

## Chapter 15

# Generators Maintenance Scheduling Using Music-Inspired Harmony Search Algorithm

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### ABSTRACT

*This work explores the potential of Music-Inspired Harmony Search (MIHS), meta-heuristic technique, in the area of power system for Generator Maintenance Scheduling (GMS). MIHS has been used to generate optimal preventive maintenance schedule for generators to maintain reliable and economical power system operation taking into account the maintenance window, load and crew constraints. The robustness of the algorithm has been evaluated for five different case studies: 8-units test system, 13-units test system, 21-units test system, 62-units test system, and 136-units test system of Water and Power Development Authority (WAPDA) Pakistan. As per previous practice, WAPDA used to use manual scheduling based on hit-and-trial. The simulations have been carried out in MATLAB<sup>®</sup>. Based on its comparison with Genetic Algorithm (GA), it has been found that MIHS has fast convergence rate and optimal schedule for all the test systems satisfying the stated constraints.*

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## 1. INTRODUCTION

The advancement and expansion of modern power system has resulted into the increased number of generators. Therefore, maintenance of generating units has become inevitable for a healthy power system. For this purpose, power systems need some schedule to switch off some of its generating units for maintenance satisfying the load demand. GMS is a large-scale, nonlinear and stochastic optimization problem with many constraints and conflicting objective functions (Ben, Duffaa and Raout, 2000).

The main concern in controlling large power production systems is to make the best use of accessible resources, which require substantial planning. In the power production system, the production output of individual unit is calculated on hourly basis to fulfill the load demand. The significant aspect in power production system is to maintain units/generators following a proper schedule, so that reliability of the system can be achieved. GMS plays an important role in increasing the efficiency and effectiveness of power system. Therefore, maintenance scheduling in the power system plays a very important role in overall operations. The effectiveness of GMS is highly dependent on the target and timing of the maintenance activities.

The main aspiration of GMS is to schedule the generating units for maintenance in such an optimized way that production costs are minimized meeting certain levels of power system security and adequacy. Maintenance ensures the long life and good performance of generators. In routine maintenance, periodic inspection of generators is performed to check any buildup of contamination (dirt, oil, etc.) on the windings. If the wound components are covered with heavy concentrations of grease and grunge, the generator is disassembled and systematically cleaned. The main concern regarding the generators maintenance planning is to achieve an optimized objective function under series of constraints.

The purpose of GMS is to extend the generator's lifetime or at least the mean time to the next failure. Maintenance can be classified into two main categories (Mohammadi, Pirmoradian and Hassanpour, 2008);

- Unplanned/Corrective Maintenance (CM)
- Planned Maintenance

CM also known as run-to-failure, a generator is not maintained until it fails (Bensnard et al., 2009). This approach is suitable when the cost of failure is not important, which is perceptibly not appropriate for most transmission systems. Planned maintenance includes Predictive Maintenance (PdM) and Preventive Maintenance (PM). PdM is carried out on the basis of regular monitoring, periodic inspections and diagnostic tests.

In PM, the maintenance is performed in order to evade a failure (Saraiva et al., 2010). PM strategies are further divided into three different types;

- Time based PM
- Condition based PM
- Reliability centered PM

Time based PM is generally a traditional and costly approach, in which inspection and maintenance are performed at fixed time intervals, often, but not essentially, based on specifications. Condition based PM offers a maintenance from knowledge characterizing the generator's condition, as condition monitoring may recognize incipient failures.

Comparative to time based PM, condition based PM usually extends the interval between successive maintenances and therefore, usually incurs less cost, although it needs a vital amount of infrastructure investment to gauge, communicate, store, and utilize the essential information characterizing the state. Reliability centered PM utilizes monitoring information together with an investigation of requirements and priorities and usually results in a prioritization of maintenance

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