# Power load flow analysis

## A case for power Distribution Network of Federal University of Technology Minna.

By

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APPROVAL PAGE

We hereby certify that we have **supervised, read & approved** this project work which we found to be adequate in scope and qualified for partial fulfilment of the award of a Post - Graduate Diploma in computer science (PGD in Computer Science).

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# DEDICATION

This project is dedicated to almighty Allah for giving me the opportunity to complete this project successfully.

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Adefemi Akinropo Oyedotun

(a) The formulation of a suitable mathematical network model which describes adequately the relationship between voltages and power in the system.

(b) Specifications of the power and voltage constraints that must be applied to the various busbars of the network.

(c) Numerical solution of the load flow equations subject to the power and voltage constraints.

(d) When all these voltages have been determined, the last step is the calculation of load flows on the various network lines.

Consumption pattern enables the Engineers to study the power consumption in the specific network and forecast the load consumption so that the contingency plan can be made for future. This will facilitate their use in power system planning, operation and interconnection studies. The transformer's load can be monitored so that overload transformers can be protected from total breakdown.

NEED FOR LOAD FLOW ANALYSIS:

Load flow studies enable the power system Engineers to make a projection of future power requirements and incorporate or create room for additional or changes in load requirement during the system planning stages of electrical power supply.

Satisfactory operation of the power system depends on system network and new load which needs to be added to the existing load of the power network. The resultant effect from load flow calculation filter out real and reactive power which are simply called useful and useless power.

The load flow analysis helps to know whether the existing transformers and lines are overloaded and to prevent total collapse of the power network. The load flow analysis takes care of the following:

(a) Additional transformers and lines may be required as a result of expansion.

(b) Changes of load may affect the busbars and conductor sizes. The load flow analysis will take care of that.

(c) Load flow incorporates many automatic features to facilitate their use in power system planning, design, operation and interconnection studies.

(d) On - line applications of automatic control and system optimization.

(e) Load flow helps to detect any short- circuit and system instability in the network.

(f) Once a computer program has been written on power load flow of a system, the input data on the increased or deceased depending on the system requirements.

(g) Load flow analysis can also be used to study an industrial power system under transient loads. This is essential in determining whether loads can be imposed on an existing power system design.

# CHAPTER 2

## 2.1 LOAD FLOW ANALYSIS OF FEDERAL UNIVERSITY OF TECHNOLOGY MINNA.

The analysis on the load flow pattern of this electrical distribution network of the campus can best be described by a one line diagram shown in fig 1.

An 11Kv transmission line from Minna entered the campus through the main gate. A ring main unit device located near the gate for easy isolation of electrical network of the campus. Two numbers of distribution transformers (500KVA, 11/0.415KV) are located at the load centers of the university.

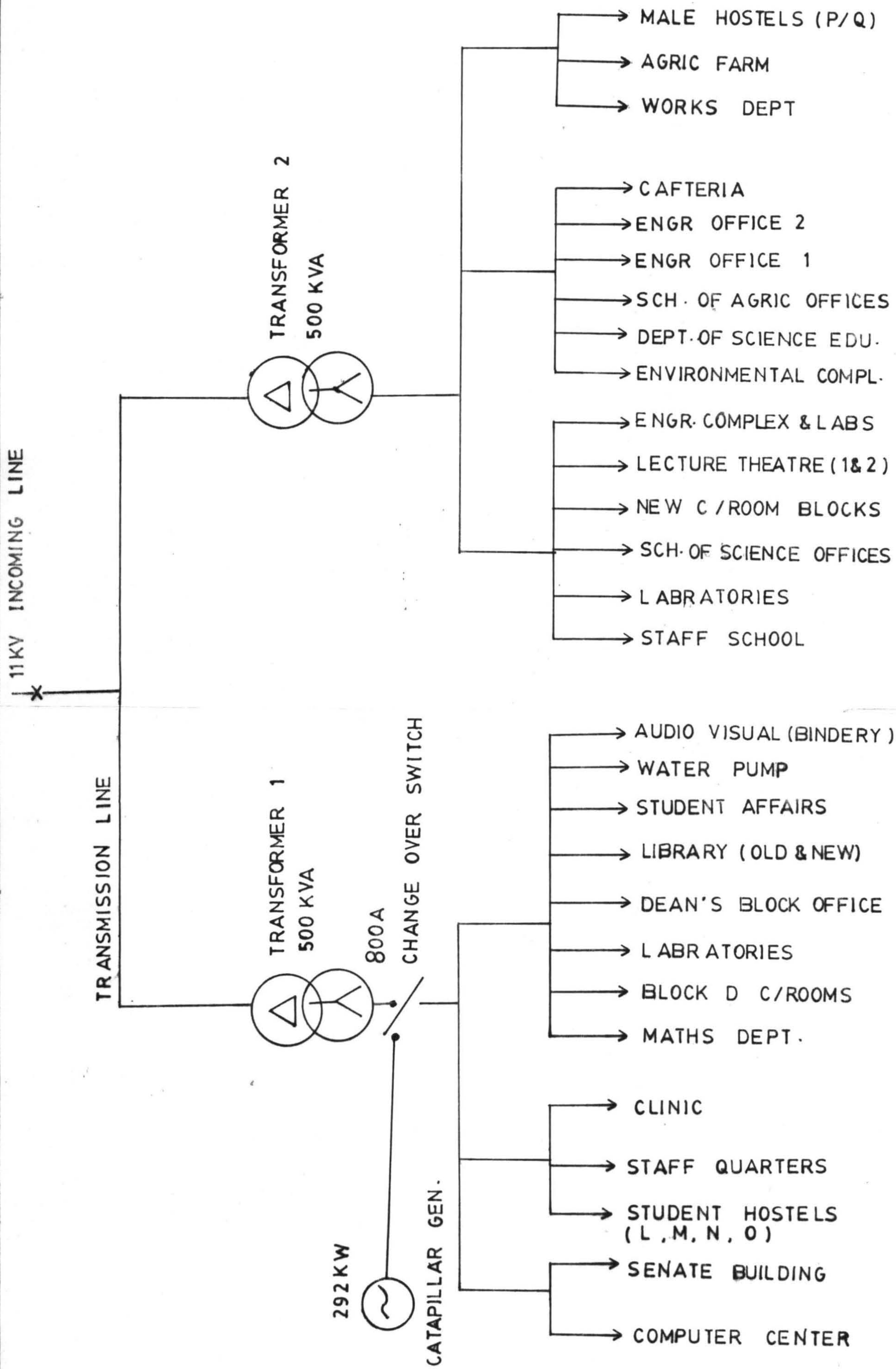
(i) The first sub-station with a transformer is located near the university clinic. A 365KVA catapillar generator is attached to this sub-station to provide an alternative power to the essential load within the university. The three upriser feeders came out from the substation to feed the electric load in different section of the university.

(a) An upriser feeder - line - one consists of the following load: Computer center and senate building. A load flow analysis would be considered for upriser feeder which will take care of the attached mentioned load.

(b) An upriser feeder - liner - tow consists of library, water pump, audit unit, biological sciences block and Dean of SSSE block. A load flow analysis would take care of the above mentioned load in upriser feeder two.

(c) An upriser feeder - line - three consists of female hostel, block D classroom, Mathematics department, staff quarters and

ONE LINE ELECTRICAL DIAGRAM FOR FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA . BOSSO CAMPUS



clinic: A load flow analysis would also be considered.

(ii) The second sub - station with a transformer is located near cafeteria to take care of the load with in that section of the university.The three upriser feeder lines also emanated from this sub - station.

(a) An upriser feeder line-one consists of the Engineering complex block, Lecture theaters, Geology laboratories, physics laboratories, block of offices for SSSE and staff school. This is the longest upriser feeder line in the university. A load flow analysis is written for that:

(b) An upriser feeder line-two consists of the male hostels, cafeteria, engineering block offices and school of Environmental. A load flow analysis is written.

(c) An upriser feeder line - three consists of the works department, kiosks and animal garden area. A load flow analysis would be considered.

A load flow analysis for this university would consists of 2 NO of Distribution transformers, 6NO of upriser feeder lines and cabling to feed the above mentioned load. Six busbars (buses) would be used in load flow analysis. the Parameters and the required data for SIX buses which are essential in the computer application of load flow analysis.

The data below are obtained from feeder lines for the two substations. Each feeder line would represent a busbar.

| Line | feeder | Busbar | Load KVA | Load KW | Load Ampere | Areas cover |
|---|---|---|---|---|---|---|
| M | M | | | | | |
| 1 | 1 | 1 | 277.5 | 222 | 400 | senate comp |
| 2 | 2 | 2 | 145.8 | 116.7 | 210 | Lib. & SSSE |
| 3 | 3 | 3 | 69.4 | 55.5 | 100 | Female Hos. |
| 4 | 4 | 4 | 101.5 | 81.2 | 146 | Staff school |
| | 5 | 5 | 84.5 | 67.6 | 122 | Male hostel |
| 6 | 6 | 6 | 42.9 | 34.3 | 62 | Works dept |
| | | | 721.KVA | | | |

## 2.2 CALCULATION OF BUS DATA SPECIFICATION

The total installed power from the two transformers is 1000 KVA which is 1MVA. This will be used as base power and feeder load will be referred to base power as per unit form.

The assumed power factor of 0.8 in a stable and reliable network is considered.

The real power is called useful power while the reactive power is relatively termed to be useless power.

The per-unit calculation can be expressed as shown.

feeder 1.

Total power = 277.5WA

= 0.2775MVA

Per - unit = 0.2775MVA/base power

= 0.2775MVA/1 MVA

= 0.2775

Real power = 0.2775 cos $36.9^0$ = 0.222

Reactive power = 0.2775 sin 36.9$^0$ = 0.222

The power can be written as <u>0.222 + j0.166</u>

<u>feeder 2</u>

Total power = 145.8KVA

= 0.1458 MVA

Per Unit = 0.1458MVA/1 MVA

= <u>0.1458</u>

Real power = 0.1458 cos 36.9 = 0.1166

reaction power = 0.1458 sin 36.9 = 0.0875

The power can be written as 0.1166 + jo.0875

<u>feeder 3</u>

Total power = 69.4 KVA

= 0.0694 MVA

per unit = 0.0694MVA/1 MVA

= 0.0694

Real power = 0.0694 cos 36.9$^0$ = 0.0555

Reactive power = 0.0694 sin 36.9$^0$ = 0.0416

The power can be expressed as 0.555 + jo 0.0416

<u>feeder 4</u>

Total power = 101.5KVA

= 0.1015MVA

Per - unit = 0.1015MVA/1 MVA

= 0.1015

Real power = 0.1015 cos 36.9 = 0.0812

Reactive power = 0.1015 sin 36.9 = 0.0610

The power can be expressed as 0.0812 + 0.0610 feeder 5

Total power = 84.5KVA

= 0.0845 MVA

Per - unit = 0.0845MVA/1 MVA

= 0.0845

Real power = 0.0845 cos $36.5^0$ = 0.0676

Reactive power = 0.0845 sin 36.5 = 0.0507

The power can be expressed as

0.0676 + jo 0.0507.

feeder 6

Total power = 42.9KVA

=0.429MVA

Per unit = 0.0429MVA/q MVA = 0.0429

Real power = 0.0429 cos $36.9^0$ = 0.0343

Reactive power = 0.0429 sin $36.9^0$ = 0.0257

The power can be expressed as

0.0343 + jo 0.0257

Load consumption of Federal University of Technology Minna

A consumption pattern could be analyzed from the year the university was established up to date.The university was established in 1983 and there was only one substation existing at that time. In 1985, the second sub - station was built which takes care of electrical load at the down stream side of the university. The table below shows the load consumption pattern in kilowatt for both transformers

| | Load consumption in KW | |
|---|---|---|
| Year | Sub-station 1 | Sub-station 2 |
| 1983 | 19.59 KW | - |
| 1984 | 147.16 " | - |
| 1985 | 315.69 " | 32.0 Kw |
| 1986 | 300.00 " | 119.20 |
| 1987 | 300.00 " | 180.86 |
| 1988 | 320.00 " | 205.67 |
| 1989 | 320.00 " | 284.05 |
| 1990 | 320.00 " | 300.55 |
| 1991 | 320.47 " | 300.55 |
| 1992 | 330.17 " | 300.55 |
| 1993 | 330.17 " | 320.65 |
| 1994 | 340.17 " | 330.55 |
| 1995 | 350.46 | 330.55 |
| 1996 | 360.46 | 330.55 |

## CHAPTER 3

(i) SYSTEM ANALYSIS AND DESIGN.

The load flow analysis problem consists of the calculation of power flow and voltages of the electrical distribution network for specifies busbars condition.

The associated parameters of busbars are

(1) Real power (useful power)

(2) Reactive power (useful power)

(3) Voltage magnitude

(4) Phase angle.

The load flow analysis can be formulated in its basic analytical form with reference to network which can be represented by linear bilatered and balanced lumped parameters. The power and voltage constraints make it the nonlinear in nature.The numerical solution must be iterative in nature.

The electrical current problem encountered in the development of load flow are ever increasing size of the systems to be solved, on-line applications and system optimization.

Five main properties are essential in load flow solution method.

(a) High computational speed: This is very important when dealing with large system, real time applications i.e. on - line application and interactive application i.e. off - line application.

(b) Low computer storage:- This is also important for large electrical systems and the use of computers with small core storage available, e.g. mini computer for on - line application.

(c) Reliability of solution: The solution of load flow must be obtained for both ill- conditioned problem, outage studies and real life time application

(d) Versatile: An ability of load flow analysis to handle conventional and special features.

(e) Simplicity: The ease of coding a computer program of the load flow algorithm.

The type of solution required for a load flow also spell out the method apply which satisfies the following condition.

(i) Accurate or approximate

(ii) Unadjusted or adjusted

(iii) Off - line or on - line

(iv) Simple case or multiple case

For an unbalanced three phase system, each busbar consists of three single - phase bus and six equation which has to be solved by load flow analysis. For a balanced three phase system, a one line diagram is always used to represent a complete 3 - phase system. It consists of a diagram identifying busbars and connecting lines with loads and transformers in their respective places in the system. Each interconnecting lines originate from a particular bus and terminates on a different bus.

Load flow calculations can be solved by using bus self and mutual admittance which compose of bus admittances. In the calculation of load flow, the following information are essential.

(a) One line diagram of the system network. Also positive sequences diagram.

(b) Oriented graph showing tree, cotree, links, cutset and loops.

(c) The values of series impedances and shunt admittances of transmission lines or distribution network from these values of busbar admittance or bus impedance matrix elements can be calculated.

(d) Transformer ratings

(e) The value of reactive power and voltage magnitude at each bus

(f) The limitation of voltage magnitude and reactive power must be clearly stated. the voltages and powers at the busbar must lie within the range of an interval.

(i) Voltage minimum < voltage level < voltage max.

(ii) Power minimum < power level < power max

(iii) Reactive power mini < per power level < reac. power max.

## 3.1 LOAD FLOW ANALYSIS MATHEMATICAL MODEL.

A matrix equation always provide a convenient mathematical model for computational analysis. The elements of the matrix equation are impedances and admittances.

The nature of matrix will depend on the number of busbars and their looping. It is always convenient to assign bus number, line number and the form of the appropriate network matrix in the load flow analysis.

Basic loops of the network are identify first.The formulation of the busbar impedance matrix requires matrix inversion, non-singular an transformation of the use of algorithm. Also the formulation of the loop admittance matrix involve a matrix inversion using either loop transformation or augmented loop admittances matrix obtained by non-singular transformation.

For 'n' number of busbars, there are n by n number of element in matrix equation. The nodal current equation is given by:

(a) $I_{Bus} = Y_{Bus} * V_{Bus}$

(b) $V_{Bus} = Z_{Bus} * I_{Bus}$

where $V_{Bus}$ = voltage measured with respect to reference bus.

$Z_{Bus}$ = Bus impedance matrix

$Y_{Bus}$ = Bus admittance

<u>Note</u> Bus = Busbar

The matrices $Y_{Bus}$ and $Z_{Bus}$ can be expressed in a model of passive portions of the busbar networks as shown below.

$Y_{Bus}$ and $Z^{1}_{Bus}$ = $Y_{11}$ $Y_{12}$ ----------$Y_{in}$

$Y_{21}$ ----------$Y_{in}$

$Y_{ni}$ ----------$Y_{nn}$

Certain rules have to be followed in order find out the elements of the admittance matrix these are:

(a) The diagonal elements are obtained by finding the algebraic sum of all admittances incident to node A

(b) The off diagonal elements $Y_{AR} == Y_{RA}$ are obtained as the negative of the admittance connecting nodes A andR.

$Y_{AR} == Y_{RA}$ ---------> 2c

The elements at zero busbar are neglected or considered as one element and is equivalent to all the zero busbar elements. With this method, computer storage time can be conserved.

Any node A of the network for the total is given by

$I = Y_{AR} \quad V_R$

$A = 1,2,3, -----n\}$ -------> 2d

$R = 1,2,3 -----n\}$

$I_A = P_A - Q_R/V_A$

Equation 2e can be re-written as

$P_A - jQR = Y_{AR} \quad V_R \; V_A$

$P_A - jQR = Y_{AR} \quad V_R \; V_A \; = 0$ ------> 2f

where $P_A$ = Active power

$R_R$ = reactive power

$Y_{AR}$ = Line admittance between A and R

$V_R \; V_A$ = Voltages at busbars A and R respectively.

3.2 <u>NUMERICAL SOLUTION TECHNIQUES</u>

The algebraic equations for the power load flow are based on iterative techniques because of their non-linearity in nature nature.The iterative methods are specifically designed to compute accurate estimates of unknown voltages until the results are obtained to the desire accuracy. This is done in a finite number of iterations.It has been established that the busbar equations must satisfy kirchoff's laws.The laws are:

(a) The algebraic sum of currents flow at a busbar must be equal to zero.

(b) The algebraic sum of all voltage in a loop must also be equal to zero

The above laws are used for convergence of the solution in the iterative computational method. the most common iterative methods are.

(i) The Gauss iterative method

(ii) The Newton - Raphison method.

These iterative methods are analysis below.

(i) <u>GAUSS ITERATIVE METHOD</u>

The Guass iterative method was used for load flow. The computational procedure usually follow a set of algorithm for computer execution. The calculation of load equations follows some series of steps which are

(a) Read in the following numerical values of

(i) Length

(ii) Impedance

(iii) Number of busbars

(iv) Number of line

(v) Acceleration factor

(vi) Busbar power

(b) Assembly the 'y' Bus admittance matrix and the iterative solution of the bus voltages

$V_p = 1/Y_{p1}$ ($1_p$ - E $Y_{p1}$ $V_1$ ---------------(1)

$1_p = p_p - JQ_p /V_p$ ---------------(2)

$V_p = 1/Y_{p1}$ [ $P_p$ JQ $_{1p}$ E $Y_{p1}$ $V_1$

$V_p = 1/Y_{p2}$ [ $P_p$ JQ $_{2p}$ /vpk E $Y_{p2}$ -------->(3)

This iterative process will continue until the magnitude of the change of the bus voltage between two consecutive iteration is less than certain tolerance level for all the bus voltages.

When the iterations have converged, the next step is to calculate the value of slack bus power given by:

$S_i = P_i + JQ_i$ -----------> (4)

The final step is the calculation of load flows on various distribution lines of the network. this can be expressed as

$S_{ii} = P_{ij} + JQ_{ij} = V_i (V_i - V_j) Y_{ij} + V_i V_i Y_{ij}$

This expression is from buses i to j

(ii) <u>Newton - Raphson method:</u>

The Newton - Raphson method is tested to be the most sophisticated of the iterative techniques and it converges <u>faster</u> without the risk of divergence than the Gauss method.

The rate of convergence can be increased by applying an acceleration factor to the approximate solution obtained form each iteration. The accelerated values of voltages are given by

$V_p = V_p + \& (V_p - V_p)$

where k = iteration count

& = acceleration factor.

The acceleration factor is between 1.5 and 1.7 for both real and imaginary.

# CHAPTER 4

## 4.1 PROGRAMMING LANGUAGES

High level programming languages can be classified into scientific oriented languages, business oriented language specific purpose language and multi-purpose language.

### (i) SCIENTIFIC ORIENTED LANGUAGES

These languages are designed for scientific and engineering applications and therefore they contain a lot of mathematical expressions for complex calculation.

Examples of such languages are Basic, ALGOL, and FORTRAN.

### (ii) BUSINESS ORIENTED LANGUAGES

The most popular of business oriented languages is COBOL. These languages can only accommodate few simple mathematical and provide extensive filing system,

### (iii) SPECIAL PURPOSE LANGUAGES.

These languages are specially designed for some particular types of problems. Example of these language is CSL - computer simulation language CORAL-66 - design for direct control of physical processors. Scientific and engineering control experiments.

### (iv) MULTI - PURPOSE LANGUAGES:

These languages are designed to solve scientific and business applications. Example of such language is PASCAL . Pascal language was designed to be a structured language.The purpose is to encourage the building of good programs.The program language is efficient on present day computers. The language is widely used up till today.

## PROGRAMMING OF POWER LOAD FLOW

The two languages applicable for power load flow are BASIC and FORTRAN. These languages are good for engineering applications such as power load flow in electrical engineering profession.

## TYPE OF ELECTRICAL NETWORK

There are six types of network

(a) 415V low tension line network

(b) 11KV medium line network

(c) 33KV Transmission line network

(d) 66Kv Transmission line network

(e) 132KV Transmission line network

(f) 330 KV transmission line network

### 11KV and 33KV line network

The 11KV and 33KV lines have resistance, inductance and capacitance parameters. Because of distance design to cover ,capasitance and inductance are considered as inactive parameters along the transmission lines. FORTRAN language is suitable for the line.

### 66KV 132KV and 330KV transmission line

The 66KV, 132KV and 330KV have resistance,inductance and capacitance parameters These parameters are active because of the distance and power involved at the load centers (Users).

The mathematical expression for voltages and power involve imaginary parameters and 'j' must be used as operator. In order to handle such engineering problems with imaginary roots, FORTRAN program language will be convenient to solve such a complex mathematical expression.

## 415V LOW TENSION LINES

The 415V lines have resistance, inductance and capacitance along the lines. These parameters are considered inactive except resistance because of the small distance designed to cover and power meant to be transferred to load centers (users).

Basic programming language is quit suitable for power load flow of this kind of line.

## 4.3 FEDERAL UNIVERSITY OF TECHNOLOGY DISTRIBUTION NETWORK AND THE CHOICE OF PROGRAM LANGUAGE.

Federal university of technology electrical distribution network is on 415V low tension lines.These run into the load centers (users) within the university system.

In developing the programming language for this, a BASIC program language is deemed fit to solve the power load flow analysis because the imaginary parameters such as inductance and capacitance are assumed to be inactive.

There are six distribution lines and each line serves a particular load center. For simplicity, a program has been written for each line. The limiting voltage is determined by using Gauss seidel iteration method. the power flow available at the load center is determined.

### PROGRAM 1

This program is to determine the main admittance (Ynn1) for the network. A program is written to solve the "Determinant" of the network.

PROGRAM 2 This program is to determine the voltage and power available to senate building and computer center of the university. A gauss seidel iteration program is written to determine the voltage available to the users. The iteration voltage simply called limiting voltages which is 397V and power flow along the line is 158.80KW.

PROGRAM 3

This program is to take care of voltage and power available at university water pump, library and part of school of science and science education. The iteration voltage for the line is 400.7v and the power flow along the line is 84.15KW.

PROGRAM 4

This program is designed to take care of voltage and power flow along the female hotels, clinic and staff-quarters. The iteration voltage for the line is 399V and power flow along the line is 39.89KW.

PROGRAM 5

This program is designed to take care of voltage and power flow available to the users along the line serving the staff school, lecture theater and engineering complex. The iteration voltage is 402V while the power flow along the line is 58.8KW.

PROGRAM 6

The program is designed to take care of voltage and power flow available to the users along the line serving the male hostel, cafeteria and environmental technology. the iteration voltage is

404V while the power flow along the line is 48.6KW.

PROGRAM 7

The program is designed to take care of voltage and power flow available to the users along the line serving the Works and Maintenance department, Kiosk and Animal garden. The iteration voltage is 411V while the power flow along the line is 25.5KW.

4.4 The table below shows the detail result of all the programs in relation to the feeder lines fig. 4.1.

| line | NAME OF FEED. | DIST.(KM) | LOAD CUR.A | NO OF ITER | LIM.VOL. | LO.POWER |
|---|---|---|---|---|---|---|
| 1 | Senate/comput center | 0.25 | 400 | 4 | 397 | 158.8 |
| 2 | Water pump/ library/SSSE | 0.75 | 210 | 6 | 401 | 84.2 |
| 3 | Female hostel clinic/staffq | 0.4 | 100 | 4 | 399 | 39.9 |
| 4 | Staff school/ LT/Eng.Comp | 1.5 | 146 | 4 | 402 | 58.8 |
| 5 | Male/hostel/ caf/envir/co | 0.6 | 122 | 5 | 404 | 48.6 |
| 6 | works dept/ animal garden | 0.3 | 62 | 5 | 411 | 25.5 |

... TECHNOLOGY, MINNA.

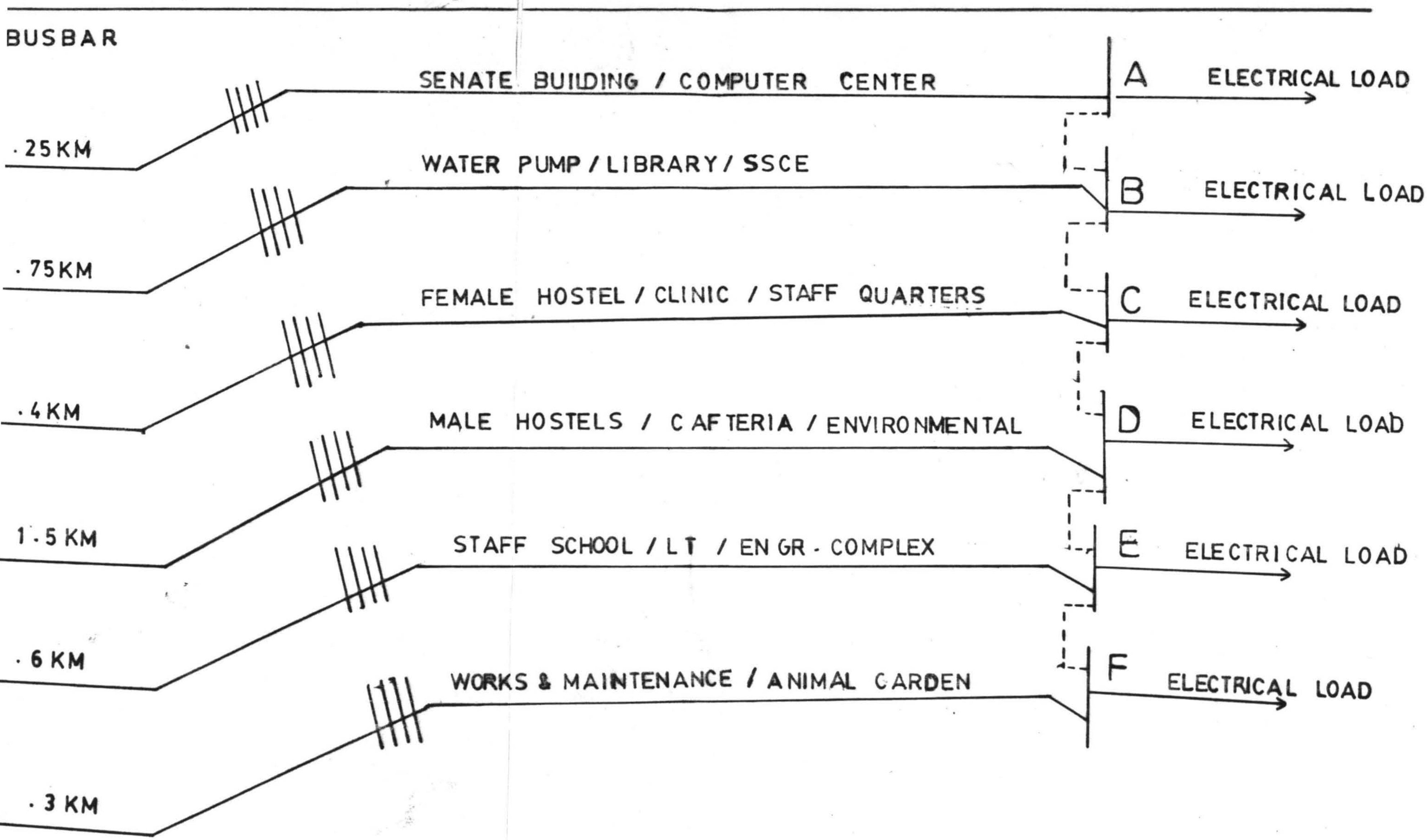



Fig.4.1

Program 1

Flow Chart Diagram

start

|

Read $Y_{11}$, $Y_{12}$
$Y_{13}$, $Y_{21}$ $Y_{22}$, $Y_{23}$
$Y_{31}$, $Y_{23}$ $Y_{33}$,

|

Data 1,1,0
5,15.6,0,0,0,1

|

Set up loop
for J = 1 to 3
for K = 1 to 3

|

Caculate
Det 1 = $Y_{11}$ *($Y_{22}$ * $Y_{33}$ -$Y_{23}$*$Y_{32}$) - $Y_{12}$ *($Y_{21}$ * $Y_{33}$
-$Y_{23}$ * $Y_{31}$)+$Y_{13}$ * ($Y_{21}$ *$Y_{33}$ - $Y_{22}$ * $Y_{31}$)

|

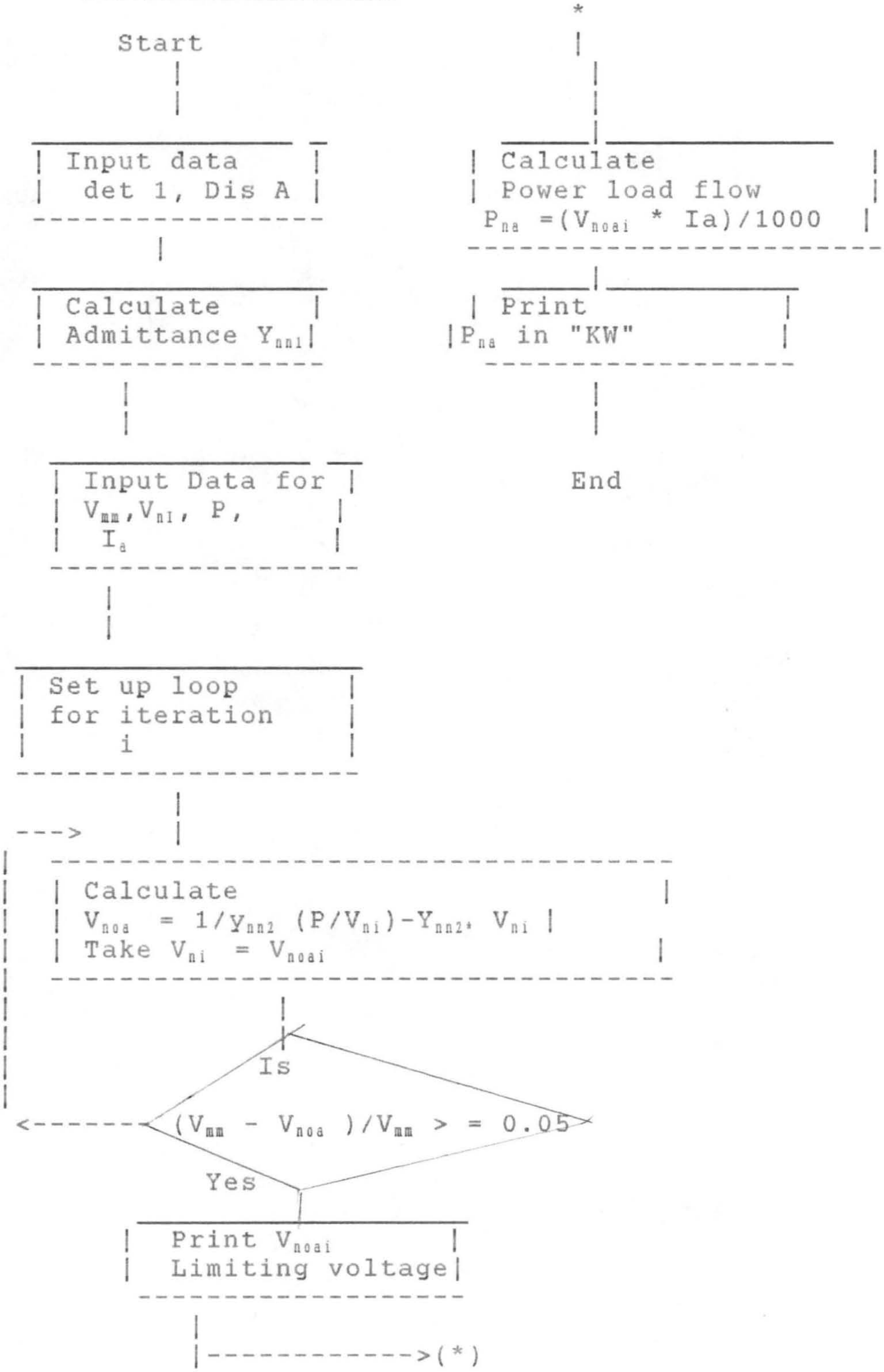
Print
Det

|

End

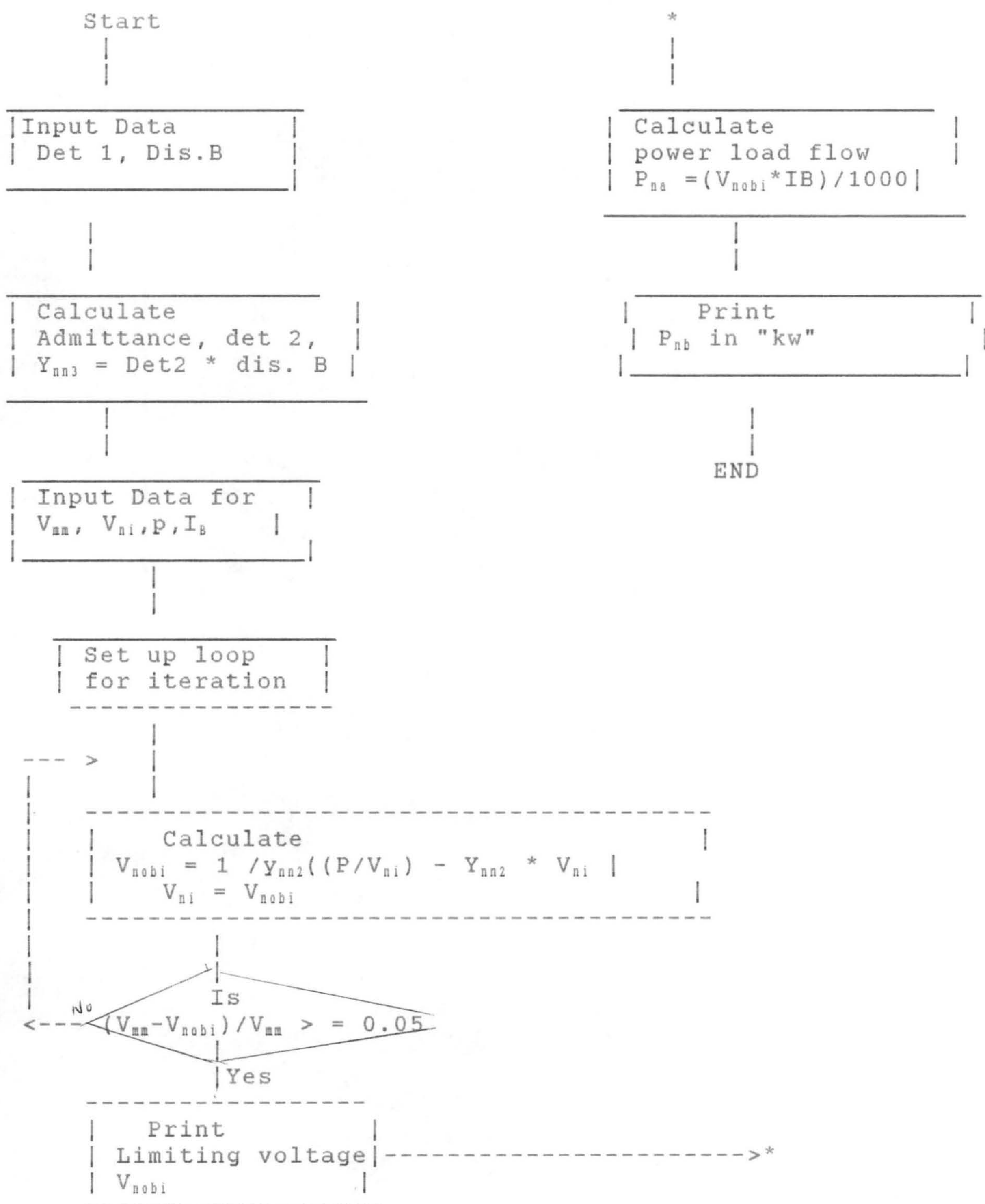
Program 2

Flow chart Diagram



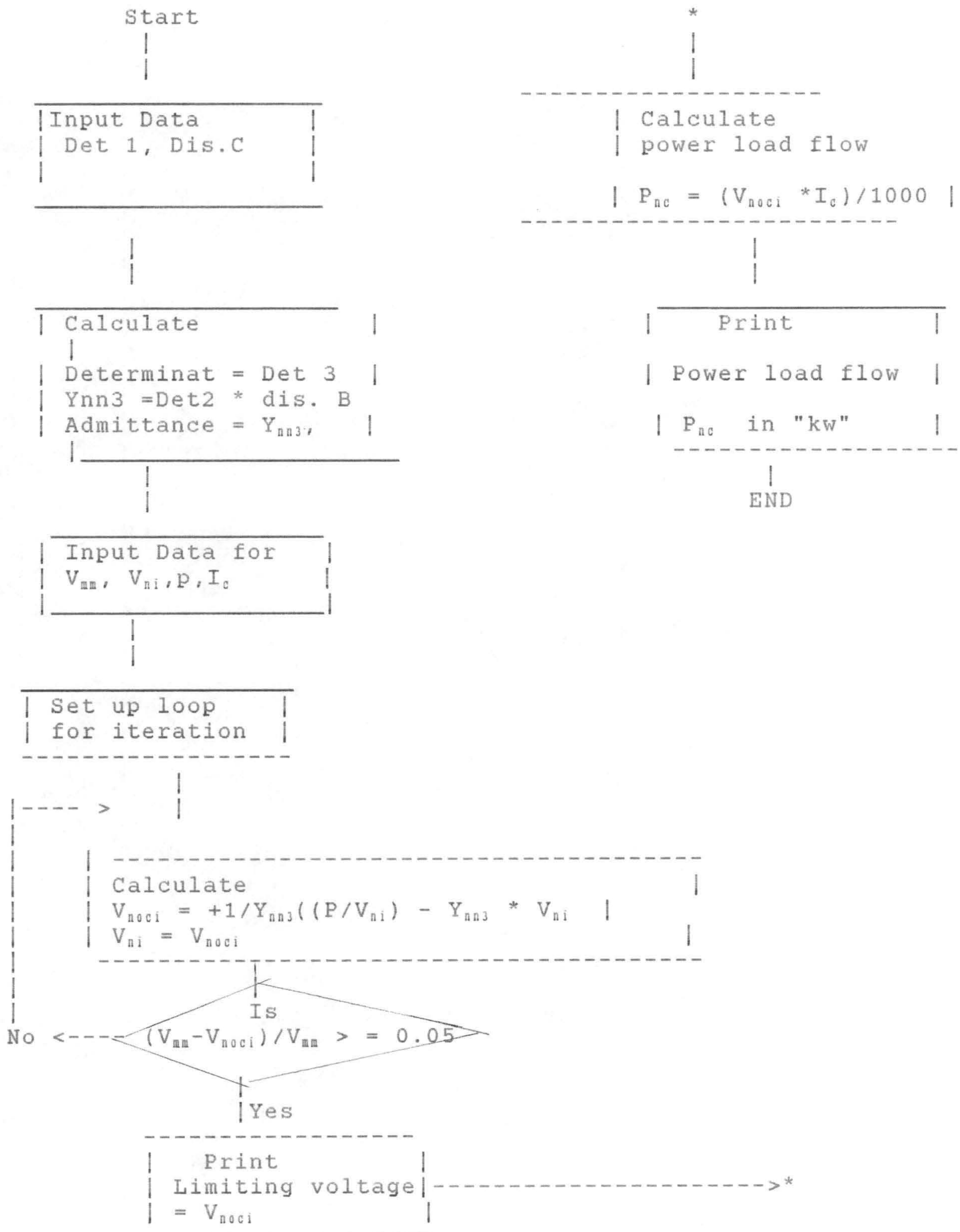
## 4.8 Program 3

Flow chart diagram



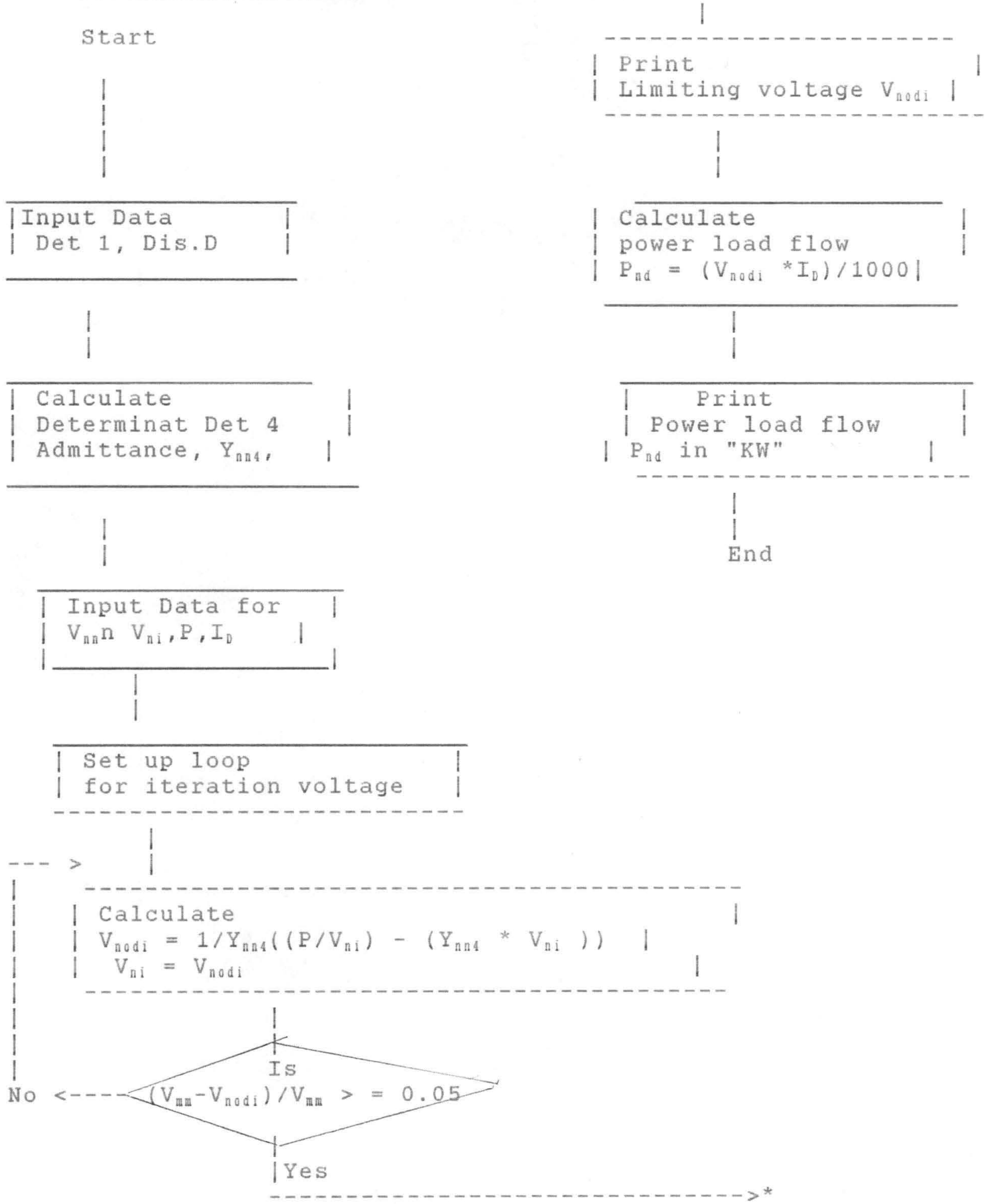
## 4.9 Program 4

Flow chart diagram

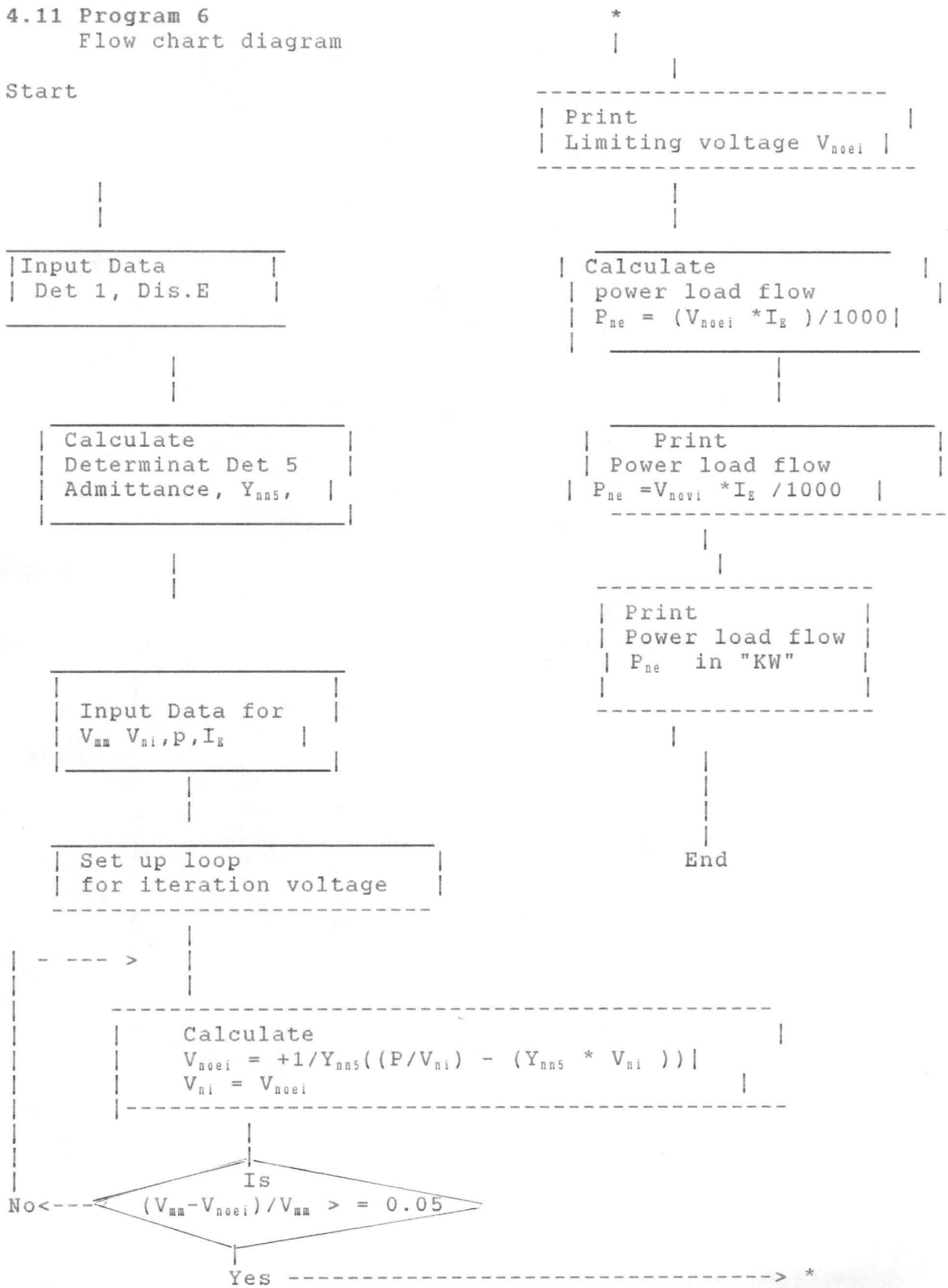


4.10 Program 5

Flow chart diagram

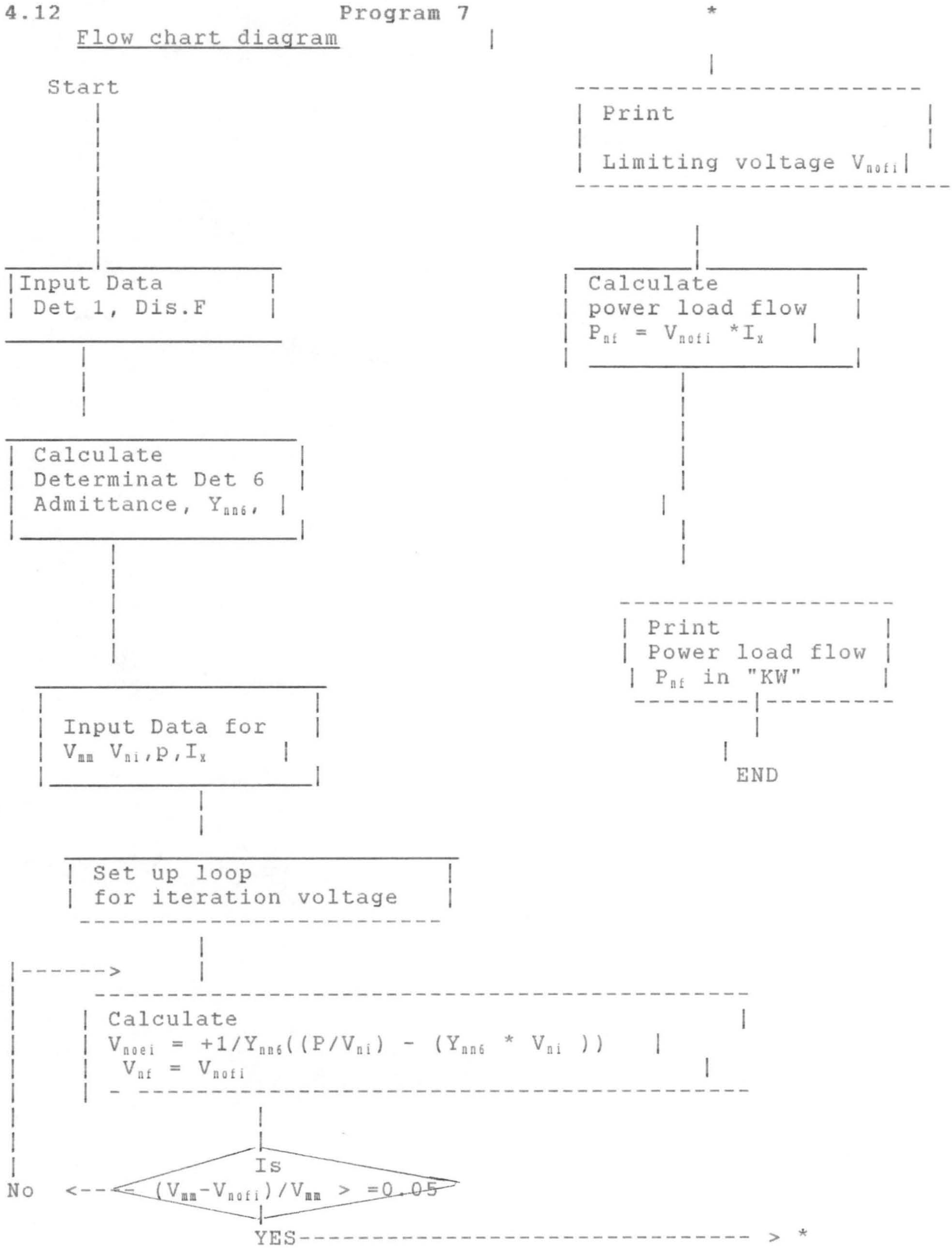


## 4.11 Program 6
Flow chart diagram



4.12 Program 7

Flow chart diagram



## 4.13 Data as an Input

| Name of the Dat. | Pro.1 | Pro.2 | Pro.3 | Pro.4 | Pro.5 | Pro.6 | Pro7 |
|---|---|---|---|---|---|---|---|
| Admittance $Y_{11}$, $Y_{12}$ $Y_{13}$ $Y_{21}$ $Y_{22}$ $Y_{23}$ $Y_{31}$ $Y_{32}$ $Y_{33}$ | 1,1,0<br>4,15.60<br>0,0,1 | - | - | - | - | - | - |
| Maximum vol. $V_{mm}$ | - | 422v | 422v | 422v | 422v | 422v | 422v |
| Distance | - | .25km | .75km | 0.4km | 1.5km | 0.6km | 0.3km |
| Volt. at main Bus. | - | 415v | 415v | 415v | 415v | 415v | 415v |
| Line Current | - | 400A | 210A | 100A | 146A | 122A | 62A |
| Power at main Bus. | - | 1000000 | 1000000 | 1000000 | 1000000 | 1000000 | 1000000 |
| Determinat 1 | - | 11.6 | 11.6 | 11.6 | 11.6 | 11.6 | 11.6 |
| Det. | - | - | 2.9970 | 1.5998 | 5.9980 | 2.3990 | 1.1990 |
| Note<br>Busbar | - | A | B | C | D | E | F |

Program 1

```
Cls

Read Y11 ,Y12,Y13,Y21 Y22,Y23,Y31,Y32,Y33

Data 1 1 0 4 15.6 0 0 0 1
FOR j = 1 TO 3
     FOR J = 1 TO 3
     for k = 1 to 3
Det 1 = Y11, (Y22 * Y33 - Y23 * Y32)-Y12 (Y21 * Y33 -Y23 *Y31)+

     Y13 * (Y21 * Y32 - Y22 *Y31 )

Print "Determinant 1 = ", Det 1
     Next K
Next J

End
Stop

     Result:
     Det1 = 11.6
```

4.15 Program 2

```
     ' Power load flow analysis for senate building and computer
centre
     Input "Enter maximum voltage";  Vmm
     Input "Enter Distance A"; Dis.A
     Input "Enter voltage at Main busbar"; Vn
     Input "Enter line current A"; IA
     Input "Enter power at main busbar.; P
     Input "Enter Determinant"; Det 1
Ynn1 = Det 1 * dis. A
Print "Admittance = "; Ynn1
for i = 1 to 5
Vnnai = (1/Ynn1 ) * ((P/Vni) -( Ynn1 * Vni))
     Vni = Vnai
Print "Vnoai"; i, "="; Vnoai, "V"
IF (Vmm - Vnoai)/Vmm > = 0.05 Then goto 100
     Next
100 print "Limiting voltage = "; Vnoai "V"
Print "No of iteration = "; i
Pna = (Vnoai * IA)/1000
Print " Power at busbar A = ", Pna; "KW"
End
Stop
```

Results

Admittance = 2.90000

Iteration voltage = $V_{noa1}$, $V_{noa2}$, $V_{noa3}$, $V_{noa4}$

415.9V, 413.2V, 421.4V, 397V

Limiting voltage = 397V

No of iteration = 4

Power at Busbar A = 158.8KW

**Program 3**

```
cls
'Power load flow analysis for Water pump, Library and SSSE
Input "Enter maximum voltage"; Vmm
Input "Enter Distance B"; dis.B
Input "Enter voltage at main busbar"; Vni
Input "Enter line current B"; IB
Input "Enter power at main busbar"; P
Input "Enter Determinant "; Det 1
Det 2 = det1/2.997
Ynn2 = det 2 * dis.B
Print "Admittance ="; Ynn2
for i = 1 to 7
Vnobi = (1/ynn2) * ((P/Vni) - (Ynn2 * Vni))
     Vni = Vnobi
     Print "Vnobi" i, "="; Vnobi "V"
IF (( Vmm -Vnobi)/Vnn) > = 0.05 Then goto 200
     Next
200   print "Limiting voltage = "; Vnobi; "V"
     Print "No of Iteration =";
     Pnb = (Vnobi * IB)/1000
     Print "power  at Busbar B = " Pnb; "KW"
     End
     Stop
```

---

<u>Results</u>

Admittance = 2.902903

iteration voltages = $V_{nob1}$ = 415.1v, $V_{nob2}$ = 414.8v, $V_{nob3}$ = 415v, $V_{nob4}$ = 413.4v, $V_{nob5}$ = 4198v $V_{nob6}$ = 401v

Limiting voltage = 401v

No of iteration = 6

Power at Busbar B = 84.2 KW

4.17

program 4

```
cls
'Power load flow analysis for female hotels, Clinic and Staff quarters
Input "Enter maximum voltage"; Vmm
Input "Enter distance C"; dis.C
Input "Enter voltage at main busbar"; Vni
Input "Enter line current C". Ic
Input "Enter power at main busbar". P
Input "Enter Determinat"; Det 1
Det 3 = Det1/1.5998
Ynn3 = Det 3 * dis.C
Print "Admittance ="; Ynn3
for i = 1 to 5
Vnoci = (1/Ynn3) * ((P/Vni) -(Ynn3 * Vni))
     Vni = Vnoci
print "Vnoci"; i' "="; Vnoci "V"
IF (( Vmm - Vnoci)/Vmm ) > + 0.05 Then goto 300
     Next
300  Print "Limiting voltage = "; Vnoci; "V"
     print "No of iteration = ";   i
     Pnc = (Vnoci * IC)/1000
     print "Power at Busbar C = "; Pnc ; "kw"
     End
     Stop
```

---

<u>Results</u>

Admittance =2.900363

Iteration voltages = $V_{noc1}$ = 415.8V, $V_{noc2}$ = 413.4V, $V_{noc3}$ = 420.6V
$V_{noc4}$ = 399V

Limiting voltage = 399V

No of iteration = 4

Power at busbar C = 39.9kw

**Program 5**

Power load flow analysis for Staff school, Lecture theaters and Engineerig Complex

```
Input "Enter maximum voltage"; Vmm
Input "Enter distance D"; dis D
Input "Enter voltage at main busbar"; Vni
Input "Enter line current D"; ID
Input "Enter Power at main busbar ; P
Input "Enter Determinant"; Det1
Det 4 = Det1/5.998
Ynn4 = Det 4 * dis.D
Print "Admittance = ; Ynn4
For i = 1 to 4
Vnodi = (1/Ynn4 )* ((p/Vni) - (Ynn4 * Vni))
     Vni =Vnodi
Print "Vnobi"; i' "="; Vnodi "V"
IF ((Vmm - Vnodi)/Vmm) > = 0.05 Then goto 400
     Next
400  print "Limiting voltage + "; Vnodi; "V"
     Print "No pf iteration ="; i
     PnD = (Vnodi * ID)/1000
     Print " Power at Busbar D = "; PnD "kw"
     End
     Stop
```

Result

Admittance = 2.900967

iteration voltage = $V_{nod1}$ = 415.6V, $V_{nod2}$ = 413.7V

$V_{nod3}$ 419.4V, $V_{nod4}$ = 402V

Limiting voltage = 402V

No of iteration 4

Power at Busbar D = 58.8kw

**Program 6**

```
Cls
'Power load flow analysis for male Hostels, Cafeteria and
Environmental complex
Input "Enter maximum voltage"; Vmm
Input "Enter Distance E"; dis E
Input "Enter voltage at main busbar"; Vni
Input "Enter line current E"; Ie
Input "Enter power at main busbar"; P
Input "Enter Determinant "; Det 1
Det 5 = Det 1/2.399
Ynn5 = Det 5 * dis E
Print "Admittance +"; Ynn5
for i = 1 to 5
Vnoei = (1/Ynn5) * ((P/Vni) - (Ynn5*Vni))
     Vni = Vnoei
print "Vnoei "; i, " = "; Vnoei, "V"
IF (( Vmm - Vnoei )/Vmm) > = 0.05 Then goto 500
     Next
500  print "limiting voltage ="; Vnoei; "V"
     print "No of iteration ="; i
     Pne = (Vnoei * Ie)/1000
     Print "power at busbar E ="; Pne "kw"
     End
     Stop
```

---

Results

Admittance = 2.901209

iteration voltage =$V_{nod1}$ 415.6 $V_{nod2}$ = 413.9V, $V_{noe3}$ = 419V

$V_{noe4}$ = 404V

Limiting Voltage = 404V

No of iteratron = 4

power at Busbar E = 48.5 Kw

4.20 Program 7

```
cls
 'Power load flow analysis for Works and maintenance and Animal
production departments.
Input "Enter maximum voltage"; Vmm
Input "Enter distance F"; dis.F
Input "Enter voltage at main busbar"; Vni
Input "Enter Line current F "; Ix
Input "Enter power at mains busbar"; P
Input "Enter Determinat"; Det 1
Det 6 = Det 1/1.99
Ynn6 = det 6 * Dis.F
Print "Admittance ="; Ynn6
     For i = 1 to 5
Vnofi = (1/Ynn6 ) * ((P/Vni) - (Ynn6 * Vni))
     Vni = Vnofi
Print Vnofi "; i; "="; Vnofi; "V"
IF (( Vmm - Vnofi )/Vmm )) = 0.05 Then goto 600
     Next
600  print "limiting voltage ="; Vnofi;"V"
     print "No of iteration ="; i
     Pnf = (Vnofi * Ix)/1000
     Print "Power at Busbar F="; Pnf "kw"
     End
     Stop
```

RESULTS

Result
Admittance = 2.902419
iteration voltage $=V_{nof1}$ 415.2v, $V_{nod2}$ = 414.6v $V_{nod3}$ 416.5v, $V_{nod4}$ = 411v

No of iteration = 4
Limiting voltage = 411v
Power at Busbar F = 25.5kw

## 4.21 ANALYSIS OF RESULTS FROM COMPUTER PROGRAM

The program solution for power load flow of federal university of technology, Minna is shown in Programs 1 - 7 (Computer result)

The iteration voltages obtained for six lines are reasonable. It values show that there are voltage drops along the lines. See fig 4.1

The power load flow results for each line are accurate when load flow results The power load flow for senate building and computer centre is the highest.

5.0 CHAPTER 5

## 5.1 RECOMMENDATIONS

The following recommendations are considered necessary in order to operate, maintain, plan and design the power load flow of federal university of technology Minna.

(i) The conductor's route must be accurately surveyed in order to get accurate distance for each line

(ii) The size of conductors used now need to be changed in order reduce the voltage drops along the line especially senate building and computer centre.

(iii) Preparation for additional transformer is considered necessary because of non-utilization of electrical machines at school of engineering

(iv) Planning, design, operation and maintenance of the existing and new lines are easy with the use of computer program but there is the need to open a data bank so that any change in input data can be reflected in the data bank.

(v) Load projection is necessary in order to avoid the overload of the existing transformers.

## 5.2 CONCLUSION:

The information obtained from the computer program is an indication that digital computer is an indispensable tool in engineering field. Engineers are relieved of tedious normal calculations. Once the program is written, for power load flows, future load flow can easily be obtained by updating the input load current and length of the lines.

## REFERENCES


1. Anthony, J. P. Electrical Distribution Engineering. New York:Mcgraw Hill, 1986.
2. Arrillaga, J. et. al. Computer Analysis of Power Systems. New York:John Wiley & Sons, 1990.
3. Badmus, R. O. Lecture Notes on System Analysis & Design (unpublished) 1996.
4. Cotton, H. et. al. The Transmission & Utilization of Electrical Power . London:Hodder & stoughton Educ., 1978.
5. Glenn, W. S. Computer Methods in Power System Analysis. London: Mcgraw Hill, 1988.
6. Leon, K. K. Economic Operation of Power Systems .New York: Wiley Eastern Ltd., 1979.
7. Olle, I. E. Basic Electrical Power Engineering. London: Addision _Wesley, 1977.
8. Uwaifo, S. O. Electric Power Distribution, Planning and Development. Lagos: Malthouse, 1994
9. Wadhwa, C. L. Electrical Power Systems. New Delhi: Wiley Eastern Ltd. , 1991.
10. Weedy, B. M. Electric Power Systems. Great Britain: John Wiley & Sons, 1992.