National Technical Examinations December 2018
17-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. Do two questions from section A, and three questions from section B. 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.
Section A		
1.	10	10
2.	10	10
3.	10	10
Section B		
4.	10	10
5.	10	10
6.	10	10
7.	10	10
8.	10	10

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Section A

Answer two questions from this section.

1. Several ideas are fundamental to the operation of production systems.
   a. Explain how 5S can improve production efficiency.
   b. One of the production innovators of the early 1960's stated that we should "ask why five times". What effect does this have, and why?

2. Variability is often blamed for inefficiency in production systems.
   a. Give an example of how variability can affect productivity, 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.

3. SMED and Kanban are concepts used in just-in-time production.
   a. Give a definition and an example of SMED.
   b. Give an example of a situation in which Kanban would work well, and explain why.

Section B

Answer three questions from this section.

4. A multi-product manufacturing line involves setups between products, and can produce component WX93 at an average rate of 600 per hour. The components use materials valued at $0.02 each. A production day is 8 hours. Production setup time is 3 hours, and inventory holding costs are estimated at 25% annualized. The production line is operated by one worker, who is paid $50/hour.
   a. If the demand is 17 000 per week, prepare a production plan for WX93 to trade-off setup and inventory costs. Also calculate the total annual setup and inventory costs for WX93.
   b. Four weeks into production, you are told that "because of sudden popularity of a product in which WX93 is used, the new demand is 34 000 per week". What considerations are necessary to make this work?

5. 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	17 000	200
Medium	$10	19 000	150
Light	$7	14 000	100

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	15 500	850 000
Toronto	17 500	700 000
Vancouver	24 200	950 000

   a. **Write a mathematical programming formulation** that allocates production of the three battery grades among the locations to maximize total profit. Do not solve the problem. Explain one other cost factor that will be important for this problem.
   b. The company negotiates a large ongoing order, from Edison Motors, for a new electric sedan. The vehicles use Heavy and Medium batteries in the proportion 3:2, and they need 15 000 units per month in total. This demand must be met each month, or the customer will be lost. **Modify your formulation** to achieve this.

6. 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. The sales report for April was misplaced.

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

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

7. The following table shows the data for a construction project.

Activity	Precedes	Duration (days)
A	B, C, D	15
B	E	14
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	12

   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; the total cost for the activity will be the same as before the accident. Late completion has a $5000/day penalty. A new subcontractor will cost $1500 per day more than the activity D subcontractor, and can complete the activity in 6 days. Will you hire them? Justify your answer.

8. A small manufacturer of circuit boards must process several 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 if possible.
    a. Schedule the jobs to meet your manager's expectations. **Explain your method.**
    b. Each machine requires a full-time operator. For the proposed four-hour schedule in part "a." above, the factory operates three, 8-hour shifts per day, seven days per week. Employees are allowed a minimum of two weekends off in every five weeks, work no more than one shift per day, and must have two days-off in every seven days. Calculate the minimum workforce required for this factory.

		SM Machine time		
Job number	Batch size	Machine A	Machine B	Machine C
B2401	72	3200		
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:	11400	26200	5600