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LOAD FLOW ANALYSIS BY NEWTON RAPHSON METHOD USING MATLAB

**Abstract:Power flow analysis is the backbone of power system analysis and design. They are necessary for planning, operation, economic scheduling and exchange of power between utilities. The principal information of power flow analysis is to find the magnitude and phase angle of voltage at each bus and the real and reactive power flowing in each transmission lines. Power flow analysis is an importance tool involving numerical analysis applied to a power system. In this analysis, iterative techniques are used due to there no known analytical method to solve the problem. To finish this analysis there are methods of mathematical calculations which consist plenty of step depend on the size of system. This process is difficult and takes a lot of times to perform by hand. The objective of this project is to develop a toolbox for power flow analysis that will help the analysis become easier. Power flow analysis software package develops by the author use MATLAB programming.**

**1.INTRODUCTION**

Load flow studies are used to ensure that electrical power transfer from generators to consumers through the grid system is stable, reliable and economic. Conventional techniques for solving the load flow problem are iterative, using the Newton-Raphson or the Gauss-Seidel methods [1]. Load flow analysis forms an essential prerequisite for power system studies. Considerable research has already been carried out in the development of computer programs for load flow analysis of large power systems. However, these general purpose programs may encounter convergence difficulties when a radial

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distribution system with a large number of buses is to be solved and, hence, development of a special program for radial distribution studies becomes necessary[1],[2]. There are many solution techniques for load flow analysis. The solution procedures and formulations can be precise or approximate, with values adjusted or unadjusted, intended for either on-line or off-line application, and designed for either single-case or multiple-case applications. Since an engineer is always concerned with the cost of products and services, the efficient optimum economic

 operation and planning of electric power generation system have always occupied an important position in the electric power industry[2]. With large interconnection of the electric networks, the energy crisis in the world and continuous rise in prices, it is very essential to reduce the running charges of the electric energy.A saving in the operation of the system of a small percent represents a significant with this economic dispatch problem is the problem of the proper commitment of any array of units out of a total array of units to serve the expected load demands in an „optimal‟ manner.For the purpose of optimum economic operation of this large scale system, modern system theory and optimization techniques are being applied with the expectation of considerable cost saving.Through the load flow studies we can obtain the voltage magnitudes and angles at each bus in the steady state[2]. This is rather important reduction in operating cost as well as in the quantities of fuel consumed. The classic problem is the economic load dispatch of generating systems to achieve minimum operating cost. This problem area has taken a subtle twist as the public has become increasingly concerned with environmental matters, so that economic dispatch now includes the dispatch of systems to minimizepollutant**s** and conserve various forms of fuel, as well as achieve minimum cost .Through the load flow studies we can obtain the voltage magnitudes and angles at eachbus in the steady state. This is rather important as themagnitudes of the bus voltages are required to be held within a specified limit. Once the bus voltage magnitudes and their angles are computed using the load flow, the real and reactive power flow through each line can be computed. Also based on the difference between power flow in the sending and receiving ends, the losses in a particular line can also be computed. Furthermore, from the line flow we can also determine the over and under load conditions. The steady state power and reactive power supplied by a bus in a power network are expressed in terms of nonlinear algebraic equations. We therefore would require iterative methods for solving these equations. In this paper we shall discuss two of the load flow methods[3].

**2.POWER FLOW OVER VIEW**

The overall aim of the whole paper is to develop a program that allow user to solve power flow problem. However the other objective that needed to complete are:

1.Power flow analysis is very important in planning stages of new networks or addition to existing ones like adding newgenerator sites, meeting increase load demand and locating new transmission sites.

2. The load flow solution gives the nodal voltages and phase angles and hence the power injection at all the buses and power flows through interconnecting power channels.

3. It determines the voltage of the buses. The voltage level at the certain buses must be kept within the closed tolerances.

4. The line flows can be known. The line should not be overloaded, it means, we should not operate the close to their stability or thermal limits.

5. To study the performance of the transmission lines, transformer and generator at steady state condition.

6. To write a program for power flow analysis for education and training purposes

7. To obtain the simulation of power flow analysis by MATLAB[2].

**3.NEWTON RAPHSON METHODALGORITHM**

The Newton-Raphson method is widely used for solving non-linear equations. It transforms the original non-linear problem into a sequence of linear problems whose solutions approach the solutions of the original problem. Let G=F(x,y) be an equation where the variables x and y are the function of arguments of F. G is a specified quantity. If F is non-linear in nature there may not be a direct solution to get the values of x and y for a particular value of G. in such cases, we take an initial estimate of x and y and iteratively solve for the real values of x and y until the difference is the specified value of G and the calculated value of F(using the estimates of x and y) i.e. ΔF is less than a tolerance value. The procedure is as follows Let the initial estimate of x and y be x0 and y0 respectively Using Taylor series

**G=F(X0,Y0)+││x0y0∆x+.x0y0**

**Where and are calculated at x0 and y0**

**G-F(x0,y0)=∆F=.∆x+.**

**In the matrix form it can be written as**

**∆x**

()

**(∆F)=(**

After the first iteration x is updated to x1 = x0 + Δx and y to y1 = y0 + Δy. The procedure is continued till after some iteration both ΔF is less than some tolerance value ε. The values of x and y after the final update at the last iteration is considered as the solution of the function F. For the load flow solution , the non-linear equations are given by equation. There will be 2n – 2 – p such equations, with n being the total number of buses and p the number of PV and generator buses**.**

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**∆δ**

**∆p**

**∆│V│**

**∆Q**

The matrix of equation ( consisting of the partial differentials, is known as the Jacobian matrix and is very often denoted as J.ΔP is the difference between the specifies value of P(Psp) and the calculated value of P using the estimates of δ and |V| in a previous iteration. We calculate ΔQ similarly. The Newton power flow is the most robust power flow algorithm used in practice. However, one drawback to its use is the fact that the terms in the Jacobian matrix must be recalculated each iteration, and then the entire set of linear equations in equation must also be resolved each iteration. Since thousands of complete power flow are often run for planning or operations study, ways to speed up this process were devised[1].

**4. NUMERICAL INSTABILITY OF THE NEWTON-RAPHSON METHOD**

Convergence problems can appear when solving the networks, which are kept “on the edge” of

their operating conditions. These networks, referred to as ill-conditioned power systems, are very sensitive to small changes of state variables (V,θ). Non-convergent behaviour is strongly connected to the reactive power problem of examined power systems. Excessively high loadings, moving final voltage values far away from the initial guess, can cause numerical divergence. Often used PQ loads, i.e. constant voltage-independent loads, have only approximate values, which are higher than real

demands in the system. When reaching critical loading values, the network is close to the voltage collapse and cannot be solved due to singularity of the Jacobian matrix. Sparse network topology (e.g. radial systems) and small number of interconnections between individual areas of the system can also cause rather poor convergence due to insufficient reactive power distribution in the network. Too narrowed operation limits, such as var constraints for PV buses and ranges of tap-changing transformers, along with incorrectly chosen slack bus, negative line reactances (i.e. series capacitors) and long lines are the most common reasons of the numerical instability. Especially, lightly loaded long lines may consume significant volume of transmitted reactive power. To avoid these problems, it is recommended to primarily switch PQ-loads to Z-loads, replace PVgenerators by PQ-generators (with relaxed var limits), disconnect long lines, add additional shunt compensators, release tap ratio limits of LTC transformers, change the slack bus position and divide the network into smaller areas which can be solved separately. In the industry, several modifications of the network topology are performed during the day. Due to above mentioned factors, the Newton-Raphson method may not be able to perform the load flow analysis of such networks previously successfully solved. Therefore, robust stability algorithms are essential for simulations of majority of load flow cases by the Newton-Raphson method[5].

Power flow or load-flow studies are important for planning future expansion of power systems as well as in determining the best operation of existing systems. The principal information obtained from the power flow study is the magnitude and phase angle of the voltage at each bus, and the real and reactive power flowing in each line.We have formulated the algorithm and designed the MATLAB programs for bus admittance matrix, converting polar form to rectangular form, Gauss-Siedel method and Newton Raphson method for analyzing the load flow of the IEEE- bus systems. The Voltage magnitude and angles of a bus system were observed for different values of Reactance loading and the findings have been presented. From the findings, it is concluded that increasing the reactance loading resulted in an increased voltage regulation. Gauss-Siedel has simple calculations and is easy to execute, but as the number of buses increase, number of iterations increases. On the other hand, in Newton-Raphson. method, is the calculations are complex, but the number of iterations is low even when the number of buses high.

**6 .CONCLUSION**

**7.REFFERENCES**

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Fig 2.N-R method implementation flow diagram[6].

Update the voltage magnitude and angle with the mismatch calculated

Solve for the voltage magnitude and angle mismatch

End

Calculate the new Jacobian matrix of the method using the new voltage magnitude and angle from the previous iteration.

Solution is met

Yes

Does power mismatch fall in range of the tolerance?

Calculate power mismatch, and .

Form the admittance matrix

Make initial estimation for all unknown voltage magnitude and angle

Identifying all bus type

**5.Implementation**