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Title of thesis ----- **FACTS Based Congestion Management in
Transmission Grids under Deregulated
Environment**

ABSTRACT

Deregulation of electricity sector has thrown up lot of issues. Congestion management is one such big issue which prevents further transmission of power through a given corridor without violating technical and operational constraints. To overcome congestion in transmission lines, FACTS (*Flexible AC Transmission System*) devices are used. In this research work seven types of FACTS devices have been mathematically modeled and incorporated into Newton-Raphson load flow algorithm. The congestion is mitigated by optimal placement of these FACTS devices in power network using meta heuristic optimization algorithms (Gravitational Search Algorithm, Improved Gravitational Search Algorithm and Genetic Algorithm) under normal and contingency conditions. The result indicates good congestion in all the cases.

Findings

- The robustness of single FACTS devices for congestion mitigation was investigated by changing loading conditions from no load to 130% of base load. The studies revealed that different types of FACTS devices could relieve congestion during increased loading condition.
- When SVC was placed on a load bus in positive reactive power compensation mode, the bus voltages were improved. The firing angle was found to vary non linearly with SVC susceptance. A higher value of firing angle gives higher value of susceptance change.

- SVC and STATCOM both are good options for control pre specified voltage at the bus. However, STATCOM is a better choice due to its ability to deliver more reactive power than SVC for identical voltage control requirements.
- Both TCSC and TCPAS enhance real power flow in a branch. But TCSC is a better option than TCPAS due to lower real power losses.
- Implementation of multiple FACTS devices of similar type suggests that it is an attractive option against single high capacity individual FACTS device. So, instead of single FACTS device of large capacity, more devices of smaller capacity could be placed at different locations for better congestion relief.
- Optimal placement of FACTS devices can significantly improve system performance by relieving congestion. The efficacy of new optimization algorithm viz. *Gravitational Search Algorithm* (GSA) was tested for optimal placement of TCSC and STATCOM. The result indicated significant improvement in performance due to mitigation of congestion.
- An improved version of GSA was introduced to overcome the shortcomings of GSA. The enhanced version called *Improved Gravitational Search Algorithm* (IGSA) was found to be useful especially when search space was very large and to prevent possibility of pre mature convergence to local optima. The algorithm was used to optimally place SSSC, IPFC and UPFC in a power network successfully.
- Multiple FACTS devices of dissimilar type were used to relieve congestion by limiting the line loadability below thermal limit even under single and double line outage conditions. This heterogeneous combination of FACTS devices was found to be most suitable for congestion management under contingency condition.