Preface

Distributed Generation (DG) penetration in the radial distribution system, especially, through Renewable Energy Sources (RES) has been increasing vastly due to minimal carbon footprints. In addition, they make the system more reliable by minimizing the system power loss and voltage deviations at buses in a distribution network. Distributed generation, Decentralized Generation, Small Scale Generation, Embedded Generation, or Dispersed generation are very low power rating generators (typically from few kW to tens of MW), installed commonly in the vicinity of the consumer's load to strengthen the traditional power system. DGs are not new to the scientific world but have become popular since last decade because of their numerous advantages over centralized power generation systems.

DGs may be quite effective in power loss minimization, and voltage profile together with voltage stability enhancement, if placed optimally in distribution networks. The research on optimal placement of DGs in distribution networks for loss minimization and voltage profile improvement may be categorized as analytical approaches and metaheuristic approaches. The analytical approaches face difficulty in obtaining global optimum solution. Metaheuristic approaches have effectively been utilized in solving many real life problems. However, metaheuristic approaches have their own limitations. The hybridization of two metaheuristic approaches may be used in overcoming these limitations. The convergence and efficacy of the optimization technique can be improved by hybridizing two metaheuristic approaches. The basis of hybridization is combining the excellent exploitation capability of one metaheuristic approach with the excellent exploration proficiency of another metaheuristic approach. Therefore, an attempt has been made in this thesis to consider some of the hybrid metaheuristic approaches in determining optimal integration of DGs. DGs may be categorized in four types based on power injection to the network. DG injecting only real power to the network is considered as Type-1 DG, whereas, DG injecting only reactive power to the network is considered as Type-2 DG. The DG injecting both real as well as reactive power is considered as Type-3 DG, whereas, DG injecting real power but drawing reactive power is considered as Type-4 DG. In this thesis, optimal integration of Type-1, Type-2, and Type-3 DG along with their various combinations have been investigated in loss minimization, voltage profile improvement, and voltage stability enhancement.

In Chapter-2, hybrid of Particle Swarm Optimization (PSO) and Grey Wolf Optimization (GWO) approach is proposed for optimal placement of multiple Type-1 DGs to minimize weighted sum of real power loss, voltage deviations at buses from desired value, and maximize voltage stability margin. Case studies have been performed on IEEE 33-bus radial distribution network. Weights have been selected optimally by the Genetic Algorithm. Optimal placement of multiple Type-1 DGs by proposed approach has resulted in significant reduction in power loss and improvement in voltage profile as well as voltage stability margin of the system. The results obtained by proposed approach are better than some existing metaheuristic approaches.

In Chapter-3, optimal placement of individual Type-1, Type-2, and Type-3 DGs considered one at a time, and their various combinations are proposed using a hybrid PSO-Gravitational Search Algorithm (GSA). The hybrid metaheuristic technique of optimal placement of DGs is tested in loss minimization for IEEE 33-bus and 69-bus radial distribution networks. Simulation results obtained on two test systems show considerable reduction in power loss. Voltage profile of the system also gets enhanced as a result of loss reduction.

Chapter-4 of this thesis presents a novel real valued hybrid Particle Swarm Optimization-Coral Reef Optimization (PSO-CRO) technique for optimal placement and sizing of Type-1, Type-2, and Type-3 DGs for system loss minimization. Case studies on IEEE 33-bus, 69-bus, and 118-bus radial distribution systems demonstrate that proposed novel PSO-CRO algorithm of loss minimization yields higher reduction in power loss compared to some existing approaches. Proposed approach of DG placement is computationally efficient, too, as computational time is much less as compared to some existing approaches.

Apart from DG placement, distribution system performance may also be enhanced through network reconfiguration by opening and closing certain branches that divert power flow from heavily loaded branches to lightly loaded branches. In Chapter-5, impact of network reconfiguration in voltage stability enhancement, loss minimization and voltage profile improvement have been studied on a radial distribution network. The network has been reconfigured optimally by a hybrid PSO-CRO algorithm. Most of the work on DG placement and network reconfiguration has considered only constant power loads. However, practical loads in power system may consist of combination of constant power, constant current and constant impedance loads, and frequency sensitive loads, as well. Practical loads may also vary over time. Therefore, in this chapter, reconfiguration of the network has been carried out under some of the voltage dependent loads. Different voltage-dependent loads considered in this work are Constant Current (CI) load, Constant Impedance (CZ) load, Residential Load (RL), Summer Day Residential Load (SDRL), Winter Day Residential Load (WDRL), Winter Night Residential Load (WNRL), Industrial Load (IL), Commercial Load (CL), Summer Day Commercial Load (SDCL), Summer Night Commercial Load (SNCL), Winter Day Commercial Load (WDCL), Agricultural Load (AL), and Electric Vehicle (EV) load. Apart from these, the above studies have also been carried out for Constant Power (CP) load. Case studies have been performed on IEEE 33-bus radial distribution network. Simulation results demonstrate the effectiveness of proposed PSO-CRO approach of network reconfiguration in a system employed with voltage dependent loads.

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