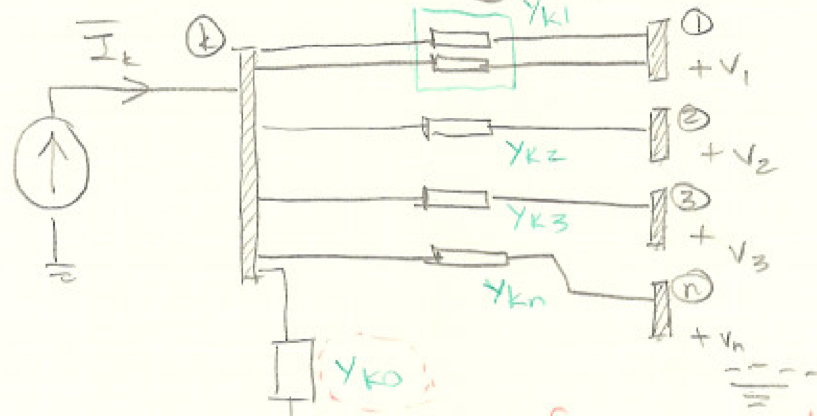
SYSTEM EQUATIONS

consider bus k of a system supplied by a current source $\bar{I}_k$ and is connected through admitances to other buses, including ground as shown below



at bus k, kirchoffs current law, we have

$$\bar{I}_k = \bar{I}_{k0} + \bar{I}_{k1} + \bar{I}_{k2} + \dots + \bar{I}_{kn}$$

$\bar{I}_k$: source current injected into bus k

$\bar{I}_{kj}$: current flowing from node k to node j

In any branch or group of parallel branches connected from k to j, the voltage drop is $\bar{V}_k - \bar{V}_j$

And we can write

$$\bar{I}_{kj} = \bar{Y}_{kj}(\bar{V}_k - \bar{V}_j)$$

where $\bar{Y}_{kj}$ is the sum of admitance from bus k to bus j.

$\bar{V}_k, \bar{V}_j$ are voltages measured $\overline{\text{wrt}}$ ground

combining the above we get

$$\bar{I}_k = \boxed{\sum_{\substack{j=0 \\ j \neq k}}^{n}} \bar{y}_{kj}(\bar{V}_k - \bar{V}_j) \qquad (3)$$

assume k is a number between Ø and j

for $k=2$, $n=3$, then

$$\bar{I}_2 = \bar{y}_{20}\bar{V}_2 + \bar{y}_{21}(\bar{V}_2 - \bar{V}_1) + \bar{y}_{23}(\bar{V}_2 - \bar{V}_3)$$

$$\bar{I}_2 = \boxed{(\bar{y}_{20} + \bar{y}_{21} + \bar{y}_{23})} V_2 - \bar{y}_{21} V_1 - \bar{y}_{23} V_3$$

equivelent to y_{22} in y_{bus}.

the above equation can be written in compact form

$$\bar{I}_2 = \bar{V}_2 \sum_{\substack{j=0 \\ j \neq 2}}^{3} \bar{y}_{kj} - \sum_{\substack{j=1 \\ j \neq 2}}^{3} \bar{y}_{2j} \bar{V}_j$$

Equation 3 given earlier as, can be written as:

$$\bar{I}_k = \bar{V}_k \sum_{\substack{j=0 \\ j \neq k}}^{n} \bar{y}_{kj} - \sum_{\substack{j=0 \\ j \neq k}}^{n} \bar{y}_{kj} \bar{V}_j$$

this equation can be written for every bus node except the reference (ground)

$$\begin{aligned} \bar{I}_1 &= y_{11}\bar{V}_1 + \dots + y_{1n}\bar{V}_n \\ \bar{I}_2 &= y_{21}\bar{V}_1 + \dots + y_{2n}\bar{V}_n \\ &\vdots \\ \bar{I}_n &= y_{n1}\bar{V}_1 + \dots + \bar{Y}_{nn}\bar{V}_n \end{aligned}$$

can be expressed as matrix.

where

$\bar{Y}_{kj}$: − (sum of admitances connected from k to j)

$\bar{Y}_{kk}$: (sum of all admitances connected to node k)

in power system problems, the source current are not known quatities. What is know a most buses is the complex power, then

$$\bar{S}_k = \bar{V}_k \bar{I}_k^*$$

$$\bar{I}_k = \frac{\bar{S}_k^*}{\bar{V}_k^*} = \frac{P_k - jQ_k}{\bar{V}_k^*} \quad (7)$$

where, $\bar{S}_k$ is the complex power injected into bus k and is positive for a source at bus k and negative for a load at bus k equ 7, takes the form,

$$\frac{\overline{S}_k}{\overline{V}_k} = \sum_{j=1}^{\infty} \overline{Y}_{kj}^{*} \, \overline{V}_j^{*}$$

note: $\overline{S}_k = P_k + jQ_k = \overline{V}_k \overline{I}_k^{*}$

$$\overline{S}_k = \overline{V}_k \sum_{j=1}^{\infty} \overline{Y}_{kj}^{*} \overline{V}_j^{*}$$

In polar form

$$\overline{V}_k = |\overline{V}_k| \angle \delta_k = |\overline{V}_k| e^{j\delta_k}$$

or $\overline{V}_k = |\overline{V}_k| [\cos \delta_k + j \sin \delta_k]$