LOAD FLOW ANALYSIS

INTRODUCTION

Network equations can be formulated systematically in a variety forms. However, the node-voltage method, which is the most suitable form for many power system analysis, is commonly used.

The formulation of the network equations in the nodal admittance form result in complex linear simultaneous algebraic equations in terms of node currents. When node currents are specified, the set of linear equations can be solved for the nod voltages. However, in a power system, powers are known rather than currents. Thus, the resulting equations in terms of power, known as the power flow equations, become nonlinear and must be solved by iterative techniques. Power flow studies, commonly referred to as load flow. They are necessary for planning, operation, economic scheduling, exchange of power between utilities, transient stability and contingency studies.

The analysis deals with the steady-state analysis of an interconnected power system during normal operation. The system is assumed to be operation under balanced condition and is represented by a single-phase network. The network contains hundreds of nodes and branches with impedances specified in per unit on a common MVA base.

Load flow or power flow is the solution obtained for the power system under static (steady state) conditions of operation.

Load flow studies are undertaken to determine:-

The line flows (active & reactive power flow) .

The bus voltages and system voltage profile .

The phase angles of load bus voltages , reactive power at generator bus .

The effect of changes in circuit configuration, and incorporating new circuits on system loading .

The effect of temporary loss of transmission capacity and/or generation on system loading and accompanied effects .

Economic system operation .

Transformer tap setting for economic operation.

Possible improvements to an existing system by change of conductor sizes and system voltages .

For the purpose of Load flow studies, a single phase representation of the power network is used since the system is generally balanced. The generators are provided with voltage magnitude and phase angle controls. The loads are represented by constant impedances. Meters are provided on the panel board for measuring voltages, currents, and powers. The load flow solution is obtained directly from measurements for any system simulated on the analyzer. With the advent of the modern digital computer processing large storage and high speed, the mode of Load flow studies have changed from analogue to digital simulation. A large number of algorithms are developed to digital power flow solution. In the network at each bus or node there are four variables:

(i) Voltage Magnitude $|V|$. (ii) Voltage Phase Angle. δ

(iii) Real Power. P (iv) Reactive Power. Q

Out of these four quantities, two of them are specified at each bus and the remaining two are determined from the load flow solution.
The system buses are generally classified into three types :

Types of network buses:

Slack bus (swing bus): Is taken as reference where the magnitude and phase angle of the voltage ($|V|$, δ) are specified. This bus makes up the difference between the scheduled loads and generated power that are caused by losses in the network.

Load buses (*P* - *Q* buses): At these buses the P and Q are specified. The magnitude and the phase angle ($|V|$, δ) of the bus voltages are unknown.

Regulated buses ($P-V$ buses): These buses are the generator buses (voltage controlled buses). At these buses $|V|$ and P are specified. The δ and Q are to be determined. The limits on the value of the Q are also specified.

Bus	Specified variables	Computed variables
Slack-bus	Voltage magnitude and its phase angle	Real and reactive powers
Generator bus(PV-bus or voltage controlled bus)	Magnitude of bus voltages and real powers (limit on reactive powers)	Voltage phase angle and reactive power
Load bus (PQ)	Real and reactive powers	Magnitude and phase angle of bus voltages