The following shows the application of the C matrix to the Active Transformation equations to determine I', Z' and finally V'. This is shown for the conductive compensated series machine and the uncompensated series machine........

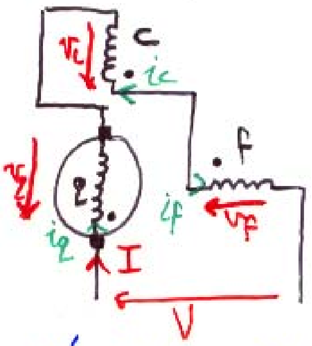
k30b

ACTIVE TRANSFORMATION FOR CONDUCTIVE COMPENSATION

$$\begin{bmatrix} V_q \\ V_c \\ V_f \end{bmatrix} = \begin{bmatrix} (R_q + jX_q) & jX_{qc} & NX_m \\ jX_{cq} & (R_c + jX_c) & 0 \\ 0 & 0 & (R_f + jX_f) \end{bmatrix} \cdot \begin{bmatrix} I_a \\ I_c \\ I_f \end{bmatrix}$$

$$[V] = [Z] \cdot [I]$$

- From inspection, $I = I_q = I_f = -I_c$, hence, we have:



$$\underset{\text{PRIMITIVE}}{I} = \underset{\text{CONNECTION}}{C} \; \underset{\text{ACTUAL}}{I'}$$

$$\begin{bmatrix} I_q \\ I_c \\ I_f \end{bmatrix} = \begin{bmatrix} 1 \\ -1 \\ 1 \end{bmatrix} \cdot [I]$$

- $V' = C_t^* V = C_t V$ since C_t is real
- Also, $V' = Z' I'$, where $Z' = C_t^* Z C = C_t Z C$

$$\underset{\text{(ACTUAL)}}{V'} = \underset{\text{(TRANSPOSE OF C)}}{C_t} \; \underset{\text{(PRIMITIVE)}}{V}$$

$$[V] = \begin{bmatrix} 1 & -1 & 1 \end{bmatrix} \begin{bmatrix} V_q \\ V_c \\ V_f \end{bmatrix}$$

$$V = V_q - V_c + V_f$$

$$\cdot\ ZC = \underbrace{\begin{bmatrix} (R_q + jX_q) & jX_{qc} & NX_m \\ jX_{cq} & (R_c + jX_c) & 0 \\ 0 & 0 & (R_f + jX_f) \end{bmatrix}}_{Z} \cdot \underbrace{\begin{bmatrix} 1 \\ -1 \\ 1 \end{bmatrix}}_{C}$$

$$ZC = \begin{bmatrix} (R_q + jX_q) - jX_{qc} + NX_m \\ jX_{cq} - (R_c + jX_c) \\ (R_f + jX_f) \end{bmatrix}$$

$$Z' = C_t ZC = \begin{bmatrix} 1 & -1 & 1 \end{bmatrix} \begin{bmatrix} (R_q + jX_q) - jX_{qc} + NX_m \\ jX_{cq} - (R_c + jX_c) \\ (R_f + jX_f) \end{bmatrix}$$

$$= \left[(R_q + jX_q - jX_{qc} + NX_m) - (jX_{cq} - R_c - jX_c) + (R_f + jX_f) \right]$$

collecting terms....

$$= (R_q + R_c + R_f) + NX_m + j(X_c + X_f - X_{qc} - X_{cq} + jX_q]$$

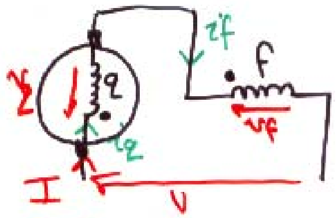
as before, $X_{qc} = X_{cq}$ & assuming perfect coupling & same no. turns, $X_{qc} = X_{cq} = X_c = X_q$

$$Z' = (\underbrace{R_q + R_c + R_f}_{R}) + NX_m + jX_f$$

· Finally, $V' = Z'I' = (R + NX_m + jX_f)I$

– The voltage equation for the transformed (actual) circuit

Same principle for uncompensated m/c .....



$$\underset{I}{\begin{bmatrix} I_f \\ I_q \end{bmatrix}} = \underset{C}{\begin{bmatrix} 1 \\ 1 \end{bmatrix}} \cdot \underset{I'}{\begin{bmatrix} I \end{bmatrix}}$$

$$\underset{V'}{\begin{bmatrix} V \end{bmatrix}} = \underset{C_t}{\begin{bmatrix} 1 & 1 \end{bmatrix}} \underset{V}{\begin{bmatrix} V_f \\ V_q \end{bmatrix}}$$

$$V = V_f + V_q$$

- $Z = \begin{bmatrix} (R_f + jX_f) & 0 \\ NX_m & (R_q + jX_q) \end{bmatrix}$

- $ZC = \begin{bmatrix} (R_f + jX_f) & 0 \\ NX_m & (R_q + jX_q) \end{bmatrix} \cdot \begin{bmatrix} 1 \\ 1 \end{bmatrix} = \begin{bmatrix} (R_f + jX_f) + 0 \\ NX_m + (R_q + jX_q) \end{bmatrix}$

- $Z' = C_t Z C = \begin{bmatrix} 1 & 1 \end{bmatrix} \begin{bmatrix} (R_f + jX_f) + 0 \\ NX_m + (R_q + jX_q) \end{bmatrix}$

$$= (R_f + jX_f) + NX_m + (R_q + jX_q)$$

$$= (R_f + R_q) + NX_m + j(X_f + X_q)$$

again, for $X_f = X_q = X$

$$Z' = R + NX_m + j2X$$

$$\Rightarrow V' = Z' I' = (R + NX_m + j2X) I$$