INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

This thesis investigates the application of metaheuristic techniques in addressing single and multi-objective combinatorial optimization problems, focusing on the essential role of efficient solution strategies. Firstly, this thesis underscores the importance of meticulously designed solution frameworks through an in-depth analysis of three specific combinatorial optimization problems: production planning of a petrochemical industry, scheduling jobs on dissimilar parallel machines, and optimization of a compression-absorption cascaded refrigeration system. The thesis also addresses the limitations of metaheuristic techniques in solving computationally expensive problems by proposing variants that leverage parallel computing architectures. Additionally, this work emphasizes the necessity of precise implementations of metaheuristic techniques to ensure optimal effectiveness in their application.

Three models of production planning within the petrochemical industry, which primarily differ in the permissible production capacity range for the implementation of processing units, are critically analyzed. A concise solution structure and efficient constraint handling methods are proposed to overcome the limitations of strategies employed in the literature. The efficiency of the proposed strategies is demonstrated in case studies using different metaheuristic techniques. The proposed strategies determined similar or better solutions than in the literature while reducing the number of variables by up to 96% and constraints by up to 98%. Further, a multiobjective multi-unit production planning model is solved by utilizing the proposed strategy to determine the trade-off between profit and investment cost. Various multi-objective metaheuristic techniques determined well-converged and diversified Pareto solutions by employing this strategy.

This thesis examines the scheduling of jobs on dissimilar parallel machines and proposes an optimization framework that integrates metaheuristic techniques with a novel no-wait time heuristic mechanism to solve the model efficiently. The heuristic mechanism refines candidate solutions by rescheduling the jobs to reduce constraint violations, identifying feasible solutions in the earlier stages of metaheuristic techniques. The performance of the framework is evaluated in different scheduling instances using multiple metaheuristic techniques, demonstrating improved convergence and identification of better schedules. Additionally, a multi-objective scheduling model is proposed

considering the minimization of total processing cost and makespan as two objectives, which is solved using the proposed framework. This approach was observed to be beneficial in determining better converged non-dominated solutions using multiple multi-objective metaheuristic techniques.

In literature, multiple optimization attempts are performed to identify the best choice of absorbent solution and refrigerant pair along with operating parameters for the vapor compressor absorber cascaded refrigeration system. This study proposed an efficient solution structure to identify the optimum solution in a single optimization attempt. The proposed strategy effectively selected the best refrigerant and absorbent solution pair from a set of combinations comparable to the results in the literature. In the direction of exploring the possibilities of parallel computing with metaheuristic techniques, a critical analysis of teaching learning-based optimization (TLBO) is analyzed. Three parallel computing variants of TLBO are proposed, differing primarily in the stages of new solution generation and evaluation during iterations. All variants demonstrate competitive performance while effectively leveraging parallel computing advantages. Lastly, two variants of multi-objective improved teaching learning-based optimization (MO-ITLBO) are proposed, which provide insights into the ambiguities in its exact implementation.