

# **EVOLUTIONARY COMPUTING TECHNIQUES AND ITS APPLICATIONS TO ELECTRIC POWER DISPATCH**

*by*

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## *Dedicated to My Beloved Parents*

*None of this would have been possible without their love,  
understanding, patience and blessings.*

# CERTIFICATE

This is to certify that the thesis entitles, “**Evolutionary Computing techniques and its applications to Electric Power Dispatch,**” being submitted by **Mr V. Ravikumar Pandi** for the award of the degree of **Doctor of Philosophy** is a record of bonafide research work carried out by him in the Department of Electrical Engineering of the Indian Institute of Technology, Delhi.

Mr V. Ravikumar Pandi has worked under my guidance and the supervision and has fulfilled the requirements for the submission of this thesis, which to my knowledge has reached the requisite standard. The results obtained here in have not been submitted to any other University or Institute for the award of any degree.

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# ABSTRACT

The complexity and large size of the power systems needs the researcher to develop efficient control and scheduling algorithm to achieve the smooth operation economically. The power dispatch problem is always considered as the most important one used to economically schedule the online generating units to meet the demand at a particular time duration, while satisfying the physical operating constraints. The day ahead dynamic dispatch, multi-area dispatch, optimal power flow with multiple objectives and congestion management in the deregulated market structure are considered as the extension of simple economic load dispatch (ELD). Even though the classical methods are simple and faster, they are dependent on the starting point. It also becomes hard to implement them with various physical constraints.

This thesis deals with the development of three novel algorithms to solve the various kinds of dispatch problems in power systems. The proposed evolutionary algorithms are mainly based on particle swarm optimization, bacterial foraging and harmony search algorithms which have emerged as the most powerful optimization algorithms in the recent years. The formulations made by either changing the algorithm structure or hybridization with other algorithms to improve the convergence and remove the stagnation compared with the classical algorithms. The proposed algorithms in this thesis aim at better convergence and reaching a superior optimal point. The highlights of the research work carried out in this thesis are as follows.

In the first algorithm, the particle swarm optimization with adaptive changes of inertia weight according to the fitness function values and re-initialization of population when the solution gets stagnated, has been developed and named as adaptive particle swarm optimization (APSO). In the second method, the run length vector in the bacterial foraging algorithm is made adaptive and hybridized with the Nelder-Mead local search algorithm, which is called as adaptive bacterial foraging with Nelder-Mead (ABF-NM). In the third algorithm a

hybrid harmony search – particle swarm optimization (HS-PSO) has been developed by using the basic structure of harmony search with the improvisation process is replaced by basic velocity based movement of swarm optimization process.

The simple ELD model having different cost characteristics such as quadratic curve, quadratic with valve point effect and piece wise quadratic curve have been considered along with various constraints such as power generation limits, ramp rate limits, prohibited operating zones and line flow limits to test the proposed evolutionary algorithms. The proposed algorithm achieves significant convergence improvement compared to the other relevant approaches. The day ahead 24 hour dynamic load dispatch has been demonstrated in this work to show the effect of solving large system with more realistic constraints.

The effect of including renewable energy sources with its uncertainty in the wind speed causing the forecast error has been modeled in the dynamic load dispatch problem and solved using the proposed evolutionary algorithms. The effectiveness of the proposed algorithm in finding the better solution in multi-area load dispatch with tie-line flow constraints and prohibited operating zones has been presented. The implementation of proposed algorithms for optimal power flow with different cost characteristics has been demonstrated with security constraints. The load flow is solved using Newton-Raphson load flow algorithm given in Matpower tool box.

In this thesis two new algorithms has been also developed in multi-objective domain. The first one uses classical bacterial foraging algorithm with suitable modification, so that it can be directly applied to multi-objective problems. The second algorithm is based on the proposed single objective HS-PSO method. This multi-objective bacterial foraging (MOBF) and multi-objective harmony search with particle swarm optimization (MO-HS-PSO) algorithms has been applied to standard IEEE-30 bus system for solving the economical

environmental dispatch by considering both cost and emission as two objectives. Extensive computational comparisons show the remarkable benefits of the proposed algorithm.

Finally the proposed single objective algorithms have been applied to solve the congestion management problem in the deregulated environment. This is done by re-scheduling the power generation level to alleviate the overload on the transmission lines while having some bilateral and multilateral power contracts. The results on various test system have been obtained to demonstrate the versatility of the proposed algorithms over the other existing approaches.

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