ABSTRACT

The large service interruptions of power supply in the transmission system have significant impact on modern society. The aim of the power system engineers is to prevent and mitigate such events with optimal decisions in design, planning, operation and maintenance. Due to the rapid growth in the power demand and competitive power market scenario the transmission and distribution systems are frequently being operated under heavily loaded conditions. This tends to make failure of components more frequent in the power system necessitating large down time to repair or replace the equipments. The majority of the service interruptions are happening due to lack of proper planning and operation of power system. Therefore complete reliability evaluation in generation, transmission and distribution systems is needed at the planning stage.

This thesis is confined to composite system reliability assessment. The composite power system combines both the generation and transmission systems adequacy. The composite power system reliability assessment is quite difficult due to the large number of equipment, interconnected network topology and uncertainties in generation capacity. The research carried out in this thesis concentrates mainly on the use of probabilistic states of components in generation and transmission systems to evaluate the overall reliability. This analysis will result in a cost effective system configuration to provide continuous power supply to the consumers at reasonable cost. The reliability level of the system is measured by the defined indices. One of these indices is the probability of average power availability at load bus. This thesis mainly focuses on development of methods to evaluate the probability of average power availability at load buses for a specified system configuration.
First, Node Elimination method for reliability evaluation is proposed. So far the classical Node Elimination method has been used for power system studies and for the first time this method is used for reliability analysis. Node Elimination method simplifies the reliability model of the power system and overcomes all the limitations and difficulties of traditional methods based on the power flow paths. Node elimination method is validated by the traditional methods like Series-Parallel, Monte Carlo Simulation methods. The methodology is tested with different reliability test systems like IEEE RTS-96 system.

Second, the assumptions made in the application of traditional minimal cut set method to assess the power availability have certain limitations. Modified minimal cut set approach developed here using conditional probability concept overcomes these limitations. The results obtained using the modified minimal cut set approach are tested using the reliability test systems and validated by the Node Elimination method and Monte Carlo Simulation method.

Third, the power transformer derating affect causing loss of load probability in composite power system is analysed. A simple method to obtain derating factor for power transformer is developed based on the estimated tank temperature. Further the power capacity availability at load buses in a Micro grid is studied by considering power transformer derating effect. A probabilistic methodology is developed for the day ahead prediction of power availability at load buses.

Fourth, the integration of wind power generation, its uncertainties and limitations are studied. The variable nature of wind causes loss of load frequently. This thesis developed day ahead wind velocity prediction models. Further a probabilistic methodology is developed for the calculation of loss of load expected (LOLE).
Finally, a solution is developed to reduce loss of load in wind integrated power systems using energy storage device. This will help to participate in day ahead power markets with higher level of confidence.

The research work carried out in thesis considers the uncertainties in both generation and transmission systems. Proposed probabilistic methods will help to analyse the integrated power system network to provide improved power supply to the consumers.