ABSTRACT

In today's world of globalization, economic reforms and quality consciousness, the conventional design methodology is advancing towards such a methodology which is cost effective, efficient, least time consuming and user friendly. Total System Design (TSD) methodology has been the focus of researchers and design engineers in recent years for the product design & development as well as for the design of engineering systems. The present thesis work has been taken up for the development of a unified, computationally simple and efficient total system design methodology and later it has been applied to a thermal power plant having 190 attributes for its analyses.

A TSD model consisting of seven phases has been presented. Two methodologies namely Graph Theoretical Methodology (GTM) and Multiple Attribute Decision Making (MADM) methodology have been evolved for the analysis, evaluation, ranking and selection of plants required at the fifth phase of the TSD model. The GTM developed employs a relatively simple mathematical formulation and is capable of solving complex multi-attribute decision problem incorporating both qualitative and quantitative factors. The graph theoretical methodology consists of graphical and mathematical modeling. The graphical models (digraphs) have been prepared for a thermal power plant considering its various subsystems, sub-systems, components and their interdependencies which affect the performance of the plant.

On the other hand, mathematical models have been developed for conversion of digraphs into matrix form and then this matrix into a mathematical function. The value of the permanent of this function yields the suitability index. This index has been used to rank the plants for selecting the best one among all available alternative plants. Computer software has also been developed for finding out the suitability index and has been tested for the said plant.

The sensitivity analysis has been carried out to identify the most dominating attributes and to explore the influence of various different sets of attributes of the plant on its overall suitability. A comprehensive comparison of potentially suitable
alternative plants has also been made using graphs and histograms for visual understanding.

Graph Theoretical Methodology has also been applied for the selection of the power plants based on their quality and reliability. Fuzzy set theory has been applied to incorporate the uncertainty associated with vagueness, imprecision, and/or lack of information to determine the numerical values to be assigned to the elements of the quality matrix. Similarly, the reliability values for different structural attributes available in the open literature have been used to assign the numerical values to the elements of the reliability matrix. Further, the value of the permanent of this reliability matrix has been used to determine the reliability index which later on determines the ranking of the power plants.

A comprehensive classification and coding scheme for a thermal power plant has been envisaged for the development of Multiple Attribute Decision Making (MADM) methodology which is capable for short-listing of alternate plants and solving non square matrices. This methodology consists of two phases. In the first phase, all possible pertinent attributes of a plant i.e. cost, plant load factor, safety etc. have been identified which influence the selection for the optimal plant. An elimination search is then applied to shortlist the potentially suitable alternative plants which satisfy the acceptable requirement levels of the pertinent attributes. In the second phase, TOPSIS approach has been applied to rank the short listed plants using their suitability index. This index represents the relative closeness of the alternative plant from the hypothetical ideal plant. User friendly software has also been developed for the use of MADM methodology.

Finally, the different modules developed in this thesis work have been integrated to yield Total System Design model for a thermal power plant. At the end of each chapter, the findings of the work are presented.