Network Design Problems are becoming increasingly critical & complex as telecommunication networks (and others) are expanded & upgraded in response to consumer’s information needs. Network design is used extensively in practice in an ever expanding spectrum of applications. Network optimization models such as shortest path, assignment, maxflow, transportation, transshipment, spanning tree, matching, traveling salesman, generalized assignment, vehicle routing, and multi-commodity flow constitute the most common class of practical network optimization problems. In this research work, a generalized network design problems (NDPs) is focused in the form of a large scale backbone network which belong to the family of NP-hard combinatorial optimization problems. The purpose of the backbone is to connect regional distribution networks and, in some instances, to provide connectivity to other peer networks. The primary objective of this research work is to develop a robust method based on genetic algorithm to solve NP-hard network design problem with minimum cost subject to a reliability constraint which meets the customer requirement. One fundamental problem in this area is the minimum spanning tree (MST) problem where all nodes in a graph have to be linked together in a circle-free structure in the cheapest possible way. The MST problem itself is easy to solve by polynomial-time algorithms like those of Prim or Kruskal, but adding additional constraints often make the corresponding optimization problem a hard one. One of these related problems is the degree-constrained MST problem, in which degree of each node is restricted with in a given range which is very important for the reliability and priority of the connecting node. Other possible constraints are path failure, node failure and connectivity which are requirement of the current network system. By adding this constraint, this network design problem becomes one of the hardest problems in NP-hard category. Due to the complexity of the problem these approaches are limited to relatively small instances with clearly less than 100 nodes when considering complete graphs. Therefore, in this research work methods have been developed to solve instances with up to 1000 and are applicable for more than
1000 nodes. However, there are also other problems that can be expressed as network design problems, such as traveling salesman problem (TSP), one has to find a round trip (Hamiltonian cycle) through a set of cities (nodes) of minimal length and Shortest Path problem. In this thesis these two problems are also considered and solved with genetic algorithm approach. Since network design is NP-hard problem and traditional heuristics have had only limited success in solving small to mid size problems. As a result, standard, traditional, optimization techniques are often not able to solve these problems of increased complexity with justifiable effort in an acceptable time period. The conventional search and optimization methods working on the commercial processors require hundreds of years to solve such a problem with limited number of components. However, evolutionary computation including Genetic Algorithms (GA) has shown promising performances to solve such problems Therefore, to overcome these problems, and to develop systems that solve these complex problems, researchers proposed using Genetic Algorithm. In this thesis it has been shown that, by this nature-inspired search method it is possible to overcome some limitations of traditional optimization methods, and to increase the number of solvable problem. In this study, Genetic Algorithm is considered as a one of the possible solutions for such kind of NP-hard problem where possible solutions are improved generation by generation and then there is more probability to find the exact solution. The main focus of this research is the consideration of up to 1000 nodes and the proposed method can be applied for any possible size of the network. In this thesis various robust fitness functions have been developed. Twenty genetic operators are developed including new approaches required by the problem. Five hundred forty six different cases are considered for the fifteen different size of network. All the experimental results are described with the help of table and graph. All the developed functions are described with the help of figures and examples. Further new methods based on Genetic Algorithm have been developed for Shortest Path Problem and Traveling Salesman Problem. All these functions and methods developed in this thesis are published in International Journals and in the proceedings of International Conference.

This research work shows that, genetic algorithm is an alternative solution for this NP hard problem where conventional deterministic methods are not able to provide the optimal solution.