POWER SYSTEM ANALYSIS AND OPTIMIZATION WITH CERTAIN AND UNCERTAIN INPUT DATA

BY

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CERTIFICATE

This is to certify that the thesis entitled "**POWER SYSTEM ANALYSIS AND OPTIMIZATION WITH CERTAIN AND UNCERTAIN INPUT DATA**" which is being submitted by Shri Vijay Narhar Pande 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 our supervision and guidance and has fulfilled the requirements for the submission of this thesis. The thesis, in our 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

Due to the exponential load growth, the electrical power systems are continuously expanding in size all over the world. The analyses of such large power systems have become increasingly more complex. The economic, financial and geographical constraints have forced electric utilities to operate the system close to the stability limit. Thus power system security is the major concern of the utilities and researchers. Conventional power system studies used for the solution of operational, planning and control problems employ standard mathematical techniques. These methods are based on certain assumptions like crisp nature of loads and other parameters. However, in practice, uncertainty exists in the power system data and must be addressed in any analysis. The restructuring of the power system has aggravated the problems more. To account for these non-statistical uncertainties, fuzzy set theory approach is being widely used. The growing number of publications indicates its potential.

The power system analysis in the fuzzy framework provides us with the fuzzy output which is intuitively more satisfying. It helps the operator in decision making and to navigate the system better. In this thesis, an attempt is made to model the problems concerned with the power system analysis and optimization with both certain and uncertain input data.

The highlights of the research work carried out in this thesis are as follows.

An efficient algorithm has been developed for ranking the line outage contingencies based on the loadability limit of the system. A non-iterative procedure is proposed using an optimal multiplier based Newton Raphson power flow to carry out the line outage simulations for all contingencies.

A method for boundary value based fuzzy power flow solution that takes into account the non-statistical uncertainties has been devised. Simultaneous uncertainties in the loads, load model and the system parameters have been modeled for the first time. The procedure for handling reactive limit violations in the fuzzy framework is also suggested.

A novel concept of fuzzy state estimation which takes care of simultaneous uncertainties in the measurements and the system parameters has been developed. The method complements the conventional (crisp) state estimation by providing a range of the state and the output variables of concern.

A fuzzy optimal power flow approach has been developed for real power loss minimization in the uncertain environment. It incorporates multiple uncertainties in the loads as well as in the load model. A novel modification of "Removal" operation provides considerable flexibility in the fuzzy optimization depending on the user specific requirements.

An algorithm has been devised for contingency ranking in the presence of uncertain loads and load model data. The method involves computation of fuzzy values of Reactive Support Index (RSI) in order to rank the line outage contingencies.

A new methodology has been developed for voltage stability analysis and optimization to take care of the load and load model uncertainties. The new algorithm computes the fuzzy values of the voltage stability index (L-index). This is then optimized subject to satisfaction of the operating constraints for improving the voltage stability margin.

Results of two test systems validate the potential of the proposed methods of the thesis.

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