This thesis presents new solution approaches developed for solving the following distribution system problems using Genetic Algorithmic (GA) and Simulated Annealing (SA) algorithmic solution procedures:

- Optimal siting and sizing of substations and network routing
- Optimal grading of conductors of distribution feeder mains
- Optimal Allocation of fixed as well as switched on-line shunt capacitor banks along the radial distribution feeders

For the substation siting, sizing and network routing problem, the mathematical modeling of the various substation components already formulated are considered with necessary changes wherever required. The cost of electrical transport associated with the substation and feeder circuit segments are non-linear in general and were represented more realistically by quadratic functions. Models that represent installation cost of feeders and substation, and energy loss costs use system parameters such as power factor, load factor, load diversity factor, utilization factor of substation transformers, study area, load density of the study area etc. The objective is to minimize the total cost subject to network operational, technical, voltage limit and feeder capacity constraints.

The optimal conductor gradation problem has been formulated using mathematical models that represent feeder voltage regulation, feeder installation cost and energy loss cost as functions of conductor cross-section. The objective is to minimize the total cost subject to voltage limit constraints.

The capacitor allocation problem has been formulated using mathematical models that represent savings due to loss reduction, capacitor cost and voltage rise during off-peak hours as functions of capacitive current flows in the feeder sections. The problem formulation has also accounted the benefits due to release in system capacities. Allocation of switched capacitors has been considered during peak load hours of a load cycle. The technique presented does not depend upon the circuit voltage, load distribution or other system and load characteristics and was applicable to all types of radial feeders.
in practice. The solution to the capacitor allocation problem is obtained in two stages. Allocation of fixed capacitors is obtained in the first stage. It is followed by a second stage, for optimum allocation of switched capacitors.

All these problems have the following common features. The space to be searched is large, noisy and is not perfectly smooth or unimodal. In the literature, it is found that large amount of research have been undertaken to solve the problems of power distribution. Different methods and technologies and approaches have been proposed. Most of the conventional methods adopt static models, giving an optimal solution for a fixed set of data. Further, these methods need large amounts of computer time to obtain the optimal solution even for moderately sized networks. These methods become tedious when the system to be studied is large and the problem defined is non-linear of higher orders, causing heavier computational burden to obtain the desired optimal solution.

The recent popularity of Artificial Intelligence (AI) based solution procedures has led many power system researchers to investigate their use for solving the problems of power distribution. Genetic Algorithms work according to the principles of natural genetics. GAs have a good chance of being competitive for such problems. Further GAs can be designed to outperform any general-purpose method for problems where, quickly finding a sufficiently good solution is considered to be enough. SA method mimics the thermodynamic process of cooling of molten metals for achieving the minimum free energy state. With proper choice of parameters, the SA algorithm can be made to find global optimal point. The methods already developed using GA and SA algorithms to solve the above problems were critically examined and improved GA and SA based techniques are developed in this research. The efficiency of the GA and SA approaches in solving real-world distribution system problems has been studied through a careful choice of operators and parameters, effective codification and effective data structure. Improvements in solution times have been achieved. The solution procedures developed using GA and SA algorithms and the investigations carried out to bring out the merits and demerits of GA and SA are presented with illustrations.