FAULT STUDY ON POWER SYSTEM USING POWERWORLD SIMULATION SOFTWARE

NURUL HUSNA BINTI MOHD NIZAN

B071710749

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2020

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

FAULT STUDY ON POWER SYSTEM USING POWERWORLD SIMULATION SOFTWARE

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Power Industry) with Honours.

by

NURUL HUSNA BINTI MOHD NIZAN

B071710749

980602-02-6192

FACULTY OF ELECTRICAL AND ELECTRONIC ENGINEERING TECHNOLOGY

2020

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: Fault Study on Power System Using PowerWorld Simulation Software

Sesi Pengajian: 2020/2021

Saya **NURUL HUSNA BINTI MOHD NIZAN** mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (X)

☐ SULIT* Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972.

☐ TERHAD* Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan.

☒ TIDAK TERHAD

Yang benar, Disahkan oleh penyelia:

....

NURUL HUSNA BINTI MOHD NIZAN TS.ASRI BIN DIN

Alamat Tetap: Cop Rasmi Penyelia

F62 KAMPUNG BUKIT RAWA SEDIM,

09700 KARANGAN KEDAH

Ts. ASRI BIN DIN
Pensyarah Kanan
Jabatan Teknologi Kejuruteraan Elektrik
Fakulti Teknologi Kejuruteraan Elektrik dan Elektronik
Universiti Teknikal Malaysia Melaka

Tarikh: 19 FEBRUARY 2021 Tarikh: 19 FEBRUARY 2021

*Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I declare that this report entitled “Fault Study on Power System using PowerWorld Simulation Software” is the result of my own research except as cited in the references. The report was not approved for any degree and is not submitted concurrently with any other degree of candidature.

Signature : 

Name : NURUL HUSNA BINTI MOHD NIZAN

Date : 19 FEBRUARY 2021

APPROVAL

I hereby declare that I have read this report and in my opinion this report is sufficient in terms of scope and quality as a partial fulfilment of Bachelor of Electrical Engineering Technology (Industrial Power) with Honours.

Signature : 

Supervisor Name : TS. ASRI BIN DIN

Date : 19 FEBRUARY 2021

DEDICATION

My dedication is especially to my lovely parents. For my late father. For my mother who is a strong person who taught me to trust in Allah S.W.T plans and to believe in my hard work, who always be by my side whenever I feel down and always pray for my success. For my siblings who helped and encourage me also to make this project success.

ABSTRACT

Within an electric power system, any irregular electrical current is a fault or fault current. A short circuit for example is a fault in which the current bypasses the normal load. An open-circuit fault arises if some failure interrupts a circuit. A fault may involve one or more phases and ground in three phase systems or can occur only between phases. Present flows into the earth through a ground fault or fault on the surface. For certain cases, the prospective short-circuit current of a predictable fault can be calculated. Protective equipment can detect fault conditions in powers systems and operate circuit breakers and other equipment to minimize service loss due to failure. Since it is beyond of our capacity to see the fault happens in the power system and to see the parameter involves when the fault occurs. This report presents a 5-bus system model and 10-bus system model with PowerWorld simulator includes fault analysis as design verifications to effect of the fault to the power system and the load flow in the system and the contingency operation were included. In order to obtain a reliable model, the basic knowledge of power system components must be met in the selection of initial data according to specific criteria. In the verification stage, the proposed model has been tested with fault analysis to simulate the proposed model responses in single – line – to – ground fault, line – to – line fault and double – line – to ground fault. The measured parameter in these stages are focused on the bus voltage magnitude and its phase angle as one of the reference indicators for the state of power system operation. There are also the load flow analysis and the parameter that have been investigated are voltage magnitude and the phase angle. The fault would result in voltage being zero at the failed phase, while voltage changes from their nominal values at the other 2 un-failed phases.

ABSTRAK

Dalam sistem kuasa elektrik, arus kerosakan adalah arus elektrik yang tidak normal. Sebagai contoh, litar pintas adalah kerosakan di mana arus memintas beban normal. Kerosakan litar terbuka berlaku sekiranya litar terganggu oleh beberapa kegagalan. Dalam sistem tiga fasa, kerosakan mungkin melibatkan satu atau lebih fasa dan bumi, atau mungkin hanya berlaku di antara fasa. Dalam kerosakan bumi. Terdapat beberapa jenis arus litar pintas kerosakan yang dapat dikenal pasti. Dalam sistem kuasa, alat pelindung dapat mengesan keadaan kerosakan dan mengoperasikan pemutus litar dan peranti lain untuk mengehadkan kehilangan perkhidmatan akibat kegagalan. Kajian ini dilakukan oleh kerana melihat kerosakan ini dan melihat parameter yang berubah merupakan di luar kemampuan kita Laporan ini menyajikan model sistem 5-bus dan 10-bus dengan simulator PowerWorld merangkumi analisis kerosakan sebagai pengesahan reka bentuk untuk mempengaruhi kerosakan kepada sistem kuasa dan aliran beban dalam sistem dan operasi kontingensi disertakan. Untuk mendapatkan model yang boleh dipercayai, pengetahuan asas komponen sistem kuasa mesti dipenuhi dalam pemilihan data awal sesuai dengan kriteria tertentu. Pada tahap verifikasi, model yang dicadangkan telah diuji dengan analisis kerosakan untuk mensimulasikan respons model yang dicadangkan dalam kerosakan satu talian ke bumi, kerosakan talian ke talian dan kerosakan dua talian ke bumi. Parameter yang diukur dalam tahap ini difokuskan pada magnitud voltan bus dan sudut fasa sebagai salah satu petunjuk untuk keadaan operasi sistem kuasa. Terdapat juga analisis aliran beban dan parameter yang telah diteliti ialah magnitud voltan dan sudut fasa. Kerosakan tersebut akan mengakibatkan voltan menjadi sifar pada fasa gagal, sementara voltan berubah dari nilai nominalnya pada 2 fasa tidak gagal yang lain.

ACKNOWLEDGEMENT

Along to finish my report, I had taken a lot of efforts from start until the end to submit this report and to get my project done. However, this not just a success of me alone, I will not achieve this without the kind support and help of many individuals. Therefore, thanks to all of them from the deep of my heart.

I am heavily indebted to my supervisor, TS Asri Bin Din for the guidance and continuous supervision as well as for providing necessary information regarding to my project and also for the motivation in completing this project.

Besides that, I want to thank all people such as my friends, colleagues, and lecturers who have directly or indirectly helped me in this project. The idea and the moral support given by them helped me a lot during the process of developing this project.

Last but not least, thank you to everyone who had been to the crucial parts of realization of this project.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter basically tells about the overall on what I am doing in my project. First of all is about the background of the project. In this part, it will explain more about what is my project all about. Then, it will come out with the problem statements of the project. The problems occur currently related with the worldwide issues. After that, the objectives about my project. This objective is related with the problem statements stated. Last but not least, the scope of my project which discuss only the main and important part that will be focused in my project.

1.1 Background of project

Power system normally works within the specified limits under controlled conditions with all equipment bearing regular load currents and the bus voltages. This condition can be disrupted due to system fault and if the electrical fault current exceeds the protective device's interrupting rating then the effects may be bad. This can constitute a significant threat to human life and can results in injuries and severe damage to the equipment. The power system fault can be classified into two types which are open circuit fault and short circuit fault. The open circuit fault occurs when one or two conductors fail. These faults take place in series with so called series fault line. Such types of faults strongly affect system reliability. The open circuit fault is also classified as open conductor fault, two open fault conductors and three open fault conductors. Commonly, the short circuit fault is divided into symmetrical and asymmetrical forms. Types of symmetrical fault is three phase line-to-ground fault and three phase line-to-line fault. Types of asymmetrical fault is single-line-to-ground fault, line-to-line fault and double-line-to-ground fault.

The causes of the failure of the power system are weather conditions like Lightning strikes, accumulation of snow transmission, heavy rainfall, high speed winds, earthquakes, deposition of salt pollution on overhead lines and conductors. Machines, motors, generators, transformers, cables, reactors, switch devices and so on is the electrical equipment that can damage and cause equipment failure, causes electrical faults. Moreover, human error like choosing inappropriate rating of equipment or devices, forgetting metallic or electrical conducting components once coupled or maintained, switching the circuit while servicing it below. PowerWorld system software is used to simulate the fault occur in power system so that people can imagine in how the fault is affecting the power system stability.

Power flow studies, commonly known as load flow form important part of power system analysis. They are necessary for planning, economic scheduling, and control of an existing system as well as planning its future expansion. The problem consists of determining the magnitudes and phase angle of voltages at each bus and active and reactive power flow in each line.

1.2 Problem statements

During fault, the stability of the power system will be reduce and power system will be less efficient. Fault can affect a lot of parameters in the powers system bus. The main problem is we always saw the failure in power system but we do not know how the fault occur and what parameters will be affected when the fault occur because when fault occur, it is beyond our capacity as a human to see what happen. Hence, most of the previous researchers did research to find the performance of the stability if the power system when the fault occurs. The previous researcher only did a research on the parameter affected and the stability of the power system during fault. There are many performances that can be known towards better results in fault analysis in power system. The fault needs to be simulate in order to make people more understand and more clear on what parameter that will be affected.

We always hear and study about load flow but we do not know the how the load flows in the system and what is the effect when there are failures in the power system to the load flows. There are any contingencies operation that can occur in the system.

1.3 Objective

The objective of this research work are:

1) Simulate established models of power system bus using PowerWorld simulation software.
2) Investigate the effect of asymmetrical fault to the voltage magnitude and phase angle at power system busbar in normal condition.
3) Investigate the effect of asymmetrical fault to the voltage magnitude and phase angle at power system busbar in various contingency operation.

1.4 Scope

In my project, the study will cover and focus on asymmetrical fault only which is the single line to ground fault, line to line fault and double line to ground fault. Then, the circuit will be constructed and simulated in PowerWorld simulation software to study the impact of the asymmetrical fault to the stability of the power system. The fault will be create at the bus only and not at the transmission line. For the first objective, a typical model of power system with 5 busbars and 10 busbars will be simulate in the PowerWorld simulator. For the second objective, the voltage magnitude and phase angle of the stated voltage stability will be investigated in normal fault condition. For the third objective, the voltage magnitude and phase angle will be investigated in the contingency operation.

1.5 Research Contribution

In the last couples of years, power engineering subjects have been less attractive for undergraduate or graduate students. This issue will create serious problems behind the rapid growth of the worldwide electricity industry and will lead to negative perceptions of the impacts of deregulation and restructuring in electricity sector. High expectations of work requirements and perception of power engineering as an old technology foster students' low interest and motivation, as well as the difficulty of subject taught in power engineering courses. However, a few strategies were made to make the power engineering fields more

attractive and fun, such as promoting technical challenges, collaborative distance learning and using visualization and simulation methods, before reaching the final limits of this problem.

This research will make students more attracted and will make people realised on how dangerous when fault occur in the power system and give them awareness of it. This research will make people understand more about the power system bus and how to simulate it in the basic ways using PowerWorld simulator. This simulator is applied for forecasting and mitigation of power system blackout. Other applications are the optimal power flow simulation and animation of power system presented.

1.6 Report Outline

Chapter 1 elaborate the problem statement, objective of the project, research contribution and scope of this project.

Chapter 2 explain the literature study related to this project. Study on previous research by other researcher, project design and system that are conducted to ensure the successfulness if this project.

Chapter 3 describes the methodology to simulate the power system bus model and how to create the fault in the system.

Chapter 4 discuss the results and analysis of the performance of the simulation.

Chapter 5 provides conclusion and recommendation for future work of this project.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter is about the literature review as a reference that helps my project based on reading of journal or conference paper to gain some ideas and knowledge for my project. The journal will go through read from the past five years. It will come out with the results and summarize of each of the paper.

2.1 Asymmetrical Faults

Asymmetrical faults are the faults in the power system network which disturb the balanced condition of the network. The asymmetrical faults are classified as single-line-to-ground faults (SLG), double-line-to-ground faults (DLG), and line-to-line faults. More than 90% of faults which occur in a power system are single-line-to-ground faults, M.Salam. (2020). Asymmetrical faults are the most common faults that occur in the power system. The magnitudes of the line currents become unequal and also these current components observed a phase displacement among them due to asymmetrical fault, M.Salam. (2020). In this case, symmetrical components are required to analyse the current and voltage quantities during the asymmetrical faults. In transmission line faults, roughly 5% to 10% are asymmetric line-to-line faults. Then, line-to-ground fault which is a short circuit between one line and ground, very often caused by physical contact. For example, due to lightning or other storm damage. In transmission line faults, roughly 65% to 70% are asymmetric line-to-ground faults. Other than that, double line-to-ground fault which is two lines come into contact with the ground and each other, also commonly due to storm damage. In transmission line faults, roughly 15% to 20% are asymmetric double line-to-ground.

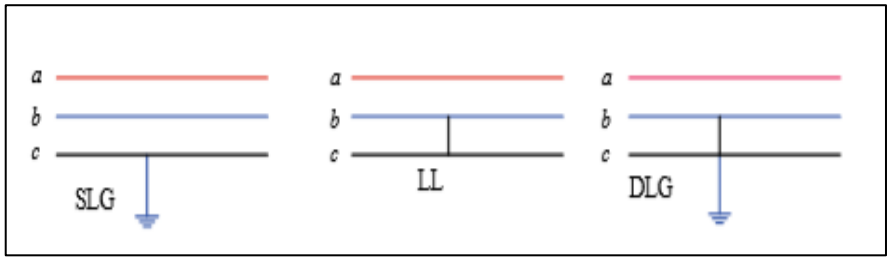

Figure 2.1: Different types of asymmetrical faults

2.1.1 Single – Line – to - Ground Fault

A three-phase Y-connected unload generator. The neutral of the generator is grounded with a solid wire initially. In this case, assume that a single-line-to-ground fault occurs in phase a of the unloaded generator, which disturbs the balance of the power system network, M.Salam. (2020). For this case, the boundary conditions are:

$$V_a = 0$$

$$I_{b=0}$$

$$I_{c=0}$$

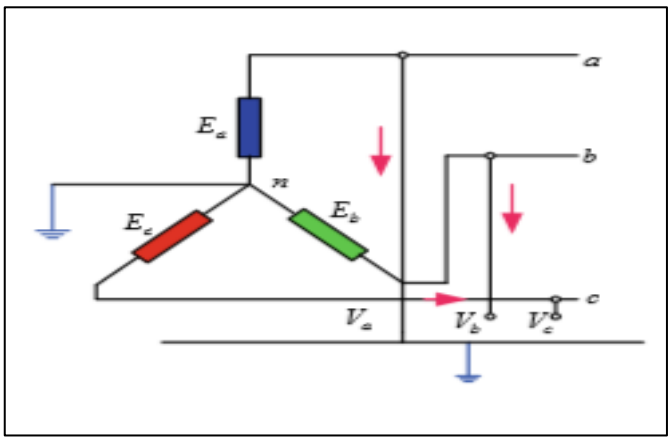

Figure 2.2: Single-line- to- ground fault of an unloaded generator.

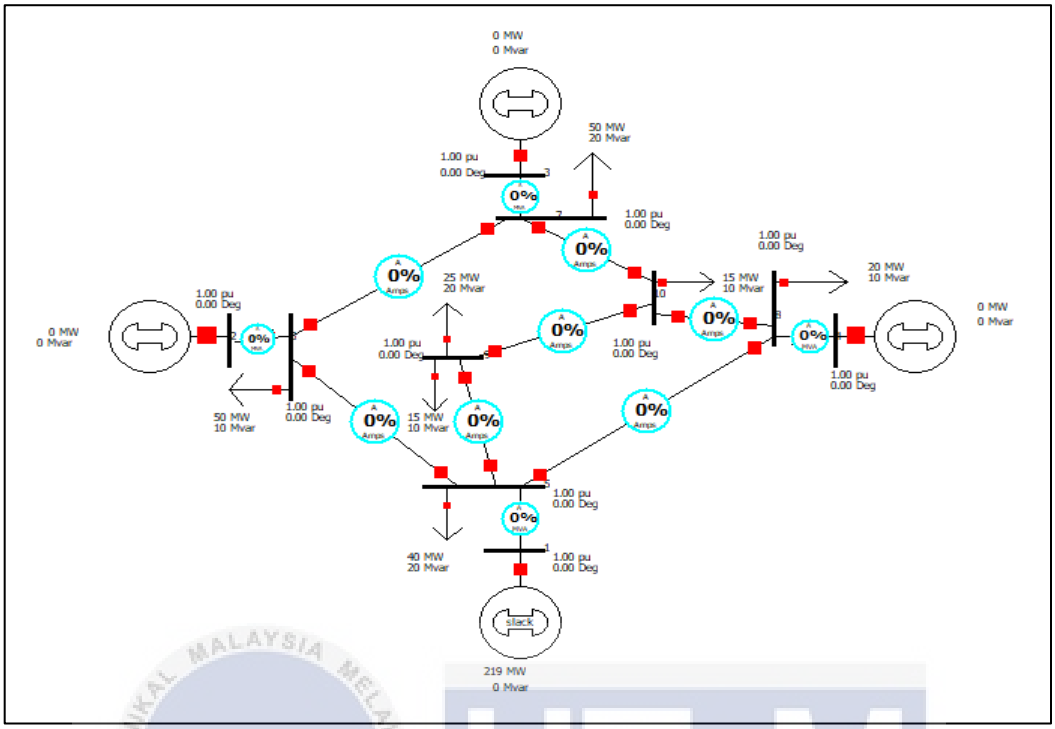

Figure 2.3: Simulation circuit by PowerWorld software

2.1.2 Line – to – Line Fault

There are three-phase synchronous generator which line-to-line fault occurs in between phase b and phase c. In this case, the voltages at phases b and c must be the same, while the currents in phase b and phase c must be equal but in opposite direction to each other, M.Salam. (2020). In the line-to-line fault, the boundary conditions are:

$$I_a = 0$$

$$I_b = -I_c$$

$$V_b = V_c$$