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1. (12%) A firm plans to improve the existing process which involves five workers and has process capacity of 60 units per hour. Labor cost is \$12 per hour per worker, material cost is \$16 per unit, and overhead cost is charged at 1.5 times direct labor cost. Each produced unit is sold at \$40. There are two process improvement alternatives. The first alternative increases the process capacity by 25%, whereas the second alternative decreases the material cost by 10%. Both alternatives increase the overhead cost to 1.6 times direct labor cost.

    (a) (8%) Analyze the productivity for the existing process and the two process improvement alternatives.

    (b) (4%) Which process improvement alternative will you recommend? Please explain.

2. (10%) There are a variety of forecasting techniques that we can choose for a particular application. There are also a few measures (such as MAD, MSE, and MAPE) with which we can compare different forecasting techniques.

    (a) (4%) Please explain the general purpose of the measures MAD, MSE, and MAPE.

    (b) (6%) Please explain the differences among MAD, MSE, and MAPE from the usage perspective.

3. (14%) Product assembly requires five sequential steps. The task times for a worker to complete these steps are 2, 4, 3, 2, and 3 minutes, respectively. The exchange of the steps is not permitted, and the assembly of a product at any time is performed only by one worker. The production manager intends to allocate workers to this product assembly line.

    (a) (6%) Consider line balancing with two workers. What is the minimum cycle time in this case?

    (b) (4%) With the minimum cycle time in (a), what is the percentage of idle time of this product assembly line?

    (c) (4%) With the minimum cycle time in (a), if product assembly begins to operate (i.e. the product assembly line is empty), how long does it take to complete the assembly of 20 products?

4. (14%) A manufacturer produces a part for a hard disk drive. The specifications require that each produced part should weigh between 12.0 and 12.2 grams. Currently, the manufacturer adopts the x-bar and R charts to monitor the central tendency and dispersion of the process that produces the parts, respectively. Based on previous

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experience, the standard deviation of the process is estimated to be 0.05 gram. The quality inspector takes a sample of $n = 4$ observations from the process on a daily basis. The recent five samples are given below.

Sample	Observations (unit: gram)			
1	12.11	12.10	12.11	12.16
2	12.15	12.12	12.10	11.95
3	11.99	12.09	12.11	12.17
4	12.22	12.10	12.08	12.04
5	12.09	12.13	12.10	12.08

(a) (10%) Compute the three-sigma control limits for the x-bar chart by using the above samples. Discuss whether the process is in control or not. (Factors for R charts: $D_3 = 0$ and $D_4 = 2.28$ at $n = 4$.)

(b) (4%) Evaluate the process capability.

5.　(20%) Prepare a master schedule based on the following information:

Week	1	2	3	4	5	6	7	8
Forecast	100	100	120	120	150	150	180	180
Orders	106	94	65	40	21	9	2	0

Currently there are 145 units in inventory. Policy calls for a fixed order quantity of 250 units. The master schedule should look like the table below:

Week	1	2	3	4	5	6	7	8
Forecast								
Orders								
Projected On Hand Inventory								
Master Production Schedule								
Available to Promise Inventory								

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6. (18%) A company can produce a part it uses in an assembly operation at the rate of 50 an hour. The company operates eight hours a day, 300 days a year. Daily usage of the part is 300 parts. The company uses the part every day. The run size is 6,000 parts. The annual holding cost is $2 per unit, and setup cost is $100.

(a) (4%) How many runs per year will there be?

(b) (4%) While production is occurring, how many parts per day are being added to inventory?

(c) (4%) Assuming that production begins when there are no parts on hand, what is the maximum number of parts in inventory?

(d) (6%) The machine is dedicated to this product. Every so often, preventive maintenance, which requires six working days, must be performed on it. Does this interrupt production cycles, or is there enough time between cycles to perform the maintenance? Explain.

7. (12%) The following jobs will be processed by a machine, the processing time and due dates are listed below:

Job number	1	2	3	4	5	6	7
Processing time	3	6	8	4	2	1	1
Due date	4	8	12	15	11	25	21

Please determine the processing sequences for the following objectives:

(a) (4%) The mean flow time

(b) (4%) The number of tardy jobs

(c) (4%) The maximum tardiness