# IMPROVED FAULT ANALYSIS TOOLS IN UNBALANCED DISTRIBUTION NETWORK

**Thesis presented in partial fulfillment for the award of the Bachelor of Engineering (Hons) Electrical Of UNIVERSITI TEKNOLOGI MARA**


**NURAMIRAH BTE SAFFEE**
**FACULTY OF ELECTRICAL ENGINEERING**
**UNIVERSITI TEKNOLOGI MARA**
**40450 SHAH ALAM, SELANGOR DARUL EHSAN**
**MALAYSIA**

# ACKNOWLEDGEMENTS

In the name of Allah, The Most Gracious, Most Merciful and Him alone worthy of all praises. Alhamdulillah, with the permission of Allah S.W.T, this project was successfully done. I would like to express my sincere gratitude to all those people who provided a constant source of help and motivation throughout my work.

Firstly, I'm very grateful to Allah S.W.T who has sustained me all the days I have been at UiTM. Secondly, I would like to thank to my final year project supervisor Mr. Mohd Fuad bin Abdul Latip for his patience, inspiration, contribution of precious idea, support and constant guidance throughout this thesis. Your supervisory support was greatly valued. Thirdly, I would like to give thanks to all the academic staff in the Department of Electrical Engineering, who has lectured me for the period of my undergraduate studies at UiTM. I am greatly thankful to you all for making it possible for me in my studies.

I would also like to thank to my family and friends who provided a great assistance in terms of materials, effort and ideas, directly or indirectly, I would like to dedicate my special thanks for their blessings and encouragement. To my parents, thank you for having faith in me that I will be able to make it. Thank you for your affectionate love and support. Lastly, may all of efforts will be blessed with great rewards from the Almighty Allah.

# ABSTRACT

This thesis addresses a new approach for a short-circuit analysis algorithm for radial three-phase distribution networks, based on two relationship matrices method, the bus-current-injection-to branch-current matrix (BIBC) and branch-current-to bus-voltage matrix (BCBV). Both matrices developed from the topological structures of distribution systems are used to analyze the variations of bus voltages, bus-current injections and branch currents under fault conditions. A short-circuit-analysis method can then be developed from these two matrices and be used to solve the various types of single or simultaneous unsymmetrical faults by using only one model. This model consists of four impedances that their values can be varying from zero to extreme so that each kind of unsymmetrical faults can be simply modeled. Since the proposed method does not use the traditional admittance matrix, the time-consuming procedures such as tri-factorization or inverse of admittance matrix are not necessary. Simulation of IEEE 34-bus and IEEE 4-bus network together with the results obtained such as phase fault currents and voltage profiles are presented and discussed.

# Table of Contents

# CHAPTER 1

# INTRODUCTION

## 1.1 BACKGROUND TO THE THESIS

Protection and reliability improvement are the most important problems in distribution system. Operation setting of protective devices requires accurate parameters appropriate to characteristic and configuration of distribution network. An essential part of the design of a power supply network is calculation of the currents when faults of various types occur. The magnitude of the fault current gives the engineer the current settings for the protection to be used and the ratings of the over-current protective devices, such as circuit breakers and fuses. These devices should isolate faults at a given location safely with minimal circuit and equipment damage and minimal disruption of the plant's operation. Other parts of the system, such as cables, bus-ways, and disconnecting switches, shall be able to withstand the mechanical and thermal stresses resulting from maximum flow of short-circuits current through them. Also as the distribution system becomes more heavily loaded and the need an ability to reconfigure the system for service restoration, load balancing and loss reduction grows; the network configuration will be changed more frequently. With each change protection device settings in the system may need updating. Therefore, there is a need for fast and more accurate short circuit calculations [1]. Nowadays, Distribution Automation (DA) is become one of the important tools to improve reliability and efficiency in the operation of distribution systems. Many applications, such as network optimization, reactive-power planning, feeder reconfiguration, state estimation, short-circuit-analysis etc. are necessary to construct DA effectively. Among those applications, a robust and efficient short-circuit-analysis program is very important for off-line planning and real-time operation of the protective needs of DA [2]. The real-time short circuit analysis is oriented toward applications in operations area rather than in planning analysis. Therefore, the program must be capable of handling special features of distribution system, such as radial and weakly meshed configurations with several thousand nodes, unbalanced loads, and multi-