الآية

وَقُلِ اعْمَلُوا فَسَيَرَى اللَّهُ عَمَلَكُمْ وَرَسُولُهُ وَالْمُؤْمِنُونَ ۖ وَسَتُرَدُّونَ إِلَىٰ عَالِمِ الْغَيْبِ وَالشَّهَادَةِ فَيُنَبِّئُكُم بِمَا كُنتُمْ تَعْمَلُونَ ﴿﴾

التوبة (١٠٥)

# DEDICATION

*To*

*My Dearest Parents who are the part of my soul and whose*

*love, affection and confidence enabled me to achieve this goal.*

*TO*

*my brothers Abdalla and Mohammed and to my sister Eman*

*for their help and patience, for every period I was away.*

*TO*

*the soul of my grandfather (Ahmed), may Allah forgive him*

*and grant him his highest paradise (Ameen).*

# ACKNOWLEDGEMENT

# Abstract

One of serious problems in power systems that can threaten the concept of power systems reliability and security is voltage instability. Improving the system's reactive power handling capacity via Flexible AC Transmission System (FACTS) devices is a remedy for prevention of voltage instability and hence voltage collapse.

This thesis presents the enhancement of voltage stability and reduced active and reactive power losses on standard IEEE-14 bus system by selecting the optimal size and location of SVC using voltage stability index method (L-index). The bus with the highest L-index value will be the most vulnerable bus in the system, and hence this method helps in identifying the weak areas in the system which its reactive power needs support .

The analysis is carried out using  NEPLAN and PSAT software. And the results is discussed.

# المستخلص

واحدة من اخطر المشاكل في أنظمة القدرة الكهربائية والتي يمكن أن تهدد أمن وموثوقية نظم القدرة الكهربائية هى عدم استقرارية أنظمة الجهد الكهربائية . لحل عدم استقرارية الجهد يتم تحسين إمداد القدرة الرد فعلية عن طريق أجهزة نظام نقل التيار المتردد المرنة.

في هذا البحث يتم التعرض لتحسين استقرارية نظام الجهد وتقليل مفاقيد القدرة الفعلية والرد فعلية لشبكة IEEE-14 bus المعيارية وذلك بتحديد الحجم والمكان المثاليين لتوصيل معوضات القدرة الرد فعلية باستخدام طريقة مؤشر اسقرارية الجهد (المؤشر L). قضيب التوزيع الذي يحوي أعلى قيمة للمؤشر ل يعتبر هو الأكثر ضعفا في النظام.وبالتالي تساعد هذه الطريقة لمعرفة الأماكن الضعيفة في النظام والتي تحتاج لإمداد بالقدرة الرد فعلية.

هذا التحليل أجري عن طريق برنامجي NEPLAN وPSAT. ثم نوقشت النتائج.

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# LIST OF SYMBOLS

| | |
|---|---|
| α | Thyristor firing angle |
| B | Susceptance [S] |
| | Power factor |
| C | Capacitance [F] |
| I | Current [A] |
| L | Inductance [H] |
| $\omega_o$ | Nominal angular frequency [rad/s] |
| $B_L$ | reactor susceptance |
| $X_C$ | reactances of the capacitor |
| $X_L$ | reactances of reactor |
| $I^G$ | currents at generator |
| $I^L$ | currents at the load node |
| $V^G$ | voltages at generator node |
| $V^L$ | voltage at load nodes |
| φ | Phase angle between voltage and current [rad] |
| P | Active power [W] |
| Q | Reactive power [VAr] |
| S | Apparent power [VA] |
| $\theta$ | Bus voltage angle [rad] |
| X | Reactance [ Ω ] |
| R | resistance |
| $B_{SVC}$ | Susceptance |
| $Q_{SVC}$ | reactive power drawn by SVC. |
| $V_K$ | voltage at bus k |
| $I_{SVC}$ | The current drawn by the SVC |
| $\omega_r$ | TSC resonant frequency |
| λ | loading point |

# LIST OF ABBREVIATIONS

| | |
|---|---|
| FACTS | Flexible Alternating Current Transmission System |
| IEEE | Institute Of Electrical And Electronics Engineers |
| HVDC | High Voltage Direct Current |
| ATC | Available Transfer Capability |
| SSR | Subsynchronous Resonance |
| SVC | Static Var Compensator |
| TCSC | Thyristor Controlled Series Capacitor |
| SSSC | Static Synchronous Series Compensator |
| STATCOM | Static Compensator |
| UPFC | Unified Power Flow Controller |
| LTC | Load Tap Changer |
| TCR | Thyristor Controlled Reactor |
| PSAT | Power System Analysis Toolbox |
| IPFC | Interline Power Flow Controller |
| VSC | Voltage Source Converter |
| PS | Thyristor-Controlled Phase Shifter |
| IPC | Interphase Power Controller |
| GTOs | Gate Turn-Off Thyristors |
| IGBTs | Insulated Gate Bipolar Transistors |
| FC-TCR | Fixed Capacitors & Thyristor Controlled Reactor |
| TSC-TCR | Thyristor Switched Capacitors & Thyristor Controlled Reactor |
| GA | Genetic Algorithm |
| PSO | Particle Swarm Optimization |
| AVR | Automatic voltage regulator |
| EHV | Extra High Voltage |