iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 Issue: IV Month of publication: April 2022

DOI: https://doi.org/10.22214/ijraset.2022.41590

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue IV Apr 2022- Available at www.ijraset.com

Load Flow Analysis on IEEE 14 Bus System

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Abstract: This article presents a load flow analysis of an IEEE14 BUS system using the Newton-Raphson method, which simplifies the analysis of load balancing problems. The software used for the programming platform is MATLAB. This paper gives an overview of the electrical performance and power flows (real and reactive) under a steady state. There are various methods for load flow computations. The gauss-seidel method is more popular in smaller systems because of less computational time. In the case of larger systems computation time increases in this condition, the Newton-Raphson method is preferred. This project aims to develop a MATLAB program to calculate voltages and active and reactive power at each bus for IEEE 14 bus systems. The MATLAB program is executed with the input data and results are compared.
Keywords: load flow studies, Newton-Raphson method, IEEE 14 bus system.

I. INTRODUCTION

In addition to providing real and effective power flow research provides information about line loading and transformer (as and losses) throughout the system and voltages at different locations in the system to monitor and control the performance of power systems. Required research is already done in the development of computer programs for a load flow analysis. When a radial distribution system with a large number of buses is to be solved, however, these general-purpose programs may encounter convergence difficulties, necessitating the development of a special program for radial distribution studies. Load flow analysis can be solved using a variety of methods. The N-R Technique is used to solve nonlinear equations numerically.
The method is named an iterative root-finding scheme. This method aims to solve equations such, as f(x) =0. In such an equation, the solution will be called x*, and it is the root of the function f(x). Power flow calculations are generally obtained by the first-order N-R method. Since successive approximations are required to reach a solution, it is iterative. Below is a general overview of the process. To start, guess a solution. The guess will be wrong, until & unless we are very fortunate. In other words, we update the "old" solution with a "new" solution with the objective that the "new" solution is better than the "old" solution.

II. POWER FLOW OVERVIEW

This paper aims to make a system that allows users to solve power flow problems. The objectives are:
1) The power sector is in its fast-growing phase to meet the growing electricity demand, with the integration of a Distribution network (DN).
2) The power grid is committed to providing good quality power to the consumer and maintaining the stability of the network.
3) Load flow studies are very important to analyze the performance of the network. Based on the case studies, the results show that the Newton-Raphson method is preferable for a distribution system.
4) The load flow solution determines the voltage at various buses and phase angles, therefore the power injection at all the buses and power flows through interconnecting power channels are computed.
5) It determines the voltage of the buses. The voltage level at certain buses must be kept within the closed tolerances.
6) the line flows can be known. The line should not be overloaded, which means, we should not operate close to their stability or thermal limits
7) To study the performance of the transmission lines, transformer, and generator at steady-state conditions.

III. POWER FLOW ANALYSIS

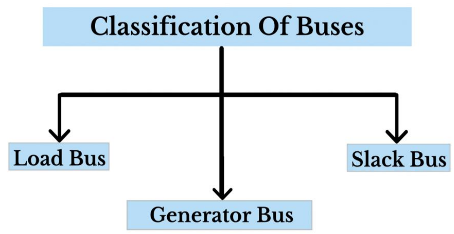
A junction at which one or many lines, one or many loads, and generators are connected is calles as a Bus or Node. In an electrical network, each node or the bus is having 4 measures which are , the voltage magnitude, phase angle of voltage, the active or true power, and reactive power in a load flow problem two out of these 4 quantities are specified and the remaining 2 are required to be determined through the solution of the equation. Depending on the specified measures, the buses are classified into 3 types. Load buses- This is also called the P-Q bus and at this bus, the active and reactive power is filled into the network. The magnitude and phase of the voltage are to be computed. Here the active power P and reactive power Q are defined, and the load bus voltage can be allowed within a tolerable value, i.e., 5%.

A. Generator Bus or Voltage Controlled Bus

This bus is additionally called the P-V bus, and on this bus, the voltage magnitude like generate voltage and true or active power P like its rating are specified. Voltage is kept constant & defined by injection of reactive power. The reactive power generation Q and phase angle δ of the voltage is to be computed.

B. Slack Bus or Reference Bus

Slack bus during a power grid absorbs or emits the active or reactive power from the facility system. The slack bus doesn't carry any load. At this node, the voltage magnitude and phase angle are specified. The phase of the voltage is typically set adequate to zero. The active and reactive power of this bus is typically determined through the answer of equations. The slack bus can be an imaginary concept in load flow study & because the losses of the power system are unknown beforehand for the load flow calculation. Therefore, the entire injected power can't be specified on every bus. The phase of the voltage at the slack bus is typically taken as reference or zero.



C. Newton-Raphson Method of load flow Analysis

There are a few positive aspects of Newton Raphson's approach: Meetings happen as soon as the first guess is near the right solution. Also, it can be converted to many sizes and can be used to polish roots obtained by other methods. Additionally, it has a large meeting place. However, except for the long time required for Newton Raphson's repetition method, the total duration of the repetition process is shorter compared to the Gauss-Seidel method because there are fewer repetitions to meet. If not, there are a few negative aspects of Newton Raphson's approach: It takes a long time for each repetition. In addition, it becomes even more difficult to create codes. Short-term steps to implementing the N-R method:

1) Construct Y Bus per Unit
2) Begin from an initial supposition for unknown magnitude and angle of voltage for a flat start
3) For iteration k, find the divergence vector
4) For iteration k, obtain the Jacobian matrix J - Identify the error vector
5) Using an iteration number (k+1), verify that the power mismatches are acceptable, if so, you can continue, otherwise, go back to the second step.
6) Calculate the active and reactive power of the Slack Bus
7) Calculate Line Flows

IV. REQUIRED CHARACTERISTICS OF LOAD FLOW SOLUTION METHOD

To be a good method for load flow analysis, it must acquire the following properties:

1) *High Computational Speed:* High computational speed is needed for effective results to deal with large power system networks, real-time operations, or multiple case data.
2) *Low Computer Storage:* Large computer memory is required to store load flow data for large power system networks and this can be achieved by using mini-computers mainly for online applications.
3) Reliability of Solution: It's veritably essential that the results attained after carrying out cargo inflow computations must be dependable and should give effective data.
4) *Versatility:* The versatility of the solution means the ability of the load flow method to handle conventional and special features. E.g., transformer tap setting. The load flow solution obtained must be a versatile one.
5) *Simplicity:* While carrying out load flow calculations, the load flow method should provide ease of coding.

V. COMPUTATIONAL ALGORITHM FOR NEWTON RAPHSON LOAD FLOW METHOD

For executing load flow analysis with N-R approach, the required methodology is as follows: Step 1: Develop the nodal admittance matrix (Yij).

Step 2: Assume a set of bus voltage and set bus n as the reference bus.

Vi=1<0º (at all PQ Buses).

Step 3: find the real Power Pi;

$$P_i = G_{ii}|V_i|^2 + \sum_{j=1}^{n}|V_i||V_j|\left(G_{ij}\cos\theta_{ij} + B_{ij}\sin\theta_{ij}\right)$$

Step 4: find the reactive Power Qi;

$$Q_i = -B_{ii}|V_i|^2 + \sum_{j=1}^{n}|V_i||V_j|\left(G_{ij}\sin\theta_{ij} - B_{ij}\cos\theta_{ij}\right)$$

Step 5: Form the Jacobian matrix using sub-matrices H, N K, and L.

Step 6: Find the power differences ΔPi

And ΔQi for all i=1, 2, 3... (n-1);

Pi= Pispec -Pical.,

Step 7: set the tolerance values.

Step 8: Stop the Iteration if all and are within the tolerance values.

Step 9: Update the values of Vi and δi

using equation.

A. Detailed Flow Chart for Newton-Raphson load flow Method

In the context of varied steps concerned in completing load flow studies with the Newton Raphson methodology, the subsequent elaborate flow chart has been designed.

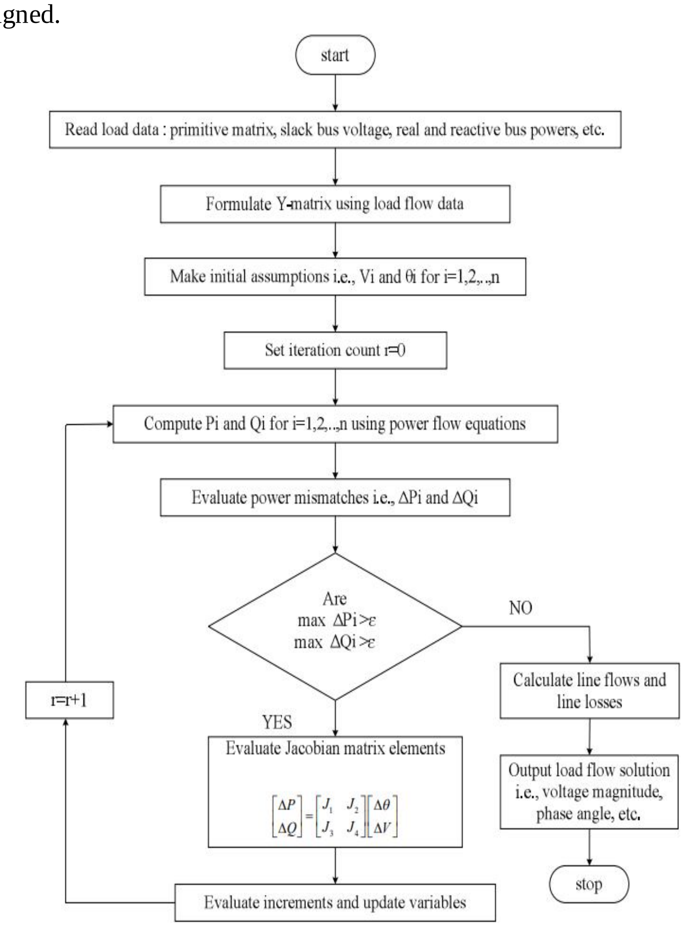


Fig 1).Detailed flowchart of Newton Raphson method

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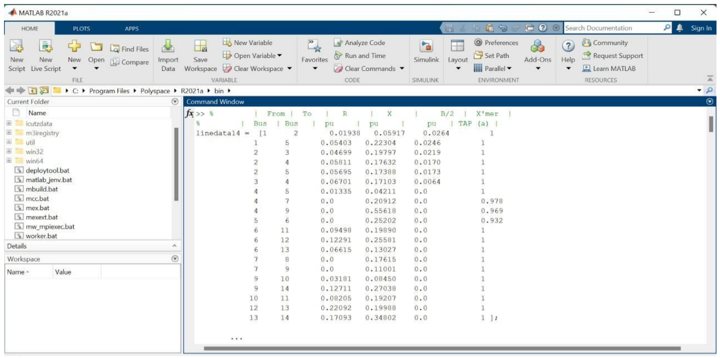

Fig.2) MATLAB Code For Newton-raphson Method.

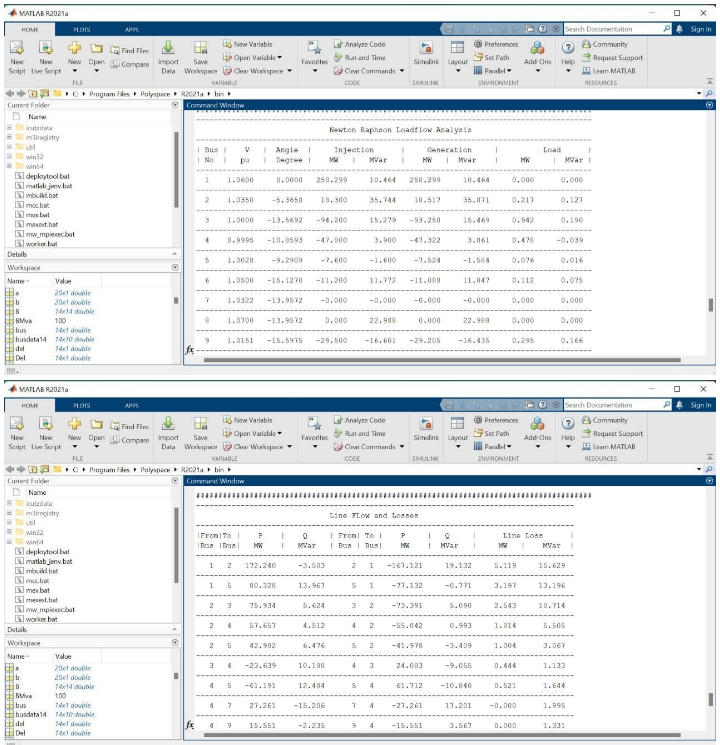

Fig.3) results obtained from MATLAB Code

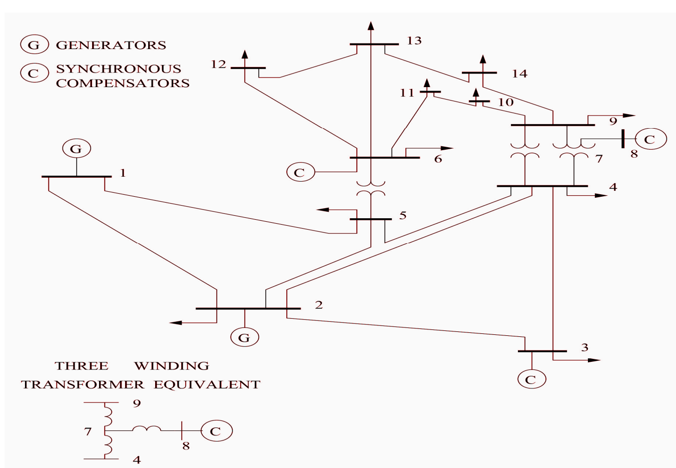

Fig.4) IEEE 14 Bus System

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VI. CONCLUSION

This paper pressed a study of the Newton-Raphson Method of Load flow analysis. Comparison is made between obtained and expected results and found that the algorithm is working properly. The result is found in 3 to 5 iterations. This method is found best to use for optimal load flow studies.

REFERENCES

[1] M.N.Alzyod and I.O.Habiballah "Review on Comparative Analysis of Load Flow Calculation Methods", vol.2. Issue-12, December 21.
[2] A. Dubey, "LOAD FLOW ANALYSIS OF POWER SYSTEMS," International Journal of Scientific & Engineering Research, vol. 7, no. 5, 2016, [Online].Available: http://www.ijser.org
[3] D.P Kothari, I.J.Nagrath, Modern Power System Analysis‟, (McGraw-Hill, 3rd edition, 2003).
[4] Glenn W Stagg, and I. Stagg, "Computer Methods in Power System Analysis".
[5] J W.D. Stevenson Jr, Elements of power system analysis‟, (McGraw-Hill, 4th edition, 1982).