(4) (7) (1)

Characteristics of Power flow Equations

1). Power flow Equations are Algebraic Equations b/c these are dealing with a static system.

2). These Equations since they involve Cos and Sin term as well as they have the multiplication of voltages involved therefore these equations are non linear Equations and therefore in general we need Iterative methods to solve this. (i-e Gauss seidal and Newton Raphson Method).

3). Power flow equations relate the injections i-e Real and Reactive Power injections at the bus in terms of Voltage Magnitude and angle at various bus bars in the system and the admittance Matrix of the system.

i-e $P, Q \rightarrow f(V, \delta)$

Characterization of Variables.

1). Loads (P_L, Q_L) → Uncontrolled (Disturbance variables) i-e no control from the operator.

2). Generation (P_G, Q_G) → Control variables. i-e. Control from the operators (Real and Reactive Power can always balance with the load)

3). The voltage at various bus bars form the <u>state variable</u> i.e. If we know the voltage magnitude and angle of the bus bar we can easily find out the Power flow in each and every line and the power injections in different bus bars.

So ⇒ For a Given Operating Conditions the Loads and generators at all buses are known (specified). then to find the Voltage Magnitude and Angle (V, δ) at all the bus bars.

Problem in Power flow solution:-

There is one problem in doing Power flow sol that we cannot know ~~bef~~ all the generations. All the Loads are known to us but generations are in our control and one can say that all generations are known to us but there is one problem. The Problem is till all the generations are available, we donot know what is the loss in the system.? Since we cannot know the loss in the system we cannot know how much the generation b/c the sum of load and the no. of losses must be equal to the total generation.

Solutions

To Overcome this problem.

→ we Choose one bus as reference bus which takes up all these losses which we find after the solution so at one bus we cannot specify the generation. Generally, this is a bus which have very large generation available so, that there will be no problem for it to take a losses. This bus in Power system terminology is called a "slack bus."

Classification of Busbars:- (~~V and δ specified~~)

In Power System Network we have different types of Busbars. The soln of Power flow equations depends on the type of Busbar.

1). **Swing Bus or Slack bus:-** (V and δ specified)

where we dont specify the generation but we specify the Voltage Magnitude and angle. Since this bus is a reference bus the Angle specified is Normally zero. Since it is a generating bus which have its own Voltage magnitude so the voltage level is fixed. i-e mostly 1.0 P.U.

So, Swing bus has voltage Magnitude and Angle specified.

2). **PV Bus (Voltage Control Bus):-** (P and V specified)

The Busbars in which we have the voltage Magnitude and a Real Power is specified. Voltage Regulators are installed which regularly check the voltage levels.

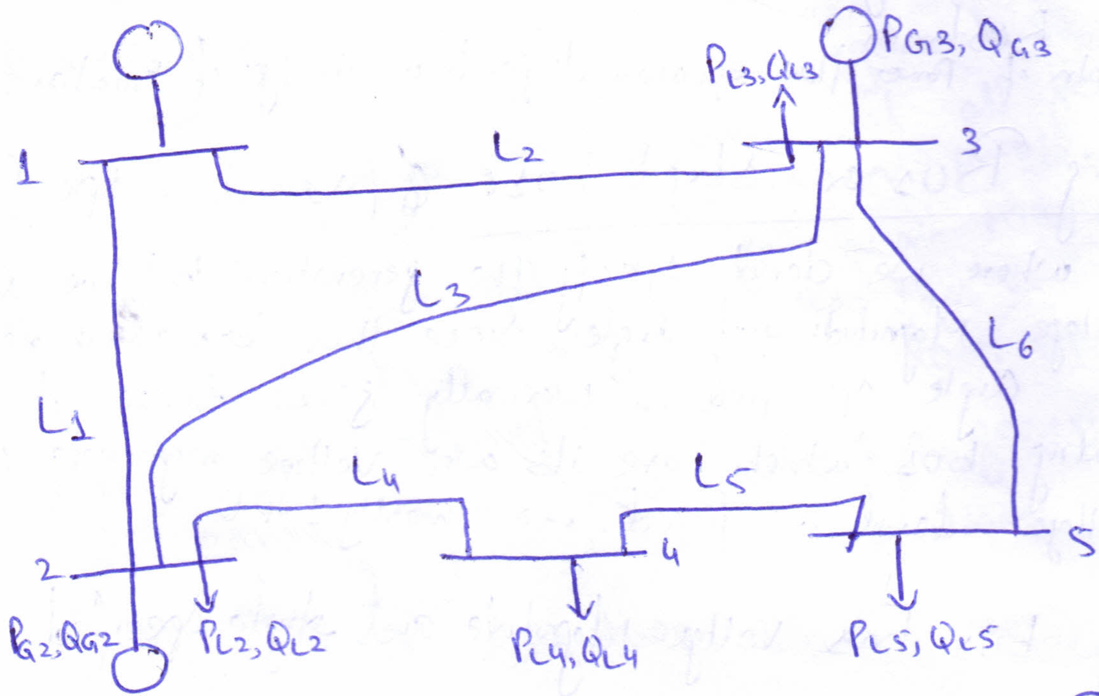
3). **PQ Bus (load Bus):-** (P and Q specified).

where both the Real and Reactive Powers are specified.

⇒ So with each bus, 4 variables (P, Q, V and δ) are associated.

Depending on the type of bus two variables are known and two Unknown variables are obtained from Power flow solution.

5 Bus Power Systems



we have normally two types of data Provided.
1) Bus Data. 2) Line Data.
e.g The Bus Data provided for this system is

Bus Data

Bus type	V P.U	δ deg	P_G P.U	Q_G P.U	P_L P.U	Q_L P.U
1 Swing	1.03	0	–	–	0	0
2 PQ	–	–	1.4	0.8	3.0	1.2
3 PV	1.05	–	2.2	–	0.8	0.4
4 PQ	–	–	0	0	0.6	0.3
5 PQ	–	–	0	0	0.5	0.2

LINE DATA

Line charging susceptance → B

Bus to bus	R P.U	X P.U	B P.U	Maximum MVA P.U
2 – 4	0.0090	0.100	1.72	12.0
2 – 5	0.0045	0.050	0.88	12.0
4 – 5	0.00225	0.025	0.44	12.0
1 – 5	0.00150	0.02	0	6.0
3 – 4	0.00075	0.01	0	10.0

This data is used for finding the Y_{bus} Matrix.

If we look at the system we find that

	Bus type	No. of buses	Specified Quantities	No. of Equations	No. of (V, δ) state variables
1	Swing	1	V, δ	0	0
2	PQ	3	P, Q	2×3 = 6	2×3 = 6
3	PV	1	P, V	1	1
Total		5	10	7	7