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Title of Ph.D. thesis: - Power System Loadability Enhancement by Using FACTS Controllers

The present research work is organized into seven chapters. Summary of each chapter is given below-

Chapter -1 introduces the deregulated power system, their evolution and status of deregulated systems around the world and India. It provides the main issues in deregulation process and various techniques to enhance system loadability. Some of the FACTS devices are selected to improve system loadability. Various applications and their advantages of FACTS are discussed in this chapter.

Chapter -2 gives the literature review on deregulation, modeling, application and control of FACTS devices for loadability enhancement; loadability enhancement by optimally locating single and multiple FACTS devices.

Chapter -3 presents the single FACTS devices such as SVC, TCSC, STATCOM and UPFC to improve the system loadability. Newton- Raphson load flow algorithm has been used and simplified models of FACTS controller are implemented in it. The performances of these devices are studied on WSCC-9 bus and IEEE-14 bus systems. Also, the impact of variable loading and parameters of FACTS devices are analyzed for loadability enhancement.

Chapter -4 focuses on incorporating multiple FACTS devices of similar type in the system. STATCOM, TCSC and UPFC are used for loadability enhancement. These devices are used in

one, two or three numbers and are placed randomly in the system. IEEE-14 bus test system is used for this purpose.

Chapter -5 discusses the gravitational search algorithm to optimally place TCSC and STATCOM in the network. Based on the cost of FACTS devices and bus voltage profile, the optimal location of single FACTS device is determined. These devices are incorporated in IEEE-14 and 57 bus systems.

Chapter -6 presents Improved Gravitational Search Algorithm for the optimal placement of SSSC, IPFC and UPFC to enhancement system loadability. Based on cost of FACTS devices, bus voltage profile and line losses optimization is carried out. These devices are incorporated in IEEE-14 and 57 bus systems.

Chapter -7 discusses the conclusions and contributions of research work. Also future scope and suggestions are given for future research.

Findings of the study: -

In this thesis, FACTS devices are implemented under steady state conditions in the power system to improve the system loadability. Simplified mathematical model of FACTS devices are developed and studied. In the MATLAB platform these models are incorporated using Newton-Raphson algorithm. Various FACTS devices are applied in a standard power system. These devices are then optimally placed and their effect on loadability enhancement has also been investigated. To determine the optimal location of these FACTS devices in the network, Gravitational Search Algorithm (GSA) is used. This algorithm converges faster and has higher accuracy. This technique is further modified to get Improved Gravitational Search Algorithm (IGSA). Multiple FACTS devices are also applied in the system to analyze their effect on loadability enhancement. Different class of FACTS devices such as first generation devices (i.e. SVC and TCSC) and second generation devices (i.e. UPFC, IPFC and STATCOM) are used. These devices are incorporated in three different standard power systems such as WSCC-9 bus

system (Western System Coordinating Council), IEEE-14 bus and IEEE-57 bus systems. The results conclude that STATCOM is much better than SVC in terms of voltage control and reactive power support but it is expensive. TCSC is a superior device for real power flow enhancement and improving system loadability. UPFC is a versatile device and is best suited for loadability enhancement because of simultaneous control of voltage, real and reactive power, but it is costly of all. Since the FACTS devices are very expensive hence they are optimally placed in the system to obtain overall benefit. To determine the optimal location of IPFC, UPFC and SSSC, GSA was further improved.

Multiple FACTS devices are also implemented and their effects are analyzed in the power system. Results show that in many cases using multiple FACTS devices of smaller capacity is much better than using individual device of higher capacity. GSA technique is applied to optimally place FACTS devices based on minimum investment cost.