VOLTAGE STABILITY IMPROVEMENT USING UNIFIED POWER FLOW CONTROLLER (UPFC)

This thesis is presented in partial fulfillment of the award of
the Bachelor of Electrical Engineering (Honors)
UNIVERSITI TEKNOLOGI MARA
MALAYSIA

Mohamat Faisol bin Abdul Hamid
Faculty of Electrical Engineering
Universiti Teknologi MARA
40450 Shah Alam, Selangor
MALAYSIA

ACKNOWLEDGEMENT

In the name of ALLAH S.W.T., The most Beneficent, The most Merciful. It is with the deepest sense of the Al-Mighty Allah that gives me the strength and ability to complete this project. All good aspirations, devotions and prayers are due to ALLAH whose blessing and guidance have helped me throughout the entire project.

I would like to acknowledge and express my sincere gratitude towards my supervisor, Associate Professor Dr. Ismail bin Musirin for his concern, valuable time of consultation and advice, guidance and patience in supervising my project from the beginning until the completion of this project thesis.

My appreciation goes to Encik Ehsan for his dedication in advising and willingly gives his ideas and suggestions for completing my project especially on how to use MATLAB for the Evolutionary Programming codes development.

Last but not least, my special thanks to all my friends for their valuable help and motivation given in completing this project. To all of my beloved family, especially my father and my mother who are the dearest persons in my life and greatest source of my inspiration, thank you for the endless love and encouragement that they have given and for being so understanding.

ABSTRACT

This thesis presents the effectiveness of Unified Power Flow Controller (UPFC) in controlling the voltage stability of power system. UPFC is utilized in this study due to its versatile capabilities of line power flow regulation and oscillations damping; can provide simultaneous, real-time control of all basic power system parameters (transmission voltage, impedance and phase angle) and dynamic compensation of power system. In order to indicate the stability of each line in the system, a voltage stability index, namely *Line Stability Index* L_{mn} is used. Several UPFCs are installed at selected lines in order to improve the voltage stability in the power system. The location of UPFC installation is chosen at the line with the highest L_{mn} value. The optimal sizings of UPFCs are identified using Evolutionary Programming (EP). The proposed optimization technique was validated on the IEEE 30 bus Reliability Test System and indicating that the technique is feasible to be implemented in larger system.

Keywords :

Unified Power Flow Controller (UPFC), Voltage stability, Line Stability Index L_{mn}*, Evolutionary programming.*

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.1 Background

In power system planning and operation, the major concern is the problems related to voltage stability experienced in power systems network. Voltage stability is concerned with the ability of a power system to maintain acceptable voltages at all nodes in the system under normal condition and after being subject to a disturbance [1]. The increased demand of electric power will affect the stability of voltage in power system to become unstable. As power systems become more complex and heavily loaded, along with economical and environmental constraints, voltage instability becomes an increasingly serious problem, leading the systems to operate close to their limits.

Voltage collapse that happens due to voltage instability problem in power system is an emerging phenomenon in generation, transmission and distribution/load of electric power systems [2]. Since the demand for electric power in many countries has increased, it requires increasing the transmission capabilities [3, 4]. Many factors, such as financial and environmental concerns, constrain the construction of new transmission lines. Electric utilities are forced to operate the system in ways which make maximum use of existing transmission facilities [4]. As a consequence, some transmission lines are more loaded than what was planned. With the increased loading of long transmission lines, the problem of transient stability after a major fault can become a transmission power limiting factor [5].

The study of voltage stability has been analyzed under different approaches that can be classified into dynamic and static analysis [6]. The static voltage stability methods depend mainly on the steady state model in the analysis, such as power flow model or a linearized dynamic model described by the steady state operation. The dynamic analysis implies that the use of a model characterized by nonlinear differential and algebraic