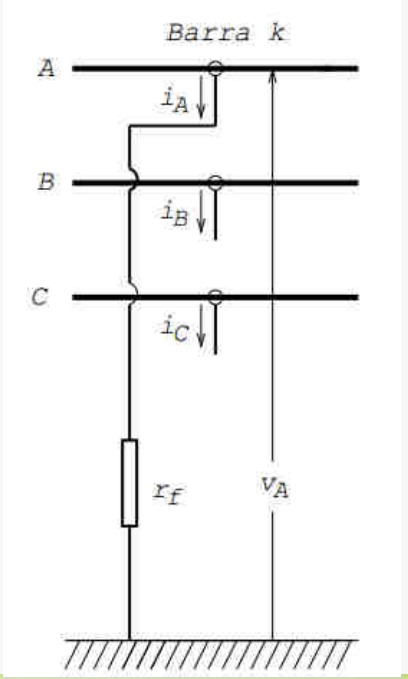
Sistemas Elétricos de Potência

Aula 05-P1 – Curto-Circuito Monofásico



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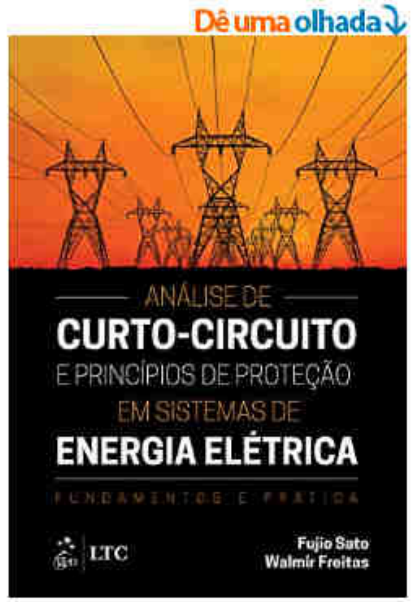
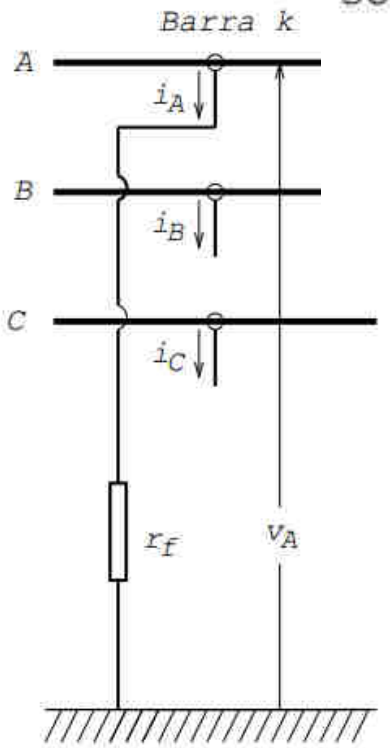
Tópicos abordados

- Capítulo 4

- Curto-circuito Monofásico



Curto-circuito Monofásico



Condições de contorno

$$i_B = i_C = 0$$

$$v_A = i_A r_f$$

$$\underline{i}_S = T^{-1}\underline{i}_P$$

$$\begin{bmatrix} \hat{i}_{A+} \\ \hat{i}_{A-} \\ \hat{i}_{Ao} \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & a & a^2 \\ 1 & a^2 & a \\ 1 & 1 & 1 \end{bmatrix} \cdot \begin{bmatrix} \hat{i}_A \\ 0 \\ 0 \end{bmatrix}$$

$$\hat{i}_{A+} = \hat{i}_{A-} = \hat{i}_{A0}$$

$$\hat{i}_A = \hat{i}_{A+} + \hat{i}_{A-} + \hat{i}_{A0}$$

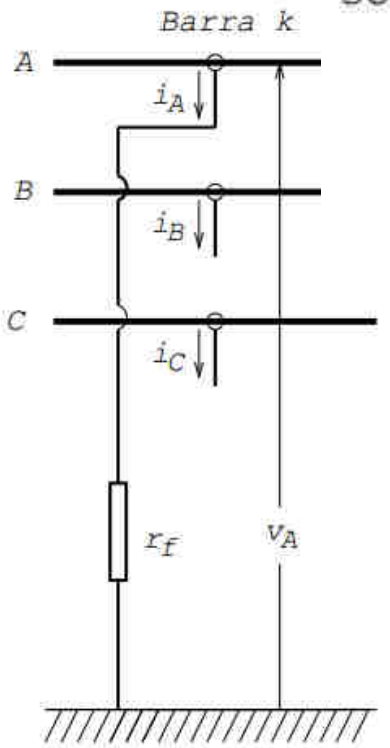
$$\hat{i}_A = 3\hat{i}_{A+}$$

$$\hat{i}_{A+} = \frac{1}{3}(\hat{i}_A)$$

$$\hat{i}_{A-} = \frac{1}{3}(\hat{i}_A)$$

$$\hat{i}_{Ao} = \frac{1}{3}(\hat{i}_A)$$

Curto-circuito Monofásico



Condições de contorno

$$i_B = i_C = 0$$

$$v_A = i_A r_f$$

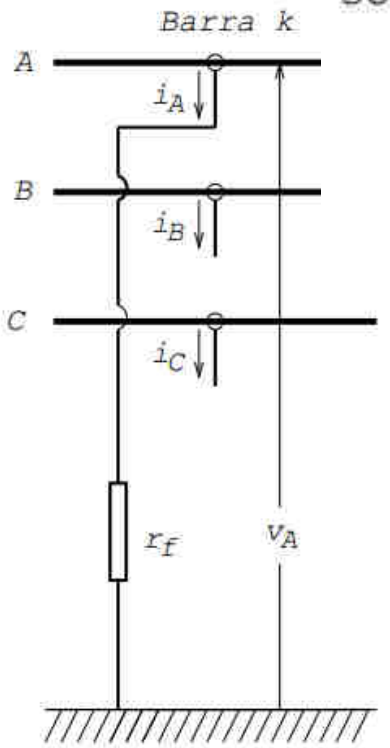
$$\begin{bmatrix} \hat{v}_{A+} \\ \hat{v}_{A-} \\ \hat{v}_{Ao} \end{bmatrix} = \begin{bmatrix} \hat{e}_A \\ 0 \\ 0 \end{bmatrix} - \begin{bmatrix} Z^+_{k,k} & 0 & 0 \\ 0 & Z^-_{k,k} & 0 \\ 0 & 0 & Z^o_{k,k} \end{bmatrix} \cdot \begin{bmatrix} \frac{\hat{i}_A}{3} \\ \frac{\hat{i}_A}{3} \\ \frac{\hat{i}_A}{3} \end{bmatrix}$$

$$\hat{v}_{A+} = \hat{e}_A - \frac{\hat{i}_A}{3} Z^+_{k,k}$$

$$\hat{v}_{A-} = -\frac{\hat{i}_A}{3} Z^-_{k,k}$$

$$\hat{v}_{A0} = -\frac{\hat{i}_A}{3} Z^o_{k,k}$$

Curto-circuito Monofásico



Condições de contorno

$$i_B = i_C = 0$$

$$v_A = i_A r_f$$

$$\hat{v}_A = \hat{v}_{A+} + \hat{v}_{A-} + \hat{v}_{Ao} \quad \text{e} \quad \hat{v}_A = \hat{i}_A r_f$$

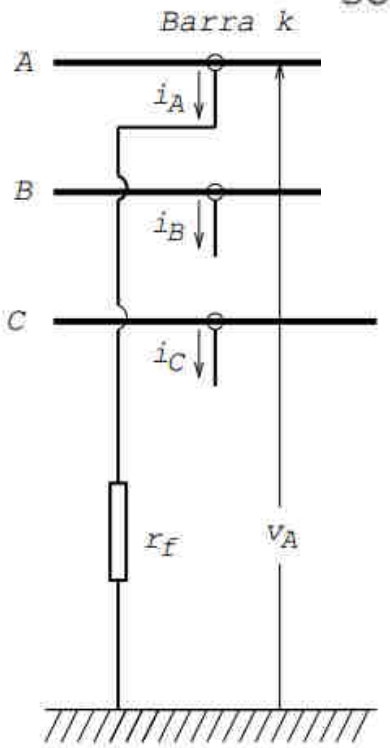
$$\hat{v}_{A+} = \hat{e}_A - \frac{\hat{i}_A}{3} Z^+_{k,k}$$

$$\hat{v}_{A-} = -\frac{\hat{i}_A}{3} Z^-_{k,k}$$

$$\hat{v}_{A0} = -\frac{\hat{i}_A}{3} Z^o_{k,k}$$

$$\hat{i}_A r_f = \hat{e}_A - \frac{\hat{i}_A}{3}(Z^+_{k,k} + Z^-_{k,k} + Z^o_{k,k})$$

Curto-circuito Monofásico



Condições de contorno

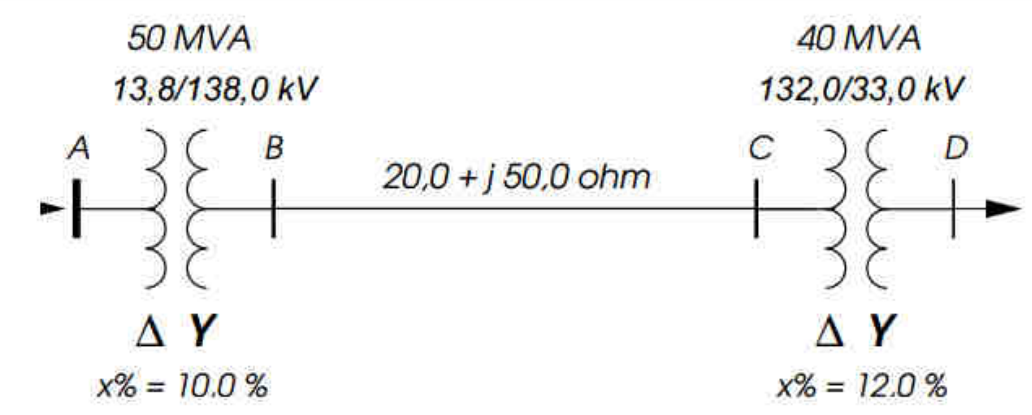
$$i_B = i_C = 0$$

$$v_A = i_A r_f$$

$$\hat{i}_A r_f = \hat{e}_A - \frac{\hat{i}_A}{3}(Z^+_{k,k} + Z^-_{k,k} + Z^o_{k,k})$$

$$\hat{i}_A = \frac{3\hat{e}_A}{(Z^+_{k,k} + Z^-_{k,k} + Z^o_{k,k} + 3r_f)}$$

Curto-circuito Monofásico na barra D

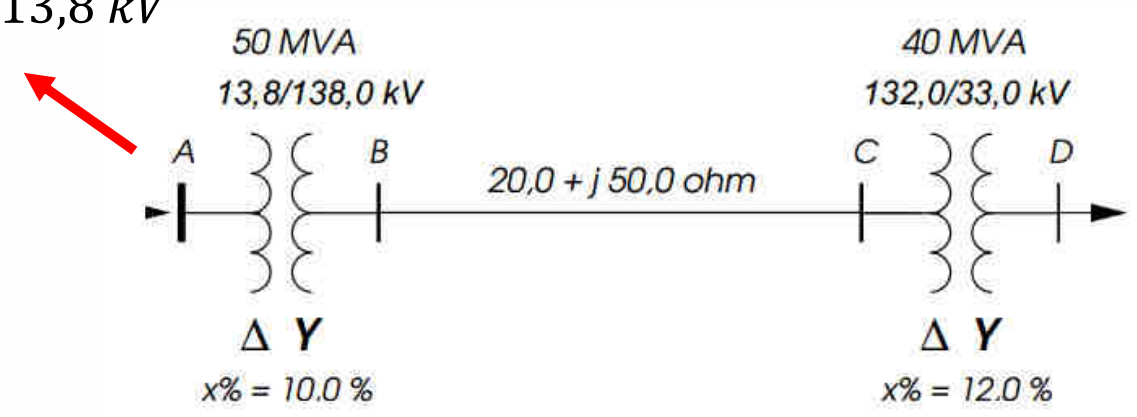


a) Calcule a corrente de curto circuito devido um curto monofásico na barra D.

b) Calcule a tensão na barra C.

Exemplo – Cálculo de curto-circuito Monofásico

Considere $V_A = 13{,}8\ kV$

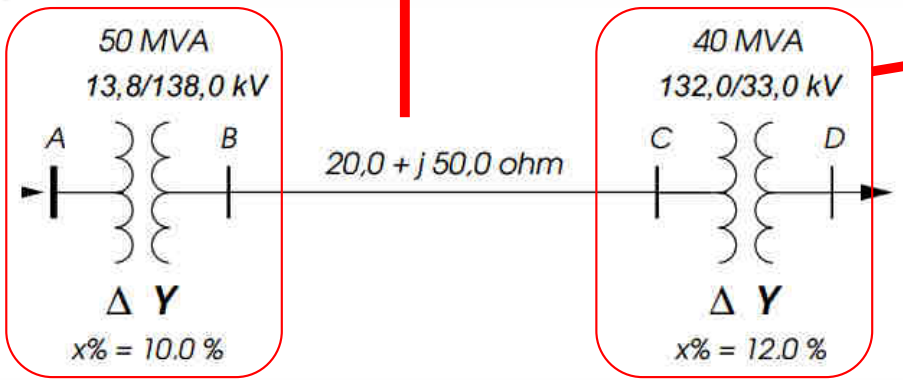


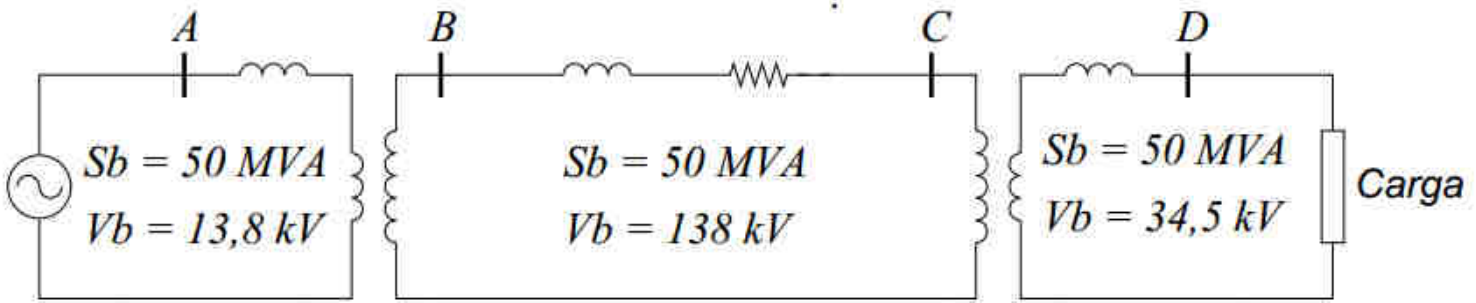
$$z_l\% = \frac{(20,0 + j50,0)}{\frac{138^2}{50,0}} 100\% = 5,251 + j13,127\ \%$$

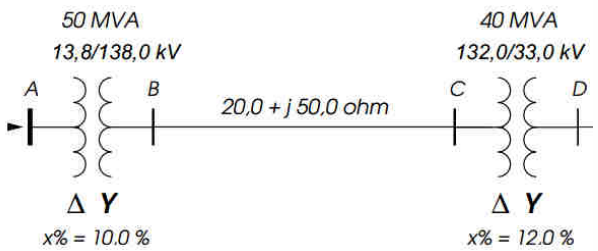
$$x_{te}\% = j10,0\ \%$$

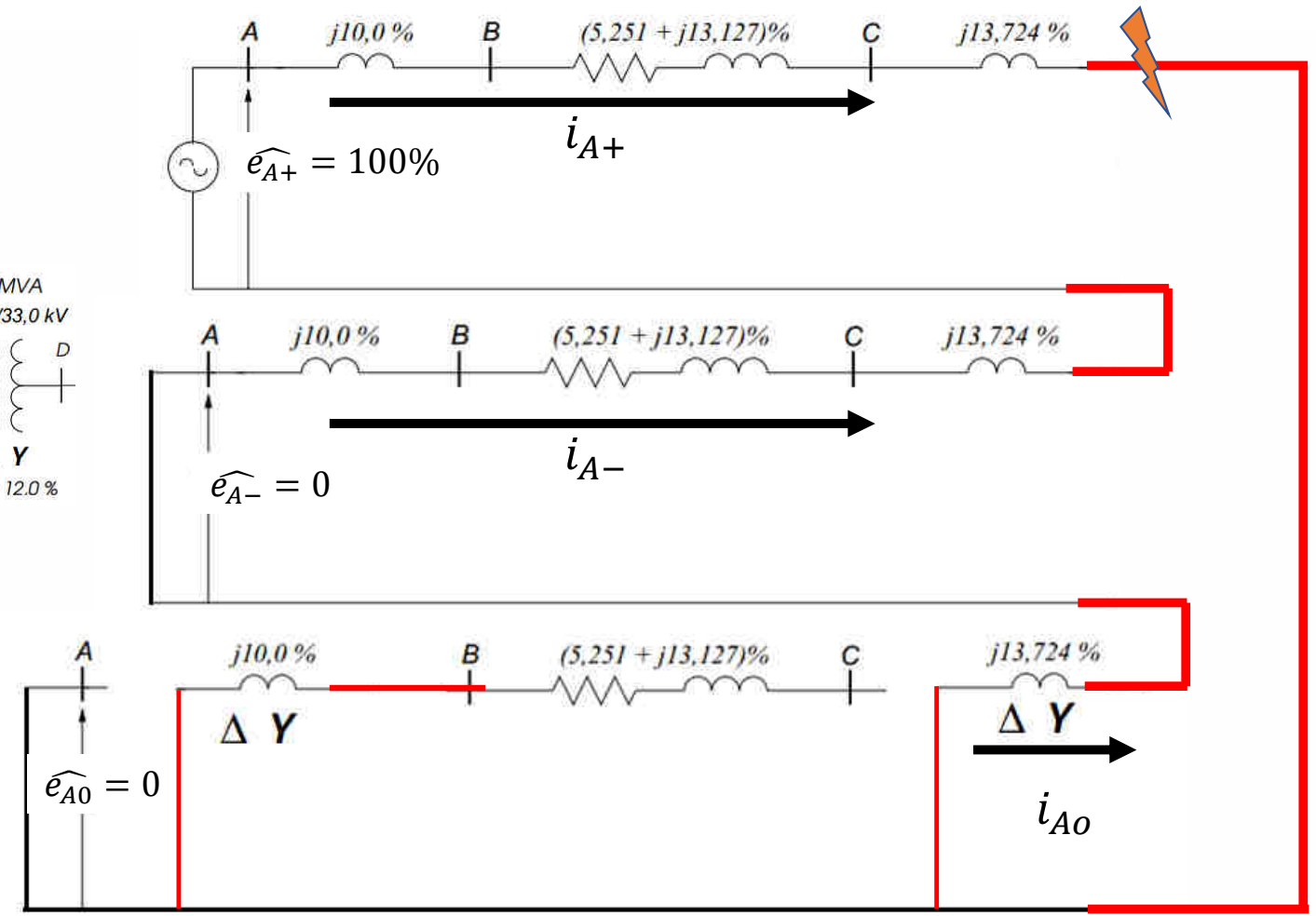
$$x_{ta}\% = 12,0(\frac{50}{40})(\frac{132}{138})^2$$

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






50 MVA
13,8/138,0 kV
40 MVA
132,0/33,0 kV
A
B
C
D
20,0 + j 50,0 ohm
Δ Y
x% = 10.0 %
Δ Y
x% = 12.0 %


A
j10,0 %
B
(5,251 + j13,127)%
C
j13,724 %
$\widehat{e_{A+}} = 100\%$
i_{A+}
A
j10,0 %
B
(5,251 + j13,127)%
C
j13,724 %
$\widehat{e_{A-}} = 0$
i_{A-}
A
j10,0 %
B
(5,251 + j13,127)%
C
j13,724 %
Δ Y
Δ Y
$\widehat{e_{A0}} = 0$
i_{Ao}

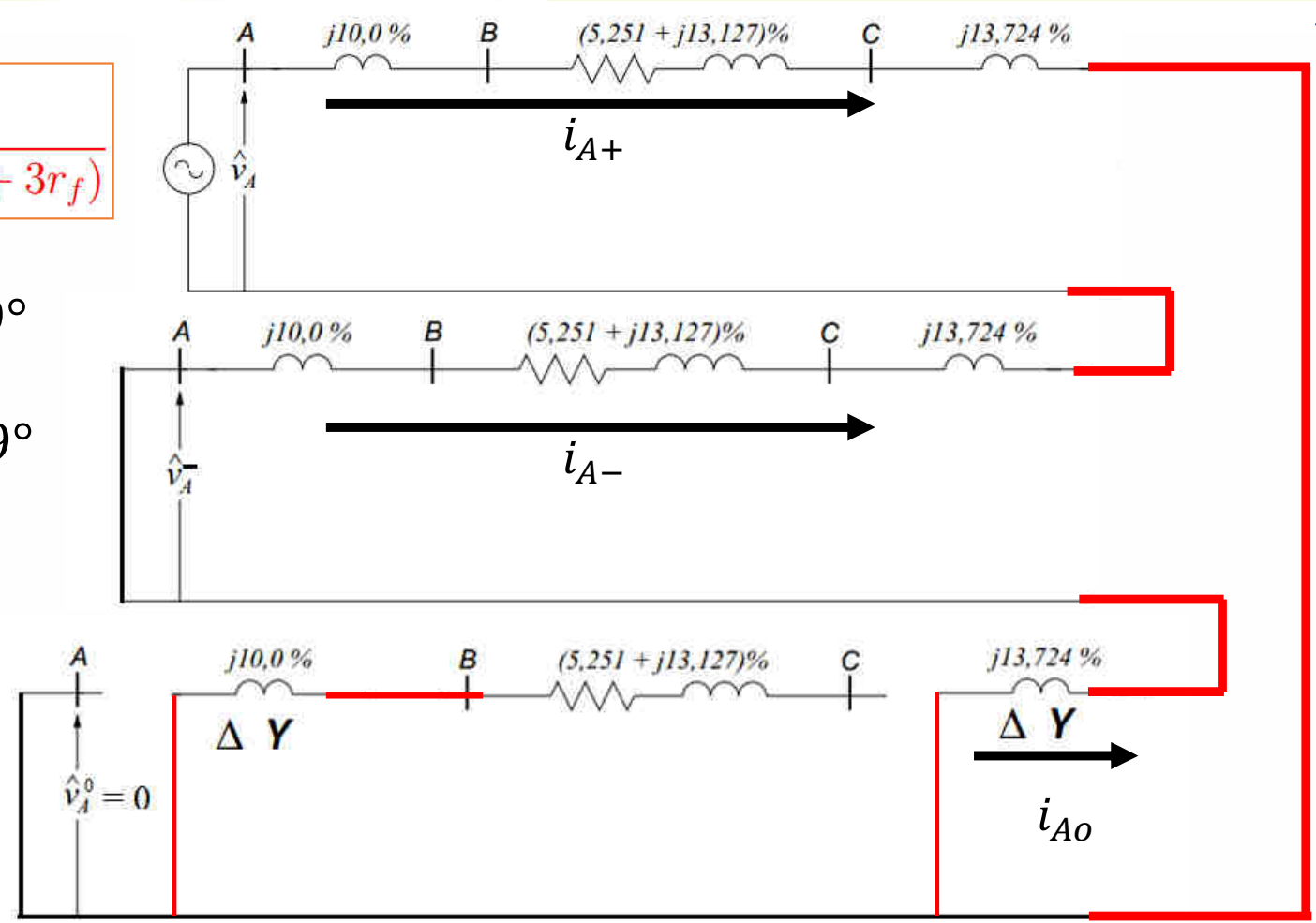
$$\hat{i}_A = \frac{3\hat{e}_A}{(Z^+_{k,k} + Z^-_{k,k} + Z^o_{k,k} + 3r_f)}$$

$$Z^+_{k,k} = 37{,}223\angle 81{,}89°$$

$$Z^-_{k,k} = 37{,}223\angle 81{,}89°$$

$$Z^0_{k,k} = 13{,}724\angle 90°$$

$$r_f = 0$$



$$\hat{i}_A = \frac{3\hat{e}_A}{(Z^+_{k,k} + Z^-_{k,k} + Z^o_{k,k} + 3r_f)}$$

$$i_A^D = \frac{3 \times 100\angle 0°}{2 \times 37{,}223\angle 81{,}89° + 13{,}724\angle 90°} = 3{,}4\angle -83{,}15°\ pu$$

$$Z^+_{k,k} = 37{,}223\angle 81{,}89°$$

$$I^D_{base} = \frac{50 \times 10^6}{\sqrt{3} \times 34{,}5 \times 10^3} = 836{,}74\ A$$

$$Z^+_{k,k} = 37{,}223\angle 81{,}89°$$

$$I_A^D = 836{,}74 \times 3{,}4\angle -83{,}15° = 2850{,}8\angle -83{,}15°A$$

$$Z^0_{k,k} = 13{,}724\angle 90°$$

$$\begin{bmatrix} I_A^D \\ I_B^D \\ I_C^D \end{bmatrix} = \begin{bmatrix} 2850{,}8\angle -83{,}15° \\ 0 \\ 0 \end{bmatrix} A$$

$$r_f = 0$$

$$\hat{i}_{A+} = \frac{\hat{i}_A}{3} = \frac{2850{,}8\angle -83{,}15°}{3} = 950{,}25\angle -83{,}15°A$$

$$\hat{i}_{A+} = \hat{i}_{A-} = \hat{i}_{A0}$$

$$\hat{i}_{A+} = \frac{\hat{i}_A}{3} = \frac{3{,}4\angle -83{,}15°}{3} = 1{,}13\angle -83{,}15°pu$$

$$I_{A+}^{D} = 950{,}25\angle -83{,}15°A$$

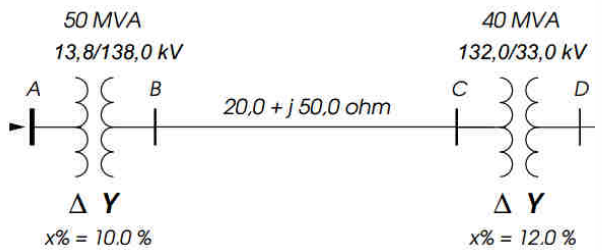
$$I_{A-}^{D} = 950{,}25\angle -83{,}15°A$$

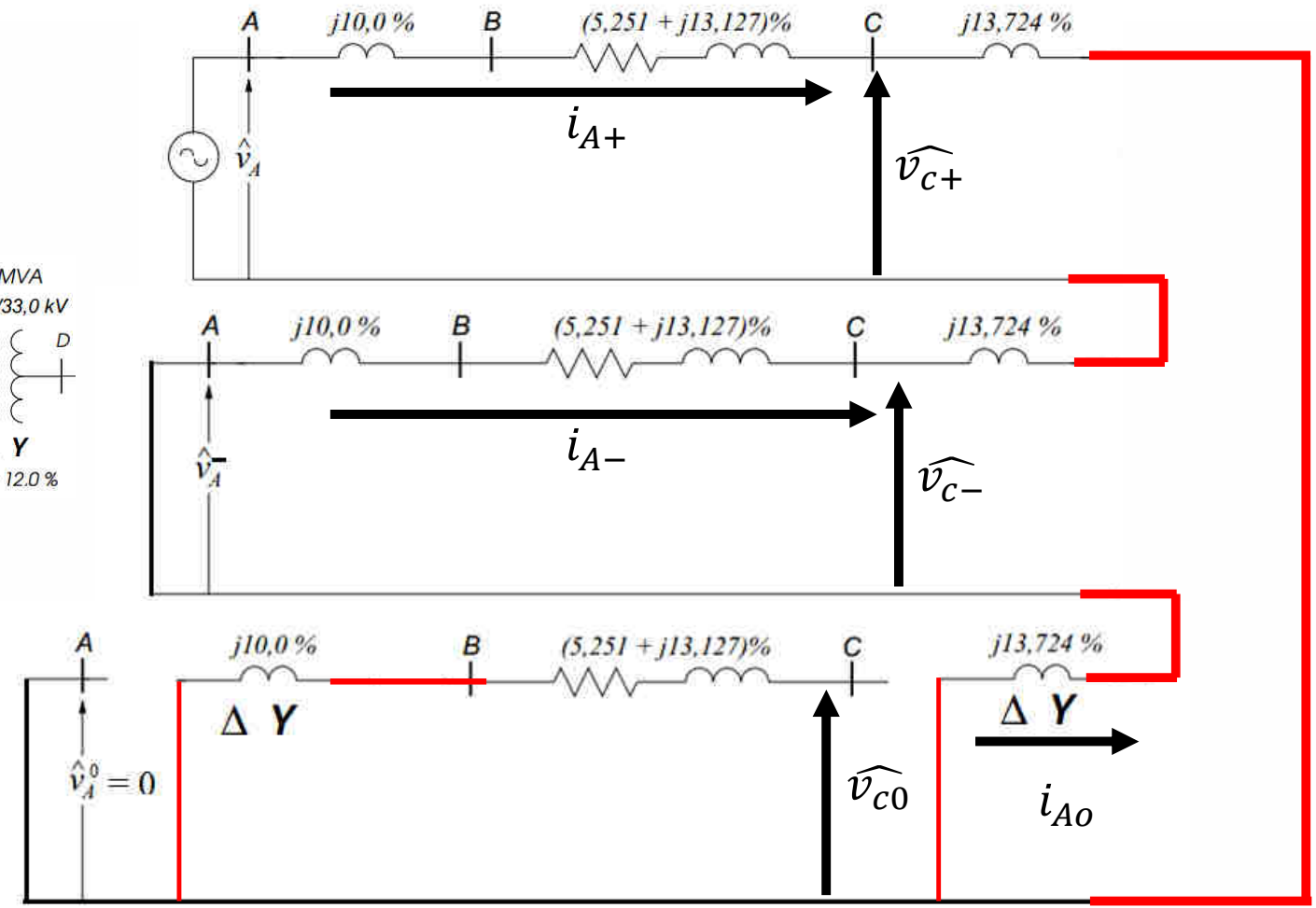
$$I_{A0}^{D} = 950{,}25\angle -83{,}15°A$$

$$\begin{bmatrix} I_A^D \\ I_B^D \\ I_C^D \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ a^2 & a & 1 \\ a & a^2 & 1 \end{bmatrix} \begin{bmatrix} I_{A+}^D \\ I_{A-}^D \\ I_{A0}^D \end{bmatrix}$$

$$\begin{bmatrix} I_A^D \\ I_B^D \\ I_C^D \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ a^2 & a & 1 \\ a & a^2 & 1 \end{bmatrix} \begin{bmatrix} 950{,}25\angle -83{,}15° \\ 950{,}25\angle -83{,}15° \\ 950{,}25\angle -83{,}15° \end{bmatrix}$$

$$\begin{bmatrix} I_A^D \\ I_B^D \\ I_C^D \end{bmatrix} = \begin{bmatrix} 2850{,}8\angle -83{,}15° \\ 0 \\ 0 \end{bmatrix} A$$


50 MVA
13,8/138,0 kV
40 MVA
132,0/33,0 kV
A
B
C
D
20,0 + j 50,0 ohm
Δ Y
x% = 10.0 %
Δ Y
x% = 12.0 %


A
j10,0 %
B
(5,251 + j13,127)%
C
j13,724 %
$\hat{v}_A$
i_{A+}
$\widehat{v_{c+}}$
A
j10,0 %
B
(5,251 + j13,127)%
C
j13,724 %
$\hat{v}_A$
i_{A-}
$\widehat{v_{c-}}$
A
j10,0 %
B
(5,251 + j13,127)%
C
j13,724 %
Δ Y
Δ Y
$\hat{v}_A^0 = 0$
$\widehat{v_{c0}}$
i_{Ao}

$$\widehat{v_{c+}} = 100\angle 0° - 23{,}716\angle 77{,}21° \times 1{,}1357\angle -83{,}15°$$

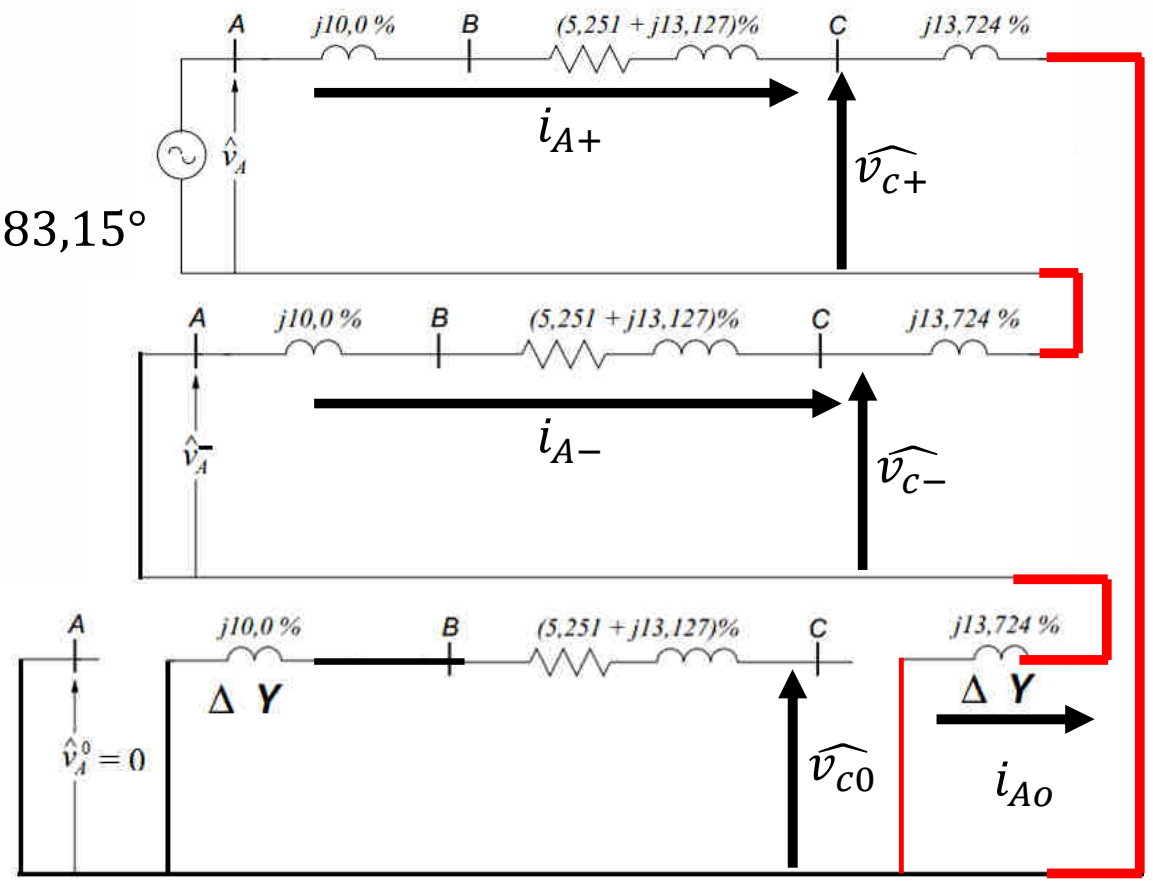
$$\widehat{v_{c+}} = 0{,}733\angle 2{,}18°\ pu$$

$$\widehat{v_{c-}} = 0 - 23{,}716\angle 77{,}21° \times 1{,}1357\angle -83{,}15°$$

$$\widehat{v_{c-}} = 0{,}269\angle 174{,}06°\ pu$$

$$\widehat{v_{c0}} = 0$$

$$\hat{i}_{A+} = 1{,}13\angle -83{,}15°pu$$



$$\widehat{v_{c+}} = 0{,}733\angle 2{,}18°\ pu$$

$$\widehat{v_{c-}} = 0{,}269\angle 174{,}06°\ pu$$

$$\begin{bmatrix} V_A^C \\ V_B^C \\ V_C^C \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ a^2 & a & 1 \\ a & a^2 & 1 \end{bmatrix} \begin{bmatrix} V_{A+}^C \\ V_{A-}^C \\ V_{A0}^C \end{bmatrix}$$

$$\begin{bmatrix} V_A^C \\ V_B^C \\ V_C^C \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ a^2 & a & 1 \\ a & a^2 & 1 \end{bmatrix} \begin{bmatrix} 0{,}733\angle 2{,}18° \\ 0{,}269\angle 174{,}06° \\ 0 \end{bmatrix} = \begin{bmatrix} 0{,}47\angle 6{,}85° \\ 0{,}92\angle -104{,}56° \\ 0{,}87\angle 105{,}48° \end{bmatrix} pu$$

$$\begin{bmatrix} V_A^C \\ V_B^C \\ V_C^C \end{bmatrix} = \begin{bmatrix} 0{,}47\angle 6{,}85° \\ 0{,}92\angle -104{,}56° \\ 0{,}87\angle 105{,}48° \end{bmatrix} \times 138 \cdot 10^3 = \begin{bmatrix} 64{,}53\angle 6{,}85° \\ 127{,}45\angle -104{,}56° \\ 120{,}02\angle 105{,}48° \end{bmatrix} kV$$

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Obrigado!

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