



**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER II  
SESSION 2023/2024**

- COURSE NAME : PLANT ENGINEERING & QUALITY MANAGEMENT
- COURSE CODE : BDJ 31003
- PROGRAMME CODE : BDJ
- EXAMINATION DATE : JULY 2024
- DURATION : 3 HOURS
- INSTRUCTIONS :
1. ANSWER ALL QUESTIONS
  2. THIS FINAL EXAMINATION IS CONDUCTED VIA
    - Open book
    - 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 SEVEN (7) PAGES

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**Q1** Answer all the following questions.

- (a) **Table Q1.1** shows the cost of shipping the spare parts from each warehouse to each service centre. Also list the spare parts available at each warehouse and the number of spare parts needed at each service centre. Identify the optimal total shipment cost for this case.

(7 marks)

**Table Q1.1** The cost for transport the spare parts.

FROM	TO				Supply
	Service Centre A	Service Centre A	Service Centre A	Service Centre A	
Warehouse 1	6	8	8	5	30
Warehouse 2	5	11	9	7	40
Warehouse 3	8	9	7	13	50
Demand	35	28	32	25	120

- (b) The transportation model involves finding the lowest-cost plan to distribute goods from several origins to several destinations. List **THREE (3)** important factors that need to apply to the transportation model.

(3 marks)

- (c) An owner of European Ignition Manufacturing needs to expand his capacity. He is considering a new plant for Athens, Brussels, and Lisbon. The company wishes to find the most economical location for an expected volume of 2000 units per year. The fixed cost per year at the sites are \$30,000, \$60,000 and \$110,000 respectively for Athens, Brussels and Lisbon. The variable cost is \$75 per unit, \$45 per unit and \$25 per unit, respectively. The expected selling price of each ignition system produced is \$120.

- (i) Calculate the total cost for all location considered.

(3 marks)

- (ii) Construct a graph for performing the locational cost volume analysis.

(4 marks)

- (iii) Calculate the crossover point between Athens with Brussel and Brussel with Lisbon.

(4 marks)

- (iv) Justify the answer from **Q1(c)(iii)** for suitable location preferred.

(2 marks)

- (v) Calculate the expected profit for 2000 units.

(2 marks)

**Q2** Answer all the following questions.

- (a) Production planning (PP) forecasting involves using data to make predictions about the future impact of various scenarios. The goal is to gather as much data as possible to make well-informed predictions about how different scenarios will affect operations. List down and describe **THREE (3)** types of forecasting by time horizon and provide an example of when each type could be applied.

(6 marks)

- (b) The sales of Perodua's popular Axia have steadily increased over the past 10 years, as shown in **Table Q2.1**. In 2000, the sales manager predicted that 2001 sales would be 820. Using exponential smoothing with  $\alpha = 0.1$ , calculate the forecast for the year 2010.

(8 marks)

**Table Q2.1: Years and sales of Perodua from 2001 to 2009**

WEEK	DEMAND
2001	820
2002	775
2003	680
2004	655
2005	750
2006	802
2007	789
2008	689
2009	775
2010	?

- (c) **Table Q2.2** shows data on the sales of 20-inch televisions and unemployment rates for Zeta Company. Based on the given facts,

- (i) Derive predictive equation for sales based on unemployment levels using linear regression model technique.

(9 marks)

- (ii) Using predictive equation derived from **Q2(c)(i)**, predict how many units sold by Zeta Company if the unemployment is 2.8%.

(2 marks)

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**Table Q2.2: Sales of 20” TV and unemployment for Zeta Company**

PERIOD	UNIT SOLD	UNEMPLOYMENT (%)
1	20	7.2
2	41	4.0
3	17	7.3
4	35	5.5
5	25	6.8
6	31	6.0
7	38	5.4
8	50	3.6
9	15	8.4
10	19	7.0
11	14	9.0

**Q3** Statistical process control (SPC) exists due to variations in characteristics of the process output, which is used to evaluate the process output still “in control” or “out of control”.

(a) Many factors that contribute to variation. List **FOUR (4)** sources of variation and its **TWO (2)** examples.

(4 marks)

(b) The Nuha Alias Sdn. Bhd. wishes to monitor and control the product’s dimension during the casting process. The measurement data is summarized in **Table Q3.1**. The given values for A2, D3, and D4 are 0.577, 0, and 2.114, respectively. Based on this information,

**Table Q3.1: Data collected during measurements**

Subgroup Number	Date	Time	Measurements (mm)				
			X <sub>1</sub>	X <sub>2</sub>	X <sub>3</sub>	X <sub>4</sub>	X <sub>5</sub>
1	April 1	00:00	8.0	9.4	7.6	8.8	8.9
2		02:00	9.3	8.8	9.2	9.2	8.2
3		04:00	7.4	7.4	7.9	9.0	8.1
4		06:00	9.3	8.0	7.4	7.9	8.2
5		08:00	9.4	7.9	9.6	9.4	9.2
6	April 2	00:00	8.7	9.3	8.8	<b>8.9</b>	8.7
7		02:00	8.0	8.5	8.1	8.4	8.4
8		04:00	9.6	8.3	8.3	7.9	8.9
9		06:00	8.4	7.6	8.7	8.5	8.0
10		08:00	9.4	8.7	9.0	9.6	9.4
11	April 3	00:00	8.5	8.1	9.6	8.3	8.2
12		02:00	8.5	8.5	8.0	9.0	9.4
13		04:00	8.0	9.2	8.2	8.5	8.4
14		06:00	8.1	8.8	9.4	8.4	7.9
15		08:00	7.8	9.6	9.0	8.0	8.3

- (i) Determine the average and range for each subgroup. (6 marks)
- (ii) Determine the control limits for the X-bar chart. (5 marks)
- (iii) Determine the control limits for the R-chart. (2 marks)
- (iv) Plot the X-bar chart for preliminary data with trial control limits. (3 marks)
- (v) Plot the R-chart for preliminary data trial control limits. (3 marks)
- (vi) Based on the plotting of X-bar chart, comment the quality condition of the dimension measurements. (2 marks)

**Q4** There are **SEVEN (7)** quality control tools that are used in the TQM principles and Pareto diagram is one of the QC tools.

- (a) State the purpose of using Pareto diagram in TQM. (2 marks)
- (b) Flex Homes is a contractor that specialized in building renovations. The company has conducted a final inspection and recorded the defects. The data recorded for defects found during the inspection is shown in **Table Q4.1**.

**Table Q4.1** Data defects during inspection

Type of defects	Occurrence
Woodwork	46
Plumbing	33
Electrical	25
Interior paint	16
Doors	14
Damaged walls	13
Cabinetry	12
HVAC	11
Exterior paint	5
Roof	3

- (i) Calculate the cumulative percentage for each type of defects.  
(8 marks)
- (ii) Construct a pareto diagram for the defects with proper labelling.  
(9 marks)
- (iii) Recommend the types of defects that requires attention to be resolved first.  
(2 marks)
- (iv) Interpret the correlation between two variables investigation from your answer in **Q4(b)(ii)**.  
(4 marks)

**- END OF QUESTIONS -**

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## APPENDIX A

## FORMULA

1. Total Cost = FC + VC(Q)  
= Fixed Cost + Variable Cost (Quantity or volume of output)
2. Profit = Revenue – Total cost
3. Exponential Smoothing Forecast  
 $F_t = F_{t-1} + \alpha (A_{t-1} - F_{t-1})$
4. Forecast Equation  
 $Y_i = a + bx_i$
5. Slope  $b = \frac{n \sum (xy) - \sum x \sum y}{n \sum x^2 - (\sum x)^2}$
6. Y interface,  $a = \frac{\sum y - b \sum x}{n}$
7. Average,  $\bar{X} = \text{Total no. of measurement}/n$
8. Range,  $R = \text{Highest value} - \text{Lowest value}$
9. Upper Control Limit (UCL) & Lower Control Limit (LCL) for X and R  

$$UCL_{\bar{x}} = \bar{\bar{x}} + 3\sigma_{\bar{x}} = \bar{\bar{x}} + A_2 \bar{R}$$

$$LCL_{\bar{x}} = \bar{\bar{x}} - 3\sigma_{\bar{x}} = \bar{\bar{x}} - A_2 \bar{R}$$

$$UCL_R = \bar{R} + 3\sigma_{\bar{x}} = D_4 \bar{R}$$

$$LCL_R = \bar{R} - 3\sigma_{\bar{x}} = D_3 \bar{R}$$
10. Payback period (years) = Estimated project cost/ Annual saving

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