Chapter 4
Optimal Power Flow and Optimal Reactive Power Dispatch Using Different Evolutionary Optimization Techniques

ABSTRACT

This chapter describes grey wolf optimization (GWO), teaching-learning-based optimization (TLBO), biogeography-based optimization (BBO), krill herd algorithm (KHA), chemical reaction optimization (CRO), and hybrid CRO (HCRO) algorithms to solve both single and multi-objective optimal power flow (MOOPF) and optimal reactive power dispatch (ORPD) problems while satisfying various operational constraints. The proposed HCRO approach along with GWO, TLBO, BBO, KHA, and CRO algorithms are implemented on IEEE 30-bus system to solve four different single objectives: fuel cost minimization, system power loss minimization, voltage stability index minimization, and voltage deviation minimization; two bi-objectives optimization, namely minimization of fuel cost and transmission loss; minimization of fuel cost and voltage profile; and one tri-objective optimization, namely minimization of fuel cost, minimization of transmission losses, and improvement of voltage profile simultaneously. The simulation results clearly suggest that the proposed is able to provide a better solution than other approaches.

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INTRODUCTION

The main objective of any electrical power utility is to ensure reliable and stable power supply economically to the consumers. For smaller size power systems, it is comparatively a trivial problem and also individual power systems were used and operated separately in regional concept earlier. However, the state of the art is to have interconnection of different supply agencies to form very large complex power systems in order to achieve several advantages. In an interconnected power system, the real and the reactive powers of the generators are required to vary within operating limits in order to meet the particular load demand with minimum fuel cost. In the generation plant, there are two factors which are to be considered at every load change. These are the division of load and economic factor. But due to the deregulation in the industry, optimal power flow (OPF) (Dommel & Tinney, 1968; El-Fergany & Hasanien, 2018) is used to handle such problems. At present, OPF has become reliable enough for practical use and has taken a place on standard power system analysis tools. Thus, the main purpose of OPF solution is to schedule the power generation in such a way that minimizes the fuel cost while satisfying all the equality and inequality constraints. In addition to the minimization of fuel cost, the OPF may also be used to achieve the other benefits such as reduction of system loss, improvement of voltage profile and improvement of system security. Thus, the objective of the OPF is to find steady state operating point which minimizes generation cost, system loss, voltage deviation etc while maintaining an acceptable system performance in terms of limits on generators' real and reactive powers, line flows, outputs of various compensating devices etc.

Due to the continuous growth in the demand of electricity with unmatched generation and transmission capacity expansion, voltage instability is emerging as a new challenge to power system planning and operation. Unavailability of sufficient reactive power sources to maintain normal voltage profiles at heavily loaded buses are the main reasons for the voltage collapse. This problem may be overcome by reallocating reactive power generations in the system. This can be achieved by adjusting transformer taps, var injections of shunt compensators and generator voltages. In addition, the system losses can be minimized via redistribution of reactive powers in the system.

Optimal reactive power dispatch (ORPD) (Mei et al., 2017; Mouassa et al., 2017; Nuaekaew et al., 2017) which is one of the application functions of modern energy management system (EMS) is used to minimize total system

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