IE375 Spring 2020 Mini Homework V-VI- Due: May 14, 2020 Due-time: 17:00

- **Mini Homework V-VI is 4%** (I have combined two of the homework into a single one). The weights are presented within the question. These questions are exam questions from previous years. Make sure that you review course material before you start. Cite sources used if any.
- **Academic Dishonesty (taken from IE375 Course Information):** Academic misconduct is not tolerated, and violations will be treated in accordance with the University policy. For assignments: Discussion of the course material and working in groups are effective ways of learning. However, this does not mean that you can copy the assignment from one of your friends. You can discuss with your friends, but you should be alone, without any written solution in front of you, when you actually prepare your assignment. It is extremely important to understand the value of this exercise in the process of learning. Any violation of the above understanding will result measures outlined in the student rules and regulations.
- **Submission Information:** Please send your solution as a pdf file to IE375 Course TA Emin Özyoruk.
- **More Information on Question: What is expected? How to study?**
- To answer the questions, make sure that you understand the material presented during the course, as well as the reading material from the textbook. All the questions are on Scheduling. Make sure that you understand each problem and present your answer clearly. All the questions are numeric and hence you have chances of making computational errors. To avoid possible cases with no partial grades, make sure that you present formulas (and/or explain) how you are proceeding with computations. If you are using a program or device to make computations, make sure that you write all the equations, formulas, etc. you are using and explain how you are using them clearly (as an example, see the **Solution and Comments for Case 1** in course WEB site). Additionally, you may need to draw Gantt Charts to make several computations in all the questions: Make sure that you present them clearly and neatly.
- **One final remark:** In the exams, please get used to receiving question types that you have not seen before. One useful purpose of homework and exercises is to cover the "routine" so that you can go beyond that during the exams, and elsewhere.

Question 1 (30 points)

There are five cars waiting to be repaired. The repair shop is quite small, so only one car can be repaired at a time. Moreover, the repairman, who is the owner at the same time, is very careful in quality and wants to complete the repair of one car, before starting another. The following data summarizes the repair time needed (in days) as well as promised date given for each car.

Cars	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Repair time (days)	3	2	4	1	5	2	1	4	1	3	2
Promised Date (in days from now)	14	12	9	11	8	15	18	21	18	27	32

a) **(15 points)** Compute **average tardiness** and **maximum tardiness** as the performance measure for each of the sequences obtained the following sequencing rules:

(i) Shortest Processing Time (SPT)
(ii) Earliest Due Date (EDD)

Make sure that you show your computations clearly.

b) **(15 points)** The repairman (owner) has agreed to provide a rental car if completion time exceeds the promised date. Assume that the following rate for rental cars apply for this case per car:

- 1 day/car – 200 TL
- 2 days/car – 350 TL for two days
- 3 days/car or more days – 150 TL/day

Compute the total cost for the owner for each of the schedules obtained in Part a).

Question 2 (40 points)

Consider a print shop with a book-bounding (in Turkish: ciltlemek) facility. Currently (consider it to be the beginning of a week, (Monday 8 am to be precise) the shop has 5 manuscripts of various number of pages to be printed in different numbers and bounded. Each manuscript should first be printed and then bounded before being delivered to the customer. The processing times and the promised due dates are given below. Note that the shop operates at a regular 40-hour week (5 days, each day from 8 am to 5 pm, including 1-hour break).

Job	Required printing time (hours)	Required bounding time (hours)	Due date and time
A	7	6	Friday 5 pm
B	14	12	Thursday 5 pm
C	5	10	Wednesday 5 pm
D	8	11	Next Monday 5 pm
E	3	8	Thursday 9 am

A. **(10 points)** Assume that there is a single worker who is responsible for both printing and bounding. **Without a need to obtain a schedule** answer the following:

- Do you think that all the jobs can be completed before their due-dates? Justify your answer.
- If the worker was allowed to work overtime, what is a lower bound for hours of overtime needed to complete all the repairs before their due-dates?

B. **(15 points)** While you are thinking on how to deal with the situation, you receive a phone call (sharp at 8 am, Monday morning) from the police, telling you not to do anything for Job B. Hence, Job B is no longer in the pool of jobs to be performed. Now assume that there is a single worker who is responsible for both printing and bounding.

- What order should the shop perform these jobs in order to minimize the maximum tardiness?
- What is the minimum of maximum tardiness values?
- State if you need any overtime to carry out this plan so that no job will be completed after its due-date. If so, how many hours?

C. **(15 Points)** Job B is no longer in the pool of jobs to be performed. Now assume that there are two workers in the shop. First worker is responsible for printing and the second worker is responsible for bounding.

- What order should the shop perform the jobs in order to minimize the makespan?
- What is the minimum makespan value obtained?
- Will you need overtime to carry this plan so that no job will be completed after its due-date? If so, how many hours?

Question 3 (30 points),

Seven jobs are to be processed through a single machine. The processing times and the due dates are given below:

Job	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Processing time	2	3	2	1	4	3	2
Due date	5	17	17	6	12	10	15

Furthermore, assume that the following precedence relationships must be satisfied:

Job2 should be completed before **Job1** can start.
Job1 should be completed before **Job6** can start.
Job3 should be completed before **Job4** can start.
Job4 should be completed before **Job6** can start.

a) (15 points) Find the sequence that minimizes the maximum tardiness, and compute maximum tardiness value that resulted from the sequence. (You are encouraged to use Gantt for computations.)

b) (15 points) Now, consider the following situation: Precedence relations given above turns out to be more binding that you think. To be precise, these additional limitations require that you proceed with **Job1** immediately after **Job2**, and similarly **Job4** immediately after **Job3**. Also note that the due-date for Job 2 and Job 3 is 17, and 17 is the sum of processing times. Now find the sequence that minimizes the maximum tardiness, and compute maximum tardiness value which results from the sequence. (You are encouraged to use Gantt for computations.)