} 100\% = 5,251 + j13,127 \%$$

$$x_{te}\% = j10,0 \%$$



20,0 + j 50,0 ohm



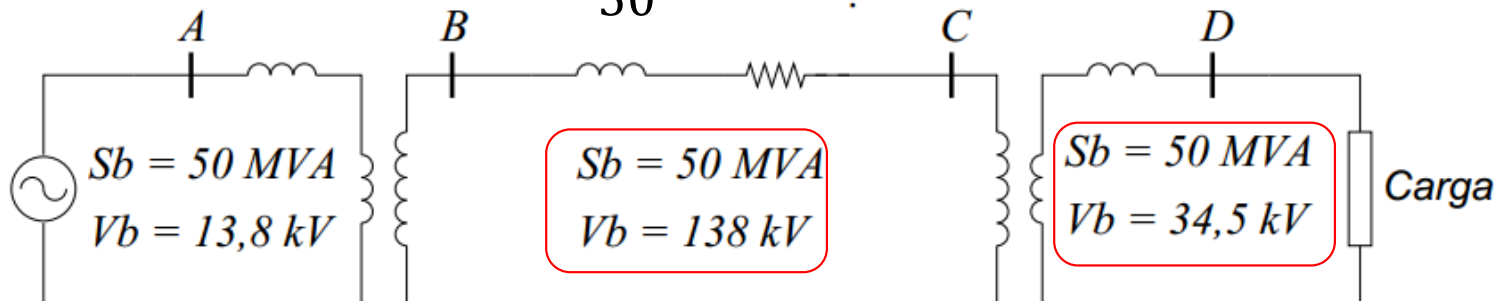
Carga

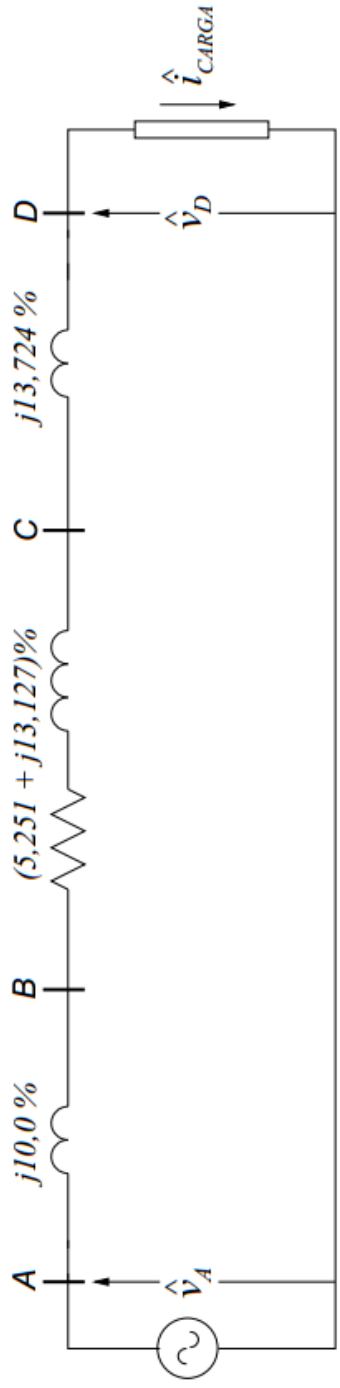
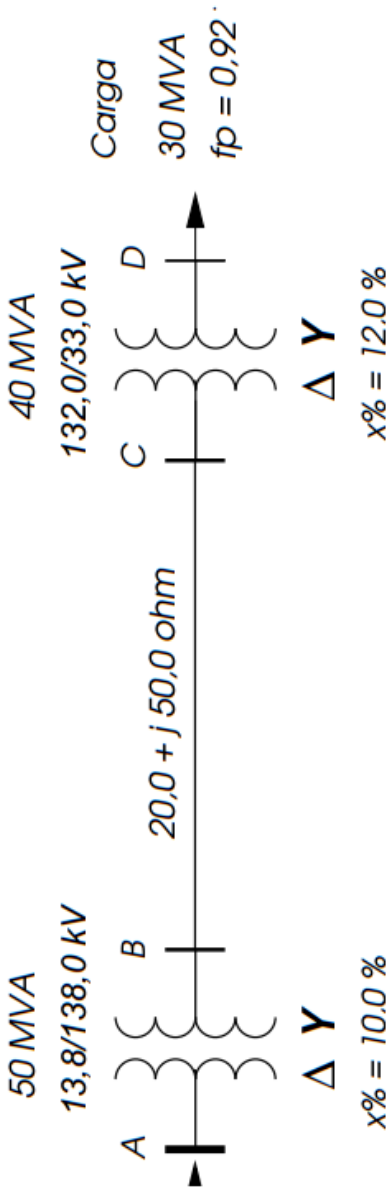
30 MVA
fp = 0,92

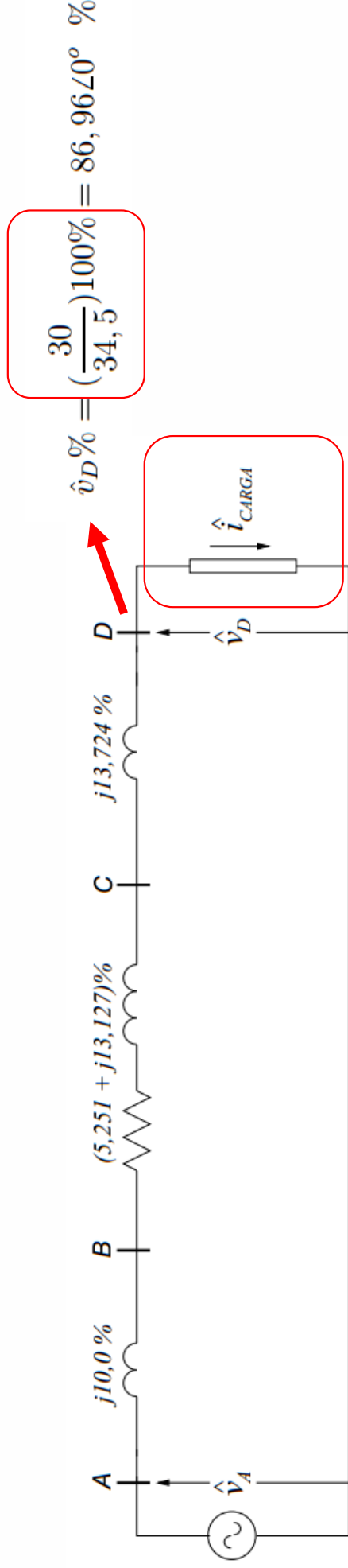
$$x_{ta}\% = 12,0 \left(\frac{50}{40}\right) \left(\frac{132}{138}\right)^2$$

$$x_{ta}\% = j13,724 \%$$

$$Z_B = \frac{138^2}{50} = 380,88 \Omega$$





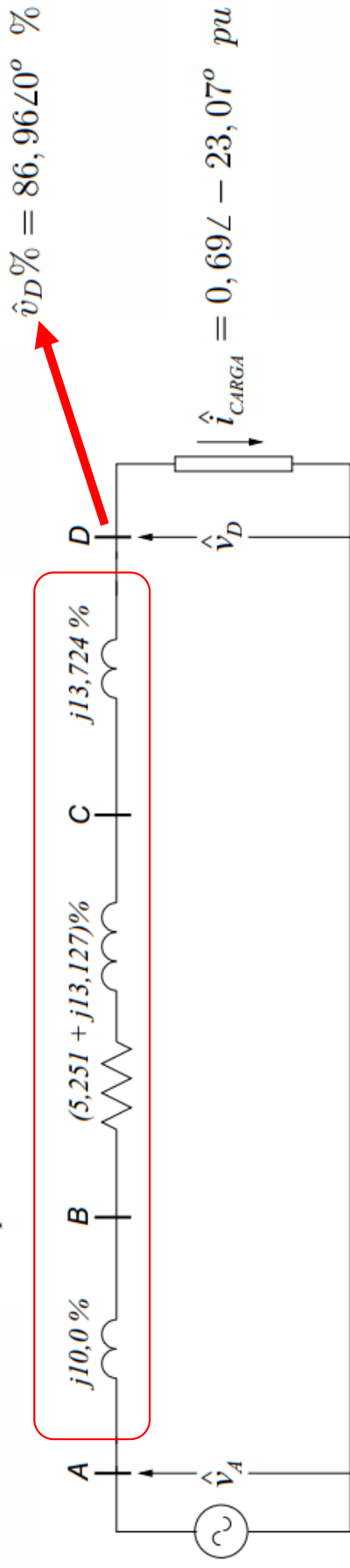


$$\hat{I}_{CARGA} = \frac{30.000}{(\sqrt{3})30} \angle -23,07^\circ = 577,35 \angle -23,07^\circ \text{ A}$$

$$\hat{i}_{CARGA} = \frac{\hat{I}_{CARGA}}{I_{base}} \text{ pu} \quad I_{base} = \frac{50.000}{(\sqrt{3})34,5} = 836,74 \text{ A}$$

$$\hat{i}_{CARGA} = \frac{577,35}{836,74} \angle -23,07^\circ = 0,69 \angle -23,07^\circ \text{ pu}$$

$$z_{eq}\% = 5,251 + j36,851 = 37,223\angle 81,89^\circ$$



$$\hat{v}_A\% = 86,96\angle 0^\circ\% + (37,223\angle 81,89^\circ\%)(0,69\angle -23,07^\circ) = 102,64\angle 12,36^\circ\%$$

$$\hat{V}_A = 14,164\angle 12,36^\circ \text{ kV}$$



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Obrigado!

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