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SYSTEM ANALYSIS OF LOAD FLOW IN RADIAL DISTRIBUTION NETWORK POWER

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Abstract: In this thesis, load-flow technique for solving radial distribution networks by reducing data preparation using sequential numbering scheme has been proposed. The proposed method needs only the source node and number of total node of main feeder, lateral(s) and sub lateral(s) only and does not need equivalent network. The simple algebraic equations have been considered. Effectiveness of the load flow has been tested by two examples (33□node and 69□node radial distribution networks) with constant power (CP), constant current (CI), constant impedance (CZ), composite and exponential load modeling for each of these examples. The superiority of the proposed method has been compared with the other methods available in literature.

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Introduction

To meet the present growing domestic, industrial and commercial load day by day, effective planning of radial distribution network is required. To ensure the effective planning with load transferring, the load flow study of radial distribution network becomes utmost important. In this chapter introduction of distribution system will be carried out at first followed by load flow.

Power Distribution Systems

Distribution networks have typical characteristics. The aim of this article is to introduce distribution networks design and establish the distinction between country and urban distribution networks.

Global Design of Distribution Networks

The electric utility system is usually divided into three subsystems which are generation, transmission, and distribution. A fourth division, which sometimes is made, is sub transmission. However, the latter can really be considered as a subset of transmission since the voltage levels and protection practices are quite similar.
The distribution system is commonly broken down into three components: distribution substation, distribution primary and secondary. At the substation level, the voltage is reduced and the power is distributed in smaller amounts to the customers. Consequently, one substation will supply many customers with power. Thus, the number of transmission lines in the distribution systems is many times that of the transmission systems.
Furthermore, most customers are connected to only one of the three phases in the distribution system. Therefore, the power flow on each of the lines is different and the system is typically 'unbalanced'. This characteristic needs to be accounted for in load flow studies related to distribution networks.

Distribution Substations

The distribution system is fed through distribution substations. These substations have an almost infinite number of designs based on consideration such as load density, high sideband low side voltage, land availability, reliability requirements, load growth, voltage drop, cost and losses, etc.

Distribution Feeders

There are three basic types of distribution system designs: Radial, Loop, or Network. As one might expect, one can use combinations of these three systems, and this is frequently done. The Radial distribution system is the cheapest to build, and is widely used in sparsely populated areas. A radial system has only one power source for a group of customers. A power failure, short-circuit, or a downed power line would interrupt power in the entire line, which must be fixed before power can be restored. A loop system, as the name implies, loops through the service area and returns to the original point. The loop is usually tied into an alternate power source. By placing switches in strategic locations, the utility can supply power to the customer from either direction.

Load Flow Analysis

Load flow analysis is concerned with describing the operating state of an entire power system, by which we mean a network of generators, transmission lines, and loads that could represent an area as small as a municipality or as large as several states. Given certain known quantities—typically, the amount of power generated and consumed at different locations— load flow analysis allows one to determine other quantities. The most important of these quantities are the voltages at locations throughout the transmission system, which, for alternating current (AC), consist of both a magnitude and a time element or phase angle. Once the voltages are known, the currents flowing through every transmission link can be easily calculated

Choice of Variables

Basically load flow analysis deals with known real and reactive power flows at each bus, and those voltage magnitudes that are explicitly known, and from this information calculating the remaining voltage magnitudes and all the voltage angles. We are familiar with the notion of organizing the descriptive variables of the circuit into categories of "known's" and "unknowns," whose relationships can subsequently be expressed in terms of multiple equations. Given sufficient information, these equations can then be manipulated with various techniques so as to yield numerical results for the hitherto unknowns. For AC circuits, because we have introduced the dimension of time: unlike in DC, where everything is essentially static (except for the instant at which a switch is thrown), with AC we are describing an ongoing oscillation or movement. Thus each of the two main variables, voltage and current, in an AC circuit really has two numerical components: a magnitude component and a time component. By convention, AC voltage and current Magnitude is described in terms of root-mean-squared (r.m.s.) values and their timing interims of a phase angle, which represents the shift of the wave with respect to a reference point in time. To fully describe the voltage at any given node in an AC circuit, we must, therefore, specify two numbers: a voltage magnitude and a voltage angle. Accordingly, when we solve for the currents in each branch, we will again obtain two numbers: a current magnitude and a current angle. When we consider the amount of power transferred at any point of an AC circuit, we again have two numbers: a real and a reactive component. An AC circuit thus requires exactly two pieces of information per node in order to be completely determined. More than two, and they are either redundant or contradictory; fewer than two and possibilities are left open so that the system cannot be solved. Owing to the nonlinear nature of the load flow problem, it may be impossible to find one unique solution because more than one answer is mathematically consistent with the given configuration. However, it is usually straightforward in such cases to identify the "true" solution among the mathematical Possibilities based on physical plausibility and common sense. Conversely, there may be no solution at all because the given information was hypothetical and does not correspond to any situation that is physically possible. Still, it is true in principle—and most important for a general conceptual understanding that two variables per node are needed to determine everything that is happening in the system. In practice, current is not known at all; the currents through the various circuit branches turn out to be the last thing that we calculate once we have completed the load flow analysis.

Voltage, as we will see, is known explicitly for some buses but not for others. More typically, what is known is the amount of power going into or out of a bus.

Types of Buses

Previously we discussed that in load flow analysis buses are represented as nodes.
But there are many type of buses(typically 3) which should be known to us for better understanding. Let us now articulate which variables will actually be given for each bus as inputs to the analysis. Here we must distinguish between different types of buses based on their actual, practical operating constraints. The two main types are generator buses and load buses, for each of which it is appropriate to specify different information. At the load bus, we assume that the power consumption is given—determined by the consumer—and specify two numbers, real and reactive power, for each load bus. Referring to the symbols P and Q for real and reactive power, load buses are referred to as PQ buses in load flow analysis.
At the generator buses we could in principle also specify P and Q. Here we run into two problems. However, the first has to do with balancing the power needs of the system, and the second with the actual operational control of generators. As a result, it turns out to be convenient to specify P for all but one generator, the slack bus, and to use the generator bus voltage, V, instead of the reactive power Q as the second variable. Generator buses are therefore called PV buses.

Objectives of the Research

This work endeavors to propose a new technique for load flow analysis.
The objectives are divided into the following:

- To use sequential numbering scheme.
- To reduce data preparation using the radial feature of distribution networks using only the source node of the feeder, lateral(s) and sub lateral(s).
- To check the loads flow results using the constant power, constant current, constant impedance, composite as well as exponential load modeling .The methods proposed in literature till date could not reduce the data preparation even using the radial features of the distribution networks. Data preparation for branch number, sending end node, receiving end node is a rigorous task and also time-consuming.

Solution Methodology

Figure 1 shows single-line diagram of a radial distribution network. The proposed method does not need the rigorous data preparation for branch numbers, sending endnotes and receiving end nodes respectively. The proposed method needs only the following:
(i) Source node of feeder, lateral(s) and sub lateral(s) and their total number of nodes,
(ii) Branch resistance and reactance and
(iii) Real and reactive power load at each node

If the sub lateral exists, it can also be handled. The total branch numbers in each case will be one less than the total number of nodes in each case. The last node is the end nodes.

The proposed In Figure 1, the source nodes of feeder, lateral(s) are 1, 3 and 5 and their total nodes are6, 3 and 4 respectively. The proposed software will immediately generate and store the node numbers of feeder,

Lateral of Figure 1, in the array FN(i,j).

For feeder,

F(1,1) = 1, F(1,2) = 2, F(1,3) = 3, F(1,4) = 4, F(1,5) = 5 and F(1,6) = 6.

For lateral 1,

F(2,1) = 3, F(2,2) = 7 and F(2,3) = 8

For lateral 2,

F(3,1) = 5, F(3,2) = 9, F(3,3) = 10 and F(3,4) = 11

Figure 1: Single-line diagram of a radial distribution network

1 2 32

4 5 6

7

87

9

10

11

S/S

1 2 3 4 5

6 8

7 9

10

x : Branch Number

logic will find the common nodes of lateral(s) and feeder of Figure 1. To-do this proposed logic will check the node numbers of feeder with that of lateral(s).

The common nodes in this case are 3 and 5 respectively of lateral 1 and lateral 2 with the feeder respectively. These nodes are stored in the array CN where CN means the common nodes and the number of lateral are stored in the array LN where LN means lateral number.

Here CN(1) = 3 and CN(2) = 5.

LN(1) = 2 and LN(2) = 3.

Current of each branch of the network must be calculated at first. To calculate the current of each branch, the proposed software starts from the last lateral or last sub lateral if sub lateral exists.

For lateral 2:

I(FB(3,10)) = IL(FN(3,11)) = IL(FN(3,10+1)) (2.1)

I(FB(3,9)) = I(FB(3,10)) + IL(FN(3,10)) = I(FB(3,9+1)) + IL(FN(3,9+1)) (2.2)

I(FB(3,8)) = I(FB(3,9)) + IL(FN(3,9)) = I(FB(3,8+1)) + IL(FN(3,8+1)) (2.3)

For lateral 1:

I(FB(2,7)) = IL(FN(2,8)) = IL(FN(2,7+1)) (2.4)

I(FB(2,6)) = I(FB(2,7)) + IL(FN(2,7)) = I(FB(2,6+1)) + IL(FN(2,6+1)) (2.5)

For Feeder:

I(FB(1,5)) = IL(FN(1,6)) = IL(FN(1,5+1)) (2.6)

I(FB(1,4)) = I(FB(1,5)) + IL(FN(1,4)) + I(FB(LN(2),1)) = I(FB(1,4+1)) + IL(FN(1,4+1)) + I(FB(LN(2),1)) (2.7)

I(FB(1,3)) = I(FB(1,4)) + IL(FN(1,4)) = I(FB(1,3+1)) + IL(FN(1,3+1)) (2.8)

I(FB(1,2)) = I(FB(1,3)) + IL(FN(1,3)) + I(FB(LN(1),1)) = I(FB(1,2+1)) + IL(FN(1,2+1)) + I(FB(LN(1),1)) (2.9)

I(FB(1,1)) = I(FB(1,2)) + IL(FN(1,2)) = I(FB(1,1+1)) + IL(FN(1,1+1)) (2.10)

From above expressions, we can conclude that

I(FB(i,j)) = IL(FN(i,j+1)) for end nodes (2.11)

and I(FB(i,j)) = I(FB(i,j +1)) + IL(FN(i,j+1)) for other nodes (2.12)

While calculating the branch currents, the proposed software checks the node numbers

with the nodes stored in the array. If it matches, the equation (2.12) is modified as

follows:

I(FB(i,j)) = I(FB(i,j +1)) + IL(FN(i,j+1)) + I(FB(LN(k),1)) (2.13)

for nodes when node FN(i,j+1)) is common to the source node of any lateral.

For branch FB(1,1), voltage of node FN(1,2) can be expressed as

V(FN(1,2)) = V(FN(1,1)) – I(FB(1,1))Z(FB(1,1)) (2.14)

Similarly for branch FB(1,2),

V(FN(1,3)) = V(FN(1,2)) – I(FB(1,2))Z(FB(1,2)) (2.15)

In general we have

V(FN(i,j)) = V(FN(i,j□1)) – I(FB(i,j□1))Z(FB(i,j□1)) (2.16)

The load current of node FN(i,j) is

PL(IL(FN(i, j)) FN(i,*j)) jQL(FN(i, j)) V (FN(i, j))

□(2.17)

and the charging current at a node m2 is shown below

IC(FN(i,j)) = yo(FN(i,j)) V(FN(i,j)) (2.18)

If charging currents are present at any particular receiving end node FN(i,j+1) of branch j,

the expression for branch current becomes

I(FB(i,j)) = I(FB(i,j +1)) + IL(FN(i,j+1)) + IC(FN(i,j+1)) for other nodes (2.19)

i.e., I(FB(i,j)) = I(FB(i,j +1)) + IL(FN(i,j+1)) + I(FB(LN(k),1)) + IC(FN(i,j+1)) (2.20)

for nodes when node FN(i,j+1)) is common to the source node of any lateral for feeder or

any sub lateral for lateral.

Real and reactive power losses of each branch are

LP(FB(i,j)) = I(FB(i,j)) 2 R(FB(i,j)) (2.21)

and LQ(FB(i,j)) = I(FB(i,j)) 2 X(FB(i,j)) (2.22)

respectively for i =1,2,..,TN and j = 1,2,3,…,N(i) □1.

After computing the voltages at all nodes, convergence of the solution is checked.

As per the method proposed in this paper, the solution converges after successive iterations if the maximum difference in voltage magnitude (Vmax) is equal to 0.00001.

Load Modeling

Load modeling has a crucial role in voltage stability analysis of a distribution network system. Every load depends upon the voltage and frequency in the distribution system.

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A balanced load is being considered in this paper that can be represented either as Constant power, constant current, constant impedance or as an exponential load. The method of load flow analysis must have the capability to handle all types of load modeling. Equation (2.23) and (2.24) shows the load modeling.

P(FN(i,j)) = Pn [a0 + a1V(FN(i,j)) + a2V2(FN(i,j)) + a3Ve1(FN(i,j))] (2.23)

Q(FN(i,j))= Qn[b0 + b1V(FN(i,j)) + b2V2(FN(i,j)) + b3Ve1(FN(i,j))] (2.24)

Where, Pn and Qn are nominal real and reactive power respectively and V(FN(i,j)) is the voltage at node m2.

For all the loads, Equation 2.23 and Equation 2.24 are modeled as

a0 + a1 + a2 + a3 = 1.0 (2.25)

b0 + b1 + b2 + b3 = 1.0 (2.26)

For constant power (CP) load a0 = b0= 1 and ai = bi = 0 for i = 1, 2, 3. For constant current (CI) load a1 = b1= 1 and ai = bi = 0 for i = 0, 2, 3. For constant impedance (CZ) load a2 = b2= 1 and ai = bi = 0 for i = 0, 1, 3. Composite load modeling is combination of CP, CI **and** CZ. For composite load a3 = b3= 0 and ai = bi = 1 for i = 0, 1, 2. For exponential load a3 = b3= 1 and ai = bi = 0 for i = 0, 1, 2 and e1 and e2 are 1.38 and 3.22respectively.

Algorithm for Load flow Computation

The complete algorithm for load flow calculation of radial distribution network is shown below.

Step 1 **:** Get the number of Feeder(A), lateral(s) (B) and sub lateral(s) (C).

Step 2 **:** TN = A + B + C

Step 3 **:** Read the source node and total number of nodes i.e., N(i) of feeder, lateral(s) and sub lateral(s) for i = 1,2,…,TN

Step 4 **:** Read real and reactive power load at each node i.e., PL[FN(i,j)] and QL[FN(i,j)] for j = 2,3,..,N(i) and i = 1,2,..,TN.

Step 5 **:** Total number of branches B(i) = N(i) □ 1 of feeder, lateral(s) and sub lateral(s) for i = 1,2,…,TN and store them in FB(i,j).

Step 6 **:** Read resistance and reactance of each branch i.e., R[FB(i,j)] and X[FB(i,j)] for j = 2,3,..,N(i) □1 and i = 1,2,..,TN.

Step 7 **:** Read base kV and base MVA, Total number of iteration (ITMAX), □(0.00001)

Step 8 **:** Initialize PL[FN(1,1)] = 0.0 and QL[FN(1,1)] = 0.0

Step 9 **:** Set V[FN(i,j)] = 1.0 + j0.0 for j =1,2,…,N(i) and i = 1,2,….,TN and also set V1[FN(i,j)] = V[FN(i,j)] for j =1,2,…,N(i) and i = 1,2,….,TN.

Step 10 **:** Set IT (iteration count) = 1

Step 11 **:** Compute the per unit values of PL[FN(i,j)] and QL[FN(i,j)] for j = 2,3,..,N(i) and i = 1,2,..,TN as well as R[FB(i,j)] and X[FB(i,j)] for j = 1,2,3,..,N(i) □1 and i = 1,2,..,TN.

Step 12 **:** Set PL1[FN(i,j)] = PL[FN(i,j)] and QL1[FN(i,j)] = QL[FN(i,j)] for j = 2,3,..,N(i) and i = 1,2,..,TN

Step 13 **:** Set LP[FB(i,j)] = 0.0 and LQ[FB(I,j)] = 0.0 for all j = 1,2,…,N(i) □1 and i = 1,2,….,TN.

Step 14 **:** Set V[FN(i,j)] = 1.0 + j0.0 for j =1,2,…,N(i) and i = 1,2,….,TN and set V1[FN(i,j)] = V[FN(i,j)] for j =1,2,…,N(i) and i = 1,2,….,TN.

Step 15 **:** Use proper load modeling using Equations (2.23) and (2.24).

Step 16 **:** Calculate the current of each node IL(FN(i,j)) using Equation (2.17).

Step 17 **:** Calculate current through each branch i.e., I[FB(i,j)] for for all j = 1,2,…,N(i) □1 and i = 1,2,….,TN using Equations (2.11),(2.12) or (2.13) when charging capacitors are absent or Equation (2.19) or (2.20) when charging capacitors are present.

Step 18 **:** Compute voltage |V[FN(i,j)]| using Equation (2.16) for j = 2,3,..,N(i) and i = 1,2,..,TN.

Step 19 **:** Compute |□V[FN(i,j)]| = |V1[FN(i,j)]| □ |V[FN(i,j)]| for j = 2,3,..,N(i) and i = 1,2,..,TN.

Step 20 **:** Set |V1[FN(i,j)]| = |V[FN(i,j)]| for j = 1,2,3,..,N(i) and i = 1,2,..,TN.

Step 21 **:** Compute LP[FB(i,j)] and LQ[FB(i,j)] for all j = 1,2,…,N(i)□1 and i = 1,2,….,TN using Equations (2.22) and (2.23) respectively.

Step 22 **:** Find □Vmax from |□V[FN(i,j)]| for j = 2,3,..,N(i) and i = 1,2,..,TN.

Step 23 **:** Set PL[FN(i,j)] = PL1[FN(i,j)] and QL[FN(i,j)] = QL1[FN(i,j)] for j = 2,3,..,N(i) and i = 1,2,..,TN

Step 24 **:** If □Vmin □0.00001 go to Step 27 else go to Step 25.

Step 25 **:** IT = IT + 1

Step 26 **:** If IT □ITMAX go to Step 16 else write "NOT CONVERGED" and go to Step 28.

Step 27 **:** Write " CONVERGED" and display the results

Step 28 **:** Stop

Examples

Two examples have been considered to demonstrate the effectiveness of the proposed method. The first example is **33□node** radial distribution network. Data for this system are available in [9] shown in **Appendix A**. Real and reactive power losses of this system for CP, CI, CZ, Composite load **(40% CP + 30% CI + 30% CZ)** and Exponential load modeling. The minimum voltage occurs at node number 18 in all cases. Base values for this system are **12.66 kV and 100 MVA** respectively. The second example is **69□node** radial distribution network (nodes have been renumbered with Substation as node 1) shown in Figure 2.3. Data for this system are available in shown in **Appendix B**. Real and reactive power losses of this system for CP, CI, CZ, Composite load **(40% CP + 30% CI + 30% CZ)** system are**12.66 kV and 100 MVA** respectively.

APPENDIX A

Table A.1 Line Data of 33 Node Radial Distribution Network

Table A.2 Load Data of 33 Node Radial Distribution Network

Branch Number	Sending end Node	Receiving end Node	Branch Resistance (□)	Branch Reactance (□)
1	1	2	0.0922	0.0470
2	2	3	0.4930	0.2511
3	3	4	0.3660	0.1864
4	4	5	0.3811	0.1941
5	5	6	0.8190	0.7070
6	6	7	0.1872	0.6188
7	7	8	0.7114	0.2351
8	8	9	1.0300	0.7400
9	9	10	1.0040	0.7400
10	10	11	0.1996	0.0650
11	11	12	0.3744	0.1238
12	12	13	1.4680	1.1550
13	13	14	0.5416	0.7129
14	14	15	0.5910	0.5260
15	15	16	0.7463	0.5450
16	16	17	1.2890	1.7210
17	17	18	0.7320	0.5740
18	2	19	0.1640	0.1565
19	19	20	1.5042	1.3554
20	20	21	0.4095	0.4784
21	21	22	0.7089	0.9373
22	3	23	0.4512	0.3083
23	23	24	0.8980	0.7091
24	24	25	0.8960	0.7011
25	6	26	0.2030	0.1034
26	26	27	0.2842	0.1447
27	27	28	1.0590	0.9337
28	28	29	0.8042	0.7006
29	29	30	0.5075	0.2585
30	30	31	0.9744	0.9630
31	31	32	0.3105	0.3619
32	32	33	0.3410	0.5302

BASE kV = 12.66 and BASE MVA = 100

Node Number	PL (kW)	QL (kVAr)
1(S/S)	0.0	0.0
2	100.0	60.0
3	90.0	40.0
4	120.0	80.0
5	60.0	30.0
6	60.0	20.0
7	200.0	100.0
8	200.0	100.0
9	60.0	20.0
10	60.0	20.0
11	45.0	30.0
12	60.0	35.0
13	60.0	35.0
14	120.0	80.0
15	60.0	10.0
16	60.0	20.0
17	60.0	20.0
18	90.0	40.0
19	90.0	40.0
20	90.0	40.0
21	90.0	40.0
22	90.0	40.0
23	90.0	50.0
24	420.0	200.0
25	420.0	200.0
26	60.0	25.0
27	60.0	25.0
28	60.0	20.0
29	120.0	70.0
30	200.0	600.0
31	150.0	70.0
32	210.0	100.0
33	60.0	40.0

APPENDIX B

Table B.1 Line Data of 69 Node Radial Distribution Network

Branch Number	Sending□end	Receiving□end	Branch Resistance (□)	Branch Reactance (□)
1	1	2	0.0005	0.0012
2	2	3	0.0005	0.0012
3	3	4	0.0015	0.0036
4	4	5	0.0251	0.0294
5	5	6	0.3660	0.1864
6	6	7	0.3811	0.1941
7	7	8	0.0922	0.0470
8	8	9	0.0493	0.0257
9	9	10	0.8190	0.2707
10	10	11	0.1872	0.0619
11	11	12	0.7114	0.2351
12	12	13	1.0300	0.3400
13	13	14	1.0440	0.3450
14	14	15	1.0580	0.3496
15	15	16	0.1966	0.0650
16	16	17	0.3744	0.1238
17	17	18	0.0047	0.0016
18	18	19	0.3276	0.1083
19	19	20	0.2106	0.0696
20	20	21	0.3416	0.1129
21	21	22	0.0140	0.0046
22	22	23	0.1591	0.0526

23 23 24 0.3463 0.1145
24 24 25 0.7488 0.2475
25 25 26 0.3089 0.1021
26 26 27 0.1732 0.0572
27 3 28 0.0044 0.0108
28 28 29 0.0640 0.1565
29 29 30 0.3978 0.1315
30 30 31 0.0702 0.0232
31 31 32 0.3510 0.1160
32 32 33 0.8390 0.2816
33 33 34 1.7080 0.5646
34 34 35 1.4740 0.4873
35 3 36 0.0044 0.0108
36 36 37 0.0640 0.1565
37 37 38 0.1053 0.1230
38 38 39 0.0304 0.0355
39 39 40 0.0018 0.0021
40 40 41 0.7283 0.8509
41 41 42 0.3100 0.3623
42 42 43 0.0410 0.0478
43 43 44 0.0092 0.0116
44 44 45 0.1089 0.1373
45 45 46 0.0009 0..0012
46 4 47 0.0034 0.0084
47 47 48 0.0851 0.2083
48 48 49 0.2898 0.7091
49 49 50 0.0822 0.2011
50 8 51 0.0928 0.0473
51 51 52 0.3319 0.1114
52 9 53 0.1740 0.0886
56 53 54 0.2030 0.1034
53 54 55 0.2842 0.1447
54 55 56 0.2813 0.1433
55 56 57 1.5900 0.5337
56 57 58 0.7837 0.2630
57 58 59 0.3042 0.1006
58 59 60 0.3861 0.1172
59 60 61 0.5075 0.2585
60 61 62 0.0974 0.0496
61 62 63 0.1450 0.0738
62 63 64 0.7105 0.3619
63 64 65 1.0410 0.5302
64 11 66 0.2012 0.0611
65 66 67 0.0047 0.0014
67 12 68 0.7394 0.2444
68 68 69 0.0047 0.0016

Table B.2 Load Data of 69 Node Radial Distribution Network

Node
Number
PL(kW) QL(kVAr) Node
Number
PL(kW) QL(kVAr)
1 00.00 00.00 36 26.00 18.55
2 00.00 00.00 37 26.00 18.55
3 00.00 00.00 38 00.00 00.00
4 00.00 00.00 39 24.00 17.00
5 00.00 00.00 40 24.00 17.00
6 2.600 2.200 41 1.200 1.000
7 40.40 30.00 42 00.00 00.00
8 75.00 54.00 43 6.000 4.300
9 30.00 22.00 44 00.00 00.00
10 28.00 19.00 45 39.22 26.30
11 145.0 104.0 46 39.22 26.30
12 145.0 104.0 47 00.00 00.00
13 8.000 5.000 48 79.00 56.40
14 8.000 5.500 49 384.7 274.0
15 00.00 00.00 50 384.7 274.0
16 45.50 30.00 51 40.50 28.30
17 60.00 35.00 52 3.600 2.700
18 60.00 35.00 53 4.350 3.500
19 00.00 00.00 54 26.40 19.00
20 1.000 00.60 55 26.00 17.20
21 114.0 81.00 56 00.00 00.00
22 5.000 3.500 57 00.00 00.00
23 00.00 00.00 58 00.00 00.00
24 28.00 20.00 59 100.0 72.00
25 00.00 00.00 60 00.00 00.00
26 14.00 10.00 61 1244.0 888.0
27 14.00 10.00 62 32.00 23.00
28 26.00 18.60 63 00.00 00.00
29 26.00 18.60 64 227.0 162.0
30 00.00 00.00 65 59.00 42.00
31 00.00 00.00 66 18.00 13.00
32 00.00 00.00 67 18.00 13.00
33 14.00 10.00 68 28.00 20.00
34 19.50 14.00 69 28.00 20.00
35 6.000 4.000

BASE kV = 12.66 and BASE MVA = 100

Conclusion

In this thesis work a method of load flow analysis has been proposed for radial distribution networks based on the new method to identify the set of branches for every feeder, lateral and sub lateral without any repetitive search for computation of each branch current. Also this method has shown the relation of branch number with its receiving end node and the next branch if the sequential branch numbering as well as node numbering is adopted. Effectiveness of the proposed method has been tested by two examples 33□node and 69□ node radial distribution networks with constant power load, constant current load, and constant impedance load, composite and exponential load for each of these examples. The voltage convergence has assured the satisfactory convergence in all these cases. The superiority of the proposed method in terms of speed has been checked by comparing with the other existing methods. The proposed method consumes less amount of memory compared to the other due to reduction of data preparation.

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