National Technical Examinations May 2016
98-Ind-A4, Production Management

3 hours duration

Notes:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit, with the answer paper, a clear statement of any assumptions made.
2. This is a Closed Book exam. Candidates may use one of two calculators, the Casio or Sharp approved models.
3. Five questions constitute a complete paper. Only the first five questions as they appear in your answer book will be marked.
4. All questions are equally weighted.
5. Write your answers in point-form whenever possible.

Marking Scheme

	a.	b.	c.	d.
1.	7	7	6	
2.	10	5	5	
3.	10	10		
4.	10	10		
5.	10	10		
6.	10	5	5	
7.	10	10		

Front Page

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1. A number of innovators have changed the direction of production management in recent years. Some used long-existing methods, others used new ideas.
   a. Little's law can be used to calculate WIP on a production line. Explain how this is done, and explain why you may need to control WIP in a production system.
   b. 5S – explain this concept, and explain why it can improve production.
   c. Explain why the "seven zeros" work.

2. A manufacturing line uses plastic fasteners at an average rate of 6000 per week. The fasteners cost 0.002 cents each. Each order costs the company $12 to process, and holding costs are estimated at 25% annualized.
   a. How often should the fasteners be ordered, and in what quantities? Also calculate the total annual ordering and holding costs for the fasteners.
   b. If the demand forecast was wrong, and the actual demand is 12,000 per week, calculate the total cost of ordering and holding, using the order quantities derived in a.
   c. How does this compare to the inventory cost of the optimal order quantities for 12,000 items per week? Comment on the differences.

3. The following table shows the actual sales of a tablet computer (both old and new models combined) for a recent eight-month period at an electronics retailer. One of the data values is missing (the sales report was misplaced).

Month	Sales
February	450
March	300
April	Missing data
May	740
June	1000
July	950
August	1000
September	800

   a. Develop sales forecasts using the following methods (choose appropriate parameters): naïve, exponential smoothing.
   b. Choose the best forecast; justify your answer and suggest ways in which the forecast can be improved.

4. You are the production manager overseeing three plants producing Li-ion batteries. These are used in electric vehicles, and are made in three grades: light, medium and heavy. The unit profits, monthly demand and Li requirements per battery are given in the table below.

Product	Unit profit (per battery)	Maximum demand (units/month)	Li requirements (kg/battery)
Heavy	\$12	7 000	200
Medium	\$10	9 000	150
Light	\$7	4 000	100

There are three plants where the batteries are produced. The maximum assembly capacities for any mix of battery grades are given below. The number of batteries that can be manufactured at a site is limited by the amount of Li the site can produce. The maximum Li production of each site is also given below.

Plant Location	Assembly capacity (batteries/month)	Maximum Li production (kg/month)
Quebec City	5 500	100 000
Toronto	7 500	70 000
Seattle	2 200	40 000

   a. Write a mathematical programming formulation that allocates production of the three battery grades among the three locations to maximize total profit.
   b. The company negotiates a large ongoing order from Edison Motors, for their new electric sedan. The vehicle uses only Heavy batteries, and they need 10 000 units per month. This demand must be met each month, or the customer will be lost. Modify your formulation to achieve this.

5. Variability is sometimes blamed for inefficiency in a production system.
   a. Give an example of how variability can affect production, and suggest a way to reduce or eliminate this variability.
   b. Suggest a set of principles for reducing variability, and briefly explain why they will work.

6. The following table shows the data for a construction project. Late completion has a \$5000/day penalty.

Activity	Precedes	Duration (days)
A	B, C, D	15
B	E	12
C	E, G	6
D	H	5
E	F	3
F	I	8
G	F, J	8
H	J	9
I	END	7
J	END	14

a. Draw the project diagram, determine the critical path, and find the earliest and latest start time of each activity.
b. Just as the project is about to begin, you are informed that activity D will now have 15 days duration, because of an accident investigation ongoing at the subcontractor responsible for the activity. Determine the effect on the project's finish date, and discuss strategies you could use to complete the project.
c. If you can find a new sub-contractor that costs \$1000 per day more than the activity D contractor, and who can complete the activity in 8 days, will you hire them? Justify your answer.

7. A small manufacturer of circuit boards must process a number of jobs through their facility. Three surface-mount machines with similar capabilities are available (Machines A, B and C). Each job is in a batch. An initial allocation of jobs to machines is given below. All times are in seconds. Your manager has asked that the jobs be completed such that you minimize the lateness of the worst job. The manager would like to have all jobs complete in 4 hours.

   a. Schedule the jobs to meet your manager's expectations.
   b. The machines cannot run faster, but if you are allowed to change any other aspect of the operations, suggest a better way to schedule the machines.

		SM Machine time		
Job number	**Batch size**	**Machine A**	**Machine B**	**Machine C**
B2401	72	3100		
B7982	126	4400		
B6183	45		6000	
B1184	110	3800		
B9455	240			3800
B4056	32		4300	
B1847	32		4300	
B6298	32		4300	
B9989	192			1800
B1910	64		1200	
B3311	64		1200	
B8212	32		2900	
B4813	64		1000	
B7214	64		1000	
	Total time:	11300	26200	5600