

Department of Computer Science & Engineering  
Indian Institute of Technology Kharagpur  
Tutorial 4  
Subject: Analysis and Design of Algorithms (CS60007)  
Time: 1 hour  
October 24, 2024

ANSWER ALL QUESTIONS

Consider the p-Processor Scheduling Problem (p-PSP) defined as follows: Given a set  $T$  of  $n$  tasks, each having execution time  $t_i$ , and  $p$  identical processors which can execute each of the tasks, we are to schedule all tasks of  $T$  in  $p$  processors in minimum total time. This means that if the total execution time of the scheduled tasks on processor  $k$  is  $d_k$ , then the total time across all processors is  $D$ , which is the maximum of  $d_k$ , taken over all  $p$  processors. The scheduling objective is to schedule the tasks on  $p$  processors in such a manner so as to minimize  $D$ .

Now do the following:

- a) Show that the p-PSP, an optimization problem, is in NP.
- b) Provide a polynomial-time reduction from some known problem like 0/1 Knapsack Problem to the p-PSP to show it to be NP-hard.
- c) Present a bounded polynomial time approximation algorithm to solve the p-PSP. Show what is the bound and the complexity of the algorithm.
- d) Present an efficient algorithm to find the optimal solution to the p-PSP.