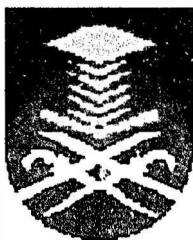


**IDENTIFYING THE OPTIMAL LOCATION AND SIZING OF  
EMBEDDED GENERATION IN A DISTRIBUTION SYSTEM**

This thesis is presented in partial fulfilment for the award of the *Bachelor in Electrical  
Engineering (Hons)*  
*Of*  
**UNIVERSITI TEKNOLOGI MARA (UiTM)**



**SITI AISHAH BT. BAKAR**  
**Faculty of Electrical Engineering**  
**Universiti Teknologi MARA**  
**40450, Shah Alam, Selangor**  
**Malaysia**

**MAY 2003**

## **ACKNOWLEDGEMENT**

In the name of ALLAH, the Beneficent and the Merciful. It is with the deepest sense gratitude of the Al-Mighty that gives strength and ability to complete this project.

I would like to take this opportunity to express this special thanks to my project supervisor Dr. Titik Khawa Abd. Rahman for being helpful. Without her guide and cooperation I will not be able to complete this project successfully.

Finally, also special thanks to my lovely parent for their encouragement and understanding and to all my friends and many others who somehow or other had helped me directly or indirectly in successful completion of my project.

## **ABSTRACT**

This project report presents a technique to determine the location and sizing of Embedded Generation (EG) in order to minimize system losses in the distribution system. A new indicator was developed and found to be able to find the best location of EG. The performance of this technique is tested on a 69-bus IEEE Reliability Test System. A load flow program written in Matlab programming was used to evaluate the power flow voltage and losses in radial distribution network. The results show the best of location of EG has able to minimize the system losses.

**Keywords: Embedded generation, Voltage stability index, Power losses.**

# TABLE OF CONTENTS

CHAPTER	DESCRIPTION	PAGE
1	INTRODUCTION	
	1.1 Introduction	1
	1.2 Aim of the Project	2
	1.3 Scope of the Project report	2
	1.4 Literature Review	
	1.4.1 Introduction to Load Flow	3
	1.4.2 Voltage Stability	5
	1.4.3 Distribution System and Embedded Generation	5
2	LOAD FLOW ANALYSIS	
	2.1 Introduction	7
	2.2 Type of Bus	8
	2.3 The Sign of Real and Reactive Powers	9
	2.4 Power Flow Equation	10
	2.5 Newton Raphson Power Flow Solution	12
	2.6 Power Flow Program	17
	2.7 Data Preparation	18
3	VOLTAGE STABILITY	
	3.1 Introduction	20
	3.2 Derivation of Voltage Stability Index	21
	3.3 Power System Voltage Stability Monitoring	24

# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

For many years, power systems were vertically and centralized operated. The large thermal and nuclear generation plants have produced most of the power since it has the scale and economic merits. These kinds of generation are often related to adequate geographical placement (water sources, technical constraints, etc). The electric power is transmitted and distributed toward consumers over long distance and using different voltage levels. The centralized and hierarchical control is applied which allows the system to be monitored and controlled in a real time.

The existing power system structures are changing, due to electric utilities as well as public organization. There are several reasons for these changes, some of which are as follows:

- Geographical and environmental constraints of large generating plants
- Stability and security problems
- Continuous growth of power demand, especially in the emerging countries. Need of investments to sustain the development in the power demand
- Privatization, deregulation and competitive markets
- Emergence of generation techniques with small ratings, environmental benefits, increased profitability and which can be combined with heat generation i.e. fuel cells and co-generation.