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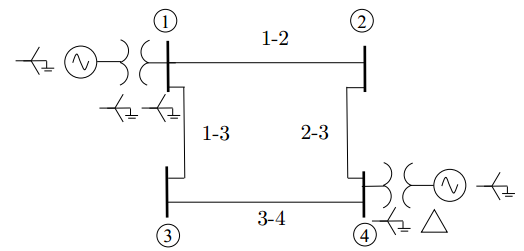
EE559

Final Project: Fault Analysis of N-bus System

# Introduction

This project utilizes MatLAB programming in order to calculate and predict the different kinds of faults that could occur in an N-bus sized system. Results outputted are the post fault voltages of the system at each bus as well as the fault current. The code was tested on a small 4-bus system (Figure shown below) with reasonable data as results.

Everything was calculated in per unit values. Although the results were reasonable, there are certain limitations and restrictions that need to be met for the code to produce reasonably correct results. In order to meet the specifications, there is also additional development that can be implemented to make the code further robust.



4-bus Test System

# Limitations of Code

In order for the code to produce correct results, parameters must be inputted in a certain way. For transmission line parameters, a matrix must be passed with the row order of variables as follows: [From Bus Number, To Bus Number, Zero Sequence Impedance, Positive Sequence Impedance, Negative Sequence Impedance, Y/2 admittance of Line]. The reasoning behind this setup is to allow the user to be able to have lines with different sequence impedances for each transmission lines instead of each transmission line having the same impedances.

In addition to the line parameters, a matrix vector the size of N-busses by 2 must be passed in for the generator information. The row variables are [If Gen Exists at Bus, If Gen is Grounded] where bus number corresponds to row number. This information is necessary in order to build the sequence Y-Busses, especially the Zero sequence. Generator admittances must be passed in a row vector [Zero Sequence, Positive Sequence, Negative Sequence]. This assumes the generators have similar admittances, which limits the code (see Further Development section).

Lastly, the transformer data must be passed in via a matrix N by 3 with row variables meaning [If Xfrmr Exists at Bus, if Bus Side of Xfrmr is Grounded, if Non-Bus Side of Xfrmr is Grounded] where row number corresponds to bus number. Another row vector of transformer sequence admittances [Zero, Positive, Negative] is passed. This also assumes transformers are similar in admittance (further discussed in Further Development section).

# Results of Code

If the previously mention restrictions are met, the code should output the following reasonable results. This is done by building the sequential Y-Busses and then inverted to get the sequential Z-Busses. It is then possible to use the diagonal values of the Z-Busses in order to calculate post fault bus voltages and fault current for the different kinds of faults. Both sequential Y-Busses and Z-Busses are shown in the Appendix section.

## 3 phase Faults

With a 3 phase fault, we are assuming the system is balanced and can find the fault current as well as the post fault voltages by analyzing pre-fault voltage conditions and the positive sequence Z-Bus. The fault currents calculated can be shown below as well as the post-fault bus voltages.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bus** | **FaultAtBus1** | **FaultAtBus2** | **FaultAtBus3** | **FaultAtBus4** |
| **I\_f** | 6.8571i | 5.7143i | 5.7143i | 6.8571i |

3 phase Fault Current

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bus** | **FaultAtBus1** | **FaultAtBus2** | **FaultAtBus3** | **FaultAtBus4** |
| **V\_1** | 0.0000 | 0.1429 | 0.1429 | 0.2857 |
| **V\_2** | 0.2857 | 0.0000 | 0.2857 | 0.2857 |
| **V\_3** | 0.2857 | 0.2857 | 0.0000 | 0.2857 |
| **V\_4** | 0.2857 | 0.1429 | 0.1429 | 0.0000 |

Post Fault Bus Voltages of 3 phase Fault

## Single Line to Ground (SLG) faults

With a SLG fault we can utilize the sequential Z-bus diagonals and calculate them in series. Shown below we can see the phase fault currents and the post-fault phase voltages of bus 1. Further detailed table can be seen in the Appendix.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bus** | **FaultAtBus1** | **FaultAtBus2** | **FaultAtBus3** | **FaultAtBus4** |
| **I\_af** | -8.1203i | -5.5959i | -5.5959i | -8.9256i |
| **I\_bf** | 0 | 0 | 0 | 0 |
| **I\_cf** | 0 | 0 | 0 | 0 |

Phase Fault Currents of SLG faults

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bus** | **FaultAtBus1** | **FaultAtBus2** | **FaultAtBus3** | **FaultAtBus4** |
| **V1\_a** | 0 | 0.4508 | 0.4508 | 0.3471 |
| **V1\_b** | -0.3158-0.866i | -0.3497-0.866i | -0.3497-0.866i | -0.2231-0.866i |
| **V1\_c** | -0.3158+0.866i | -0.3497+0.866i | -0.3497+0.866i | -0.2231+0.866i |

Post-Fault Bus Phase Voltages of Bus 1 of SLG faults

## Line to Line (LL) faults

With a LL fault we can utilize the sequential Z-bus diagonals and calculate the positive and negative sequences in parallel while the zero sequence is disconnected. Shown below we can see the phase fault currents and the post-fault phase voltages of bus 1. Further detailed table can be seen in the Appendix.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bus** | **FaultAtBus1** | **FaultAtBus2** | **FaultAtBus3** | **FaultAtBus4** |
| **I\_af** | 0 | 0 | 0 | 0 |
| **I\_bf** | -5.9385 | -4.9487 | -4.9487 | -5.9385 |
| **I\_cf** | 5.9385 | 4.9487 | 4.9487 | 5.9385 |

Phase Fault Currents of LL faults

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bus** | **FaultAtBus1** | **FaultAtBus2** | **FaultAtBus3** | **FaultAtBus4** |
| **V1\_a** | 1 | 1 | 1 | 1 |
| **V1\_b** | -0.5 | -0.5-0.2474i | -0.5-0.2474i | -0.5-0.2474i |
| **V1\_c** | -0.5 | -0.5+0.2474i | -0.5+0.2474i | -0.5+0.2474i |

Post-Fault Bus Phase Voltages of Bus 1 of LL faults

## Double Line to Ground (DLG) faults

With a DLG fault we can utilize the sequential Z-bus diagonals and calculated with all the sequences parallel to each other. Shown below we can see the phase fault currents and the post-fault phase voltages of bus 1. Further detailed table can be seen in the Appendix

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bus** | **FaultAtBus1** | **FaultAtBus2** | **FaultAtBus3** | **FaultAtBus4** |
| **I\_af** | 0 | 0 | 0 | 0 |
| **I\_bf** | -5.9385+4.977i | -4.9487+2.7411i | -4.9487+2.7411i | -5.9385+6.3905i |
| **I\_cf** | 5.9385+4.977i | 4.9487+2.7411i | 4.9487+2.7411i | 5.9385+6.3905i |

Phase Fault Currents of DLG faults

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bus** | **FaultAtBus1** | **FaultAtBus2** | **FaultAtBus3** | **FaultAtBus4** |
| **V1\_a** | 0.7742 | 0.8528 | 0.8528 | 0.6036 |
| **V1\_b** | 0 | -0.3046-0.2474i | -0.3046-0.2474i | -0.2308-0.2474i |
| **V1\_c** | 0 | -0.3046+0.2474i | -0.3046+0.2474i | -0.2308+0.2474i |

Post-Fault Bus Phase Voltages of Bus 1 of DLG faults

# Further Development

This code can be further improved in a couple of aspects. Since this code only expects to take system that are similar to that of the test system. Meaning it will only work when the transformers are generator to bus side, not between transmission lines. If the transformer and generator parameters could be rearranged into a single matrix similar to that of the transmission line parameters so that each generator could have unique admittances.

The code could be optimized by only calculating for the requested faults at requested busses instead of ALL possible faults and ALL the post fault voltages. This could be implemented in function where the user inputs the different parameters as inputs instead of having to go in and change the variables. Also, the code could have built in functions to change the fault impedance (there is a fault impedance variable set to 0 for bolted faults) and the pre fault voltages instead of assuming pre fault voltages are 1.0 angle 0.

Lastly, in order to make the code more robust, the implementation of sparse matrices would need to be implemented in order to have it code systems that have very large N number of busses.

## Appendix

### Sequential Y-Busses and Z-Busses

Zero

|  |  |  |  |
| --- | --- | --- | --- |
| **Ybus\_z** |  |  |  |
| -16.6667i | 3.3333i | 3.3333i | 0 |
| 3.3333i | -6.6667i | 0 | 3.3333i |
| 3.3333i | 0 | -6.6667i | 3.3333i |
| 0 | 3.3333i | 3.3333i | -26.6667i |

|  |  |  |  |
| --- | --- | --- | --- |
| **Zbus\_z** |  |  |  |
| 0.0778i | 0.0444i | 0.0444i | 0.0111i |
| 0.0444i | 0.1861i | 0.0361i | 0.0278i |
| 0.0444i | 0.0361i | 0.1861i | 0.0278i |
| 0.0111i | 0.0278i | 0.0278i | 0.0444i |

Positive

|  |  |  |  |
| --- | --- | --- | --- |
| **Ybus\_p** |  |  |  |
| -24i | 10i | 10i | 0 |
| 10i | -20i | 0 | 10i |
| 10i | 0 | -20i | 10i |
| 0 | 10i | 10i | -24i |

|  |  |  |  |
| --- | --- | --- | --- |
| **Zbus\_p** |  |  |  |
| 0.1458i | 0.125i | 0.125i | 0.1042i |
| 0.125i | 0.175i | 0.125i | 0.125i |
| 0.125i | 0.125i | 0.175i | 0.125i |
| 0.1042i | 0.125i | 0.125i | 0.1458i |

Negative

|  |  |  |  |
| --- | --- | --- | --- |
| **Ybus\_n** |  |  |  |
| -24i | 10i | 10i | 0 |
| 10i | -20i | 0 | 10i |
| 10i | 0 | -20i | 10i |
| 0 | 10i | 10i | -24i |

|  |  |  |  |
| --- | --- | --- | --- |
| **Zbus\_n** |  |  |  |
| 0.1458i | 0.125i | 0.125i | 0.1042i |
| 0.125i | 0.175i | 0.125i | 0.125i |
| 0.125i | 0.125i | 0.175i | 0.125i |
| 0.1042i | 0.125i | 0.125i | 0.1458i |

### Detailed Fault Currents and Voltage Tables

3ph

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bus** | **FaultAtBus1** | **FaultAtBus2** | **FaultAtBus3** | **FaultAtBus4** |
| **I\_f** | 6.8571i | 5.7143i | 5.7143i | 6.8571i |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bus** | **FaultAtBus1** | **FaultAtBus2** | **FaultAtBus3** | **FaultAtBus4** |
| **V\_1** | 0.0000 | 0.1429 | 0.1429 | 0.2857 |
| **V\_2** | 0.2857 | 0.0000 | 0.2857 | 0.2857 |
| **V\_3** | 0.2857 | 0.2857 | 0.0000 | 0.2857 |
| **V\_4** | 0.2857 | 0.1429 | 0.1429 | 0.0000 |

SLG

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bus** | **FaultAtBus1** | **FaultAtBus2** | **FaultAtBus3** | **FaultAtBus4** |
| **I\_af** | -8.1203i | -5.5959i | -5.5959i | -8.9256i |
| **I\_bf** | 0 | 0 | 0 | 0 |
| **I\_cf** | 0 | 0 | 0 | 0 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bus** | **FaultAtBus1** | **FaultAtBus2** | **FaultAtBus3** | **FaultAtBus4** |
| **V1\_a** | 0 | 0.4508 | 0.4508 | 0.3471 |
| **V1\_b** | -0.3158-0.866i | -0.3497-0.866i | -0.3497-0.866i | -0.2231-0.866i |
| **V1\_c** | -0.3158+0.866i | -0.3497+0.866i | -0.3497+0.866i | -0.2231+0.866i |
| **V2\_a** | 0.203 | 0 | 0.4663 | 0.1736 |
| **V2\_b** | -0.282-0.866i | -0.5207-0.866i | -0.3342-0.866i | -0.2107-0.866i |
| **V2\_c** | -0.282+0.866i | -0.5207+0.866i | -0.3342+0.866i | -0.2107+0.866i |
| **V3\_a** | 0.203 | 0.4663 | 0 | 0.1736 |
| **V3\_b** | -0.282-0.866i | -0.3342-0.866i | -0.5207-0.866i | -0.2107-0.866i |
| **V3\_c** | -0.282+0.866i | -0.3342+0.866i | -0.5207+0.866i | -0.2107+0.866i |
| **V4\_a** | 0.406 | 0.4819 | 0.4819 | 0 |
| **V4\_b** | -0.2481-0.866i | -0.3187-0.866i | -0.3187-0.866i | -0.1983-0.866i |
| **V4\_c** | -0.2481+0.866i | -0.3187+0.866i | -0.3187+0.866i | -0.1983+0.866i |

LL

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bus** | **FaultAtBus1** | **FaultAtBus2** | **FaultAtBus3** | **FaultAtBus4** |
| **I\_af** | 0 | 0 | 0 | 0 |
| **I\_bf** | -5.9385 | -4.9487 | -4.9487 | -5.9385 |
| **I\_cf** | 5.9385 | 4.9487 | 4.9487 | 5.9385 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bus** | **FaultAtBus1** | **FaultAtBus2** | **FaultAtBus3** | **FaultAtBus4** |
| **V1\_a** | 1 | 1 | 1 | 1 |
| **V1\_b** | -0.5 | -0.5-0.2474i | -0.5-0.2474i | -0.5-0.2474i |
| **V1\_c** | -0.5 | -0.5+0.2474i | -0.5+0.2474i | -0.5+0.2474i |
| **V2\_a** | 1 | 1 | 1 | 1 |
| **V2\_b** | -0.5-0.1237i | -0.5 | -0.5-0.2474i | -0.5-0.1237i |
| **V2\_c** | -0.5+0.1237i | -0.5 | -0.5+0.2474i | -0.5+0.1237i |
| **V3\_a** | 1 | 1 | 1 | 1 |
| **V3\_b** | -0.5-0.1237i | -0.5-0.2474i | -0.5 | -0.5-0.1237i |
| **V3\_c** | -0.5+0.1237i | -0.5+0.2474i | -0.5 | -0.5+0.1237i |
| **V4\_a** | 1 | 1 | 1 | 1 |
| **V4\_b** | -0.5-0.2474i | -0.5-0.2474i | -0.5-0.2474i | -0.5 |
| **V4\_c** | -0.5+0.2474i | -0.5+0.2474i | -0.5+0.2474i | -0.5 |

DLG

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bus** | **FaultAtBus1** | **FaultAtBus2** | **FaultAtBus3** | **FaultAtBus4** |
| **I\_af** | 0 | 0 | 0 | 0 |
| **I\_bf** | -5.9385+4.977i | -4.9487+2.7411i | -4.9487+2.7411i | -5.9385+6.3905i |
| **I\_cf** | 5.9385+4.977i | 4.9487+2.7411i | 4.9487+2.7411i | 5.9385+6.3905i |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bus** | **FaultAtBus1** | **FaultAtBus2** | **FaultAtBus3** | **FaultAtBus4** |
| **V1\_a** | 0.7742 | 0.8528 | 0.8528 | 0.6036 |
| **V1\_b** | 0 | -0.3046-0.2474i | -0.3046-0.2474i | -0.2308-0.2474i |
| **V1\_c** | 0 | -0.3046+0.2474i | -0.3046+0.2474i | -0.2308+0.2474i |
| **V2\_a** | 0.7327 | 1.0203 | 0.8376 | 0.5858 |
| **V2\_b** | -0.1452-0.1237i | 0 | -0.3198-0.2474i | -0.1154-0.1237i |
| **V2\_c** | -0.1452+0.1237i | 0 | -0.3198+0.2474i | -0.1154+0.1237i |
| **V3\_a** | 0.7327 | 0.8376 | 1.0203 | 0.5858 |
| **V3\_b** | -0.1452-0.1237i | -0.3198-0.2474i | 0 | -0.1154-0.1237i |
| **V3\_c** | -0.1452+0.1237i | -0.3198+0.2474i | 0 | -0.1154+0.1237i |
| **V4\_a** | 0.6912 | 0.8223 | 0.8223 | 0.568 |
| **V4\_b** | -0.2903-0.2474i | -0.335-0.2474i | -0.335-0.2474i | 0 |
| **V4\_c** | -0.2903+0.2474i | -0.335+0.2474i | -0.335+0.2474i | 0 |

### Matlab Code

% Sulayman Dehlawi

%EE 559 Final Project

%3/17/2014

close all

clear all

alpha = exp(j\*2\*pi/3);

A = [1 1 1; 1 alpha^2 alpha; 1 alpha alpha^2];

%Need line parameters to build Y bus

Vpf = 1.0;

Zf = 0; %Fault Impedance;

Ladm = [j\*0.3, j\*0.1, j\*0.1]; %[z0, zPos, zNeg], Lines have similar Parameters

%[From ,To, z0pu, zPospu, zNegpu Y/2pu]

Lineparam = [1 2 Ladm 0;1 3 Ladm 0; 2 4 Ladm 0; 3 4 Ladm 0];

%Can modify above parameters if lines have differing impeadance parameters

%Row number is bus location, first column if gen exists at that bus

%Second Column is whether generator is grounded

Gens = [1 1;0 0;0 0;1 1]; %[if exists, if grounded]

Genadm = [0.05, 0.2, 0.2]; %Generator admittances [z0, zPos, zNeg]

Zn = 0; %neutral impeadance

%Transformer Params, Row number is bus location

%[if exists, if ground on bus side, if ground on non bus side]

Trans = [1 1 1; 0 0 0; 0 0 0; 1 1 0];

Tadm = [0.05, 0.05, 0.05]; %[z0, zPos, zNeg]

%%Build Ybuses

Ybus\_z = zeros(size(Gens,1));

Ybus\_p = Ybus\_z;

Ybus\_n= Ybus\_z;

%From Lines only

for i=1:size(Lineparam,1)

From = Lineparam(i,1);

To = Lineparam(i,2);

%Zero Seq

Ybus\_z(From,To) = Ybus\_z(From,To) - inv(Lineparam(i,3));

Ybus\_z(To,From) = Ybus\_z(From,To); %Making Ybus Symmetric

Ybus\_z(To,To) = Ybus\_z(To,To) + j\*Lineparam(i,end); %Adding Line Capacitance

Ybus\_z(From,From) = Ybus\_z(From,From) + j\*Lineparam(i,end); %On Both ends

%Positive Seq

Ybus\_p(From,To) = Ybus\_p(From,To) - inv(Lineparam(i,4));

Ybus\_p(To,From) = Ybus\_p(From,To);

Ybus\_p(To,To) = Ybus\_p(To,To) + j\*Lineparam(i,end);

Ybus\_p(From,From) = Ybus\_p(From,From) + j\*Lineparam(i,end);

%Negative Seq

Ybus\_n(From,To) = Ybus\_n(From,To) - inv(Lineparam(i,5));

Ybus\_n(To,From) = Ybus\_n(From,To);

Ybus\_n(To,To) = Ybus\_n(To,To) + j\*Lineparam(i,end);

Ybus\_n(From,From) = Ybus\_n(From,From) + j\*Lineparam(i,end);

end

%Compute and add in diagonal values

Ybus\_z = Ybus\_z -diag(sum(Ybus\_z));

Ybus\_p = Ybus\_p -diag(sum(Ybus\_p));

Ybus\_n = Ybus\_n -diag(sum(Ybus\_n));

%Add in Admittance from Generator Reactance and Transformers

%Special Zero sequence calcs needed dependent on Transformers grounding

for i = 1:size(Trans,1)

if(Trans(i,1:2)) %if there is xfrmr and grounded on bus side

if(Trans(i,3)) %if also grounded on non bus side

Ybus\_z(i,i) = Ybus\_z(i,i) + inv(j\*(Genadm(1)+ Tadm(1))+3\*Zn);

else

Ybus\_z(i,i) = Ybus\_z(i,i) + inv(j\*(Tadm(1))); %Only xfrmr

end

end

end

Ybus\_p = Ybus\_p + inv(j\*(Tadm(2)+Genadm(2)))\*diag(Gens(:,1));

Ybus\_n = Ybus\_n + inv(j\*(Tadm(3)+Genadm(3)))\*diag(Gens(:,1));

Zbus\_z = inv(Ybus\_z);

Zbus\_p = inv(Ybus\_p);

Zbus\_n = inv(Ybus\_n);

%%3 phase fault, only need to look at positive seq

If3ph = zeros(1,length(Gens));

V3ph = ones(length(Gens));

V2 = zeros(size(V3ph));

VarNames = cell(size(If3ph));

VoltBusNames = cell(size(If3ph));

for i=1:length(If3ph)

injI = zeros(length(Gens),1);

If = Vpf/Zbus\_p(i,i);

If3ph(i) = If;

injI(i) = -If;

V2(i,:) = Zbus\_p\*injI;

VarNames{i} = ['FaultAtBus' num2str(i)];

VoltBusNames{i} = ['V\_' num2str(i)];

end

V3ph = V3ph + V2;

V3ph\_T = array2table(V3ph,'VariableNames',VarNames,'RowNames',VoltBusNames);

If3ph\_T = array2table(If3ph,'VariableNames',VarNames,'RowNames',{'I\_f'});

%% SLG Faults

%If\_z = If\_n = If\_p All in series, If\_a = If\_z + If\_n + If\_p because of A

%matrix

IfSLG = zeros(3,length(Gens));

VSLG = zeros(3\*length(Gens),length(Gens));

PhVoltBusNames = cell(size(VSLG,1),1);

PhFaultNames = {'I\_af' 'I\_bf' 'I\_cf'};

for i=1:length(Gens)

injI = zeros(length(Gens),1);

If\_p = Vpf /(Zbus\_z(i,i) + Zbus\_p(i,i) + Zbus\_n(i,i) + 3\*Zf);

injI(i) = -If\_p;

V\_z = Zbus\_z\*injI;

V\_p = ones(length(Gens),1)\*Vpf + Zbus\_p\*injI;

V\_n = Zbus\_n\*injI;

IfSLG(:,i) = A\*[If\_p;If\_p;If\_p];

for l = 3:3:length(VSLG)

VSLG(l-2:l,i) = A\*[V\_z(l/3);V\_p(l/3);V\_n(l/3)];

PhVoltBusNames{l-2} = ['V' num2str(l/3) '\_a'];

PhVoltBusNames{l-1} = ['V' num2str(l/3) '\_b'];

PhVoltBusNames{l} = ['V' num2str(l/3) '\_c'];

end

end

VSLG\_T = array2table(VSLG,'VariableNames',VarNames,'RowNames',PhVoltBusNames);

IfSLG\_T = array2table(IfSLG,'VariableNames',VarNames,'RowNames',PhFaultNames );

%% LL Faults

%If\_p = -If\_n, If\_z = 0, Vf\_p = Vf\_n, parallel networks

IfLL = zeros(3,length(Gens));

VLL = zeros(3\*length(Gens),length(Gens));

% PhVoltBusNames = cell(size(VSLG,1),1);

% PhFaultNames = {'I\_af' 'I\_bf' 'I\_cf'};

for i=1:length(Gens)

injI = zeros(length(Gens),1);

If\_p = Vpf /(Zbus\_p(i,i) + Zbus\_n(i,i));

injI(i) = -If\_p;

V\_z = Zbus\_z\*injI\*0;

V\_p = ones(length(Gens),1)\*Vpf + Zbus\_p\*injI;

V\_n = Zbus\_n\*-1\*injI;

IfLL(:,i) = A\*[0;If\_p;-If\_p];

for l = 3:3:length(VLL)

VLL(l-2:l,i) = A\*[V\_z(l/3);V\_p(l/3);V\_n(l/3)];

end

end

VLL\_T = array2table(VLL,'VariableNames',VarNames,'RowNames',PhVoltBusNames);

IfLL\_T = array2table(IfLL,'VariableNames',VarNames,'RowNames',PhFaultNames );

%% DLG Faults

%If\_z = -If\_p - If\_n, Vf\_p = Vf\_n, parallel networks of everything

%V\_z - V\_p = 3Zf\*If\_z

IfDLG = zeros(3,length(Gens));

VDLG = zeros(3\*length(Gens),length(Gens));

for i=1:length(Gens)

injI = zeros(length(Gens),1);

If\_p = Vpf /(Zbus\_p(i,i) + (Zbus\_n(i,i)\*(Zbus\_z(i,i) + 3\*Zf)/...

(Zbus\_n(i,i)+(Zbus\_z(i,i) + 3\*Zf))));

injI(i) = -If\_p;

V\_p = ones(length(Gens),1)\*Vpf + Zbus\_p\*injI;

If\_n = -V\_p(i)/Zbus\_n(i,i);

If\_z = -If\_p - If\_n;

injI = injI\*0; %Reset injection

injI(i) = -If\_n;

V\_n = Zbus\_n\*injI;

injI = injI\*0; %Reset injection

injI(i) = -If\_z;

V\_z = Zbus\_z\*injI;

IfDLG(:,i) = A\*[If\_z;If\_p;If\_n];

for l = 3:3:length(VDLG)

VDLG(l-2:l,i) = A\*[V\_z(l/3);V\_p(l/3);V\_n(l/3)];

end

end

VDLG\_T = array2table(VDLG,'VariableNames',VarNames,'RowNames',PhVoltBusNames);

IfDLG\_T = array2table(IfDLG,'VariableNames',VarNames,'RowNames',PhFaultNames );

%%Write Tables into txts files, then manually imported into xls for Report

%Ybuses and Zbuses

xlswrite('Ybuses',imag(Ybus\_z),'Ybusz')

xlswrite('Ybuses',imag(Ybus\_p),'Ybusp')

xlswrite('Ybuses',imag(Ybus\_n),'Ybusn')

xlswrite('Zbuses',imag(Zbus\_z),'Zbusz')

xlswrite('Zbuses',imag(Zbus\_p),'Zbusp')

xlswrite('Zbuses',imag(Zbus\_n),'Zbusn')

%3ph

writetable(V3ph\_T,'V3ph.txt','WriteRowNames',1,'Delimiter','tab')

writetable(If3ph\_T,'If3ph.txt','WriteRowNames',1,'Delimiter','tab')

%SLG

writetable(VSLG\_T,'VSLG.txt','WriteRowNames',1,'Delimiter','tab')

writetable(IfSLG\_T,'IfSLG.txt','WriteRowNames',1,'Delimiter','tab')

%LL

writetable(VLL\_T,'VLL.txt','WriteRowNames',1,'Delimiter','tab')

writetable(IfLL\_T,'IfLL.txt','WriteRowNames',1,'Delimiter','tab')

%DLG

writetable(VDLG\_T,'VDLG.txt','WriteRowNames',1,'Delimiter','tab')

writetable(IfDLG\_T,'IfDLG.txt','WriteRowNames',1,'Delimiter','tab')