Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2022/2023

COURSE NAME	:	INDUSTRIAL ENGINEERING
COURSE CODE	:	BDA 40703
PROGRAMME CODE	:	BDD
EXAMINATION DATE	:	FEBRUARY 2023
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER ANY **FIVE (5)** FROM **SIX (6)** QUESTIONS PROVIDED. 2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK**. 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK.

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

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Q1 (a) Differentiate the roles of Industrial Engineer for manufacturing and service industry.

(4 marks)

(b) Industrial Engineers widely use lean and six sigma approaches to improve operations in industry. Compare the differences between lean and six sigma.

(6 marks)

(c) Kamaruddin works as a packer for a manual assembly process that requires the movements above the shoulder and bending his hips and waist while access materials such as bubble wrap rolls beneath the work surface, as shown in **Figure Q1(c)**. He must bend down to access the materials, which is one of the most problematic work positions, particularly if any weight or physical manipulation below the waist is involved. Evaluate the situation and propose design of an ergonomic workstation in term of eliminating extreme movements and bending posture while performing his work activity. Provide suitable sketch and detail explanation.

(10 marks)

Q2 Toasters are commonly used kitchen appliances and uses heat to brown and harden bread. The assembly of a pop-up toaster involves 9 tasks as summarized in **Table 1**. The production line needs to produce 5,200 units of toaster a week with operation time is 45 hours per week.

(a) Determine the appropriate cycle time.

(4 marks)

(b) Evaluate the given data and propose the precedence diagram.

(6 marks)

(c) Calculate the theoretical minimum number of stations possible.

(3 marks)

(d) Calculate the theoretical maximum efficiency of the set-up.

(5 marks)

(e) Determine the idle time for the production line.

(2 marks)

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Table 1: Assembly tasks of pop-up toaster

Task	Time Required (seconds)	Immediate Predecessors
A	12	-
B	6	A
C	6	A
D	5	-
E	11	D
F	12	D
G	13	B, C
H	9	E, F
I	7	G, H

Q3 (a) Mister Potato is a product line introduced by Mamee Double-Decker (M) Sdn Bhd, well known as Mamee with interests in the manufacturing, marketing and distribution of snack foods, beverages, and other products. Their representative products include Mamee monster snack, potato chips, and Mamee chef. **Table 2** shows potato chips manufacturing process. As an industrial engineer, Mr. Ali needs to prepare a process chart for this potato chips manufacturing process. Analyse the situation and recommend a process chart for this process. Use the process chart form provided in **Figure Q3(a).**

(10 marks)

Table 2: Potato chips manufacturing process

No	Activity	Time (minutes)	Distance (m)
1	From raw material storage to storage bins at work cell	3	10
2	Storage bins	-	-
3	Move to chipping machine	3	5
4	Chipping process	5	-
5	Move to washing machine	3	5
6	Operation at washing machine	5	-
7	Move to strainer	3	6
8	Water dripping process at strainer	5	-
9	Move to frying bowl	3	10
10	Frying process	7	-
11	Move to cooling strainer	3	1
12	Cooling process	15	-
13	Quality inspection	3	10
14	Move to packaging section	5	30

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(b) A time study has been conducted on the potato chips production task as shown in **Table 3**. Based on the observation and performance rating data, company X wants to develop a standard time for this task. The delay and fatigue allowance factor are 13%.

(i) Evaluate the given data dan propose normal time for each job element.
(8 marks)

(ii) Calculate standard time for the task.
(2 marks)

Table 3: Observation and performance rating data

No	Activity	Observation (minutes)			Performance rating
1	From raw material storage to storage bins at work cell	1	2	3	120
2	Storage bins	3	5	2	115
3	Move to chipping machine	3	5	3	100
4	Chipping process	5	4	6	105
5	Move to washing machine	3	5	9*	95
6	Operation at washing machine	5	4	4	100
7	Move to strainer	3	2	6	90
8	Water dripping process at strainer	5	6	5	85
9	Move to frying bowl	3	10*	4	100
10	Frying process	7	8	5	120
11	Move to cooling strainer	3	3	3	105
12	Cooling process	15	15	17	110
13	Quality inspection	3	5	5	115
14	Move to packaging section	5	3	5	110

* Outliers

Q4 (a) In the beginning of the month, there are six jobs available at a fabrication factory. All jobs involve two processes which must specifically starts with Process 1 and ends with Process 2 as shown in **Table 4**. The manager at the factory has a plan to arrange the jobs in ABCDEF sequence which will result to the makespan (overall completion time) value of 77 days.

(i) Propose a better scheduling solution using Johnson's rule. Support your evaluation using Gantt chart schedule.
(8 marks)

(ii) Locate and compute the idle time between jobs at the Gantt chart.
(2 marks)

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Table 4: Job data

Job	Process 1 (Days)	Process 2 (Days)
A	10	12
B	11	13
C	9	2
D	8	5
E	12	9
F	15	12

(b) A well-known supermarket is preparing a budget for its special product known as "Sponge-Bob-Pants". The supermarket expected to sell 30 units of the product daily with the operating period of 360 days per year. The cost of the product is RM125 per unit. The ordering cost is RM100 per order, the holding cost is 20% of the per unit product cost per year and the delivery time from the supplier is 7 days.

(i) Solve for the Economic Order Quantity (EOQ) and 'Number of Order' (per year) for the product.

(5 marks)

(ii) From last year purchasing record, the supermarket always used 500 units as the ordering quantity. Evaluate the cost savings that can be obtained if the EOQ answer in **Q4(b)(i)** is adopted by the supermarket.

(5 marks)

Q5 (a) Just-In-Time (JIT) partnerships exist when a supplier and purchaser work together to remove waste and drive down costs. Elaborate **TWO (2)** goals of JIT partnerships.

(4 marks)

(b) Evo Company sells three models of electro-mechanical parts. The company buys three basic models (M, N, and O) from a Taiwan manufacturer and adds two features (component D) to further differentiate the models. D is bought from a local manufacturer. Lead times are 2 weeks for all items except O, which is 1 week. There are ample supplies of the special feature units (E, F, and G) on hand. There are also 15 units of N, 25 units of O, and 35 units of D on hand. Lot-sizing rules are lot-for-lot ordering for all items except D, which must be ordered in multiples of 50 units. There is a scheduled receipt of 50 units of D in week 1. The master schedule calls for 50 units of M to be produced in week 4, 80 units of N in week 5, and 50 units of O in week 6. Product structure tree is shown in **Figure Q5(b)**. Evaluate all available information and propose material requirements plan for D and its parents.

(16 marks)

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Q6 A high-voltage power supply should have a nominal output voltage of 350 V. Sample of four units are selected each day and tested for process-control purposes. The voltage data are shown in **Table 5**.

(a) Calculate the central line and control limits for X-bar chart and R chart. Use the information in **Table 6** to compute the control chart limits.

(7 marks)

(b) Based on the results in **Q6(a)**, construct control charts and evaluate whether the voltage data is in-control. Justify your answer.

(8 marks)

(c) Propose a suitable quality tool and its procedures about how to make investigation on the out-of-control process.

(5 marks)

Table 5: Voltage data, X_i

Sample number	X_1	X_2	X_3	X_4
1	410	440	450	500
2	450	390	410	460
3	420	430	450	400
4	430	440	410	480
5	440	450	420	480
6	470	460	450	450
7	510	450	430	440
8	420	400	450	390
9	440	420	430	470
10	500	510	450	480
11	430	470	490	510
12	410	480	440	460
13	510	440	480	500
14	420	480	450	470
15	460	420	450	510
16	500	450	460	490
17	440	430	470	450
18	500	420	450	460
19	430	410	440	470
20	480	490	460	500

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Table 6: Factors for calculating $\overline{X}$ and R control charts

Size of sample (n)	Factor for UCL and LCL for $\overline{X}$-charts (A_2)	Factor for LCL for R-charts (D_3)	Factor for UCL for R-charts (D_4)
2	1.880	0	3.267
3	1.023	0	2.574
4	0.729	0	2.282
5	0.577	0	2.114
6	0.483	0	2.004
7	0.419	0.076	1.924
8	0.373	0.136	1.864
9	0.337	0.184	1.816
10	0.308	0.223	1.777

- END OF QUESTIONS -

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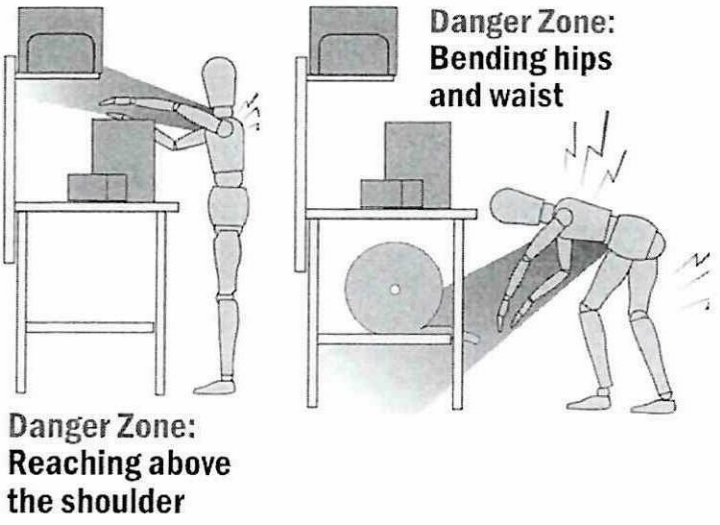

Figure Q1(c)

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PROCESS CHART

Subject Charted :
Date :
Chart by / Name :
Department/ Section :

Distance (meter)	Time (min)	Chart Symbols	Process Description
		O⇨□D▽	
		O⇨□D▽	
		O⇨□D▽	
		O⇨□D▽	
		O⇨□D▽	
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		O⇨□D▽	

O = operation ⇨ = transport □ = inspect D = delay ▽ = storage

Figure Q3(a)

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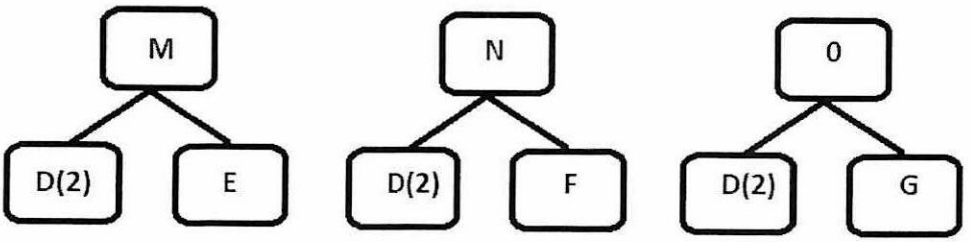

Figure Q5(b)

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