ME 714 Computer-integrated Manufacturing

Assignment 4

Due: April 11, 2021

Important Instructions:

- Submit this assignment as a Microsoft WORD file ('.doc', '.docx' format) on Teams. ANY other format will attract ZERO grade.
- Please show all the important steps while answering the questions. Clearly state ANY assumptions, whenever applicable. **For programming assignments, include a well-commented code.** The program should run properly without any errors to get full credit.
- **Any student found to have committed or aided and abetted the offense of plagiarism will receive ZERO credit for the whole assignment without any exceptions.**
- ONLY Q1 can be attempted as a team. A team will consist of maximum two members. **Both the team members will need to include the answer to Q1 as well as name and ID of their partner in their word files.**

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1. Write a function/program in Matlab/Python to solve n/2 (n jobs, 2 machines) shop floor scheduling problem using Johnson's algorithm. An $n \times 2$ matrix in which an element at row 'i' and column 'j' depicts the duration of job 'j' on machine 'i' (see Fig. 1 below as an example) should serve as an input to your function/program. Your program should be able to output: [20]

   i The optimal sequence of jobs

   ii The idle time 'X_i' on machine 'B' for all jobs

   iii Total idle time on machine B

   iv Total processing time

   Include a well-commented code/script. Test your code with the example shown in Figure 1.

	Job 1	Job 2	Job 3	Job 4	Job 5
Machine A	1	3	2	4	1
Machine B	4	2	6	2	3

Figure 1: n/2 example problem with n = 5

Activity	Predecessor	Duration
A	-	2
B	-	6
C	-	4
D	A	3
E	C	5
F	A	4
G	B, D, E	2

Figure 2: Project activities

2. Given the project activities with their respective duration (in days) as shown in the Table (Fig. 2) below, find the critical path and the total duration of the project. Also, find float (or slack) for each activity, i.e., how much the activity can be delayed without delaying the project. Show all the necessary steps. [7]

3. During manufacturing of cylindrical liner, samples are collected each hour to measure the critical dimension, i.e., the inner diameter. The data is shown in the Table below. Each sample consists of 5 parts chosen at random. Construct a well-labeled $\bar{x}$ and R control chart to determine if the process is in-control. Identify the deviations outside the control limit, remove them from the data and revise your control chart. [8]

Sample #	Collection Time	x_1	x_2	x_3	x_4	x_5
1	08:00 AM	202	206	204	206	206
2	09:00 AM	208	204	208	207	205
3	10:00 AM	208	206	207	205	208
4	11:00 AM	203	203	207	206	203
5	12:00 PM	201	204	209	208	204
6	01:00 PM	208	204	200	209	201
7	02:00 PM	207	203	200	202	206
8	03:00 PM	202	210	206	202	200
9	04:00 PM	207	208	200	202	210
10	05:00 PM	210	203	203	208	207

Figure 3: Cylindrical liner manufacturing process data

4. A cricket ball manufacturing company is asked to make balls with diameter (D) 2.83 inches. However, due to variations/imperfections in the manufacturing process, the actual diameter of the balls made is uniformly distributed over the range of 2.75 inches to 2.90 inches. In other words, the probability distribution function (PDF) is uniform/rectangular in the range (2.75,2.90). [15]

   i Assumming a quadratic loss function with zero loss to company at ball diameter of 2.83

inches, and loss of 10 Rs. for a ball diameter of 2.90 inches; find average loss per ball to the company.

ii Suppose the loss function is not quadratic. In fact, the balls with diameter between 2.80-2.86 inches are perfectly acceptable to the customer, and can be sold for profit of 100 Rs/ball. If the ball is oversized ($D > 2.86$), it can be sold, but at a smaller profit of 10 Rs/ball. However, if the ball is undersized ($D < 2.80$), it needs to be discarded with a loss of 50 Rs/ball. Now, what is the expected profit (or loss) per ball to the company?