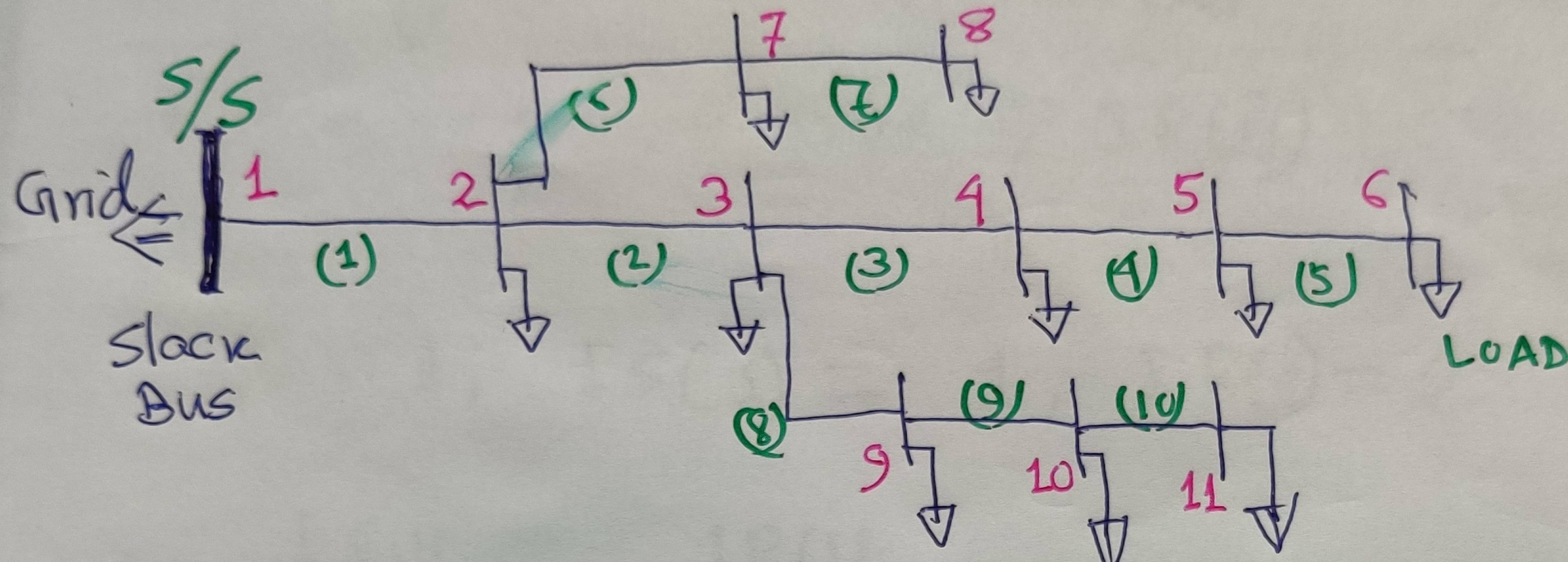
Radial Distribution Power Flow

A) Identification of Nodes Beyond Each Branch



Branch No: (j)	Sending end node, IS(j)	Receiving end node IR(j)
1	1	2
2	2	3
3	3	4
4	4	5
5	5	6
6	2	7
7	7	8
8	3	9
9	9	10
10	10	11

Consider Branch-1

Branch Number ⇒ jj

Sending end node ⇒ IS(jj)

Receiving end node ⇒ IR(jj)

When

$jj = 1, \quad IS(1) = 1, \quad IR(1) = 2$

IS(1)	IR(1)
1	2 ✓
2	3 ✓
2	7 ✓
3	4 ✓
3	9 ✓
7	8 ✓
4	5 ✓
9	10 ✓
5	6 ✓
10	11 ✓

Beyond Branch 1, Total number of nodes = $\boxed{10}$

2, 3, 7, 4, 9, 8, 5, 10, 6, 11

Consider Branch – 2

$jj = 2$

$IS(2) = 2, \quad IR(2) = 3$

IS(2)	IR(2)
2	3✓
3	4✓
3	9✓
4	5✓
9	10✓
5	6✓
10	11

Beyond Branch 2, Total number of nodes = $\boxed{6}$

3, 4, 9, 5, 10, 6, 11

Consider Branch-3

$jj = 3, \quad IS(3) = 3, \quad IR(3) = 4$

IS(3)	IR(3)
3	4 ✓
4	5 ✓
5	6 ✓

Beyond Branch 3, Total number of nodes = $\boxed{3}$

4, 5, 6

Consider Branch-4

$jj = 4, \quad IS(4) = 4, \quad IR(4) = 5$

IS(4)	IR(4)
4	5 ✓
5	6 ✓

Beyond Branch 4, Total number of nodes = $\boxed{2}$

5, 6

Consiter Branch - 5

$jj = 5$, $IS(5) = 5$, $IR(5) = 6$

IS(5)	IR(5)
5	6 ✓

~~Total number of nodes~~

Beyond Branch 5, Total number of node = $\boxed{1}$

6

Consider Branch - 6

$jj = 6$, $IS(6) = 2$, $IR(6) = 7$

IS(6)	IR(6)
2	7 ✓
7	8 ✓

Beyond Branch 6, Total number of nodes = $\boxed{2}$

7, 8

Consider Branch-7

$jj = 7$, $IS(7) = 7$, $IR(7) = 8$

Beyond Branch 7, Total number of node $= \boxed{1}$

8,

Consider Branch-8

$jj = 8$, $IS(8) = 3$, $IR(8) = 9$

IS(8)	IR(8)
3	9 ✓
9	10 ✓
10	11 ✓

Beyond Branch 8, Total number of nodes $= \boxed{3}$

9, 10, 11

Consider Branch 9

jj = 9, IS(9) = 9, IR(9) = 10

IS(9)	IR(9)
9	10 ✓
10	11 ✓

Beyond Branch 9, Total number of nodes = $\boxed{2}$

10, 11

Consider Branch 10

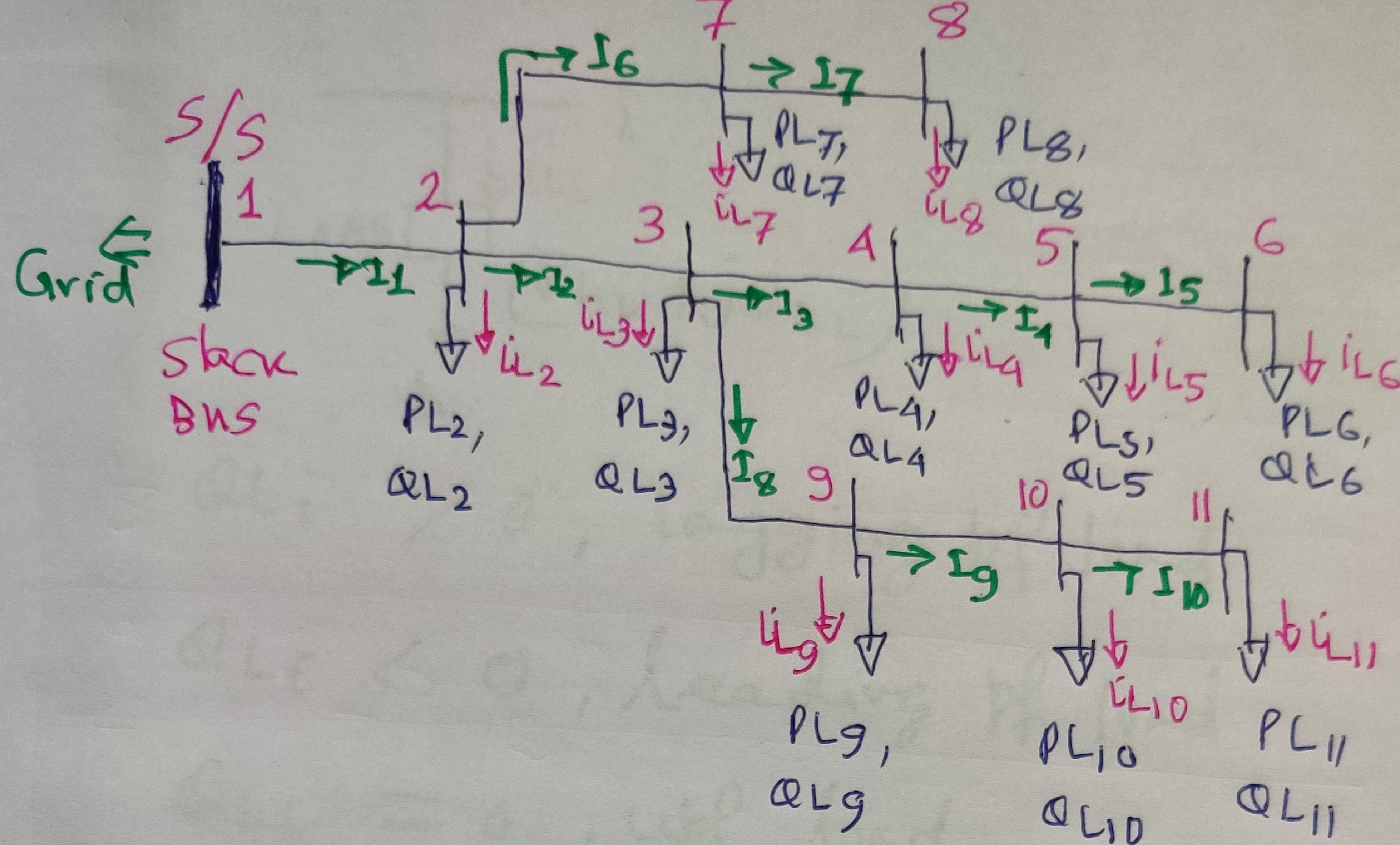
jj = 10, IS(10) = 10, IR(10) = 11

IS(10)	IR(10)
10	11 ✓

~~Total~~ Beyond Branch 10, Total number of node = $\boxed{1}$

11.

Brnds	Other option
1	2, 3, 4, 5, 6, 7, 8, 9, 10, 11
2	3, 4, 5, 6, 9, 10, 11
3	4, 5, 6
4	5, 6
5	6
6	7, 8
7	8
8	9, 10, 11
9	10, 11
10	11



PL ⇒ real power load

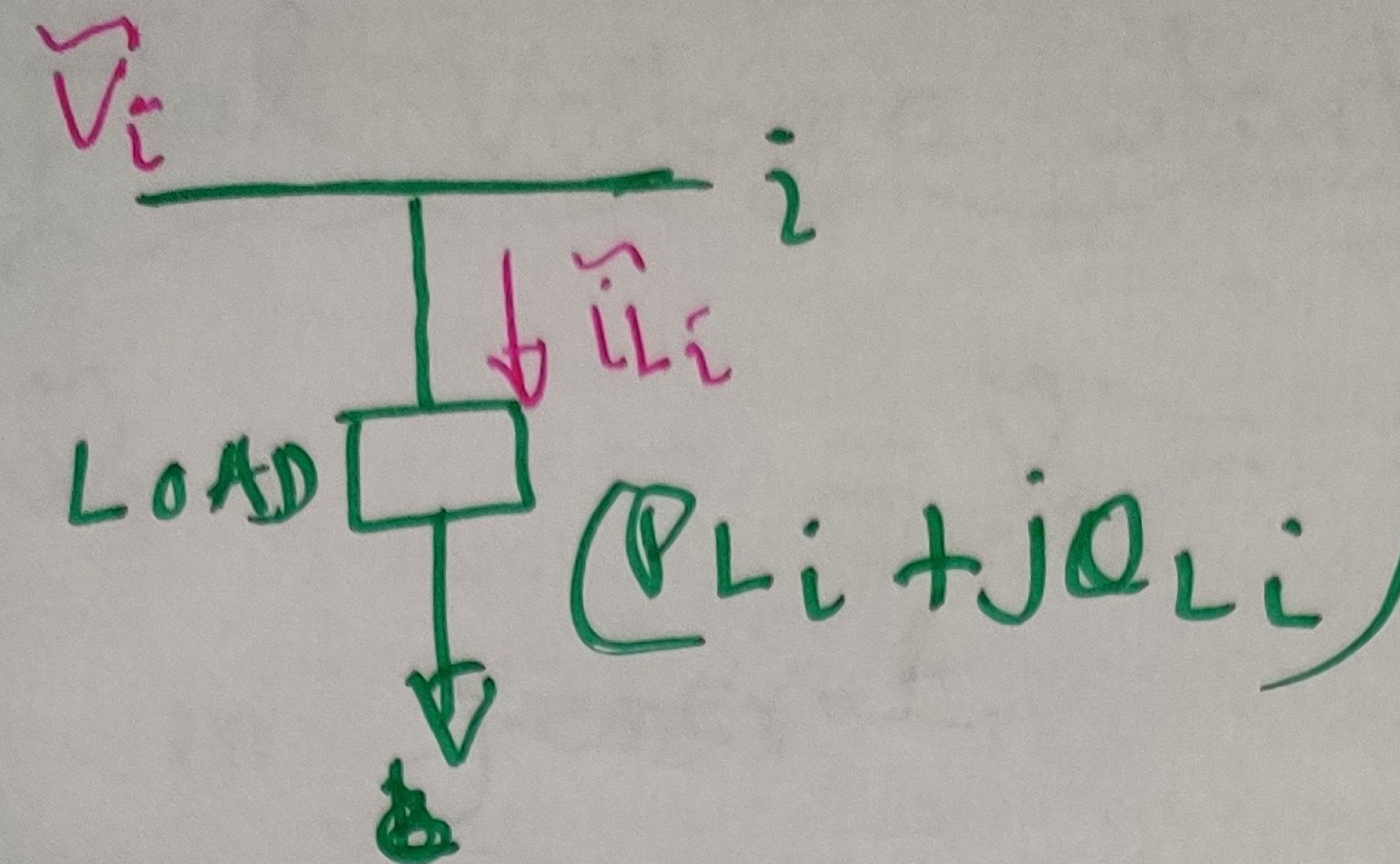
QL ⇒ reactive powerload

(PL_i, Q_{Li}) real and reactive power load of node i respectively.

for $i = 2, 3, \ldots, 11$

iL_i = load current of node i
for $i = 2, 3, \ldots, 11$.

$I_1, I_2, \ldots, I_{10}$ ⇒ Branch currents



$Q_{Li} > 0$, lagging pf load

$Q_{Li} < 0$, leading pf load

$Q_{Li} = 0$, upf load.

$$P_{Li} - jQ_{Li} = \tilde{V}_i^* \, \tilde{i}_{L_i}$$

$$\therefore \quad \tilde{i}_{L_i} = \frac{(P_{Li} - jQ_{Li})}{\tilde{V}_i^*} \quad \text{--- (1)}$$

Node 1 is slack bus

$\therefore \quad \tilde{V}_1 = V_1 \angle \delta_1$,

Assume $V_1 = 1.0$ pu, $\delta_1 = 0.0°$

Flat Voltage Start

$$\tilde{V}_2 = \tilde{V}_3 = \cdots = \tilde{V}_{11} = 1\angle 0° = V_1 \angle \delta_1$$

or in general,

$$\tilde{V}_i = V_1 \angle \delta_1 = 1\angle 0° \text{ pu}$$

for $i = 2, 3, \cdots, 11$ $\quad (NB = 11)$

Real and Reactive power loads at each node is known.
Therefore, initial load current at each node can easily be computed using Eq.(1).

~~Afr~~ After computing load currents initial branch currents can easily be computed, i.e.,

$$\hat{I}_1 = \hat{i}L_2 + \hat{i}L_3 + \hat{i}L_4 + \hat{i}L_5 + \hat{i}L_6 + \hat{i}L_7 + \hat{i}L_8 + \hat{i}L_9 + \hat{i}L_{10} + \hat{i}L_{11}$$

$$\hat{I}_2 = \hat{i}L_3 + \hat{i}L_4 + \hat{i}L_5 + \hat{i}L_6 + \hat{i}L_9 + \hat{i}L_{10} + \hat{i}L_{11}$$

$$\hat{I}_3 = \hat{i}_{L_4} + \hat{i}_{L_5} + \hat{i}_{L_6}$$

$$\hat{I}_4 = \hat{i}_{L_5} + \hat{i}_{L_6}$$

$$\hat{I}_5 = \hat{i}_{L_6}$$

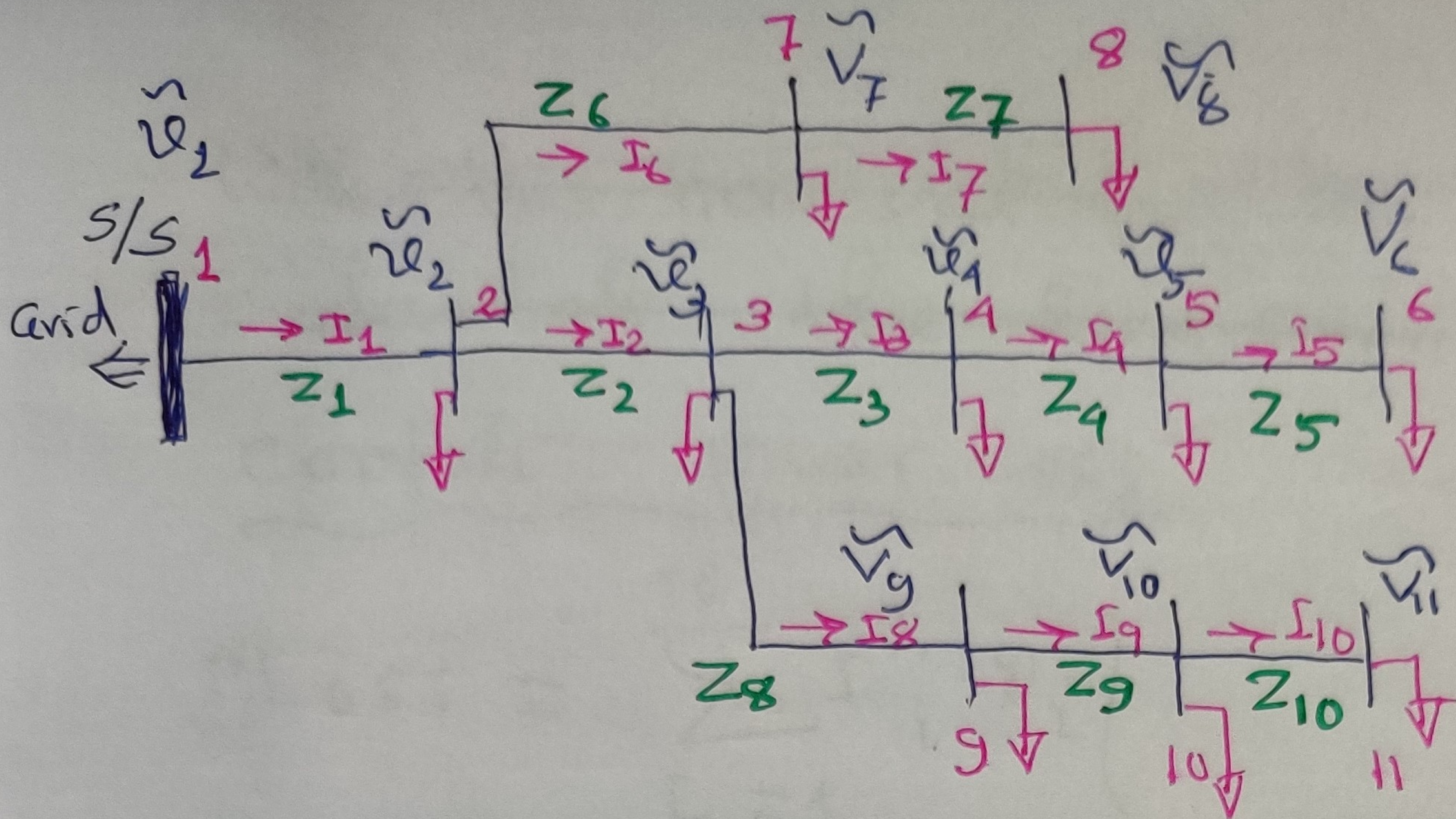
$$\hat{I}_6 = \hat{i}_{L_7} + \hat{i}_{L_8}$$

$$\hat{I}_7 = \hat{i}_{L_8}$$

$$\hat{I}_8 = \hat{i}_{L_9} + \hat{i}_{L_{10}} + \hat{i}_{L_{11}}$$

$$\hat{I}_9 = \hat{i}_{L_{10}} + \hat{i}_{L_{11}}$$

$$\hat{I}_{10} = \hat{i}_{L_{11}} \quad \text{.....} (2)$$



$$\tilde{V}_2 = \tilde{V}_1 - \tilde{I}_1 Z_1$$
$$\tilde{V}_3 = \tilde{V}_2 - \tilde{I}_2 Z_2$$
$$\tilde{V}_4 = \tilde{V}_3 - \tilde{I}_3 Z_3$$
$$\tilde{V}_5 = \tilde{V}_4 - \tilde{I}_4 Z_4$$
$$\tilde{V}_6 = \tilde{V}_5 - \tilde{I}_5 Z_5$$
$$\tilde{V}_7 = \tilde{V}_2 - \tilde{I}_6 Z_6$$
$$\tilde{V}_8 = \tilde{V}_7 - \tilde{I}_7 Z_7$$
$$\tilde{V}_9 = \tilde{V}_3 - \tilde{I}_8 Z_8$$
$$\tilde{V}_{10} = \tilde{V}_9 - \tilde{I}_9 Z_9$$
$$\tilde{V}_{11} = \tilde{V}_{10} - \tilde{I}_{10} Z_{10} \quad -(3)$$

~~for m_1 = IS~~

```
for jj = 1, 10
    m1 = IS(jj)
    m2 = IR(jj)
    V(m2) = V(m1) - I(jj) Z(jj)
end
```

Page-13

~~With this new set of voltages, calculate the load currents~~

compute power Loss

$$\left.\begin{aligned} P_{Loss} &= \sum_{i=1}^{10} I_i^2 \cdot r_i \\ Q_{Loss} &= \sum_{i=1}^{10} I_i^2 x_i \end{aligned}\right\} \quad -(4)$$

$I_i \Rightarrow$ magnitude of current in branch - i

With this new set of voltages, calculate the load currents $\vec{IL}_i$ using Eq.(1) for $i = 2, 3, \ldots, 11$.

Then compute branch currents using Eqn.(2). Then compute voltages using Eqn.(3).

Then compute Loss using Eqn (4).

Convergence Criteria

$$\Delta P = \left| PLoss^{(K+1)} - PLoss^{(K)} \right|$$

$$\Delta Q = \left| QLoss^{(K+1)} - QLoss^{(K)} \right|$$

If $\{(\Delta P \,\&\, \Delta Q) < \epsilon\}$ Solution has converged.