The G-S Algorithm

Step 0: Formulate and assemble Y_{bus} in per unit

Step 1: Assign initial guesses to unknown voltage magnitudes and angles

$|V_1|=1.0, \quad \delta=0.0$

Step 2a: For Load Buses, find using (17) V_i .

$$V_i^{(m+1)} = \frac{1}{Y_{ii}}\left[\frac{P_i - jQ_i}{V_i^{(m)*}} - \sum_{\substack{k=1 \\ k\neq i}}^{n} Y_{ik}.V_k^{\beta} - \sum_{k=i+1}^{n} Y_{ik}.V_k^{(m)}\right]$$

$$\beta = m \; for \; k > i, \;\; \beta = m+1 \; for \; k < i$$

where, m = iteration number. For generator bus, find using (11) and (17) together. That is, find Qi first.

$$Q_i^{(m+1)} = -\operatorname{Im}ag[V_i^{*(m)}\{V_i^{(m)}Y_{ii} + \sum_{\substack{k=1 \\ k\neq i}}^{n} Y_{ik}V_k^{(m)}$$

Then

$$V_i^{(m+1)} = \frac{1}{Y_{ii}}\left[\frac{P_i - jQ_i}{V_i^{(m)*}} - \sum_{\substack{k=1 \\ k\neq i}}^{n} Y_{ik}.V_k^{\beta} - \sum_{k=i+1}^{n} Y_{ik}.V_k^{(m)}\right]$$

However, V_i is specified for generator busses. So:

$$V_i^{(m+1)} = \left|V_{i,spec}\right|\angle\delta_{icalc}^{(m+1)}$$

So, for example, if there are five busses in the system being studied, and one has determined new values of bus voltages at busses 1–3, then during the determination of bus voltage at bus 4, one should use these newly calculated values of bus voltages at 1, 2, and 3; busses 4 and 5 will have the values from the previous iteration.

Step 2b: for faster convergence, apply acceleration factor to load buses

$$V_{i,acc}^{(m+1)} = V_{i,acc}^{(m)} + \alpha(V_i^{(m)} - V_{i,acc}^{(m)})$$

where α= acceleration factor.

Step 3: Check Convergence

$$\left|\mathrm{Re}\right|[V_i^{(m+1)}] - \left|\mathrm{Re}\right|[V_i^{(m)}] \le \varepsilon$$

That is, the absolute value of the difference of the real part of the voltage between successive iterations should be less than a tolerance value ε. Typically, $\varepsilon \le 10^{-4}$, and also,

$$\left|\mathrm{Im}ag\right|[V_i^{(m+1)}] - \mathrm{Im}ag[V_i^{(m)}] \le \varepsilon$$

That is, the absolute value of the difference of the imaginary value of the voltage should be less than a tolerance value ε,

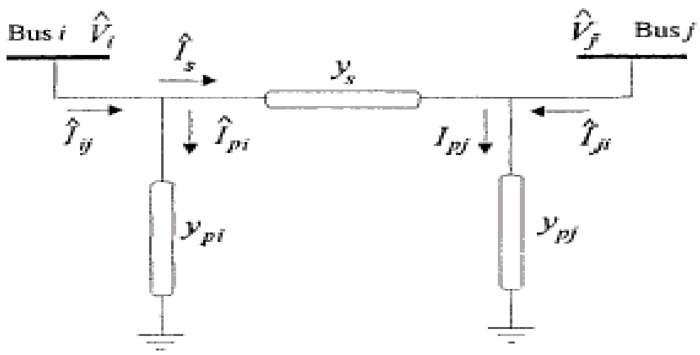


Figure : A two-bus system illustrating line-flow computation.

If the difference is greater than tolerance, return to Step 3. If the difference is less than tolerance, the solution has converged; go to Step 4.

Step 4: Find slack bus power Pg and Qg from equations (5) and (6).

Step 5: Find all line flows as described in the next section computing line flows. As the last step in any power-flow solution, one has to find the line flows. This is illustrated by the two-bus system shown in above Fig. Line current, Iij, at bus i is defined positive in the direction i to j.

$$I_{ik} = I_s + I_{pi} = (V_i - V_k).y_s + V_i.y_{pi}$$

Let S_{kj}, S_{jk} be line powers defined positive into the line at bus i and j, respectively.

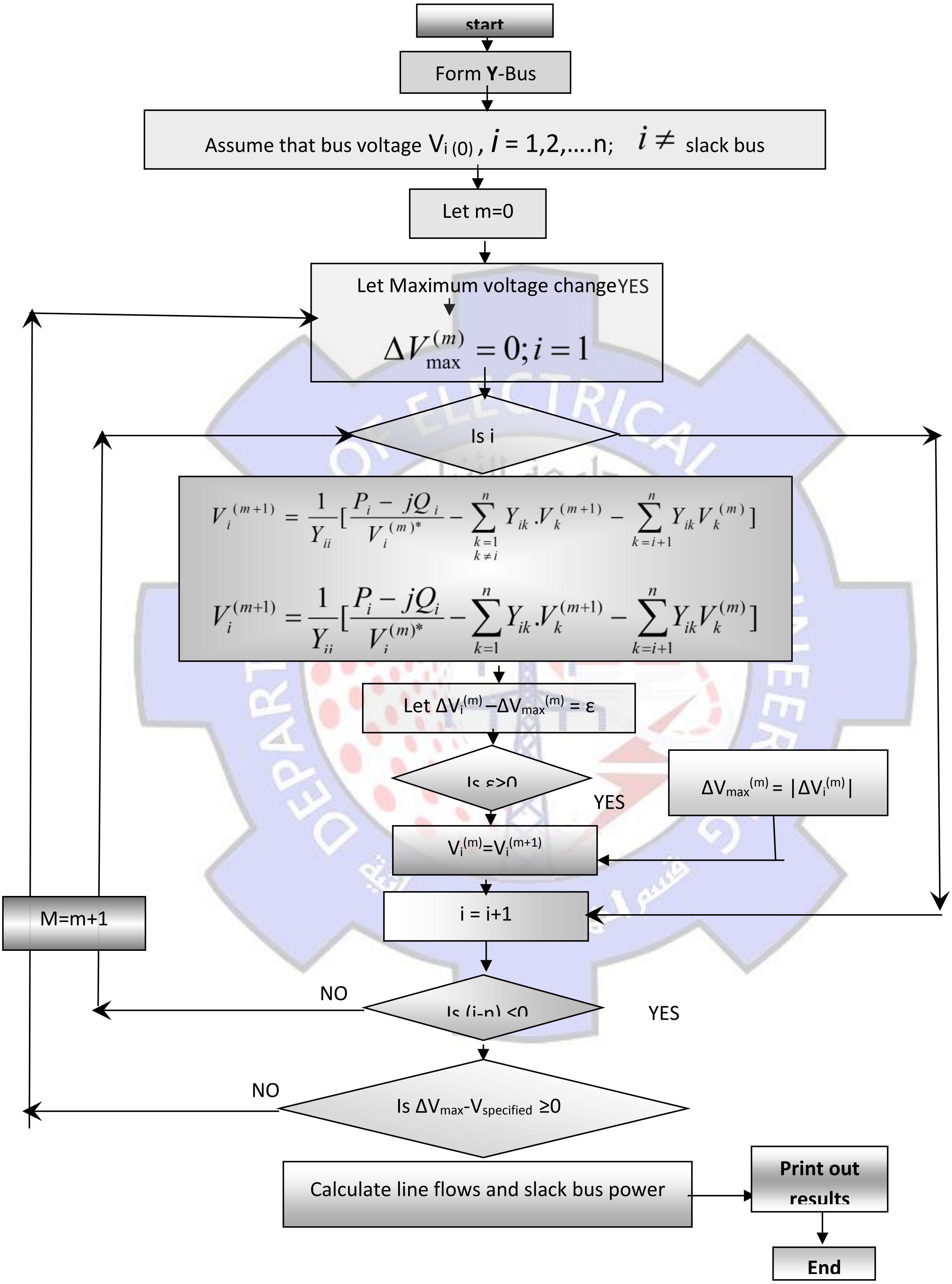
$$S_{ik} = P_{ik} + jQ_{ik} = V_i I_{ik}^* = V_i (V_i^* - V_k^*).y_s^* + |V_i|^2 .y_{pi}^* \qquad \text{(a-1)}$$

$$S_{ik} = P_{ik} + jQ_{ik} = V_i I_{ik}^* = V_i (V_i^* - V_j^*).y_s^* + |V_i|^2 .y_{pi}^* \qquad \text{(a-2)}$$

The power loss in line (i-j) is the algebraic sum of the power flows determined from (a-1) and (a-2).

$$S_{Lij} = S_{ij} + S_{ji}$$

Flowchart for **Gauss-Sediel** iterative method for load flow solution


start
Form Y-Bus
Assume that bus voltage $V_{i(0)}$, i = 1,2,....n; $i \neq$ slack bus
Let m=0
Let Maximum voltage change
YES
$\Delta V_{max}^{(m)} = 0; i = 1$
Is i
$V_i^{(m+1)} = \frac{1}{Y_{ii}}[\frac{P_i - jQ_i}{V_i^{(m)*}} - \sum_{k=1, k \neq i}^{n} Y_{ik}.V_k^{(m+1)} - \sum_{k=i+1}^{n} Y_{ik}V_k^{(m)}]$
$V_i^{(m+1)} = \frac{1}{Y_{ii}}[\frac{P_i - jQ_i}{V_i^{(m)*}} - \sum_{k=1}^{n} Y_{ik}.V_k^{(m+1)} - \sum_{k=i+1}^{n} Y_{ik}V_k^{(m)}]$
Let $\Delta V_i^{(m)} - \Delta V_{max}^{(m)} = \varepsilon$
Is ε>0
YES
$\Delta V_{max}^{(m)} = |\Delta V_i^{(m)}|$
$V_i^{(m)} = V_i^{(m+1)}$
i = i+1
M=m+1
NO
Is (i-n) <0
YES
NO
Is $\Delta V_{max} - V_{specified} \geq 0$
Calculate line flows and slack bus power
Print out results
End