

# DEVELOPING FAULT ANALYSIS PROGRAM FOR BUS AND LINE FAULT USING C PROGRAMMING

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## ABSTRACT

*The paper outlines work done in developing fault analysis program for bus and line fault using C Programming. The program of fault analysis for line and bus fault was developed using C Programming and compiled using Microsoft Visual C++. When the users run this program, they will be asked for the name of zero sequence file in txt format. Then the user will be asked for positive sequence file also in txt format. User need to choose the type of fault either: 1. A phase to ground fault, 2. Two phases to ground fault, 3. Phase to phase fault, and, 4. 3-Phase fault. Then the program will calculate the fault according to the type of fault. The project methodology was design to introduce 7 steps of research approach namely literature review stage, preliminary study, identification of software, development of output mechanism, integrate the system, system improvement and modification and lastly the final system evaluation. The project finding proved the program runs according to the fault we chose. The output of the program will be saved in File 'Jawapan'.*

**Keywords** – Fault, C Programming, Bus Impedance Matrix Methods, Microsoft Visual C++.

## 1.0 INTRODUCTION

The steady state operating mode of a power system is balanced 3-phase ac. However, due to sudden external or internal changes in the system, this condition is disrupted. When the insulation of the system fails at one or more points or a conducting object comes in contact with a live point, a short circuit or fault occurs.

There are may be a lot of probabilities of faults in power system. These may be due to lightning, sleet, wind, apparatus failure, switching to a fault, tree falling on line, sabotage, etc. The faults may be

of different types, e.g., single-phase to ground faults, phase-to-phase faults, two-phase to ground faults and three-phase faults. Single-phase to ground faults are the most common whereas the three-phase short-circuit faults are the most severe faults. The determination of the values of the fault's current may enable to select appropriate switchgear and protective relays. The fault between single-phase and earth, between phase and phase, between two phases and earth, between two phases and at the same time, fault between third phase and earth, produce unsymmetrical fault currents. The faults between all three phases and also between third phase and earth produce symmetrical short circuit currents.

C is a general-purpose programming language. It has been closely associated with the UNIX operating system where it was developed, since both the system and most of the programs that run on it are written in C. The language, however, is not tied to any one operating system or machine; and although it has been called a "system programming language" because it is useful for writing compilers and operating systems, it has been used equally well to write major programs in many different domains.

C is a relatively "low-level" language. This characterization is not negative; it simply means that C deals with the same sort of objects that most computers do namely characters, numbers, and addresses. These may be combined and moved about with the arithmetic and logical operators implemented by real machines.

## 2.0 SCOPE OF STUDY

### 2.1 Problem Statement

Fault is the unintentional connecting together of two or more conductors which ordinarily operates with a difference of potential between them. Connection between conductors may be physical metallic contact or through an arc.

The types of fault calculation can be divided into two main types:

- a) Faults short-circuiting all three phases when the network remains balanced electrically. Through this type of fault is not common but their study enable us to comprehend a whole group of problems concerning short-circuits. For these calculations normal single-phase equivalent circuits may be used.
- b) Faults other than three-phase short-circuit when the network is electrically unbalanced. To facilitate these calculations a special method for dealing with unbalanced networks is used known as the method of symmetrical components.

## 2.2 Objectives of the project

The project title is Developing Fault analysis Program for Bus and Line Fault Using C Programming. The objectives of this project are:

- To determine the maximum and minimum three-phase short-circuit currents.
- To determine the unsymmetrical fault current for single or double line to earth, line-to-line faults and open circuit faults.
- To determine fault current distribution and busbar voltage levels during faults.

## 2.3 Software used and work covered

The work done was software based. The program was develop using C programming and compiled using Microsoft Visual C++ 6.0. Visual C++ 6.0 (commonly known as VC6), which include MFC 6.0 (Microsoft Foundation Class 6.0) was released in 1998. The release was somewhat controversial since it did not include an expected update to MFC. Visual C++ 6.0 is still quite popular and often used to maintain legacy projects.

**Microsoft Visual C++** (often abbreviated as **MSVC**) is a commercial integrated development environment (IDE) product engineered by Microsoft for the C, C++, and C++/CLI programming languages. It has tools for developing and debugging C++ code, especially code written for the Microsoft Windows API, the DirectX API, and the Microsoft .NET Framework.

The work developments covered in this project were:

- Construct the flow chart of the program
- Develop the fault program using C Programming and using Bus Impedance Matrix method also involving matrix conversion Y and Z
- Analyze the output of the programming

## 3.0 METHODOLOGY

The research methodology used for this project is divided into seven parts such as the Figure 1 below:

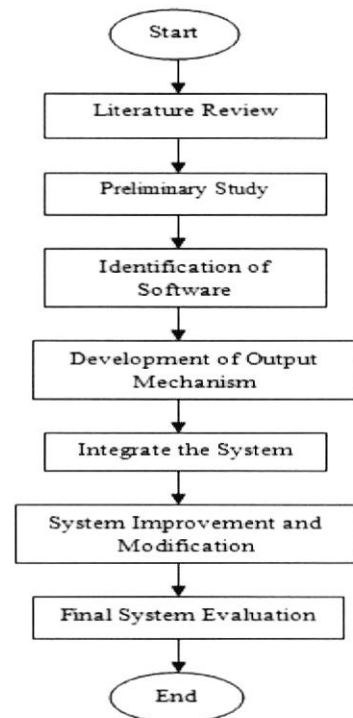


Figure 1: 7 parts of methodology

Detail the description of the methodology used in this project was as below:

### Literature review

Review from the book, journal, articles and internet were used to study the history and the requirement of the project. The reviews also include the significant and advantages of the C Programming to be implement in this project.

**Preliminary Study of the System**

After reviews the C Programming, the specific system will be study. The reviews that will estimate must be evaluated for suitable and useful to the people.

The literature review opened an idea on the appropriate system. At this stage more system study was essential.

**Identification of Software**

The detail of the commands and functions of C language must be studied clearly. The types of functions choose depend on the use of it. There are many choices of software can be used for fault analysis such as MATLAB, PSSE, PHP, etc. This project will consider the fault analysis for line and bus

This stage will identify the suitable software requirement for the fault analysis program.

**Development of Output Mechanism**

The user can easily access the program to calculate the fault that occurs in four types of fault.

**Integrate the System**

The software must be integrated and tested to make the system can be access perfectly.

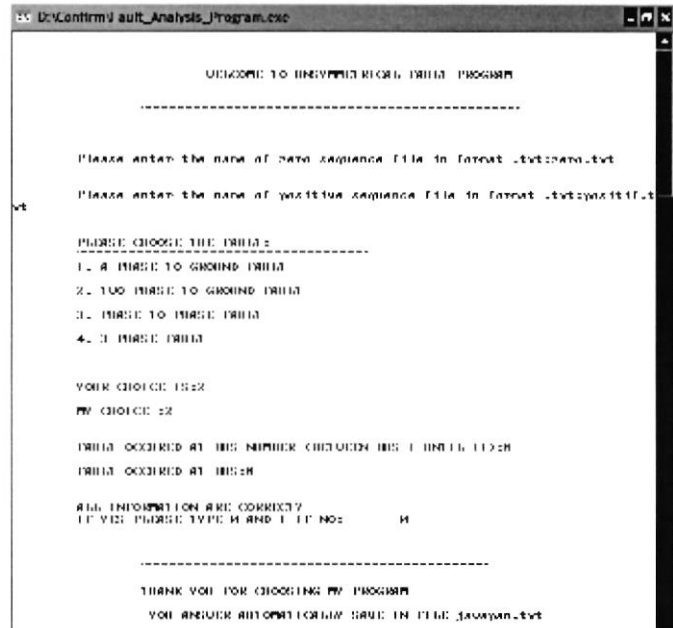
**System Improvement and Modification**

The system went through several tests to validate the performance. This stage will conduct test and make some modification in term of user friendly to improve the system.

**Final System Evaluation**

This is a final stage and must be run the test of the system to make a final result. The final system and thesis will submit.

**4.0 RESULTS AND DISCUSSIONS**



**Figure 4. 1 The program run in Code Blocks 8.02 for fault type 2. Two Phase to Ground Fault and fault occur at Bus8**

```

MATRIX Y FOR ZERO SEQUENCE
0.0000 -4.7619j      0.0000 0.0000j
          0.0000 0.0000j      0.0000 0.0000j
          0.0000 0.0000j      0.0000 0.0000j
          0.0000 0.0000j      0.0000 0.0000j
          0.0000 0.0000j
0.0000 0.0000j      0.0000 -22.7778j
          0.0000 1.6667j      0.0000 0.0000j
          0.0000 3.3333j      0.0000 1.1111j
          0.0000 0.0000j      0.0000 0.0000j
          0.0000 0.0000j      0.0000 0.0000j
          0.0000 0.0000j
0.0000 0.0000j      0.0000 1.6667j
          0.0000 -4.1667j      0.0000 1.2500j
          0.0000 0.0000j      0.0000 1.2500j
          0.0000 0.0000j      0.0000 0.0000j
          0.0000 0.0000j      0.0000 0.0000j
          0.0000 0.0000j
0.0000 0.0000j      0.0000 0.0000j
          0.0000 1.2500j      0.0000 -15.6591j
          0.0000 0.0000j      0.0000 1.0000j
          0.0000 0.0000j      0.0000 0.0000j
          0.0000 0.9091j      0.0000 12.5000j
          0.0000 0.0000j
    
```

0.0000	0.0000j	0.0000	3.3333j	0.1391j	0.0000 + 0.0269j	0.0000 + 0.0771j	0.0000 + 0.0829j	0.0000 + 0.0634j	0.0000 + 0.0000j
	0.0000	0.0000j	0.0000	0.0000	0.0000j	0.0000 + 0.133j	0.0000 + 0.0901j		
	0.0000	-4.5833j	0.0000	0.0000	0.0000j	0.0000 + 0.1922j	0.0000 + 0.0158j	0.0000 + 0.0903j	0.0000 + 0.0226j
	0.0000	1.2500j	0.0000	0.0000	0.0000j	0.0000 + 0.0749j	0.0000 + 0.1277j	0.0000 + 0.1352j	0.0000 + 0.0000j
	0.0000	0.0000j	0.0000	0.0000	0.0000j	0.0000 + 0.0436j	0.0000 + 0.0330j	0.0000 + 0.0158j	0.0000 + 0.2698j
	0.0000	0.0000j	0.0000	1.1111j	0.0000	1.0000j	0.0359j	0.0000 + 0.0728j	0.0000 + 0.0502j
	0.0000	1.2500j	0.0000	0.0000	0.0000	-4.4137j	0.0347j	0.0000 + 0.0111j	0.0000 + 0.0000j
	0.0000	0.0000j	0.0000	0.0000	0.0000	1.0526j	0.0000 + 0.0000j	0.0000 + 0.0000j	0.0000 + 0.0316j
	0.0000	0.0000j	0.0000	0.0000	0.0000	0.0000j	0.0000 + 0.1391j	0.0000 + 0.0903j	0.0000 + 0.0359j
	0.0000	0.0000j	0.0000	0.0000j	0.0000	0.0000j	0.0000 + 0.0359j	0.0000 + 0.0359j	0.0000 + 0.0000j
0.0000	0.0000j	0.0000	0.0000j	0.3313j	0.0000 + 0.0473j	0.0000 + 0.1548j	0.0000 + 0.1258j	0.0000 + 0.0635j	0.0000 + 0.0000j
	0.0000	0.0000j	0.0000	0.0000	0.0000j	0.0000 + 0.1548j	0.0000 + 0.1258j	0.0000 + 0.0635j	0.0000 + 0.0000j
	0.0000	1.2500j	0.0000	0.0000	0.0000j	0.0000 + 0.0149j	0.0000 + 0.0269j	0.0000 + 0.0149j	0.0000 + 0.0269j
	0.0000	-5.6197j	0.0000	0.0000	1.4286j	0.0000 + 0.0226j	0.0000 + 0.0728j	0.0000 + 0.0226j	0.0000 + 0.0728j
	0.0000	0.0000j	0.0000	0.0000	0.0000j	0.0473j	0.0000 + 0.2270j	0.0000 + 0.1293j	0.0000 + 0.0813j
	0.0000	0.0000j	0.0000	0.0000	0.0000j	0.0813j	0.0000 + 0.0159j	0.0000 + 0.0000j	0.0000 + 0.0000j
0.0000	0.0000j	0.0000	0.0000j	0.0000 + 0.0000j	0.0000 + 0.0205j	0.0000 + 0.0771j	0.0000 + 0.0000j	0.0000 + 0.0749j	0.0000 + 0.0502j
	0.0000	0.0000j	0.0000	0.0000j	0.0000	0.0000j	0.1548j	0.0000 + 0.1293j	0.0000 + 0.4646j
	0.0000	0.0000j	0.0000	1.0526j	0.0000	-3.5923j	0.2892j	0.0000 + 0.0527j	0.0000 + 0.0000j
	0.0000	1.4286j	0.0000	-3.5923j	0.0000	0.0000j	0.0000 + 0.0000j	0.0000 + 0.0173j	0.0000 + 0.0829j
	0.0000	1.1111j	0.0000	0.0000j	0.0000	0.0000j	0.0000 + 0.0000j	0.0000 + 0.1277j	0.0000 + 0.0347j
	0.0000	0.0000j	0.0000	0.0000j	0.0000	0.0000j	0.1258j	0.0000 + 0.0813j	0.0000 + 0.2892j
0.0000	0.0000j	0.0000	0.0000j	0.0000	0.9091j	0.0000 + 0.7115j	0.0000 + 0.0899j	0.0000 + 0.0899j	0.0000 + 0.0000j
	0.0000	0.0000j	0.0000	0.0000j	0.0000	0.0000j	0.0000 + 0.0000j	0.0000 + 0.0094j	0.0000 + 0.0634j
	0.0000	0.0000j	0.0000	0.0000j	0.0000	1.1111j	0.0000 + 0.1352j	0.0000 + 0.0111j	0.0000 + 0.0635j
	0.0000	0.0000j	0.0000	1.1111j	0.0000	0.0000j	0.0635j	0.0000 + 0.0159j	0.0000 + 0.0527j
	0.0000	-2.0202j	0.0000	0.0000j	0.0000	0.0000j	0.0899j	0.0000 + 0.1515j	0.0000 + 0.0000j
	0.0000	0.0000j	0.0000	0.0000j	0.0000	0.0000j	0.0000 + 0.0000j	0.0000 + 0.0000j	0.0000 + 0.0000j
0.0000	0.0000j	0.0000	0.0000j	0.0000	12.5000j	0.0000 + 0.0000j	0.0000j	0.0000 + 0.0000j	0.0000 + 0.0000j
	0.0000	0.0000j	0.0000	0.0000j	0.0000	0.0000j	0.0000j	0.0000 + 0.0000j	0.0000 + 0.0000j
	0.0000	0.0000j	0.0000	0.0000j	0.0000	0.0000j	0.0000j	0.0000 + 0.0000j	0.0000 + 0.0000j
	0.0000	0.0000j	0.0000	0.0000j	0.0000	-17.7632j	0.0000j	0.0000 + 0.0000j	0.0000 + 0.2300j
	0.0000	0.0000j	0.0000	0.0000j	0.0000	0.0000j	0.0000 + 0.0000j	0.0000 + 0.0000j	0.0000 + 0.0000j
0.0000	0.0000j	0.0000	0.0000j	0.0000	0.0000j	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000j	0.0000	0.0000j	0.0000	0.0000j	0.0000	0.0000	0.0000
	0.0000	0.0000j	0.0000	0.0000j	0.0000	0.0000j	0.0000	0.0000	0.0000
	0.0000	0.0000j	0.0000	0.0000j	0.0000	0.0000j	0.0000	0.0000	0.0000
	0.0000	-4.3478j	0.0000	0.0000j	0.0000	0.0000j	0.0000	0.0000	0.0000

MATRIX Y FOR POSITIVE/NEGATIVE SEQUENCE

0.0000	-21.6667j	0.0000	0.0000j
	0.0000	0.0000j	0.0000
	0.0000	0.0000j	0.0000
	0.0000	0.0000j	0.0000
	0.0000	0.0000j	0.0000
	0.0000	0.0000j	0.0000
	0.0000	0.0000j	0.0000
0.0000	0.0000j	0.0000	-28.8889j
	0.0000	0.0000j	0.0000
	0.0000	0.0000j	0.0000
	0.0000	0.0000j	0.0000
	0.0000	0.0000j	0.0000
	0.0000	0.0000j	0.0000
0.0000	0.0000j	0.0000	0.0000j
	0.0000	-8.3333j	0.0000
	0.0000	0.0000j	0.0000
	0.0000	0.0000j	0.0000

INVERSE MATRIX Z FOR ZERO SEQUENCE

0.0000 + 0.2100j	0.0000 + 0.0000j	0.0000 + 0.0000j
0.0000 + 0.0000j	0.0000 + 0.0000j	0.0000 + 0.0000j
0.0000j	0.0000 + 0.0000j	0.0000 + 0.0000j
0.0000j	0.0000 + 0.0000j	0.0000 + 0.0000j
0.0000 + 0.0000j	0.0000 + 0.0544j	0.0000 + 0.0352j
0.0000 + 0.0133j	0.0000 + 0.0436j	0.0000 + 0.0316j
0.0000 + 0.0149j	0.0000 + 0.0205j	0.0000 + 0.0173j
0.0000 + 0.0094j	0.0000 + 0.0000j	0.0000 + 0.0000j
0.0000 + 0.0000j	0.0000 + 0.0352j	0.0000 + 0.3228j
0.0000 + 0.0901j	0.0000 + 0.0330j	0.0000 + 0.0000j





```

0.0000 0.0000j      0.0000 0.0000j
0.0000 -14.0000j

```

**INVERSE MATRIX Z FOR POSITIVE/NEGATIVE SEQUENCE**

```

0.0000 + 0.0462j 0.0000 + 0.0000j 0.0000 + 0.0000j
      0.0000 + 0.0000j 0.0000 + 0.0000j 0.0000 +
0.0000j 0.0000 + 0.0000j 0.0000 + 0.0000j 0.0000 +
0.0000j 0.0000 + 0.0000j 0.0000 + 0.0000j
0.0000 + 0.0000j 0.0000 + 0.0346j 0.0000 + 0.0000j
      0.0000 + 0.0000j 0.0000 + 0.0000j 0.0000 +
0.0000j 0.0000 + 0.0000j 0.0000 + 0.0000j 0.0000 +
0.0000j 0.0000 + 0.0000j 0.0000 + 0.0000j
0.0000 + 0.0000j 0.0000 + 0.0000j 0.0000 + 0.1200j
      0.0000 + 0.0000j 0.0000 + 0.0000j 0.000

```

4.2 The Result for Type 2. Two Phase to Ground Fault that occur at Bus 8 that saved in File 'Jawapan'.txt using C Programming.

```

Double line-to-ground fault analysis
Enter Faulted Bus No. -> 8
Enter Fault Impedance Zf = R + j*X in
complex form (for bolted fault enter 0). Zf = 0
Double line-to-ground fault at bus No. 8
Total fault current = 2.4222 per unit

```

Bus Voltages during the fault in per unit

Bus No.	Phase a	Phase b	Phase c
1	0.9530	0.8441	0.8441
2	0.9562	0.7884	0.7884
3	0.9919	0.7122	0.7122
4	1.0107	0.7569	0.7569
5	0.9686	0.7365	0.7365
6	1.0208	0.5666	0.5666
7	0.9992	0.5907	0.5907
8	1.1391	0.0000	0.0000
9	1.0736	0.3151	0.3151
10	0.9991	0.8455	0.8455
11	0.9239	0.7509	0.7509

```

Another fault location?
Enter 'y' or 'n' within single quote -> 'n'

```

**4.3 The Result for Two Phase to Ground Fau**

From the result in File 'Jawapan'.txt we can easily found the total of fault current for Two phase to ground fault that occur at Bus 8 is 2.7996 p.u. It also includes voltages at all buses to Bus 8.

From the results of both programs either using C programming or Matlab programming there is some different in the total fault current value.

MATLAB (p.u)	C PROGRAMMING (p.u)	Difference (p.u)
2.4222	2.7996	0.3774

**Table 4. 1 Two Phase to Ground Fault**

It is because of the floating in C programming makes the results of the total fault current difference. In C programming, the floating point plays an important role to the output.

**5.0 CONCLUSION**

The development of fault analysis using C Programming is important to help user to calculate fault current and the voltage levels especially in a large number systems.

It can be concluded that the fault program can helps a lot to find the fault current and also the voltage levels at the Fault Bus. The program can calculate the matrix and the inverse matrix for Zero and Positive/Negative Sequence.

**6.0 FUTURE DEVELOPMENT**

There are several suggestions for future development. Firstly, using the program that less complicated and easy to develop such as MATLAB. This is because the need to increase the simplicity in the program. From the literature, MATLAB is more suitable to develop the program.

This project can also be improved in the future to be a multi-function application. In addition, the load flow for the system can also be included in the program.

## 7.0 ACKNOWLEDGEMENT

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