MODELING OVERCURRENT PROTECTION

Sharifah Khadijah Binti Syed Sulaiman

4 BEKP 2

MAY 2009

MODELING OVERCURRENT PROTECTION

SHARIFAH KHADIJAH BINTI SYED SULAIMAN

This report is submitted in partial fulfillment of the requirements for the Bachelor in Electrical Engineering (Industrial Power)

Faculty of Electrical Engineering
Universiti Teknikal Malaysia Melaka

MAY 2009

" I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)".

Signature : .....

Supervisor's Name : En. Mohd Hendra B Hairi

Date : .....

"Saya akui bahawa saya telah membaca karya ini dan pada pandangan saya karya ini adalah memadai dari skop dan kualiti untuk tujuan penganugerahan Ijazah Sarjana Muda Kejuruteraan Elektrik (Kuasa Industri)".

Tandatangan : .....

Nama Penyelia : En. Mohd Hendra B Hairi

Tarikh : 11/5/07

ACKNOWLEDGEMENT

First and foremost I would like to express my deepest gratitude to Allah S.W.T for his guidance and blessing to complete my overall Project Sarjana Muda 1 and 2.
I would also like to thank my supervisor En. Hendra B Hairi for his advices, critics, insight and willingness dealing with me to help me completes this project. Also thanks to my friend 4 BEKP 2 especially Azlan B Abu Samah who helping me a lot doing my project.

The technical assistance of all technicians from Faculty of Electrical Engineering and also other faculty are gratefully acknowledged. For my parents and friends that had supported me since the beginning till the end of this project. Without their support and help, this project will not be successful as it was.

I would like to thank the place that I begin for all the experiences and knowledge that I gained throughout my learning session in Universiti Teknikal Malaysia Melaka (UTeM). All this valuable experiences will be useful in the future.

Lastly, I would like to thank to everyone who has contributed during my Project Sarjana Muda 1 and 2. Your kindness and cooperation in completion of my thesis is much appreciated.

Thank you

ABSTRACT

The purpose of this project is to modeling the overcurrent protection system for analysis on that system of protection. The testing procedure focuses in setting the overcurrent relays and inject current to the current transformer to analyses the time of tripping. Prior to that, the equipment that available in the protection lab, UTeM is used to study and analyze the performance to be compared with data manual provided by the manufacturer.

Protection against excess current was naturally the earliest protection system to evolve. From this basic principle, the graded overcurrent system, a discriminative fault protection, has been developed. This should not be confused with 'overload' protection, which normally makes use of relays that operate in a time related in some degree to the thermal capability of the plant to be protected. Overcurrent protection, on the other hand, is directed entirely to the clearance of faults, although with the settings usually adopted some measure of overload protection may be obtained.

In electricity supply, overcurrent or excess current is a situation where a larger than intended electric current exists through a conductor, leading to excessive generation of heat and the risk of damaging infrastructure and equipment and causing fires. Possible causes for overcurrent include short circuits, excessive load, and incorrect design. Fuses, circuit breakers, temperature sensors and current limiters are commonly used protection mechanisms to control the risks of overcurrent.

ABSTRAK

Tujuan utama projek ini adalah untuk memodelkan sistem perlindungan arus lebih sebagai analisa dalam sistem perlindungan. Prosedur ujian memfokuskan kepada pengesetan geganti aruslebih dan memberi suntikan arus kepada transformer arus bagi menganalisis masa pemutusan litar. Tambahan pula, alatan yang di gunakan adalah daripada makmal UTeM dan digunakan bagi melihat perbezaan ketepatan berbanding manual yang telah diberi oleh pembekal.. Perlindungan terhadap arus lebih merupakan perlindungan paling awal dalam sistem perlindungan. Berdasarkan prinsip asas ini, perlindungan arus lebih di wujudkan. Ini tidak sewajarnya di kelirukan dengan perlindungan beban lebih, kerana ia ternyata berbeza. Perlindungan arus lebih berdasarkan pengesanan suhu pada alatan yang di lindungi. Perlindungan arus lebih adalah tindakan membuang arus rosak iaitu arus lebihan dalam sistem.

Dalam pembekalan elektrik, arus lebihan adalah situssi di mana apabila lebih arus berbanding arus yang di tetapkan berda dalam sistem dan melalui konduktor yang membolehkan peningkatan suhu dan risiko kerosakan pada alatan dan boleh menyebabkan kebakaran. Antara penyebab arus lebih ialah, litar pintas, beban lebih dan rekabentuk yang tidak tepat. Fius, pemutus litar, sensor suhu dan penghad arus adalah yang biasa digunakan adalah untuk mengawal risiko arus lebih.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX

CHAPTER 1

INTRODUCTION

1.1 Background

Purpose of this project is to design a model of overcurrent protection based on current and time discrimination. Overcurrent protection is a backup protection of protection system. Among the various possible methods used to achieve correct relay co-ordination are those using either time or overcurrent, or a combination of both. The common aim of all the methods is to give correct discrimination. That is to say, each one must isolate only the faulty section of the power system network, leaving the rest of the system undisturbed.

1.2 Objectives

The objectives of this project are:

a) Develop an overcurrent protection model to make an interactive & attractive to learn this subject

b) Show the operation of overcurrent protection and the importance of overcurrent protection in transmission system

c) Show the discrimination of relay by time and current discrimination

1.3 Scope of the research.

This project has been confined to four relatively simple aspects which they are:

(a) Literature study on overcurrent protection and faulty condition

(b) Analysis of overcurrent protection.

(c) Learning and exploring in a way to setting the relay coordination

(d) Perform an analysis of fault current and the relay operation.

1.4 Problem Statement

Generally, there are two problem have been identified in this project which are developing a circuit with a few CB and relays and prove the philosophy of discrimination of current in overcurrent protection and creating a fault in the single phase system. Too often, installations are not safe due to improper selection, application .Improper application of a device's voltage rating, current rating, or interrupting rating can result in equipment damage, eventhough injury. For example, if a circuit breaker is chosen with the wrong ampere rating, the electrical equipment may not be protected under overcurrent or short-circuit conditions, allowing destruction of the equipment, and possible injury to personnel. If a circuit breaker does not have an adequate voltage rating, it can rupture while trying to interrupt an overcurrent. Finally, circuit breakers can violently explode attempting to interrupt fault currents beyond their interrupting ratings.

A fault current is an abnormal current in an electric circuit due to a fault (usually a short circuit or abnormally low impedance path). There are variety way to create fault. In this project shorting line to ground to making a fault will give a express and big impact in this project. Currents between 100 and 200 milliamperes (0.1 ampere and 0.2 ampere) are fatal. Anything in the neighborhood of 10 milliamperes (0.01) is capable of producing painful to severe shock. The value of fault current is unexpected but it's surely high. Another way is using the variable resistor, but this way showing increasing the current in slow steps. The best way chosen based on simulation result.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Discrimination is the ability of a protection scheme to select and isolate only the faulty part of an electrical system. Based on *Network Protection& Automation Guide* stated that discrimination by current relies on the fact that the fault current varies with the position of the fault because of the difference in impedance values between the source and the fault. Hence, typically, the relays controlling the various circuit breakers are set to operate at suitably tapered values of current such that only the relay nearest to the fault trips its breaker.

In *Power system Protection* by Electricity Training Association book stated that, discrimination by current can be obtained by recognizing the fact that faults in different parts of a power system will cause fault currents of different magnitude on account of the different impedances between source and the point's faults. This, in suitable conditions, with the protective relays of the various circuit-breakers set to trip at suitably tapered current values, will ensure that the breakers near to the fault will trip and will leave others traversed by the same fault current undisturbed. Thus, supply will be maintained to those parts of which are healthy.

2.2 Devices

In overcurrent protection system, there are few devices use to ensure, this system operating safely and effective. There devices are overcurrent relays, current transformer, and circuit breaker. System protection flow according from, fault occur which is voltage or current rise from normal conditions, then the voltage or current reduced to match with relay rating by tranducers. After that, relay will activate the breaker and circuit breaker will isolates the circuit and the result is fault have been remove.

2.2.1 Overcurrent Relays

Wikipedia the free encyclopedia stated that a relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. The function of a relay is to detect abnormal conditions *(excess current)* in the system and to initiate (*relay*) through appropriate circuit breakers to disconnect of faulty circuits so that interference with the general supply is minimized. In transmission system in Malaysia, TNB use standard I.D.M.T overcurrent relays. The current/time tripping characteristics of IDMT relays may need to be varied according to the tripping time required and the characteristics of other protection devices used in the network. The characteristic that TNB use is standard inverse characteristic.

Relay Characteristic	Equation (IEC 60255)
Standard Inverse (SI)	$t = TMS \times \frac{0.14}{I_r^{0.02} - 1}$
Very Inverse (VI)	$t = TMS \times \frac{13.5}{I_r - 1}$
Extremely Inverse (EI)	$t = TMS \times \frac{80}{I_r^2 - 1}$
Long time standard earth fault	$t = TMS \times \frac{120}{I_r - 1}$

(a): Relay characteristics to IEC 60255

Table 2.1: Relay Characteristics

The IDMT relay work on the induction principle, where an aluminum or copper disc rotates between the poles of an electromagnet and damping magnet. The fluxes induce eddy currents in the disc which interact and produce rotational torque. The disc rotates to a point where it operates a pair of contacts that break the circuit and remove the fault condition.

The major advantage of IDMT relays is ability to discriminate. Without this features, faults near the sources would receive a large fault current, but by the introduction and correct setting of IDMT relay this can be reduced minimum. By correct setting of the relays only the part of the system after the faults will suffer a loss of supply and therefore only the smallest portion of the system will be affected. If the fault is closer to the source, a large part will be affected, but this will still be the smallest possible portion.

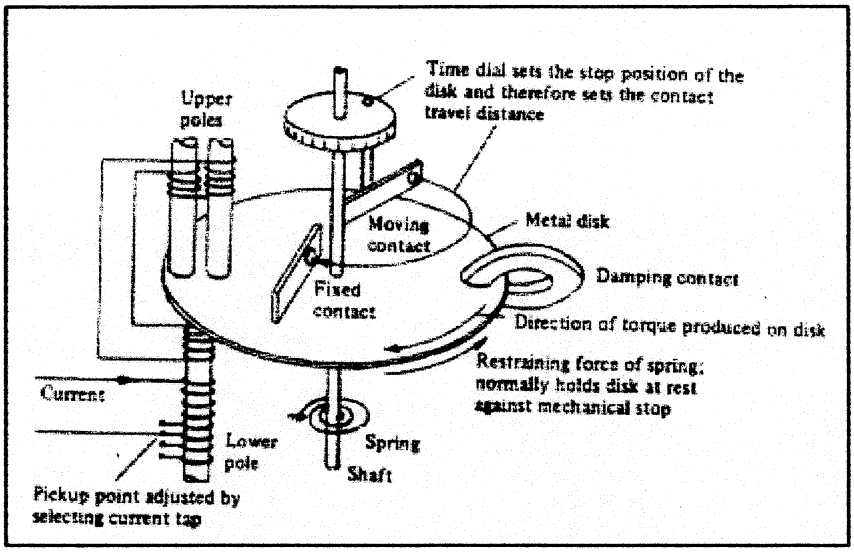


Figure 2.1: Electromechanical Relay

2.2.2 Circuit Breaker

Circuit breaker are required to control electrical power networks by switching circuit on, by carrying load and by switching circuits off under manual or automatic supervision. The character of their duty is unusual and they will normally in a closed position carrying load or in the open position providing electrical isolation.

The *National Electrical Code* defines a circuit breaker as a device designed to open and close a circuit by nonautomatic means, and to open the circuit automatically on a predetermined overcurrent without damage to itself when properly applied within its rating.

Circuit breakers provide a manual means of energizing and deenergizing a circuit. In addition, circuit breakers provide automatic overcurrent protection of a circuit. A circuit breaker allows a circuit to be reactivated after a short circuit or overload is cleared.

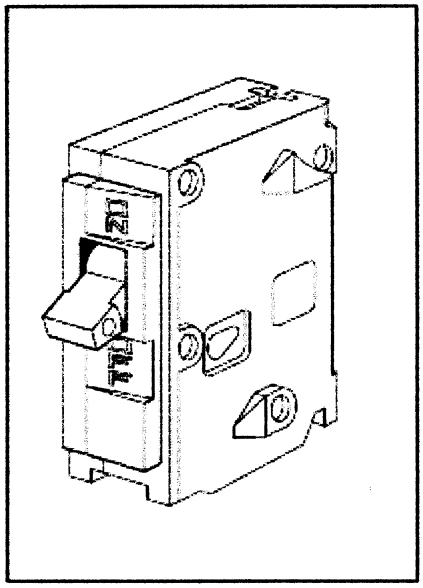


Figure 2.2: Circuit Breaker

This project use shunt trip circuit breaker. Sometimes it is advantageous to turn a breaker off from a remote location. To facilitate this task, an accessory called a shunt trip feature is installed by the manufacture inside of the breaker. This device consists of an electro-magnetic trip coil that is connected in series with an external field wired switch. When the switch contacts are closed, power is passed to the shunt trip coil causing the breaker's mechanical latch to move to the open position. Re-closing the breaker is done by physically going to the breaker and manually moving the operating handle to the on–closed position. When opened by use of the shunt trip coil, the breaker's operating handle moves to the off (maximum handle travel) and not the tripped (short of full handle travel) position. Knowing this can help when trying to determine if the breaker tripped off due to an overcurrent condition or was remotely turned off.

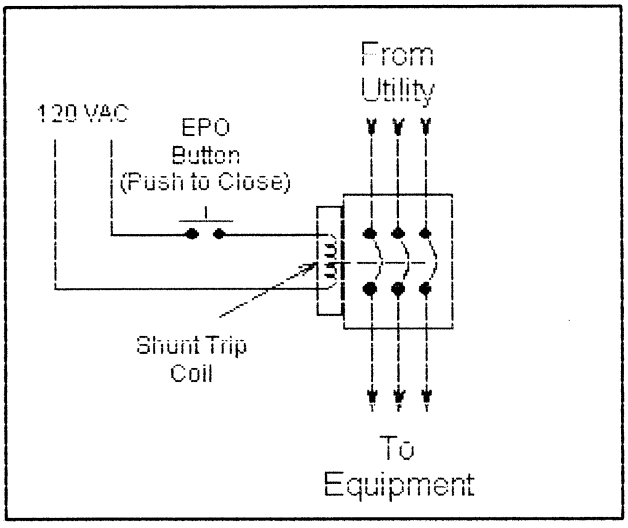


Figure 2.3: Shunt trip diagram

2.2.3 Current transformer

A current transformer (CT) is a type of transformer designed to provide a current in its secondary winding proportional to the alternating current flowing in its primary. They are commonly used in metering and protective relaying in the electrical power industry where they facilitate the safe measurement of large currents, often in the presence of high voltages. The current transformer safely isolates measurement and control circuitry from the high voltages typically present on the circuit being measured. CT is an instrument transformer that is used to supply a reduced value of current to meters, protective relays and other instrument. The primary winding consist of a single turn which is the power conductor itself. CT secondary is connected to a current-sensing device with zero impedance.

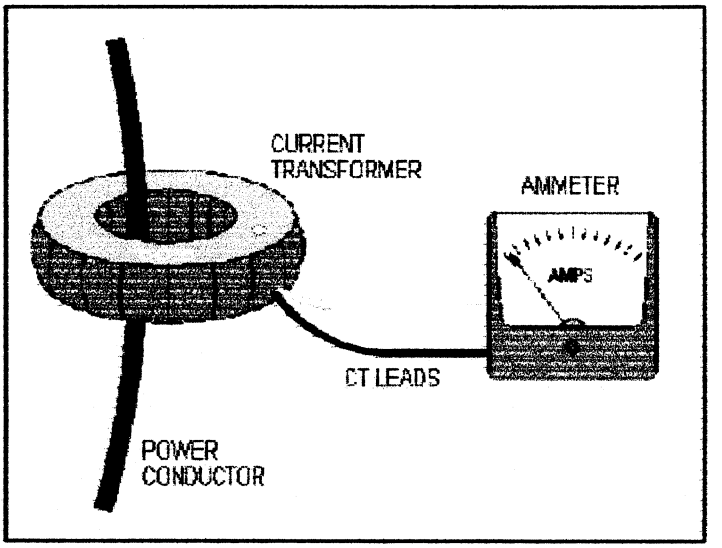


Figure 2.4: Current transformer

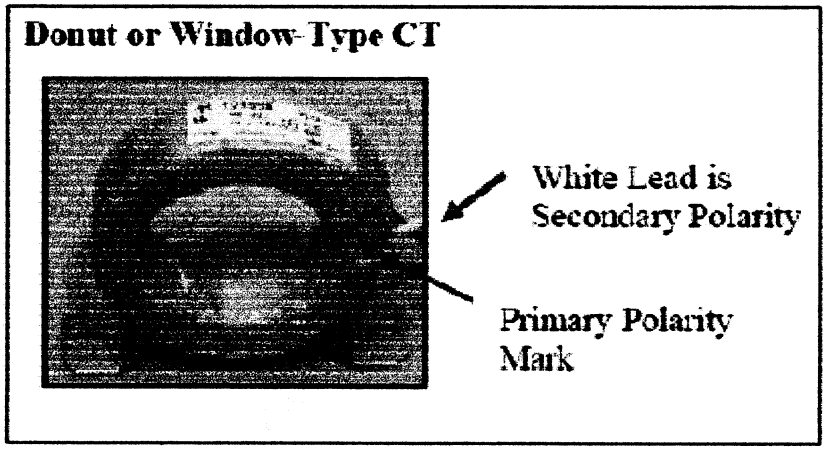


Figure 2.5: Donut or Window- Type CT

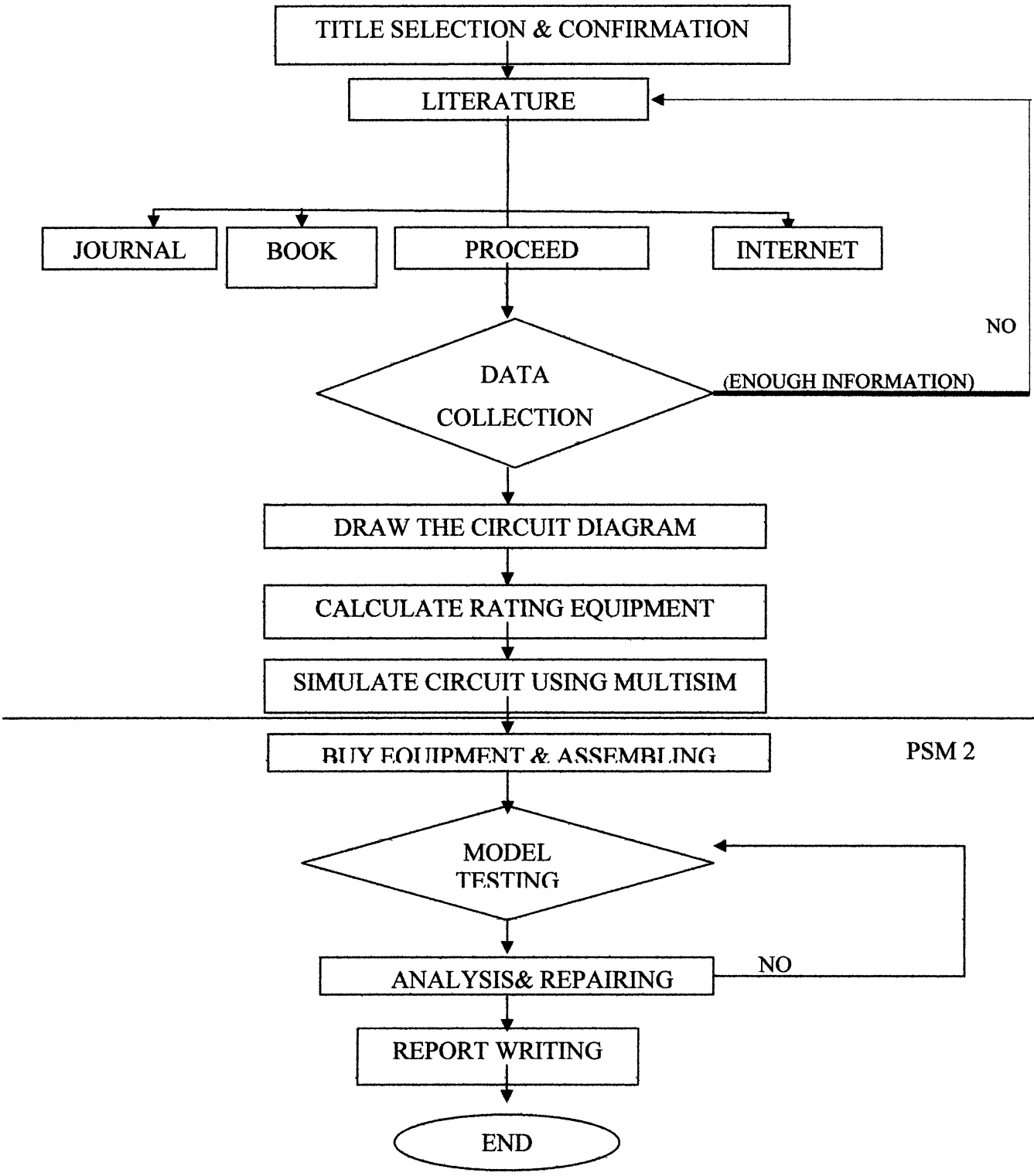
CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will cover the methodology of the project flow and the methods that have been used to make this project success. The methodology covered up the theoretical and experimental research of this project. The initial method is research any related literature review by using others journal.

3.2 Flow Chart Methodology



3.2.1 Title Selection and Confirmation

Before started the first week of the semester, author went to university to find out any available title that suitable. This tittles is choose and author see Mr Mohd Hendra Hairi to becoming supervisor. This title is choosing because based on previous practical session at TNB Transmission and done some research, author take this project which is Modeling Overcurrent Protection. At the first of the semester been a week of title selection PSM. Hence, author struggle done some research to make a proposal for this project that included objective, scope, and problem statement .

3.2.2 Literature Research

Literature research or commonly known as literature review is a big part of this project. This literature review has been research using different methods which are by journal, book, proceeding, magazine and internet. This is an important part of the project because form literature review we could know how previous research going on. Thus, it could be guidelines to go further in this project.

In literature review, find out more previous research about overcurrent protection. Overcurrent protection have a wide scope, then author decreasing the scope to discrimination of current and time. Author may concentrate the research in one topic.

In the literature review of this project covered up any research that related to the project title and objective. The objectives of this project are:

a) Develop an overcurrent protection model to make an interactive & attractive to learn this subject

b) Show the operation of overcurrent protection and the importance of overcurrent protection in transmission system

c) Show the discrimination of relay by current discrimination

From these objectives, the composite types have been considered as big role of this project. The software that will be used such as MULTISIM software also plays a role in order to make this project successful. The research that included in literature reviews are:

a) Devices
b) Overcurrent relays
c) Current transformer
d) Circuit Breaker

All the information that related to the project title gathered together in this literature review. After all the data collection could consider enough, proceed to the next stage of this project. However when there is not enough information or data collection, turn back to the research method to gather more data and information.

3.2.3 Draw the circuit diagram

Before this process started, identified the equipment which is used. The equipment are, supply 240V, current transformer, bulb, relay, circuit breaker and jumper. Then using MULTISIM software, assemble the circuit.

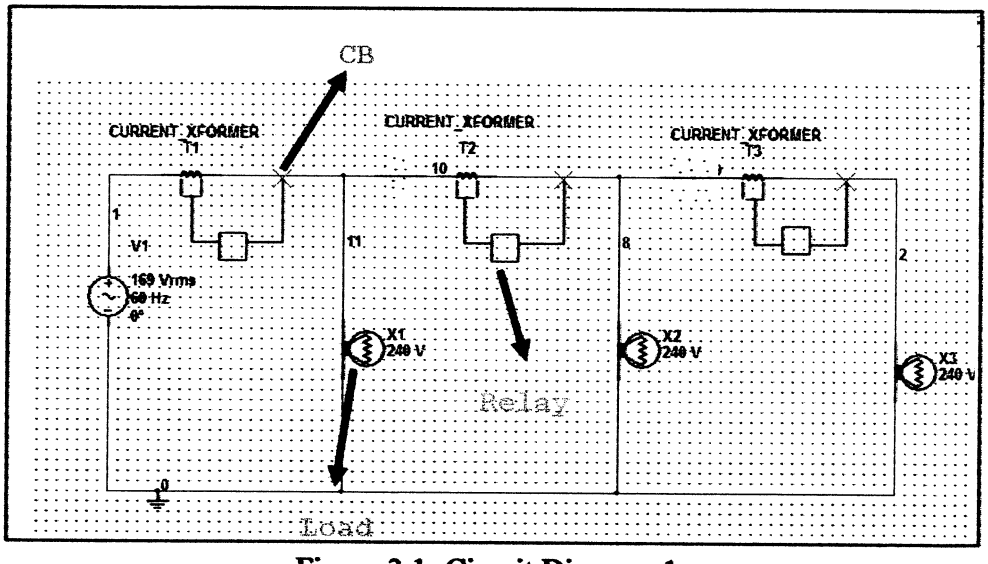


Figure 3.1: Circuit Diagram 1