



UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023**

- COURSE NAME : INDUSTRIAL ENGINEERING
- COURSE CODE : DAM 23702
- PROGRAMME CODE : DAM
- EXAMINATION DATE : JULY/ AUGUST 2023
- DURATION : 2 HOURS 30 MINUTES
- INSTRUCTIONS :
1. ANSWER **FOUR (4)** QUESTIONS ONLY.
 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 **EIGHT (8)** PAGES

- Q1 (a)** Tesle GmbH is presently assessing the feasibility of establishing a new manufacturing plant in Peninsular Malaysia. Their consultant has suggested three locations for the facility: Batu Pahat, Balakong, and Kulim. The detailed costs and average variable expenditures for each of these sites per month are tabulated in **Table Q1(a)**.
- (i) Calculate the fixed cost and variable cost for each location. (3 marks)
 - (ii) Construct the total cost curves for each location on a single graph. (3 marks)
 - (iii) Determine the monthly output range for each location that results in the most economical cost. (5 marks)
 - (iv) Determine the location that provides the lowest total cost if the chosen site is expected to produce 80,000 units per month. (1 mark)
- (b)** A company with eight existing facilities is planning to construct a new one and is in the process of identifying the optimal location. The company has two objectives in mind for determining the new facility's location. Firstly, to minimize the weighted sum of the rectilinear distances from the new facility to the existing facilities. Secondly, select the location that is closest to the existing facilities. **Table Q1(b)** provides the locations of the current facilities and the usage frequency.
- (i) Find a location for the new facility that minimizes the weighted sum of the rectilinear distances from the new facility to the existing facilities. (6 marks)
 - (ii) Find the minimax location that is closest to the existing facilities. (7 marks)
- Q2 (a)** Just-in-time is a management philosophy of continuous and forced problem-solving. Differentiate the pull system and the push system in lean production. (5 marks)
- (b)** The demand for sub-assembly product XX is 250 units in week 7. Each unit of XX requires 3 units of B and 2 units of C. Each unit of B requires 3 units of D, 2 units of E, and 1 unit of F. Finally, each unit of C requires 3 units of E and 2 units of F. One firm manufactures all items. It takes 2 weeks to make XX, 2 weeks to make B, 1 week to make C, 2 weeks to make D, 2 weeks to make E, and 1 week to make F. **Table Q2(b)** shows the on-hand inventory and rules for each item.
- (i) Construct a product structure and identify all levels, parents and components. (5 marks)
 - (ii) Construct net material requirements plan for item E. Use a template in **Table Q2(b)(ii)**. (15 marks)

- Q3 (a)** A work sampling study conducted at a metal fabricating plant has resulted in the data in **Table Q3(a)**. The plant operation time is 8 hours/day, 5 days/week, and 4 weeks/month.
- (i) Compute the standard time in minutes/unit for the fabricating process. (5 marks)
 - (ii) Determine the shortage and the overtime period per day that must be arranged to meet the customer demand if the total demand for the product is 15,000 units per month. (6 marks)
 - (iii) Determine the product unit selling price if the labour cost is RM 10/hour and the material cost is RM 40/unit. Assuming no other cost is involved, the company set a profit margin of 60% of the total cost. (4 marks)
- (b) The data in **Table Q3(b)** is derived from a time study in Petronas Fertilizer Sdn. Bhd.
- (i) Calculate standard time for the whole work process if the fatigue allowance is 15%. (6 marks)
 - (ii) Calculate the monthly capacity in this workstation for 24 days works per month with 8 hours of work per day if only one person is assigned to the task. (4 marks)
- Q4 (a)** Mitsubishi Electric Corporation making compressors for refrigerators has a set of compressors that have to go through two remaining operations before the compressors can be completed. The compressors must be processed through Operation 1 and then Operation 2 and the jobs have different time requirements for each operation. **Table Q4(a)** shows the hours required.
- (i) Determine the sequence of jobs by using Johnson's Rule to minimize the total processing time for the six jobs. (3 marks)
 - (ii) Compute the makespan time to complete the jobs. (8 marks)
 - (iii) Determine the total idle time at Operation 2. (2 marks)
- (b) IBM Computer Company uses 28,000 units of transistors annually for its computer assembly. The unit cost of each transistor is RM 8 and the cost of carrying one transistor in inventory for a year is RM 4. The ordering cost is RM 35 per order. The company is operating 280 days per year
- (i) Calculate the optimal order quantity. (3 marks)
 - (ii) Compute the expected number of orders placed each year and the expected time between orders. (4 marks)
 - (iii) Determine the optimal total annual inventory cost. (5 marks)

Q5 A company, which produces a variety of shoe models, has been introducing its latest product model to the market for the past six months. The response to the product has been extremely positive, and sales have exceeded the initial forecast, which was made two years ago. In light of this success, the company has decided to create a new forecast using the sales data from the last six months, as illustrated in **Table Q5**.

- (a) Give **two (2)** reasons why forecasts are seldom perfect. (2 marks)
- (b) Explain why forecasting is important in business. (2 marks)
- (c) Outline **six (6)** steps involved in performing forecasting. (3 marks)
- (d) Forecast the sale in August using the following methods.
 - (i) A four-month moving average. (2 marks)
 - (ii) A weighted average using the weight of 0.40 for the most recent period, 0.30 for the next most recent, 0.20 for the next, and 0.10 for the next. (3 marks)
 - (iii) Exponential smoothing with a smoothing constant equal to 0.40, assuming a February sale forecast is 25000. (6 marks)
 - (iv) A linear trend equation. (7 marks)

Q6 (a) Seven (7) basic Quality Control Tools are widely used by the industry. Explain the purpose of the following tools:

- (i) Check Sheet (2.5 marks)
- (ii) Cause and Effect Diagram (2.5 marks)

(b) In a quality control case study, subgroup samples ($n = 4$) of a critical quality characteristic are summarized in **Table Q6(b)**. Subgroups 1~6 represent the in-control process samples. Design parameters for the X-bar control chart and R-chart are given as follows; $A_2 = 0.729$, $D_3 = 0$, $D_4 = 2.282$.

- (i) Using the X-bar control chart, determine the central line (μ) and control limit (UCL, LCL). Then, plot the chart and indicate the area to be in a statistically "In-Control" and "Out-of-Control" conditions. (12 marks)
- (ii) Determine the central line (μ) and control limit (UCL, LCL) for R-Chart. Then, plot the chart and indicate the area to be in a statistically "In-Control" and "Out-of-Control" conditions. (8 marks)

– END OF QUESTIONS –

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Table Q1(a): Cost of new facilities

Locations	Cost				
	Fixed Cost			Variable Cost	
	Building and Land Rental (RM)	Municipal Council Tax (RM)	Equipment (RM)	Raw Material (RM/unit)	Transportation (RM/unit)
Batu Pahat	200,000	50,000	150,000	40	15
Balakong	600,000	75,000	175,000	35	10
Kulim	300,000	75,000	125,000	40	10

Table Q1(b): Location of the current facilities

Machine	Location coordinates (x,y)	Trips
1	(0,0)	5
2	(6,4)	2
3	(2,8)	4
4	(5,10)	6
5	(9,5)	8
6	(3,2)	6
7	(4,6)	6
8	(8,9)	3

Table Q2(b): On-hand inventory for each item

Item	On-Hand Inventory	Rules	Item	On-Hand Inventory	Rules
XX	110	L4L	E	400	FOQ=40
B	50	L4L	F	30	L4L
C	30	FOQ = 30			
D	20	FOQ = 50			



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Table Q2(b)(ii): Template for material requirements plan

Item = ?	Rule = Lead Time =							
	Week							
	1	2	3	4	5	6	7	8
Gross Requirements								
Scheduled Receipts								
Projected-on-hand inventory								
Planned Receipts								
Planned Order Releases								

Table Q3(a)

Item	Data
Total observation period	5 days
Observation time per day	8 hours
Plant in operations during the 5-day study	300 observations
Plant idle during the 5-day study	18 observations
Average daily output	550 units/day
Rating	90%
Allowances	15%

Table Q3(b)

Work Elements	Rating	Cycle Time (seconds)				
		1	2	3	4	5
Grasp and open the bag	90%	8	7.3	7.5	7.8	7.6
Arrange the bag on the conveyor	85%	15.3	16.3	15	14.5	16
Fill in the fertilizer (fully automatic)		10	10	10	10	10
Pull the bag from conveyor	110%	8.9	7.7	9	9.3	8.6
Confirm the weight	115%	5.8	4.6	6.3	6.1	5.9
Sewing the bag (fully automatic)		8	8	8	8	8

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Table Q4(a)

Job	Operation 1 (hour)	Operation 2 (hour)
A	5	8
B	9	4
C	2	1
D	7	6
E	3	5
F	2	4

Table Q5: Sale of a new model for the past 6 months

Month	Sales (unit)
Feb	27000
Mar	30000
April	30000
May	34000
June	35000
July	37000

Table Q6(b): A critical quality characteristics data

No	Subgroup: 1~6	No	Subgroup:7~12
1	70.430, 70.440,70.410, 70.359	7	70.430, 70.420, 70.410, 70.455
2	70.420, 70.415, 70.430, 70.443	8	70.450, 70.445, 70.440, 70.423
3	70.430, 70.440, 70.425, 70.522	9	70.430, 70.420,70.440, 70.492
4	70.415, 70.425, 70.435, 70.292	10	70.440, 70.450, 70.440, 70.433
5	70.420,70.410, 70.425, 70.512	11	70.450, 70.460, 70.440, 70.512
6	70.415, 70.410, 70.420, 70.429	12	70.430, 70.450, 70.440, 70.455

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Formula:

$$TC = FC + VC(Q)$$

$$f(x, y) = \sum_{i=1}^n w_i (|x - a_i| + |y - b_i|) \rightarrow \text{Minisum formula}$$

$$\left. \begin{aligned} f(x, y) &= \max(|x - a_i| + |y - b_i|) \\ \text{First point: } (x_1, y_1) &= 0.5(c_1 - c_3, c_1 + c_3 + c_5) \\ \text{Second point: } (x_2, y_2) &= 0.5(c_2 - c_4, c_2 + c_4 - c_5) \end{aligned} \right\} \text{Minimax formula}$$

$$\text{Normal time} = \frac{(\text{Total observation time}) \times (\text{Productive}) \times (\text{Rating})}{(\text{Total Output})}$$

$$a = \frac{\sum y - b \sum x}{n} \quad b = \frac{n \sum(xy) - \sum x \sum y}{n \sum x^2 - (\sum x)^2} \rightarrow \text{Regression formula}$$

$$Q^* = \sqrt{\frac{2DS}{H}} \quad TC = \frac{D}{Q}S + \frac{Q}{2}H$$

$$Q^* = \sqrt{\frac{2DS}{H(1 - \frac{d}{p})}} \quad TC = \frac{D}{Q}S + \frac{Q^*H}{2} \left(1 - \frac{d}{p}\right) \quad d = \frac{D}{\text{working days/year}}$$

$$UCL_R = D_4 \bar{R} \quad LCL_R = D_3 \bar{R} \quad CL_{\bar{X}} = \bar{\bar{X}} \pm A_2 \bar{R} \quad \bar{\bar{X}} = \frac{\sum \bar{x}}{g}$$