

VOLTAGE STABILITY ANALYSIS AND ENHANCEMENT

BY

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Thesis submitted

in fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY



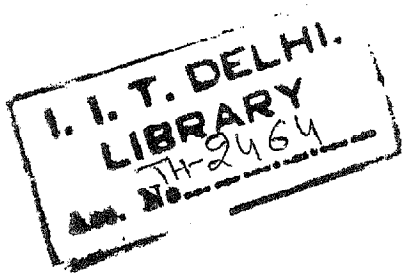
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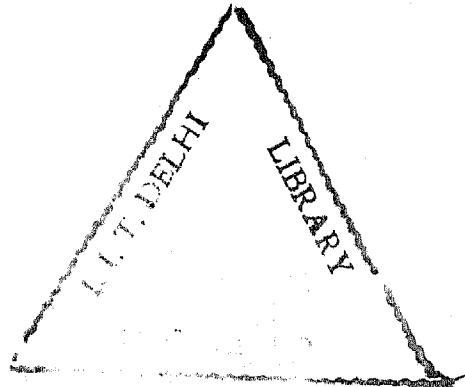
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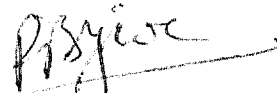


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CERTIFICATE

This is to certify that the thesis entitled "**VOLTAGE STABILITY ANALYSIS AND ENHANCEMENT**" which is being submitted by shri Rajendra Tare to the Indian Institute of Technology Delhi, for the award of **Doctor of Philosophy**, is a bona fide research work carried out by him. He has worked under my supervision and guidance and has fulfilled the requirements for the submission of this thesis. The thesis, in my opinion, has attained a standard required for a Ph.D. degree of this institute. The results contained in this thesis have not been submitted elsewhere in part or full for the award of any degree or diploma.



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ABSTRACT

Economic, environmental and other factors have forced the power system engineers to use the existing power transmission facilities to the highest possible extent. Associated voltage problems of voltage profile are being handled by extensive use of shunt compensation. This has resulted in voltage collapse prone power systems. Power industry and researchers are concerned about this unwanted phenomena and extensive research efforts are being directed for voltage stability analysis and its enhancement. Numerous voltage instability proximity indices have been developed to estimate the proximity of the present operating state to voltage instability. Some methods have also been developed to compute the margin to collapse. A few papers have also appeared in the area of control rescheduling to enhance the distance to collapse. Locally operated load shedding schemes have also been reported to protect the system from voltage collapse.

The present work aims at the problem of voltage stability from following aspect.

- (1) Development of new index to indicate the closeness of present operating state to voltage collapse. The basic requirements of the index as efficient computation, use of readily available information and reliability are of principle concern. A new index is proposed which depends upon the angle between P gradient vector and Q gradient vector. This index can be evaluated very efficiently and needs only the last iteration factored Jacobian. The reliability of this index has been found to be good.

- (2) A simple algorithm similar to one used in classical economic despatch is applied for rescheduling the reactive controls to improve the previously developed index. This has resulted in improvement in distance to collapse.
- (3) An efficient decoupled continuation power flow method is developed which retains the advantages of coupled Jacobian version, but needs factorization of lower size matrices and reduced storage.
- (4) A look ahead approach for reactive power rescheduling has been implemented to reschedule the control settings to improve voltage stability of power system at next load step while both the present as well as next load operating constraints are satisfied. This algorithm has been found to give better improvement in margin to collapse as compared to conventional reactive optimization.
- (5) When all the available controls are exhausted or can not be implemented soon enough and the load growth threatens voltage stability, the operator is forced to resort to load shedding. A new approach is proposed for centralized load shedding scheme. The method ensures operation of power system till emergency is over by minimum shedding of loads.

Results for 6-Bus, modified IEEE-30 Bus, and 91-Bus Indian power systems have been obtained to prove the utility of the proposed algorithms.

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