Power flow solution by Gauss- Seidel Method:

⑤ ⑧ ①

→ This is the first Iterative method to find out the Power flow Equations.

For this method we again start with the basics of Network equations i-e.

$$I_{BUS} = Y_{BUS} \cdot V_{BUS}$$

and for any ~~bus~~ particular bus K.

$$I_K = \sum_{n=1}^{N} Y_{Kn} V_n$$

The Complex Power

$$S_K = P_K + jQ_K = V_K I_K^*$$

$$P_K + jQ_K = V_K \left[\sum_{n=1}^{N} Y_{Kn} V_n \right]^* \text{, where } K = 1, 2, \ldots N.$$

From Complex Power

$$I_K = \frac{P_K - jQ_K}{V_K^*}$$

Also

$$I_K = \sum_{n=1}^{N} Y_{Kn} V_n \quad \text{or}$$

$$I_K = Y_{K1} V_1 + Y_{K2} V_2 + \cdots + Y_{KK} V_K \cdots + Y_{KN} \cdot V_N$$

From ~~this~~ the above eq, ~~If we leave~~

$$V_K = \frac{1}{Y_{KK}} \left[I_K - \left(\sum_{n=1}^{K-1} Y_{Kn} V_n + \sum_{n=K+1}^{N} Y_{Kn} V_n \right) \right]$$

or

$$V_K = \frac{1}{Y_{KK}} \left[\frac{P_K - jQ_K}{V_K^*} - \left(\sum_{n=1}^{K-1} Y_{Kn} V_n + \sum_{n=K+1}^{N} Y_{Kn} V_n \right) \right]$$

where $K = 1, 2, \ldots N$.

This is the equation we get for finding out V_k
where $k = 1, 2, \ldots N$. i-e for each or any bus we can
used this equation.

⇒ we Can write this equation for any buses except the
Swing bus.

Iterative Procedure:-

1):- Make an initial guess $|V_i|(0)$ and $\delta_i(0)$.
Normally we use a flat start that is
$|V_i|^{(0)} = \underline{1.0 \, P.U}$ and $\delta_1(0) = 0.0^\circ$

because in normal condition the
Voltage magnitudes at all buses
are going to be very near to 1. P.U.

2):- Use this solution in PFE to obtain a better
first solution. and this solution is called improved
estimate of V_K.

3):- First Solution is used to obtain a better
second solution and so on.
i-e we substitute the new value in place
of the old values to again get an improved
estimate of V_K and continues till the values
did not Converge i-e the change in values from the
Previous iteration to the Current iteration is not so
much.
So, in mathematicall form we can write.

$$V_K^{i+1} = \frac{1}{Y_{KK}}\left[\frac{P_K - jQ_K}{V_K^{i*}} - \left(\sum_{n=1}^{K-1} Y_{Kn} V_n^{i+1} + \sum_{n=K+1}^{N} Y_{Kn} V_n^{i}\right)\right]$$

$K = 1, 2, \ldots N$; i is iteration count.

Algorithm steps :

1). With P_{gi}, Q_{gi}, P_{Li} and Q_{Li} known. Calculate bus injections P_i, Q_i.

2). Form Y_{Bus} Matrix.

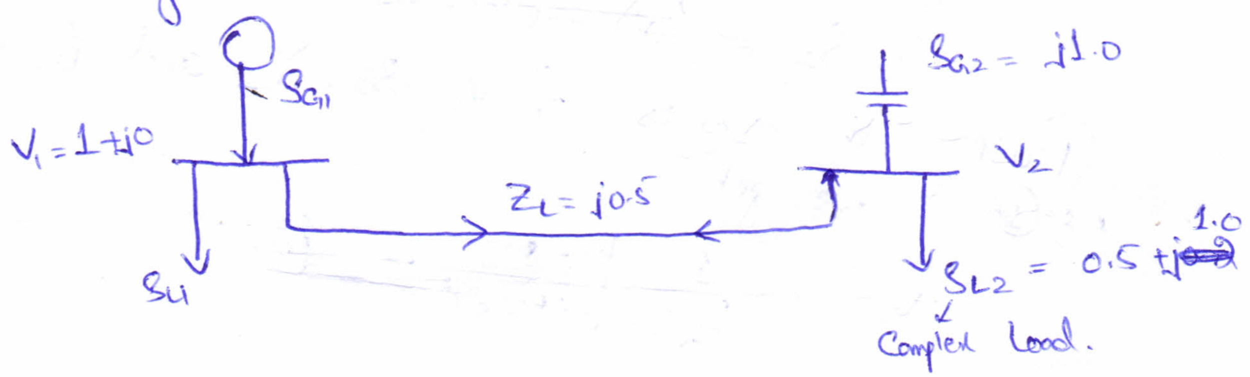
3). Set initial voltage $V_i^{(0)}$, $\delta_i(0)$

4). Iteratively solve equation.

$$V_K^{i+1} = \frac{1}{Y_{KK}}\left[\frac{P_K - jQ_K}{V_K^{*}} - \left(\sum_{n=1}^{K-1} Y_{Kn} V_n^{i+1} + \sum_{n=K+1}^{N} Y_{Kn} V_n^{i}\right)\right]$$

to obtain new values of bus voltages.

Example: For the system shown, $Z_L = j0.5$, $V_1 = 1\angle 0^\circ$, $S_{G2} = j1.0$ and $S_{L2} = 0.5 + j1.0$. Find V_2 using Gauss-Seidal Iteration Technique?



Sol. Bus 1 can be taken as a slack bus because the Voltage angle and magnitudes are Known and also we dont know the generation because we assigned all the losses to this bus 1.

First, we Calculate the elements of the Y_{Bus}.

For $Z_L = j0.5$, we have.

$$Y_{11} = \frac{1}{Z_{11}} = \frac{1}{j0.5} = -j2$$

so

$$Y_{11} = -j2$$

$$Y_{12} = j2$$

$$Y_{21} = j2$$

$$Y_{22} = -j2$$

we iterate on V_2 using the equation below.

$$V_2^{n+1} = \frac{1}{Y_{22}}\left[\frac{S_2^*}{(V_2^n)^*} - Y_{21} \cdot V_1\right] \longrightarrow (1)$$

Given $V_1 = 1\angle 0^\circ$

$$S_2 = S_{G2} - S_{L2} = (0+j1.0) - (0.5+j1.0) = -0.5$$

$$\cancel{= (0+j1.0) - (0.5+j1.0) = (-0.5+}$$

$$S_2 = \cancel{(0) - (0.5) = -0.5} \; -0.5$$

Putting the values of V_1, S_2, Y_{22} and Y_{21} in eq (1) we get.

$$\cancel{V_2^{n+1} = \frac{1}{-j2}\left[\frac{-0.5}{(1\angle 0^\circ)^*} - j2\right]}$$

$$V_2^{n+1} = \frac{Y_{21}}{Y_{22}}\left[\left(\frac{0.5}{Y_{21}(V_2^n)^*}\right) + V_1\right]$$

$$= \frac{j2}{-j2}\left[\frac{-0.5}{-j2(V_2^n)^*}\right] + 1.0]$$

$$= -1\left[\left(\frac{-0.5}{-j2(V_2^n)^*}\right) + 1.0\right]$$

$$= -1\left[\left(\frac{0.25j}{(V_2^n)^*}\right) + 1.0\right]$$

$$= -j\left[\frac{0.25}{(V_2^n)^*}\right] + 1.0 \quad \cdots (2)$$

we start with the guess, taking $V_2^{(0)} = 1\angle 0^\circ$ and iterate equation (2)

we have $V_2^0 = 1 + j0$

Putting in equation (2), and iteration for V_2, we get.

$$V_2^1 = -j\left[0.25/(1+j0)^*\right] + 1.0$$

$$= 1.0 - j0.25$$

$$= 1.3077\angle -14.036^\circ$$

$$V_2^2 = -j\left[0.25/(1.0-j0.25)^*\right] + 1.0$$

$$= \frac{(1.0 - j0.25)}{(1.0 + j0.25)} = \cancel{1.0}\ 0.970\angle -14.036^\circ$$