Project Title: Energy Efficient Scheduling in Manufacturing: Energy-Time Trade-off in Parallel Machine Environments	
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Co-Supervisor(s): *(if already known)*	
Sources of Fund: *(if any)* Internal Grant	

Research Field(s): Scheduling
Summary and Problem Statement: The increased global awareness on environmental issues necessitated to take actions for reducing energy consumptions and CO_2 emissions. As one of the largest energy consumers, the manufacturing sector also tries hard for this objective. On the one hand, energy efficient equipment, machines and processes are being developed and on the other hand, better planning and scheduling methodologies are developed to utilize the available resources more efficiently. This project is related to the latter one, where we consider improving the energy efficiency in manufacturing by better utilization of the available resources such as the machines and the material handling equipment. Also speed control of these equipment will be considered. After identifying the problem framework, its mathematical programming formulation will be developed. Also, a heuristic algorithm will be developed to solve larger problem instances. Their performance will be evaluated with a computational study. The effect of considering energy objective together with the throughput objective will also be analysed through a computational study.
Keywords: Optimization, scheduling, energy efficiency, mathematical programming, heuristics
Objectives:
The objectives of the study can be listed as follows: - Identify a practical problem framework from real manufacturing industry   - Develop exact and heuristic solution methods   - Test the performances of these methods   - Analyse the tradeoff between the energy consumption and production rate and determine the benefits of considering energy consumption objective.
Tentative Methods of Approach: Mixed integer programming, heuristic/metaheuristic algorithms, multi-objective optimization, scheduling algorithms

Required backgrounds and skills
Backgrounds: Mathematical programming, optimization
Computing Skills: Integer programming solvers such as CPLEX, Gurobi Programming languages such as C++, Java, Python
Other requirements:

References: - Gürel, Sinan, Gultekin, Hakan, Eghbal Akhlaghi, Vahid. "Energy conscious scheduling of a material handling robot in a manufacturing cell", Robotics and Computer-Integrated Manufacturing, 58:97-108, 2019.   - Che, Ada, Shibohua Zhang, and Xueqi Wu. 2017. "Energy-Conscious Unrelated Parallel Machine Scheduling under Time-of-Use Electricity Tariffs." Journal of Cleaner Production 156: 688–97.