

Sudan University of Sciences and

Technology

College of Engineering

Electrical Engineering



**Faults Detection in Transmission Line By Using
Distance Relays**

كشف الاعطال في خطوط النقل باستخدام المرحلات المسافية

**A Project Submitted in Partial Fulfillment for the Requirements of the
Degree of B.Sc. (Honor) In Electrical Engineering**

Prepared By :

- 1. Ahmed Ser Alkhatim Hassab Alrasool Abbas**
- 2. Omer Abd Alaziz Ibraheem Abd Alrafie**
- 3. Omer Elameen Bakheet Ali**
- 4. Mohammad Hassab Alrasool AwadAlla Ibraheem**

Supervised By:

Dr. Khamees Arbeesh Saad Aldeen

November2020

الآية

قال تعالى :

(وَقُلْ رَبِّ اَدْخِلْنِيْ مُدْخَلَ صِدْقٍ وَّاَخْرِجْنِيْ مُخْرَجَ صِدْقٍ
وَاَجْعَلْ لِّيْ مِنْ لَّدُنْكَ سُلْطٰنًا نَّصِيْرًا)

صدق الله العظيم

سورة الاسراء - الآية (80)

Dedication

To our great parents, who never stop giving us themselves in countless ways.

To our dearest friends, who leads us through the valley of darkness with light of hope and give us encourage and support.

To our beloved brothers and sisters who stands by us when things look bleak.

To all our family, the symbol of love and giving.

To all the people in our life who touch our heart, we dedicate this research.

Acknowledgments

First and foremost, we must acknowledge our limitless thanks to Allah, the Ever-Magnificent; the Ever-Thankful, for His help and bless.

We owe a deep debt of gratitude to our university for giving us an opportunity to complete this work.

We grateful to some people, who worked hard with us from the beginning till the completion of the present research particularly our **supervisor, Dr: khamees Arbeesh** who has been always generous during all phases of the research and we totally sure that this work would have never become truth, without His guidance.

And we highly appreciate the efforts expended by **Eng. Alrayaan** in protection system department in (Sudanese Electricity Transmission Grid) who never stingy us by his knowledge and always help us and we thank all Engineers in protection system department for help us to do our thesis.

We would like to take this opportunity to say warm thanks to all my beloved friends, who have been so supportive along the way of doing our thesis.

Abstract

Transmission lines, among other electrical power system components, suffer from unexpected failures due to various random causes. These failures interrupt the reliability of the operation of the power system. When unpredicted faults occur, protective systems are required to prevent the propagation of these faults and safeguard the system against the abnormal operation resulting from them. The function of these protective systems are to detect and classify faults as well as to determine the location of the faulty line when a fault is detected in the voltage and current line magnitudes. Once the fault is detected and classified the protective relay sends a trip signal to a circuit breakers in order to disconnect (isolate) the faulted line.

The features of numerical relay, such as their ability to learn, generalize and parallel processing, among other, have made their applications on many systems ideal. The use of numerical relay as pattern classifiers is among their most common and powerful applications.

The project presents a distance numerical relay to detection, classification and location of faults in transmission line system. The objective is to implement a complete scheme for distance protection of a transmission line system. In order to perform this goal, the distance protection task is subdivided into distance relay for fault detection, fault classification as well as fault location in different zones.

المستخلص

تعاني خطوط نقل القدرة الكهربائية كباقي مكونات نظام القدرة من الأعطال نتيجة لأسباب متنوعة و مختلفة تؤثر هذه الأعطال على كفاءة عمل منظومة القدرة الكهربائية . عند ظهور الأعطال الغير متوقعة فان نظم الحماية مطلوبة لمنع انتشار هذه الأعطال بالاضافة الى تحديد موقع الخط المعطل عند اكتشاف العطل من قيمة مطال موجة الجهد والتيار في الخط . بعد اكتشاف العطل وتصنيفه فان مرحل الحماية يرسل اشارة قطع لقاطع الدائرة .

ان خصائص المرحلات العددية من أشهر مرحلات اكتشاف الأعطال لما تقوم به من معالجة مثالية وفعالة مما يميزها عن بقية المرحلات لذا تستخدم كمرحلات مسافية في خطوط النقل .

هذا البحث يستعرض استخدام المرحلات المسافية العددية كنهج لاكتشاف الأعطال وتصنيفها وتحديد موقعها في خطوط نقل القدرة الكهربائية . الهدف من هذا البحث دراسة مخطط متكامل للوقاية المسافية لخطوط نقل القدرة الكهربائية . لتحقيق هذا الهدف تم استخدام المرحلات العددية واكتشاف الأعطال وتصنيفها وتحديد موقع العطل من عدة مواقع .

TABLE OF CONTENTS

Section	Title	Page NO
	الاستهلال	i
	Dedication	ii
	Acknowledgement	iii
	Abstract	iv
	المستخلص	v
	Table of Contents	vi-vii
	List of Figures	ix-vi
	List of Abbreviations	xi
CHAPTER ONE : INTRODUCTION		
1.1	Overview	1
1.2	Problem Statement	2
1.3	Objective	2
1.4	Methodology	3
1.5	Project Layout	
CHAPTER TWO: LITTERATURE REVIEW		
2.1	Electric Power System	4
2.2	Nature and Causes of Faults	5
2.3	Power System Protection	6
2.4	Protective Relay	12
CHAPTER THREE: DISTANCE PROTECTION		
3.1	Introduction	18
3.2	Principle of Distance Relays	20
3.3	Relay Performance	23
3.4	Zones of Protection	23
3.5	Distance Relay Characteristics	26
3.6	Auto-Reclosing	38
3.7	Auto-Reclosing on HV Transmission Lines	39

CHAPTER FOUR: RESULTS AND DISCUSSION		
4.1	Introduction	43
4.2	Impedance Detection	44
4.3	The Transmission Line Under Study	44
4.4	Fault Classification	54
4.5	Fault Location	55
CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS		
5.1	Conclusions	57
5.2	Recommendations	57
	References	58
	Appendix	59

LIST OF FIGURES

Figures	Title	Page NO
2.1	Generation, transmission and distribution of electrical power	5
2.2	Power system protection	7
2.3	Protection zones	8
2.4	Unit protection	9
2.5	Non- unit protection	9
2.6	Station battery	11
2.7	Attracted armature relay	14
2.8	Types of static relays	15
2.9	Types of digital relays	17
2.10	Type of numerical relays	17
3.1	Advantages of distance over current protection	19
3.2	Typical of impedance reach accuracy characteristics for zone 1	22
3.3	Typical operation time characteristics for zone one phase-phase faults	22
3.4	Typical operation- time contours	23
3.5	Typical time/distance characteristics for three zone distance protection	25
3.6	Plain impedance relay characteristic	28
3.7	Basic operation of impedance relay	29
3.8	Combined directional and impedance relays	29
3.9	Directional characteristics	31
3.10	Modified directional impedance relay characteristics	32
3.11	Operating characteristics of reactance relay	32
3.12	Mho relay characteristic	35
3.13	Quadrilateral characteristic	37
4.1	A single line diagram of transmission line	41
4.2	Three phase test system model in MATLAB/SIMULIN	42
4.3	Current waveforms at normal condition	48
4.4	Current waveforms at single line-to-ground fault	48
4.5	Current waveforms at line-to-line fault	49
4.6	Current waveforms at double line-to-ground fault	49
4.7	Current waveforms at three line fault	50

LIST OF ABBREVIATIONS

DC	Direct Current
AC	Alterative Current
LV	Low Voltage
LG	Line to Ground fault
LLG	Double Line to Ground fault
LL	Line to Line fault
CT	Current Transformer
VT	Voltage Transformer
HV	High Voltage
A / D	Analogue to Digital Convertors
DFT	Discrete Fourier Transform
DSB	Digital Single Processors
S.I.R	System impedance ratios
SOTF	Switch-On-To Fault
DAS	Data Acquisition System
PC	Personal Computer