A COMPUTER PROGRAM TO ANALYSIS OF UNSYMMETRICAL FAULT IN ELECTRIC P[OWER SYSTEMS BY Visual Basic

Saher A. Karim / Thi-Qar University

برنامج حاسوبي لتحليل الأعطال الغير متماثلة في منظومات القدرة الكهربائية باستخدام لغة
Visual Basic

ساهر عبدالعباس كريم/مدرس مساعد/ماجستير هندسة قدرة/جامعة ذي قار

Abstract

This work is concerned with a program to model an electrical power network ad simulate the factors which have a bearing on the fault in the network .These factors are

1- **The amount of loading at the instant that the fault occurs.**
2- **Site up the fault relative to the generation station.**
3- **The type of fault on hand.**
4- **Earthing.**
5- **Current Limiting Reactance.**

The program tries to connect its technological which depends on one step at a-time method in formulating impedance matrix for Z_{Bas} and symmetrical component method in analysis unstable systems for its training activities.

الخلاصة

يهدف البحث الحالي الى تصميم برنامج حاسوبي لنمذجة شبكات نظم القدرة الكهربائية ومحاكاة العوامل المؤثرة على تحليل الأعطال الغير متماثلة فيها والمتمثلة بما يلي:-

١- درجة تحميل المولدة لحظة حدوث العطل
٢- موقع حدوث العطل بالنسبة الى موقع التوليد
٣- نوع العطل الجاري تحليله
٤- التأريض
٥- وجود المفاعلات المحددة للتيار

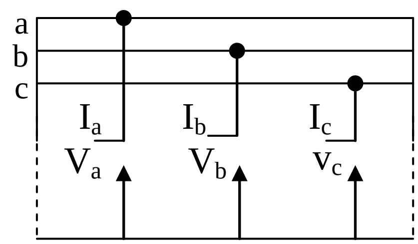
كما يتصف البرنامج الحاسوبي بمحاولته ربط المميزات التكنولوجية والتسهيلات التي يقدمها البرنامج الحاسوبي الذي يعتمد على طريقة الخطوة خطوة في تشكيل مصفوفة ممانعة عموميات الشبكة[Zbus] وعلى طريقة المركبات المتماثلة في تحليل المنظومات غير المتزنة .

1. INTRODUCTION

1.1 Unsymmetrical Faults

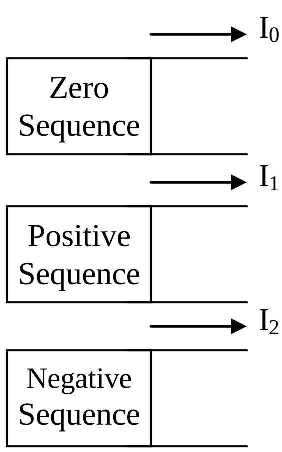
Most of the faults that occur in electrical power system are unsymmetrical Faults, these faults include malfunctioning line -to- ground fault, line -to-line fault and double line -to- ground fault ,have any of these current faults through the impedance or resistance at the site of the same faults (Impedance or resistance point of failure).
The unsymmetrical fault occur also a result of the break fuse in one or two lines together

Play all kinds of faults in the loss of asymmetrical balance currents force in the network that have already been balanced and that prior to the fault. figure (1) represents the general situation proposal. Parties have shown public abroad to be able to work representing the external wiring errors to be applied before the fault, currents (Ia, Ib, Ic)are assumed to be equal to zero [1].

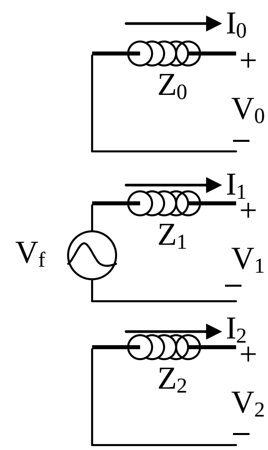


Fig(1) three phase general access port

Figure (2) represents the general sequence of networks. Since the system before a fault operating situation of imbalance therefore each of the network sequence zero, positive and negative, they are also interdependent and currents sequence (I_2, I_1, I_0) equal to zero and also Figure (3) refers to the thevenin's circuit, the reward for each network of networks sequence at the site of fault [1] [2]



Fig(2) General Network for sequence



Fig(3) Thevenins equivalent for each sequence in fault location

1.2 Symmetrical Components

Unbalanced Power System can be representation by using phasor diagram, However, it is the representation of unsymmetrical, regardless of the number of phases of the unbalanced system.

And also can not conduct analysis mathematics to such unbalanced system only through streamlining and unbalanced attitude by applying analytical processes are designed to dismantle the system unbalanced to balanced systems, each with a number of phases equal to the number of phases of the original unbalanced system and called on those systems balanced then symmetrical component or Clark components[3] ,These totals of the components are:-

1) positive sequence components

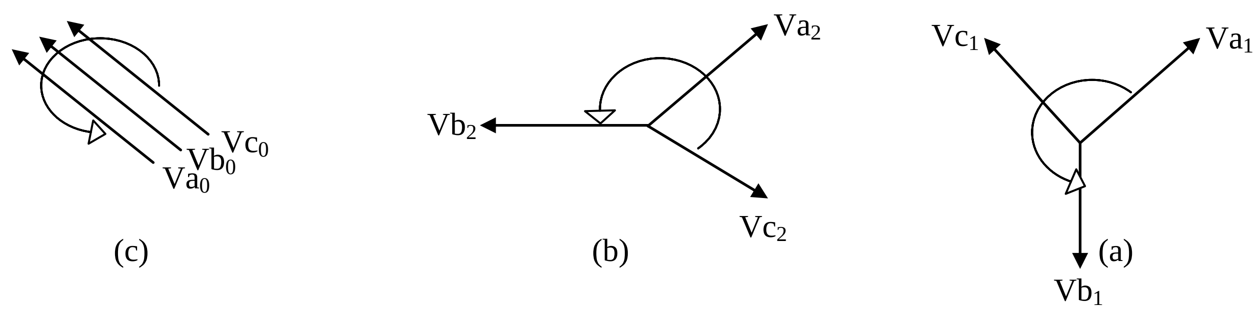
It consists of three phases of equal magnitude and the angle are 120 between these phases , and have the same sequence of the phases of the system of origin. And symbolizes the positive phase sequence (voltage) reflecting V_{c1}, $V_{b1}$and V_a1.

2) Negative sequence components

It consists of three phases of equal magnitude and the angle are 120 between these phases. but the sequence phase is Opposite of sequence to original system and symbolizes the negative phase sequence reflecting V_{a2}, V_{b2} and V_{c2} .

3) Zero sequence components

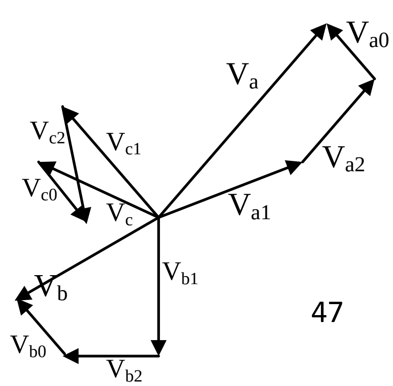
It consists of three phases of equal magnitude and identical in the direction has therefore launched by naming Zero sequence components, notes that the value phase in each sequence may vary from value phase in other sequences and symbolized voltages for the zero sequence phases V_{co} , V_{bo} and V_{ao} , Three components shown in the figure(4) (a,b and c),where traditionally been considered a zero-sequence for any system(a then b then c), The turnover phase have The opposite direction of rotation Scorpion pm



Fig(4) three phases group which symmetrical components to the system unbalanced

When applying the analytical method to each phase for all original unbalanced phases

$$\left.\begin{aligned} V_a &= V_{a1} + V_{a2} + V_{a0} \\ V_b &= V_{b1} + V_{b2} + V_{b0} \\ V_c &= V_{c1} + V_{c2} + V_{c0} \end{aligned}\right\} \quad \ldots\ldots\ldots(1)$$



Fig(5)
phase collection of symmetrical components to obtain the phase unbalanced

Reference to the definition of symmetrical components, the voltage (V_{b1}) always behind (V_{a1})by angle fixed to 120^0 and (V_{a1}). Likewise (V_{c1}) before (V_{a1})by angle of 120^0.
Therefore appropriate to use recycled factor (a), which represents vector component , Length one and phase angle 120^0,Turns out that:-

$$\left.\begin{array}{ll} V_{b1} = a^2 V_{a1} & Vc_1 = aVa_1 \\ V_{b2} = aV_{a2} & Vc_2 = a^2 Va_2 \\ V_{b0} = V_{a0} & Vc_0 = Va_0 \end{array}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

From equation (1) and equation (2):-

$$\left.\begin{array}{l} V_a = V_{a1} + V_{a2} + V_{a0} \\ V_b = a^2 V_{a1} + aV_{a2} + V_{a0} \\ V_c = aV_{a1} + a^2 V_{a2} + V_{a0} \end{array}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

In matrix from equation (3may be written as:-

$$\begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 \\ 1 & a^2 & a \\ 1 & a & a^2 \end{bmatrix} \begin{bmatrix} V_{a0} \\ V_{b0} \\ V_{c0} \end{bmatrix} \quad \ldots\ldots\ldots\ldots(4)$$

Let:-

$$A = \begin{bmatrix} 1 & 1 & 1 \\ 1 & a^2 & a \\ 1 & a & a^2 \end{bmatrix} \quad \text{then} \quad A^{-1} = 1/3 \begin{bmatrix} 1 & 1 & 1 \\ 1 & a & a^2 \\ 1 & a^2 & a \end{bmatrix} \quad \ldots\ldots\ldots(5)$$

$$\begin{bmatrix} V_{a0} \\ V_{b0} \\ V_{c0} \end{bmatrix} = 1/3 \begin{bmatrix} 1 & 1 & 1 \\ 1 & a^2 & a \\ 1 & a & a^2 \end{bmatrix} \begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix} \quad \ldots\ldots\ldots(6)$$

Write equations conversion sequentially values of the phase values and vice versa
As follows:- [4] [5] [6]

$$\vec{V}_{abc} = [A]\ \vec{V}_{012} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$$V_{012} = [A]^{-1}\ V_{abc} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

With the same way ,the currents:-

$\overrightarrow{I_{abc}} = [\ A\ ] \cdot \overrightarrow{I_{012}}$ .... (9)

$\overrightarrow{I_{012}} = [\ A\ ]^{-1} \cdot \overrightarrow{I_{abc}}$ .... (10)

1.3 Analysis of Unsymmetrical Faults by Three – Component Method

That a fault at a certain point of the power system represents by (Inter Connection)Between networks sequence at the point of fault ,Therefore the important thing to be determined is the exact nature of these networks connecting. In order to achieve this, we follow the following steps in conducting the analysis:-

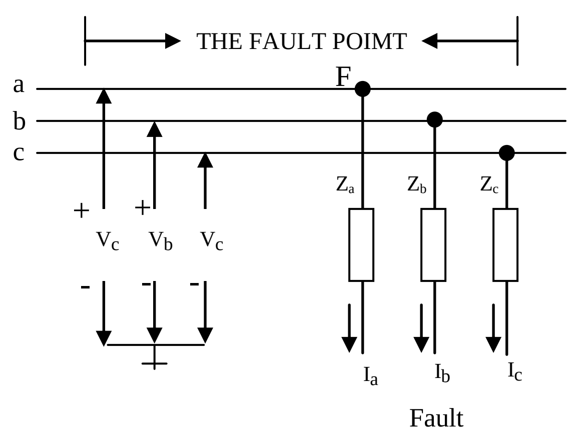
1- Make detailed circuit planner refers to all phases that connect with fault point, With coding(Label) the currents ,Voltages and Impedance (fig. 6), to impose thevenins impedance equivalent perspective from the site of a failure is known.

2- Writing values for the fault (phase values for current and voltage).

3- Transfer value of phase voltage or current (a-b-c)referred to in point(2)To the values of sequential(0 1 2)Using a matrix conversion[A] or $[A]^{-1}$.

4- Based on the sequence currents referred to in point(2) determined by the nature of connect the poles networks sequence (N,F).

5- Based on the sequence voltages determined by remaining the nature of networks connecting poles sequence, It is appropriate to add fault Impedance in this step based on points(3 and 4).



Fig(6)
circuit planner in the site of a failure(F)

The following is an analysis of unsymmetrical fault to Following five steps that have already clarified.

1.3.1 The Single Line - to – Ground Fault (SLG)

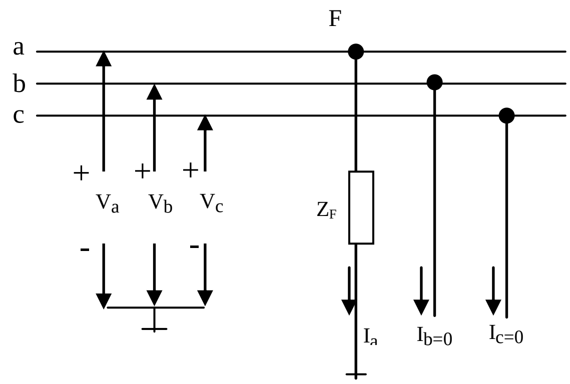


Fig.(7)
circuit planner for (SLG) at point (F)

From the circuit planner and cases study of the terminals point ,the special condition to the fault (SLG) are:-

$$\left.\begin{array}{l} I_b=I_c=0 \\ V_a=Z_F I_a \end{array}\right\} \quad \ldots\ldots\ldots\ldots \quad (11)$$

using equation ($I_{012}=A^{-1} I_{abc}$) for converting the phase values of the current to the sequential values , results:

$I_{a0}=I_{a1}=I_{a2}=1/3.I_a$ ………………(12)

As the
$V_a=Z_F\, I_a$
then
$V_a=3Z_F\, I_{a1}$ …………………(13)

$V_{a0}+V_{a1}+V_{a2}=3Z_F\, I_{a1}$ ………..(14)

We can deduce from the equation (12) that the networks sequence connecting respectively in the site of fault at point(F).

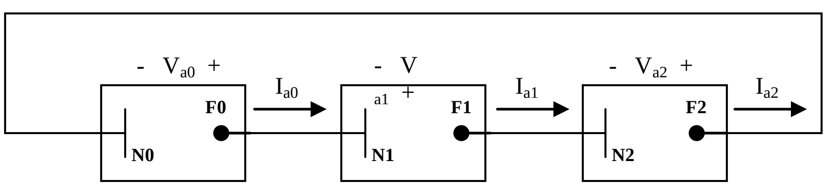
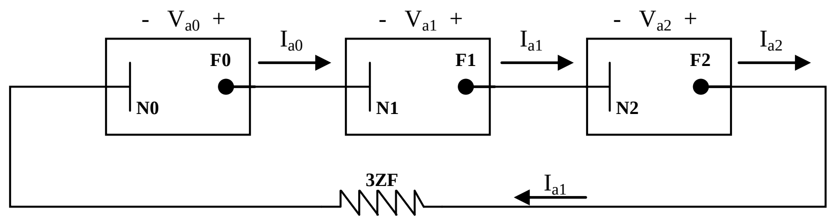


Fig.(8)
Connect partial to networks sequence On the basis of current equation to the fault (SLG)

Of the equation (١٤) is determined to connect the remaining poles networks equence
In addition to identifying external Impedance to be linked.



Fig(9) connection the networks sequence for(SLG) At a point(f)

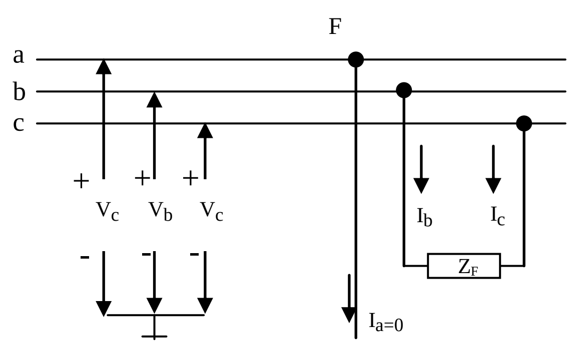
From the final connection of the to networks sequence ,Currents sequence are calculated of the following equation:

$$I_{a0}=I_{a1}=I_{a2}=\frac{V_F}{Z_0+Z_1+Z_2+3Z_F} \quad \text{……….(15)}$$

Voltages sequence are calculated according to the following:

$$\begin{pmatrix} V_{a0} \\ V_{b0} \\ V_{c0} \end{pmatrix} = \begin{bmatrix} 0 \\ E_a \\ 0 \end{bmatrix} - \begin{pmatrix} Z_0 & 0 & 0 \\ 0 & Z_1 & 0 \\ 0 & 0 & Z_2 \end{pmatrix} \begin{pmatrix} I_{a0} \\ I \\ I_{a2} \end{pmatrix} \quad \text{……….(16)}$$

1.3.2 Line –to- Line Fault (LL)



Fig(10)
circuit planner for
(LL) at point F

From note the circuit planner and study cases of the terminals point ,the special condition to the fault (LL) are:-

$$\left.\begin{aligned} I_a &= 0 \\ I_b &= -I_c \\ V_b - V_c &= I_b . Z_F \end{aligned}\right\} \qquad \ldots\ldots\ldots\ldots (17)$$

Using equation ($I_{012}=A^{-1}\ I_{abc}$) for converting the phase values of the current and voltage to the sequential values , results:

$$I_{a0} = 0 \qquad \ldots\ldots\ldots\ldots (18)$$
$$I_{a1} = -I_{a2} \qquad \ldots\ldots\ldots\ldots (19)$$
$$Z_F\ I_{a1} = V_{a1} - V_{a2} \qquad \ldots\ldots\ldots\ldots (20)$$

Since the zero sequence current (I_{a0}) equal to zero
So the zero sequence is an open circle in this type of faults.
Equation(19)indicates that the nature of a network connecting the positive and negative sequence are as follows :-

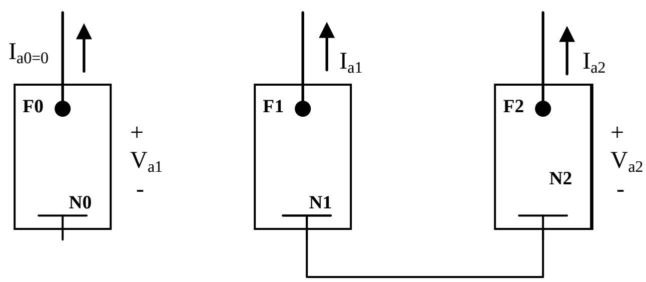
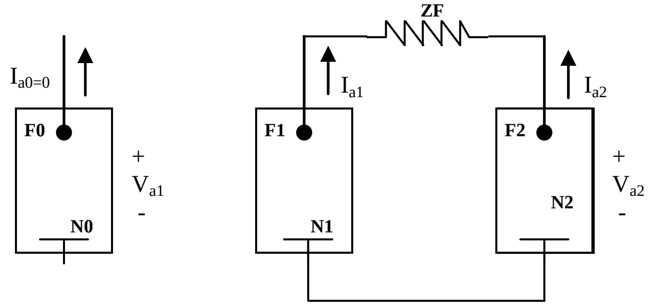


Fig.(11)
Connect partial for networks sequence on the basis of the equation current at a point (F)

Of the equation (20) is determined to connect the remaining poles networks sequence In addition to identifying external Impedance to be linked.

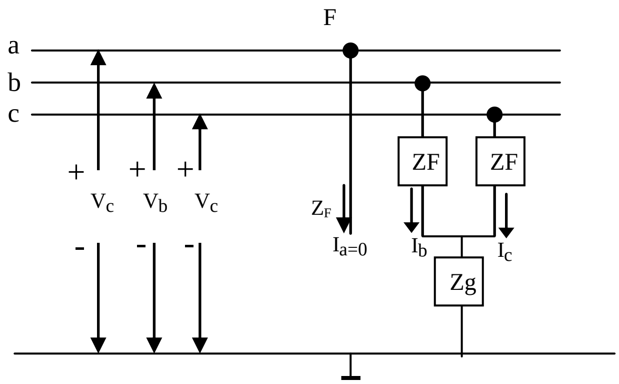


Fig(12)
connect the networks sequence for(LL) At a point(f)

Therefore, the current sequence is calculated as follows: -

$$I_{a1} = \frac{V_F}{Z_1+Z_2+Z_F} \quad \ldots\ldots\ldots..(21)$$

1.3.3 The Double Line to Ground Fault(LLG)



Fig(13)
circuit planner for
(LLG) at point F

From note the circuit planner and study cases of the terminals point ,the special condition to the fault (LLG) are:-

$I_a=0$ ………..(22)
$V_b= (Z_F+Z_g)I_b +Z_gI_c$ …………(23)
$V_c= (Z_F+Z_g)I_c +Z_gI_b$ …………(24)

Using equation ($I_{012}=A^{-1} I_{abc}$) results from equation(22):

$I_{a0} + I_{a1} + I_{a2} = 0$ …………(25)

Of the equation(3)write:-

$V_b=V_{a0} +a^2V_{a1}+_aV_{a2}$ ……….(3)a
$V_c=V_{a0} +_aV_{a1}+_a{}^2V_{a2}$ ……….(3)b

The sum of the difference between equations(3)a and (3)b, result :-

$V_b – V_c = (_a{}^2 –_a)(V_{a1} –V_{a2})$ …………(26)

The sum of the difference between equations(23) and (24), result :-
$V_b – V_c = Z_f (I_b -_{Ic)}$ …………(27)
Equality of the equation (26) and (27)With compensation for the value of the Phase currents ($I_b – I_c$)) with the equivalent of sequential values, result:-
$V_{a1} – V_F I_{a1}= V_{a2} – Z_F I_{a2}$ ………….(28)

Through the equation(3)a and (3)b par with the sum of the equation (23)and (24), result:-

$$V_{a0} - Z_F I_{a0} - 3Z_g I_{a0} = V_{a1} - Z_F I_{a1} \quad \ldots\ldots\ldots(29)$$

Of the equation currents sequence(25)conclude that point(N) in the sequence of all networks
Link to the common point as shown in Figure (14).

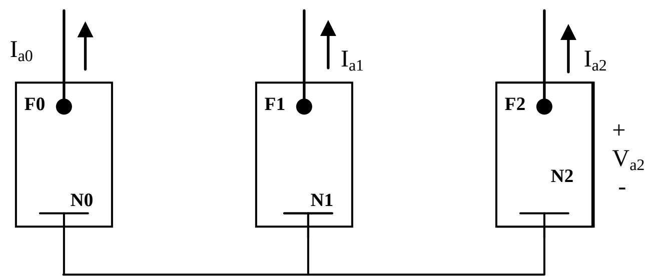
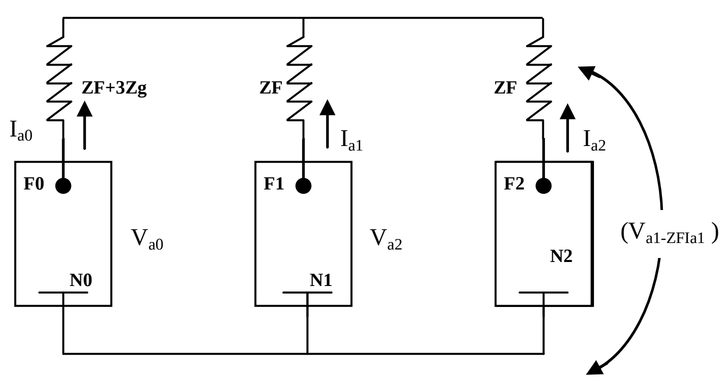


Fig.(14)
The Connect partial for networks sequence on the basis of the equation current

of the equation Voltages sequence (28)Concludes the positive sequence voltage a par with negative sequence In the case connecting the external impedance(Z_F) on series with each network.
And similarly Of the equation (29) we can deduce that Requires connecting the external impedance (Z_F+3Z_g) to The zero network sequence, as in the following figure.[4][7]



Fig(15)
The final connection to networks sequence of fault (LLG)at a point (F)

2-Engineering procedures

Was an analysis of faults short circuit in networks electrical power through the preparation of a computer program Visual Basic language
The program included a series of software subsidiary(sub routines) which:-
1-Sub routine plus1
This program work by adding a element between the new bus and old bus[[Z]old] to form a new bus impedance matrix (modified) [[Z]new]
2-Sub routine plus2
Called program (plus2) to form a new bus impedance matrix [[Z]new] through the addition of Branch between two old bus to the already existing bus impedance matrix [[Z]old]
3-Sub routine (equal)
For the purpose of an analysis unsymmetrical faults in the networks electrical power had been set up Zero, Positive& Negative Sequence Impedance[Z012]Bus
To reduce the amount of data stored in computer memory are often considered a Positive Sequence Impedance matrix [Z1] equal to Negative Sequence Impedance matrix [Z2] by summoning sub routine (equal)
4-Sub routine (change)
Use this program for the purpose of renumbering of Buses network in the event of a change in numbering consistent with the conditions that must be taken into account when forming in the Impedance matrix step-by-step manner
5-Sub routine (LLLG)
This programme has been adopted in conducting all the required calculations in the event of network failure to contact three lines to the ground(LLLG)
6-Sub routine (LG)
This programme has been adopted in conducting all the required calculations in the event of network failure to contact one line to the ground(LG)
7-Sub routine (LL)
This programme has been adopted in conducting all the required calculations in the event of network failure to contact line to the line(LL)
8-Sub routine (LLG)
This programme has been adopted in conducting all the required calculations in the event of network failure to contact two line to the ground(LLG)

The calculations required

The faults calculations (LLLG),(LL),(LG)and(LLG) include the following
1-Current at the Faults Location
2-Voltage at the Faults Location
3- Voltage at other Buses
4- fault Currents in Other Element
5-Phasors Voltage
6-Phasors Current

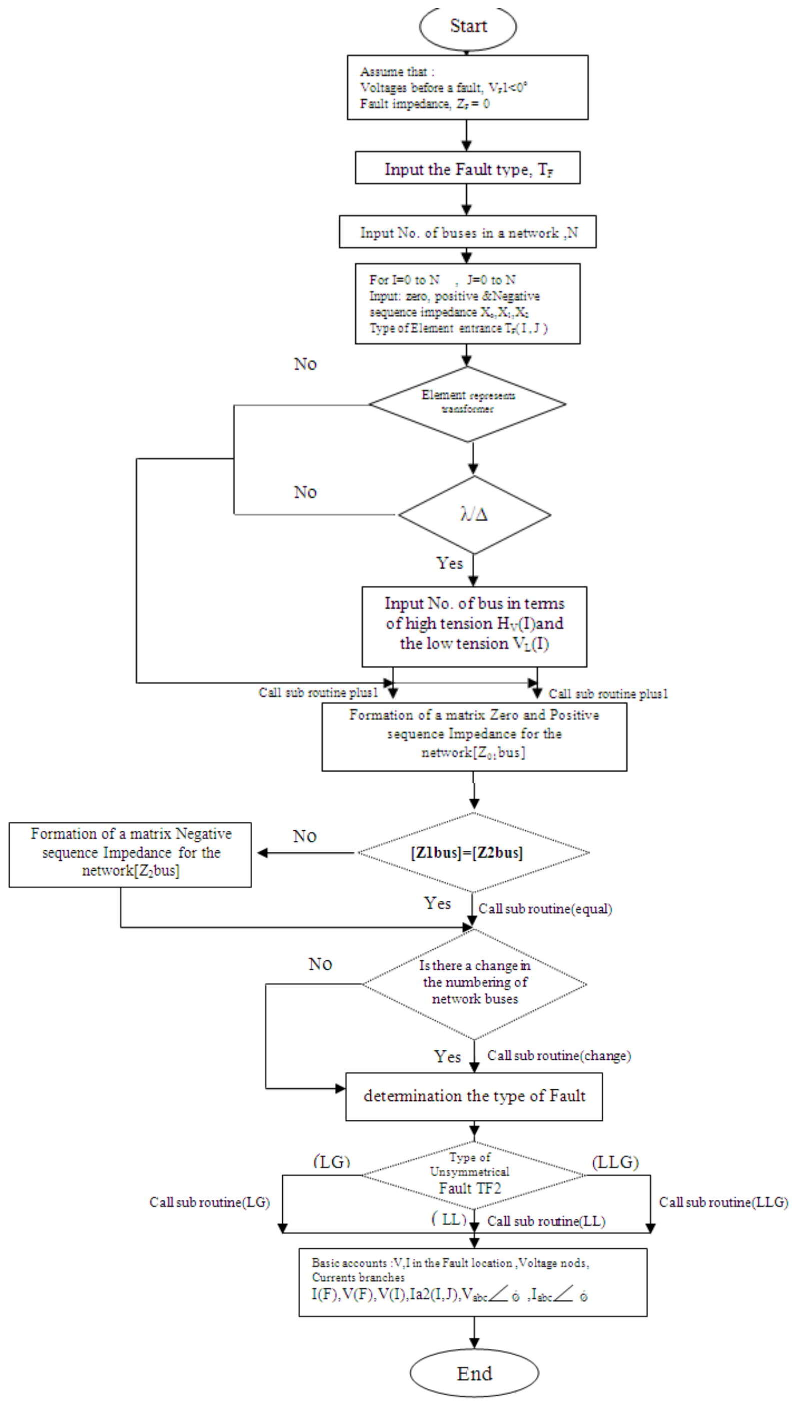


Fig (16) Flowchart of the programme

3- CONCLUSION

After extensive study of the results of current research reached the following conclusions:-

1- The formation of a buses impedance matrix Network [Zbus] by one step at a-time method ,Enabled us to overcome.

*** The difficulty of reversing buses admittance matrix network [Ybus] which represents a buses impedance matrix Network[Zbus].**

***The process of rebuilding [Zbus] after each modification of the network.**

***The difficulty of dealing with complex networks.**

***Working time and effort to conduct the analysis.**

2-The technological advantages of the media carrier of the events of educational software can provide greater flexibility program designed to help overcome the determinants. Which form the difficulties in subject of learning short circles of power systems as: Size networks, the volume of data, the complexities of the solution, calculations long and compare results.

4- References

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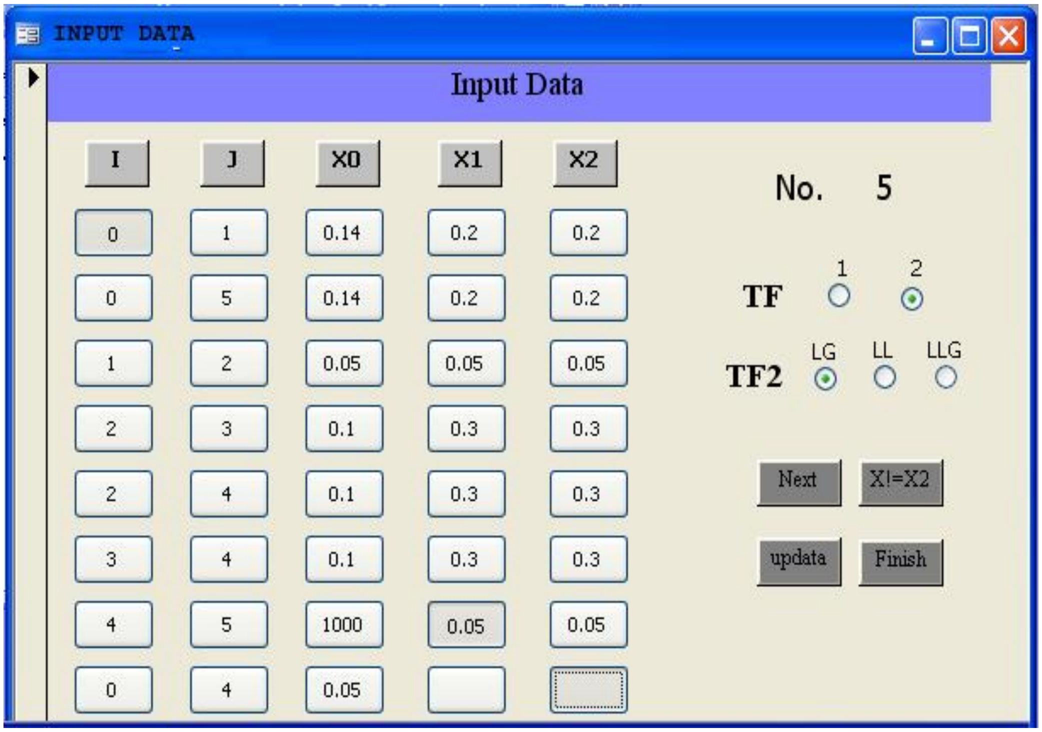
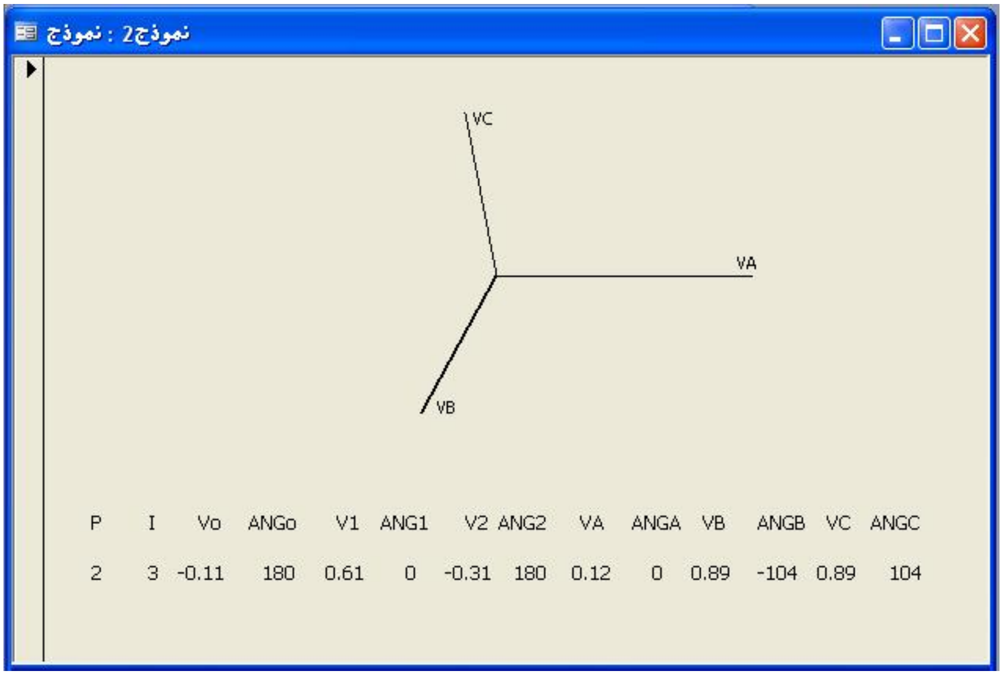


Fig(A1)
Input Data screen to analyze network under the influence of Fault (SLG)



Fig(A2)
Symmetrical components based on the results of the analysis of network under the influence of Fault (SLG)

Results

	0.107	0.021	0.064	0.079	0
	0.021	0.44	0.032	0.015	0
Z_0	0.064	0.032	0.198	0.047	0
	0.079	0.015	0.047	0.095	0
	0	0	0	0	0.0139

	0.139	0.11	0.125	0.111	0.088
	0.11	0.139	0.125	0.088	0.111
Z_1	0.125	0.125	0.175	0.1	0.1
	0.111	0.088	0.1	0.129	0.07
	0.088	0.111	0.1	0.07	0.129

	0.139	0.11	0.125	0.111	0.088
	0.11	0.139	0.125	0.088	0.111
Z_2	0.125	0.125	0.175	0.1	0.1
	0.111	0.088	0.1	0.129	0.07
	0.088	0.111	0.1	0.07	0.129

Sequence Component Of The Fault Current

F.Bus	I0=I1=I2
1	2.581539
2	3.089013
3	1.82195
4	2.822644
5	2.507498

Sequence Component Of The Fault Voltage

F.Bus	V0	V1	V2
1	-0.2707	0.6496	-0.3504
2	-0.1112	0.6496	-0.3504
3	-0.4987	0.5611	-0.4389
4	-0.2394	0.6755	-0.3245
	-0.3511	0.6755	-0.3245

Sequence Component Of The Node Voltage

F.Bus	I	V0	ANG0	V1	ANG1	V2	ANG2
1	1	-0.279	180	0.639	0	-0.361	180
1	2	-0.056	180	0.715	0	-0.285	180
1	3	-0.168	180	0.677	0	-0.323	180
1	4	-0.206	180	0.711	0	-0.289	180
1	5	-0.001	180	0.772	-30	-0.228	-150
2	1	-0.067	180	0.659	0	-0.341	180
2	2	-0.137	180	0.568	0	-0.432	180
2	3	-0.102	180	0.613	0	-0.387	180
2	4	-0.05	180	0.727	0	-0.273	180
2	5	-0.001	180	0.654	0	-0.346	-150
3	1	-0.119	180	0.772	0	-0.228	180
3	2	-0.061	180	0.772	0	-0.228	180
3	3	-0.363	180	0.681	0	-0.319	180
3	4	-0.087	180	0.817	0	-0.183	180
3	5	-0.001	0	0.817	0	-0.183	-150
4	1	-0.225	180	0.684	0	-0.316	180
4	2	-0.045	180	0.75	0	-0.25	180
4	3	-0.135	180	0.717	0	-0.283	180
4	4	-0.27	180	0.634	0	-0.366	180
4	5	-0.001	180	0.8	0	-0.2	-150
5	1	-0.001	180	0.778	0	-0.222	180
5	2	-0.001	180	0.719	0	-0.281	180
5	3	-0.001	180	0.749	0	-0.251	180
5	4	-0.001	180	0.823	0	-0.177	180
5	5	-0.352	180	0.675	0	-0.325	-150

Sequence Component Of The Fault Current In Other Element(I,J)

F.Bus	I	J	I0ij	ANG0	I1ij	ANG1	I2ij	ANG2
1	1	2	-0.744	90	-0.76	90	-0.76	90
1	1	3	-0.372	90	-0.38	90	-0.38	90
1	1	4	-1.467	90	-1.443	90	-1.443	90
1	2	1	0.743	-90	0.759	-90	0.759	-90
1	2	3	0.371	-90	0.379	-90	0.379	-90
1	2	5	-0.001	90	-1.139	90	-1.139	90
1	3	1	0.371	-90	0.379	-90	0.379	-90
1	3	2	-0.372	90	-0.38	90	-0.38	90
1	4	1	1.466	-90	1.442	-90	1.442	-90
1	5	2	0	-90	1.138	-90	1.138	-90
2	1	2	0.234	-90	0.908	-90	0.908	-90
2	1	3	0.117	-90	0.454	-90	0.454	-90
2	1	4	-0.352	90	-1.363	90	-1.363	90
2	2	1	-0.235	90	-0.909	90	-0.909	90
2	2	3	-0.118	90	-0.455	90	-0.455	90
2	2	5	-0.001	90	-1.727	90	-1.727	90
2	3	1	-0.118	90	-0.455	90	-0.455	90
2	3	2	0.117	-90	0.454	-90	0.454	-90
2	4	1	0.351	-90	1.362	-90	1.362	-90
2	5	2	0	-90	1.726	-90	1.726	-90
3	1	2	-0.194	90	0	0	0	0
3	1	3	0.814	-90	0.91	-90	0.91	-90
3	1	4	-0.622	90	-0.911	90	-0.911	90
3	2	1	0.193	-90	0	0	0	0
3	2	3	1.007	-90	0.91	-90	0.91	-90
3	2	5	-0.001	90	-0.911	90	-0.911	90
3	3	1	-0.815	90	-0.911	90	-0.911	90
3	3	2	-1.008	90	-0.911	90	-0.911	90
3	4	1	0.621	-90	0.91	-90	0.91	-90
3	5	2	0	-90	0.91	-90	0.91	-90
4	1	2	-0.599	90	-0.665	90	-0.665	90
4	1	3	-0.3	90	-0.333	90	-0.333	90
4	1	4	0.898	-90	0.996	-90	0.996	-90
4	2	1	0.598	-90	0.664	-90	0.664	-90
4	2	3	0.299	-90	0.332	-90	0.332	-90
4	2	5	-0.001	90	-0.997	90	-0.997	90
4	3	1	0.299	-90	0.332	-90	0.332	-90
4	3	2	-0.3	90	-0.333	90	-0.333	90
4	4	1	-0.899	90	-0.997	90	-0.997	90
4	5	2	0	-90	0.996	-90	0.996	-90
5	1	2	0	-90	0.589	-90	0.589	-90
5	1	3	0	-90	0.294	-90	0.294	-90
5	1	4	-0.001	90	-0.885	90	-0.885	90
5	2	1	-0.001	90	-0.59	90	-0.59	90
5	2	3	-0.001	90	-0.295	90	-0.295	90
5	2	5	0	-90	0.884	-90	0.884	-90
5	3	1	-0.001	90	-0.295	90	-0.295	90
5	3	2	0	-90	0.294	-90	0.294	-90
5	4	1	0	-90	0.884	-90	0.884	-90
5	5	2	-0.001	90	-0.885	90	-0.885	90

Phasor Component Of The Nodes Voltage

F.Bus	I	VA	ANGA	VB	ANGB	VC	ANGC
1	1	0	0	0.961	-115.83	0.961	115.82
1	2	0.374	0	0.907	-107.45	0.907	107.44
1	3	0.187	0	0.932	-111.76	0.932	111.75
1	4	0.217	0	0.961	-115.76	0.961	115.75
1	5	0.288	-12.32	0.651	-0.16	0.907	107.51
2	1	0.251	0	0.985	-104.7	0.985	104.69
2	2	0	0	0.98	-103.41	0.98	103.4
2	3	0.125	0	0.982	-104.06	0.982	104.05
2	4	0.405	0	0.909	-107.78	0.909	107.77
2	5	0.053	-12.32	0.623	-7.47	0.879	100.2
3	1	0.426	0	0.949	-114.32	0.949	114.31
3	2	0.484	0	0.927	-111.06	0.927	111.05
3	3	-0.001	0	1.022	-122.17	1.022	122.16
3	4	0.548	0	0.955	-115.11	0.955	115.1
3	5	0.379	-12.32	0.666	2.54	0.922	110.21
4	1	0.144	0	0.957	-115.35	0.957	115.34
4	2	0.456	0	0.915	-108.93	0.915	108.92
4	3	0.3	0	0.934	-112.21	0.934	112.2
4	4	0	0	0.955	-115.08	0.955	115.07
4	5	0.345	-12.32	0.66	1.54	0.916	109.21
5	1	0.557	0	0.909	-107.91	0.909	107.9
5	2	0.439	0	0.893	-104.31	0.893	104.3
5	3	0.498	0	0.901	-106.13	0.901	106.12
5	4	0.645	0	0.924	-110.52	0.924	110.51
5	5	-0.256	-12.32	0.757	13.68	1.013	121.35

Phasor Component Of The Fault Current In Other Element(I,J)

F.Bus	I	J	IijA	ANGA	IijB	ANGB	IijC	ANGC
1	1	2	-2.262	90	0.016	-90	0.016	-90
1	1	3	-1.131	90	0.008	-90	0.008	-90
1	1	4	-4.353	90	0.024	90	0.024	90
1	2	1	2.261	-90	0.016	90	0.016	90
1	2	3	1.13	-90	0.008	90	0.008	90
1	2	5	-2.278	90	1.138	-90	1.138	-90
1	3	1	1.13	-90	0.008	90	0.008	90
1	3	2	-1.131	90	0.008	-90	0.008	-90
1	4	1	4.352	-90	0.024	-90	0.024	-90
1	5	2	2.277	-90	1.138	90	1.138	90
2	1	2	2.051	-90	0.674	90	0.674	90
2	1	3	1.025	-90	0.337	90	0.337	90
2	1	4	-3.077	90	1.011	-90	1.011	-90
2	2	1	-2.052	90	0.674	-90	0.674	-90
2	2	3	-1.026	90	0.337	-90	0.337	-90
2	2	5	-3.453	90	1.726	-90	1.726	-90
2	3	1	-1.026	90	0.337	-90	0.337	-90
2	3	2	1.025	-90	0.337	90	0.337	90
2	4	1	3.076	-90	1.011	90	1.011	90
2	5	2	3.452	-90	1.726	90	1.726	90
3	1	2	-0.194	90	0.193	90	0.193	90
3	1	3	2.636	-90	0.096	90	0.096	90
3	1	4	-2.444	90	0.289	-90	0.289	-90
3	2	1	0.193	-90	0.139	-90	0.139	-90
3	2	3	2.829	-90	0.096	-90	0.096	-90
3	2	5	-1.823	90	0.91	-90		

ZBus

0.139	0.11	0.125	0.111	0.088
0.11	0.139	0.125	0.088	0.111
0.125	0.125	0.147	0.1	0.1
0.111	0.088	0.1	0.129	0.07
0.088	0.111	0.1	0.07	0.129

Sequence Component Of The Fault Current

F.Bus	I0	I1	I2
1	0	7.157	0
2	0	7.157	0
3	0	5.714	0
4	0	7.727	0
5	0	7.727	0

Sequence Component Of The Fault Voltage

F.Bus	V0	V1	V2
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0

Sequence Component Of The Node Voltage

F.Bus	I	V0	ANG0	V1	ANG1	V2	ANG2
1	1	0	0	0	0	0	0
1	2	0	0	0.21	0	0	0
1	3	0	0	0.105	0	0	0
1	4	0	0	0.199	0	0	0
1	5	0	0	0.368	-30	0	0
2	1	0	0	0.21	0	0	0
2	2	0	0	0	0	0	0
2	3	0	0	0.105	0	0	0
2	4	0	0	0.368	0	0	0
2	5	0	0	0.199	-30	0	0
3	1	0	0	0.285	0	0	0
3	2	0	0	0.285	0	0	0
3	3	0	0	0	0	0	0
3	4	0	0	0.428	0	0	0
3	5	0	0	0.428	-30	0	0
4	1	0	0	0.136	0	0	0
4	2	0	0	0.318	0	0	0
4	3	0	0	0.227	0	0	0
4	4	0	0	0	0	0	0
4	5	0	0	0.454	-3	0	0
5	1	0	0	0.318	0	0	0
5	2	0	0	0.136	0	0	0
5	3	0	0	0.227	0	0	0
5	4	0	0	0.454	0	0	0
5	5	0	0	0	-30	0	0

Sequence Component Of The Fault Current In Other Element(I,J)

F.Bus	I	J	I0ij	ANG0	I1ij	ANG1	I2ij	ANG2
1	0	1	0	0	0	0	0	0
1	0	5	0	0	-1.843	60	0	0
1	1	2	0	0	-2.106	90	0	0
1	1	3	0	0	-1.053	90	0	0
1	2	5	0	0	-3.158	60	0	0
1	3	2	0	0	-1.053	90	0	0
1	4	1	0	0	-3.999	-90	0	0
2	0	1	0	0	-1.053	90	0	0
2	0	5	0	0	-1	60	0	0
2	1	2	0	0	2.105	-90	0	0
2	1	3	0	0	1.052	-90	0	0
2	2	5	0	0	-4	60	0	0
2	3	2	0	0	1.052	-90	0	0
2	4	1	0	0	3.157	-90	0	0
3	0	1	0	0	-1.429	90	0	0
3	0	5	0	0	-2.143	60	0	0
3	1	2	0	0	0	0	0	0
3	1	3	0	0	2.857	-90	0	0
3	2	5	0	0	-2.858	60	0	0
3	3	2	0	0	-2.858	90	0	0
3	4	1	0	0	2.857	-90	0	0
4	0	1	0	0	-0.0682	90	0	0
4	0	5	0	0	-2.273	60	0	0
4	1	2	0	0	-1.819	90	0	0
4	1	3	0	0	-0.91	90	0	0
4	2	5	0	0	-2.728	60	0	0
4	3	2	0	0	-0.91	90	0	0
4	4	1	0	0	-2.728	90	0	0
5	0	1	0	0	-1.591	90	0	0
5	0	5	0	0	0	-30	0	0
5	1	2	0	0	1.818	-90	0	0
5	1	3	0	0	0.0909	-90	0	0
5	2	5	0	0	2.727	-120	0	0
5	3	2	0	0	0.909	-90	0	0
5	4	1	0	0	2.727	-90	0	0

Phasor Component Of Fault Voltage

F.Bus	I	VA	ANGA	VB	ANGB	VC	ANGC
1	1	0	0	0	0	0	0
1	2	0.21	0	0.21	-120	0.21	120
1	3	0.105	0	0.105	-120	0.105	120
1	4	0.199	0	0.199	-120	0.199	120
1	5	0.368	-30	0.368	-150	0.368	90
2	1	0.21	0	0.21	-120	0.21	120
2	2	0	0	0	0	0	0
2	3	0.105	0	0.105	-120	0.105	120
2	4	0.368	0	0.368	-120	0.368	120
2	5	0.199	-30	0.199	-150	0.199	90
3	1	0.285	0	0.285	-120	0.285	120
3	2	0.285	0	0.285	-120	0.285	120
3	3	0	0	0	0	0	0
3	4	0.428	0	0.428	-120	0.428	120
3	5	0.428	-30	0.428	-150	0.428	90
4	1	0.136	0	0.136	-120	0.136	120
4	2	0.318	0	0.318	-120	0.318	120
4	3	0.227	0	0.227	-120	0.227	120
4	4	0	0	0	0	0	0
4	5	0.454	-30	0.454	-150	0.454	90
5	1	0.318	0	0.318	-120	0.318	120
5	2	0.136	0	0.136	-120	0.136	120
5	3	0.227	0	0.227	-120	0.227	120
5	4	0.454	0	0.454	-120	0.454	120
5	5	0	-30	0	-150	0	90

Phasor Component Of The Fault Current In Other Element(I,J)

F.Bus	I	J	IijA	ANGA	IijB	ANGB	IijC	ANGC
1	0	1	0	-30	0	-150	0	90
1	0	5	-1.843	60	-1.843	-60	-1.843	-180
1	1	2	-2.106	90	-2.106	-30	-2.106	-150
1	1	3	-1.053	90	-1.053	-30	-1.053	-150
1	2	5	-3.158	90	-3.158	-30	-3.158	-150
1	3	2	-1.053	90	-1.053	-30	-1.053	-150
1	4	1	3.999	-90	3.999	150	3.999	30
2	0	1	-1.053	60	-1.053	-60	-1.053	-180
2	0	5	-1	60	-1	-60	-1	-180
2	1	2	2.105	-90	2.105	150	2.105	30
2	1	3	1.052	-90	1.052	150	1.052	30
2	2	5	-4	90	-4	-30	-4	-150
2	3	2	1.052	-90	1.052	150	1.052	30
2	4	1	3.157	-90	3.157	150	3.157	30
3	0	1	-1.429	60	-1.429	-60	-1.429	-180
3	0	5	-2.143	60	-2.143	-60	-2.143	-180
3	1	2	0	0	0	-120	0	120
3	1	3	2.857	-90	2.857	150	2.857	30
3	2	5	-2.858	90	-2.858	-30	-2.858	-150
3	3	2	-2.858	90	-2.858	-30	-2.858	-150
3	4	1	2.857	-90	2.857	150	2.857	30
4	0	1	-0.682	60	-0.682	-60	-0.682	-180
4	0	5	-2.273	60	-2.273	-60	-2.273	-180
4	1	2	-1.819	90	-1.819	-30	-1.819	-150
4	1	3	-0.91	90	-0.91	-30	-0.91	-150
4	2	5	-2.728	90	-2.728	-30	-2.728	-150
4	3	2	-0.91	90	-0.91	-30	-0.91	-150
4	4	1	-2.728	90	-2.728	-30	-2.728	-150
5	0	1	-1.591	60	-1.591	-60	-1.591	-180
5	0	5	0	-30	0	-150	0	90
5	1	2	1.818	-90	1.818	150	1.818	30
5	1	3	0.909	-90	0.909	150	0.909	30
5	2	5	2.727	-90	2.727	150	2.727	30
5	3	2	0.909	-90	0.909	150	0.909	30
5	4	1	2.727	-90	2.727	150	2.727	30