UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(ONLINE)
SEMESTER II
SESSION 2019/2020

COURSE NAME : ENGINEERING STATISTICS

COURSE CODE : BDA 24103

PROGRAMME CODE : BDD

EXAMINATION DATE : JULY 2020

DURATION : 3 HOURS

INSTRUCTION : **SECTION A:** ANSWER **ALL** QUESTIONS
SECTION B: ANSWER **THREE (3)** FROM FOUR (4) QUESTIONS.

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THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

SECTION A

Instruction: Please answer **ALL questions** in this section.

Q1 Raw material used in the production of a synthetic fiber is stored in a place that has no humidity control. Measurements of the relative humidity and the moisture content of samples from the raw material (both in percentage) on 12 days yielded the results as shown in **Table Q1**.

Table Q1: Data of relative humidity and moisture content

Humidity (x)	Moisture content (y)
46	12
53	14
37	11
42	13
34	10
29	8
60	17
44	12
41	10
48	15
33	9
40	13

(a) Draw a scatter plot for the variables.

(4 marks)

(b) Determine the regression line using the least squares method and interpret the result.

(6 marks)

(c) Estimate the moisture content when the relative humidity is 38 percent

(2 marks)

(d) Test the hypothesis concerning $H_0 : \beta_1 = 1$ against the $H_1 : \beta_1 > 1$ at the 0.05 level of significance.

(8 marks)

Q2   (a)   **Table Q2(a)** displays the observations from a single factor experiment (replicate n = 2). Use Analysis of Variance (ANOVA) to determine whether the factor of temperature (T) has significant effect on the number of products per hour (m) (use $\alpha = 0.05$).

(6 marks)

Table Q2(a): Results of a single factor experiment

Factor	Observations	
Temperature, T (°C)	Number of products per hour (m)	
10	2	3
20	3	5
30	7	7

(b)   A pharmaceutical manufacturer wants to investigate the efficacy of a new drug on a Covid-19 coronavirus. The efficacy of the drug is indicated by the low number of observations. A completely randomized single-factor experiment was conducted with three dosage levels, and the results as shown in **Table Q2(b)** were obtained.

Table Q2(b): Results of a new drug test

Dosage	Observations			
20 g	24	28	37	30
30 g	37	44	31	35
40 g	42	47	52	38

(i) Is there evidence to indicate that dosage level affects the efficacy? Use $\alpha = 0.05$.

(8 marks)

(ii) Analyze the residuals from this experiment through normal distribution plot and constant variance check and comment on model adequacy.

(6 marks)

SECTION B

Instruction: Please answer **THREE (3) questions** from FOUR (4) questions provided in this section.

Q3 (a) Any experiments or data gathering will always consist of two errors. Name the two common errors.

(4 marks)

(b) In approaching to formulating and solving problems by employing the engineering method or statistical thinking, please arrange the sequence as shown in **Figure Q3** below accordingly to form a process flow.

(1) Conduct experiments
(2) Confirm the solution
(3) Identify the important factors
(4) Propose or refine the model
(5) Develop a clear descriptions
(6) Conclusions and recommendation
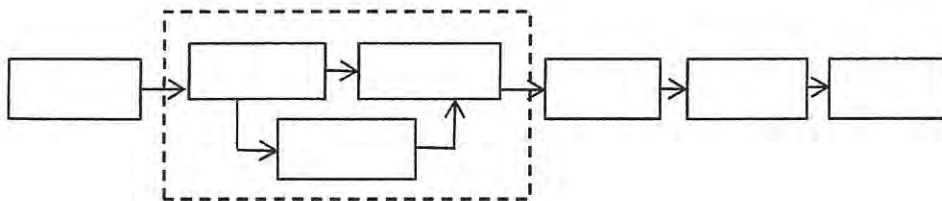(7) Manipulate the model

(7 marks)

Figure Q3: Sequence of engineering/statistical method in problem solving.

(c) The weight, in grams, of red beans in a can is normally distributed with mean μ and standard deviation 7.6. Given that 5% of cans contains less than 200g, determine;

(i) The value of μ.

(5 marks)

(ii) The percentage of cans that contains more than 225 g of beans.

(4 marks)

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Q4 The number of hits on a certain website follows a Poisson distribution with a mean rate of 8 per minute.

(a) What is the probability that 5 messages are received in a given minute?

(6 marks)

(b) What is the probability that 9 messages are received in 1.5 minutes?

(6 marks)

(c) What is the probability that fewer than 3 messages are received in a period of 30 seconds?

(8 marks)

Q5 (a) A production engineer collected data of copper rods produced from two different rolling machines. The population diameter data on both machines follow normal distribution with standard deviation of 0.45 mm for machine A and 0.38 mm for machine B. 40 random samples were taken from machine A yielding the average rod diameter of 32.5 mm. 50 random samples were also taken from machine B yielding 31.9 mm average rod diameter.

(i) Calculate 90% confidence interval for difference between means rod diameter for machine A and machine B.

(8 marks)

(ii) Explain the meaning of your answer in Q5(a)(i).

(2 marks)

(b) A study was conducted to determine if the students from the public universities take longer to graduate than the students from the private universities. 100 students from both the public universities and private universities were surveyed. Suppose that from the years of research, it was known that the population standard deviations were 1.58 years and 1 year respectively. The following data were collected. The public and private universities students took an average of 4.5 and 4.1 years respectively with a standard deviation of 0.3. Use a 0.01 level of significance to test the claim.

(i) State the null and alternative hypotheses.

(2 marks)

(ii) Is there any evidence to support the claim at $\alpha = 0.01$?

(8 marks)

Q6 An experiment has been conducted to test the failure of aluminium under repeated alternating stress at 210000 psi and 18 cycles per second. The numbers of cycles to failure of $n = 70$ aluminium test are given in **Table Q6** (arranged in ascending order).

  (a) Determine the sample mean, sample variance, minimum value and maximum value, and sample range of the test.

(8 marks)

  (b) Calculate number of bins, widths of a bin and limits of the histogram. Then, construct a histogram based on these values.

(10 marks)

  (c) Based on the histogram, state the skewness of the distribution and describe the value of mean, median and mode of the distribution.

(2 marks)

Table Q6: Results of failure test on aluminium

375	706	758	785	798	845	865	885	910	990
1000	1015	1016	1018	1020	1055	1085	1102	1102	1109
1115	1120	1203	1223	1238	1258	1260	1269	1270	1310
1315	1315	1330	1416	1421	1452	1468	1481	1501	1502
1512	1522	1535	1540	1560	1567	1578	1594	1605	1608
1642	1674	1730	1750	1750	1764	1781	1782	1792	1820
1883	1888	1890	1910	1940	2023	2100	2130	2215	2265

END OF QUESTIONS

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