# SHUNT CAPACITOR INJECTION TO IMPROVE VOLTAGE STABILITY IN POWER SYSTEM

This thesis is presented in partial fulfillment for the award of the Bachelor of Electrical Engineering (Hors.)

UNIVERSITI TEKNOLOGI MARA

MALAYSIA



Universiti Teknologi Mara NUR IZZATI ZAHRAWANI BINTI EMBONG Faculty of Electrical Engineering UNIVERSITI TEKNOLOGI MARA 40450 Shah Alam Selangor Darul Ehsan

#### ACKNOWLEDGEMENT

In the name of ALLAH s.w.t, the Beneficent and Merciful. It is with the deepest sense of gratitude to the Al-Mighty Allah who gives strength and ability to complete this project and thesis as it today.

The success of this project was due in part to various personnel involved at each of every stage. It is to this effect that I would like to convey my most sincere gratitude to my supervisor PM Wan Norainin Wan Abdullah, who has given me many valuable suggestions, constructive criticism, guardian and encouragement throughout the time until the project is completed.

I am also greatly indebted to all the lecturers who had given me knowledge, advises and valuable information throughout my study period in UiTM. To all of them I would like to express my appreciation and sincere gratitude.

My special thanks to all laboratory and workshop technicians who gave me valuable information during the course of my study and during lab experiment.

I also would like to express my appreciation to those who have devoted their time either directly or indirectly, especially friends who have been together through happy and difficult moment during our stay in UiTM.

May Allah bless all our efforts and rewards us accordingly.

Nur Izzati Zahrawani Binti Embong Bachelor in Electrical Engineering (Hons.) Faculty of Electrical Engineering Universiti Teknologi MARA (UiTM) Shah Alam, Selangor

i

#### ABSTRACT

Voltage stability is an important factor to be considered in power system operation and planning since voltage instability would lead to system collapse. Furthermore a stable system contributes to reliability and reduction in system loss. Therefore voltage stability analysis is important in order to identify critical buses to enable certain measures to be taken to avoid any incidence of voltage collapse.

This project focused on shunt capacitor injection that is used to prevent voltage collapse or instable. To validate the feasibility of the shunt capacitor injection method, 14-bus and 30-bus IEEE test system will be consider as a case study. All simulation was done by MATLAB 7.0.

## **TABLE OF CONTENTS**

### PAGE

ACKNOWLEDGEMENT		i
ABSTRACT		ii
TABLE OF CONTENTS		iii, iv & v
LIST OF FIGURES		vi
LIST OF TABLES		vii
LIST OF GRAPH		viii
SYMBOL AND ABBREVIATIONS		ix
CHAPTER 1	INTRODUCTION	
1.1	Background	1
1.2	Objective	2
1.3	Scope of Work	2
1.4	Thesis Organization	3 & 4
	1.	
CHAPTER 2	POWER FLOW ANALYSIS	
2.1	Introduction	5
2.2	Bus Classification	6
2.3	Power Flow Analysis	7-9
2.4	Data Preparation	9
2.5	Busdata and File-busdata	9
2.6	Linedata and File-linedata	10
2.7	Newton Raphson Power Flow Solution	11-15
CHAPTER 3	BASIC STABILITY THEORY	
3.1	Introduction	16
3.2	Power System Stability	16-17

3.3	Voltage Stability	18-20	
3.4	PV Curve and QV Curve	21	
	3.3.1 PV Curve	21-22	
	3.3.2 QV Curve	22-23	
CHAPTER 4	SHUNT CAPACITOR		
4.1	Method to Supply VAR	24-25	
4.2	Location of Shunt Capacitor		
	4.2.1 Group Capacitor Bank	26	
	4.2.2 Branch Capacitor Bank	27	
	4.2.3 Local Capacitor Bank	27-28	
4.3	System Benefits	28-29	
CHAPTER 5	METHODOLOGY		
5.1	Introduction	30	
5.2	Study framework	30	
5.3	The Earlier Stage of Study	30	
5.4	Data Collection	30	
5.5	Data Analysis	31	
5.6	Flow chart of the Matlab Program.	31-32	
CHAPTER 6	RESULTS AND DISCUSSION		
6.1	Introduction	33	
6.2	Simulation Result		
	6.2.1 Simulation for IEEE 14-Bus System	34-36	
	6.2.2 Simulation for IEEE 30-Bus System	36-39	
CHAPTER 7	CONCLUSION AND FUTURE DEVELOPMI	ENT	
7.1	Conclusion	40	
7.2	Future Development	40	