CONFIDENTIAL

Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	STATISTICS FOR MANAGEMENT
COURSE CODE	:	BPA 12303
PROGRAMME CODE	:	BPA / BPB / BPC / BPP
EXAMINATION DATE	:	JULY / AUGUST 2023
DURATION	:	3 HOURS
INSTRUCTIONS	1.	ANSWER **ALL** QUESTIONS
	2.	THIS FINAL EXAMINATION IS CONDUCTED **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) The owner of a small restaurant decides to change the menu. A trade magazine claims that 40% of all diners choose organic foods when eating away from home. On a randomly chosen day, there are 20 diners eating in the restaurant.

(i) Assuming the claim made by the trade magazine to be correct, suggest a suitable model to describe the number of diners X who choose organic foods.
(3 marks)

(ii) Find P $(5 < X < 15)$
(4 marks)

(iii) Find the mean and standard deviation of X.
(3 marks)

(b) A 100-watt light bulb has an average brightness of 1640 lumens, with a standard deviation of 62 lumens.

Compute:

(i) The probability that a 100-watt light bulb will have a brightness more than 1800 lumens.
(3 marks)

(ii) The probability that a 100-watt light bulb will have a brightness less than 1550 lumens.
(3 marks)

(iii) The probability that 100-watt light bulb will have a brightness between 1600 and 1700 lumens.
(4 marks)

Q2 (a) A manufacturer produces a certain type of battery, where the lifetime of this battery follows a normal distribution with a mean of 1100 days and a standard deviation of 80 days. The manufacturer has randomly chosen to send 400 batteries of this type to a departmental store.

(i) Calculate the mean and standard deviation of the sampling distribution of $\bar{x}$.
(5 marks)

(ii) Find the probability that the average lifetime of these 400 batteries is between 1097 and 1104 days.
(5 marks)

(b) Suppose there are two populations of UTHM students participating in a French Language debate competition, and they are categorized based on their scores as Score A and Score B. Let X denote the number of questions answered by the participating students. **Table Q2(b)** shows the summary of the scores.

Table Q2(b): Summary of the scores

	Score A	Score B
Sample mean	83	91
Sample standard deviation	12	8
Sample size	15	14

Based on **Table Q2(b)**, determine the probability that the mean number of questions answered by the students who received Score B is less than or equal to that of the students who received Score A.

(10 marks)

Q3 A student is investigating the relationship between the price of 100 grams of chocolate and the percentage of cocoa solid in the chocolate. **Table Q3** shows the data which is used to develop a simple regression model.

Table Q3: Price and percentage of cocoa solid

Chocolate Brand	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
Percentage of Cocoa, %	10	20	30	35	40	50	60	70
Price per 100 grams (RM)	35	55	40	100	60	90	110	130

(a) Sketch a scatter plot for the data.

(4 marks)

(b) (i) Find the estimated regression line by using the least square method.

(6 marks)

(ii) Interpret the result in **Q3(b)(i)**.

(2 marks)

(c) Predict the price of 1 kilogram of chocolate when the percentage of cocoa solid in the chocolate is 85%.

(2 marks)

(d) (i) Calculate the coefficient of correlation, r and coefficient of determination, r^2.

(4 marks)

(ii) Interpret the result in **Q3(d)(i)**.

(2 marks)

Q4 (a) The Durable Construction Company produces frames for solar panels. The frames need to withstand certain pressures. The frame is expected to support a mean weight of 40 kilos before distortion. At periodic intervals, a sample is selected and tested to determine whether the mean weight which can be supported by the frame is still 40 kilos or not. If not, then it is assume that something has gone wrong in the production line of the frames. A random sample of 45 frames is taken from the production line. The test results from the sample of 45 frames suggest a mean weight of 39.8 kilos with a standard deviation of 6 kilos.

(i) Construct a 95% confidence interval estimate for the population mean weight which can be supported by the frame.

(5 marks)

(ii) The manager of Durable Construction Company claims that something has gone wrong in the production process.

Explain whether his claim is acceptable or not.

(2 marks)

(b) A manufacturer of automobile shock absorbers was interested in comparing the durability of its shock absorbers with that of the shock absorbers produced by its biggest competitor. To make the comparison, one of the manufacturer's and one of the competitor's shock absorbers were randomly selected and installed on the rear wheels of each of six cars. After the cars had been driven 20,000 kilometres, the strength of each test shock absorbers was measured, coded, and recorded. It is given that the population variances are equal for both groups. The results of the examination are shown in the **Table Q4(b)**.

Table Q4(b): Strength of test shock absorbers

Car number	Manufacturer's shock absorbers	Competitor's shock absorbers
1	8.8	8.4
2	10.5	10.1
3	12.5	12.0
4	9.7	9.3
5	9.6	9.0
6	13.2	13.0

Determine whether there is sufficient evidence to conclude that there is a difference in the mean strength of the two types of shock absorbers after 20,000 kilometres of use by using a level of significance of 0.05.

(13 marks)

Q5 An experiment was conducted to study the effects of various diets on lambs. The diets are categorised as A, B, C, D and E. A total of 25 similar lambs were selected and randomly allocated to one of the five category such that each category have five lambs. After a fixed time the gains in mass, in kilograms, of the lambs were measured. Table Q5 shows the gains in mass for the 25 lambs.

Table Q5: Mass gained by the lambs

A	B	C	D	E
23.1	21.9	18.3	21.0	20.1
15.5	13.2	31.0	25.4	18.4
22.6	19.7	30.9	21.5	17.1
14.6	16.5	21.9	21.2	21.2
15.7	22.8	29.8	19.8	20.5

(a) Determine whether there is evidence of difference in the mass gained by the lambs from different diets, at the 0.01 level of significance.

(18 marks)

(b) Choose the best diet for the lambs based on the result in **Q5(a)** and justify your selection.

(2 marks)

-END OF QUESTIONS –

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Special Probability Distributions

Binomial:

$P(X=x)={}^{n}C_{x}.p^{x}.q^{n-x}$ Mean, $\mu=np$ Variance, $\sigma^{2}=npq$

Poisson:

$$P(X=x)=\frac{e^{-\mu}.\mu^{x}}{x!}$$

Normal:

$$P(X>k)=P\left(Z>\frac{k-\mu}{\sigma}\right)$$

Sampling Distribution

Z – value for single mean:

$$Z=\frac{\bar{x}-\mu}{\sigma/\sqrt{n}}$$

Probability related to single Mean:

$$P\left(\bar{x}>r\right)=P\left(Z>\frac{r-\mu}{\sigma/\sqrt{n}}\right)$$

Let,

$$\mu_{\bar{x}_1-\bar{x}_2}=\mu_1-\mu_2 \quad and \quad \sigma_{\bar{x}_1-\bar{x}_2}=\sqrt{\frac{\sigma_1^{2}}{n_1}+\frac{\sigma_2^{2}}{n_2}}$$

Z – value for Two Mean:

$$Z=\frac{\left(\bar{x}_1-\bar{x}_2\right)-\mu_{\bar{x}_1-\bar{x}_2}}{\sigma_{\bar{x}_1-\bar{x}_2}}$$

Probability related to two Mean:

$$P\left(\bar{x}_1-\bar{x}_2>r\right)=P\left(Z>\frac{r-\mu_{\bar{x}_1-\bar{x}_2}}{\sigma_{\bar{x}_1-\bar{x}_2}}\right)$$

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Estimation

Confidence interval for single mean:

Large sample: $n \geq 30 \Rightarrow \sigma$ is known: $\left(\bar{x} - z_{\alpha/2}\left(\sigma / \sqrt{n}\right) < \mu < \bar{x} + z_{\alpha/2}\left(\sigma / \sqrt{n}\right)\right)$

$\Rightarrow \sigma$ is unknown: $\left(\bar{x} - z_{\alpha/2}\left(s / \sqrt{n}\right) < \mu < \bar{x} + z_{\alpha/2}\left(s / \sqrt{n}\right)\right)$

Small sample: $n < 30 \Rightarrow \sigma$ is unknown: $\left(\bar{x} - t_{\alpha/2}\left(s / \sqrt{n}\right) < \mu < \bar{x} + t_{\alpha/2}\left(s / \sqrt{n}\right)\right)$

Hypothesis Testing

Testing of hypothesis on a difference between two means

Variances	*Samples size*	*Statistical test*
Unknown (Equal)	$n_1, n_2 < 30$	$T_{Test} = \dfrac{\left(\bar{x}_1 - \bar{x}_2\right) - \left(\mu_1 - \mu_2\right)}{S_p \cdot \sqrt{\dfrac{1}{n_1} + \dfrac{1}{n_2}}}$ $v = n_1 + n_2 - 2$ where $S_p = \sqrt{\dfrac{\left(n_1 - 1\right)s_1^2 + \left(n_2 - 1\right)s_2^2}{n_1 + n_2 - 2}}$
Unknown (Not equal)	$n_1 = n_2 < 30$	$T_{Test} = \dfrac{\left(\bar{x}_1 - \bar{x}_2\right) - \left(\mu_1 - \mu_2\right)}{\sqrt{\dfrac{1}{n}\left(s_1^2 + s_2^2\right)}}$ $v = 2(n-1)$
Unknown (Not equal)	$n_1, n_2 < 30$	$T_{Test} = \dfrac{\left(\bar{x}_1 - \bar{x}_2\right) - \left(\mu_1 - \mu_2\right)}{\sqrt{\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}}}$ $v = \dfrac{\left(\dfrac{s_1^2}{n_1} + \dfrac{s_2^2}{n_2}\right)^2}{\dfrac{\left(\dfrac{s_1^2}{n_1}\right)^2}{n_1 - 1} + \dfrac{\left(\dfrac{s_2^2}{n_2}\right)^2}{n_2 - 1}}$

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Simple Linear Regressions

Let

$$S_{xy}=\sum_{i=1}^{n}x_iy_i-\frac{1}{n}\left(\sum_{i=1}^{n}x_i\right)\left(\sum_{i=1}^{n}y_i\right),\quad S_{xx}=\sum_{i=1}^{n}x_i^2-\frac{1}{n}\left(\sum_{i=1}^{n}x_i\right)^2 \text{ and } S_{yy}=\sum_{i=1}^{n}y_i^2-\frac{1}{n}\left(\sum_{i=1}^{n}y_i\right)^2$$

Simple linear regression model

$$\hat{y}=\hat{\beta}_0+\hat{\beta}_1x$$

where

$$\hat{\beta}_1=\frac{S_{xy}}{S_{xx}}$$

$$\hat{\beta}_0=\bar{y}-\hat{\beta}_1\bar{x}$$

Coefficient of Determination

$$r^2=\frac{\left(S_{xy}\right)^2}{S_{xx}\cdot S_{yy}}$$

Coefficient of Pearson Correlation

$$r=\frac{S_{xy}}{\sqrt{S_{xx}\cdot S_{yy}}}$$

Analysis of Variance

Mean square for treatment (between)

$$MS_B=\frac{\sum n_i\left(\bar{x}_i-\bar{x}_{GM}\right)^2}{k-1}$$

Mean square for error (within)

$$MS_W=\frac{\sum\left(n_i-1\right)s_i^2}{N-k}$$

F test value

$$F=\frac{MS_B}{MS_W}$$