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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	STATISTICS FOR ENGINEERING TECHNOLOGY
COURSE CODE	:	BDJ22502
PROGRAMME CODE	:	BDJ
EXAMINATION DATE	:	JULY/AUGUST 2023
DURATION	:	2 HOURS
INSTRUCTION	:	1. ANSWER ALL QUESTIONS
		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 **FOUR (4)** PAGES

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Q1 According to *Chemical Engineering*, an important property of fiber is its water absorbency. The average percent absorbency of 9 randomly selected pieces of cotton fiber was 20 with a standard deviation of 1.5. A random sample of 9 pieces of acetate yielded an average percent of 12 with a standard deviation of 1.35.

(a) Past experience indicates that the average percent absorbency of acetate is 13 with a standard deviation of 1.25.

(i) Compute the probability that the sample mean in percent absorbency of acetate falls between 12.6 and 14.2.

(6 marks)

(ii) Determine the required size of a sample if 5% of the sample mean in percent absorbency of acetate is more than 13.4.

(7 marks)

(b) Compute a 90% confidence interval for the variance in percent absorbency of cotton fiber.

(6 marks)

(c) Given that the population variances in percent absorbency for the two fibers are the same.

(i) Determine an appropriate distribution for this problem. Give your reason.

(3 marks)

(ii) Calculate a 98% confidence interval for the difference in the true average percent absorbency for the two fibers.

(7 marks)

(d) Calculate a 95% confidence interval for the ratio of the variances in percent absorbency for two fibers.

(7 marks)

(e) Assume that the percent absorbency is approximately normally distributed and that the population variances in percent absorbency for two fibers are different.

(i) Determine an appropriate distribution for this problem. Give your reason.

(3 marks)

(ii) Is there strong evidence that the population means percent absorbency is significantly higher for cotton fiber than for acetate at a 5% significance level?

(11 marks)

(f) Based on your conclusion in **Q1(e)(ii)**, what type of error that you possibly make? Explain in the context of the problem.

(4 marks)

Q2 Consider two samples,

$$Y_1 = \frac{X_1 + X_2 + \cdots + X_7}{7} \text{ and } Y_2 = \frac{5X_1 + 2X_3 - 3X_6}{4}.$$

Determine whether they are both consistent estimators. If yes, recommend the most efficient estimator.

(11 marks)

Q3 An automobile company management believes that the number of customers in a quarter of the year can be accurately predicted based on the number of new automobile registrations in the previous quarter. **Table Q3** shows the number of customers (in hundreds) during the last 12 quarters and the number of new car registrations (in thousands) for each previous quarter.

Table Q3

Quarter	New cars registered	Number of customers
1	13.4	6.1
2	16.1	7.2
3	7.9	3.3
4	19.2	8.1
5	16.0	7.1
6	13.0	5.4
7	10.1	4.2
8	14.2	5.1
9	13.4	5.1
10	16.1	6.2
11	9.9	4.3
12	18.2	7.1

(a) Calculate the correlation coefficient between the number of customers per quarter and the number of new cars registered.

(5 marks)

(b) Based on your answer in **Q3(a)**, will the number of new cars registered help predict the number of new customers per quarter?

(2 marks)

(c) Fit a linear regression model relating the number of new cars registered to the number of new customers per quarter.

(5 marks)

(d) Estimate the number of new customers for the following quarter if the number of new cars registered is expected to be 20.

(3 marks)

- END OF QUESTIONS -

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FORMULA

$$Var(X)=E[(x-\mu)^2]=E(x^2)-[E(x)]^2$$

$$\Pr(X=r)=\binom{n}{r}p^r(1-p)^{n-r}={}^nC_r p^r q^{n-r}$$

$$\Pr(X=r)=\frac{e^{-\mu}\mu^r}{r!}$$

$$Z=\frac{(\bar{x}_1-\bar{x}_2)-(\mu_1-\mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1}+\frac{\sigma_2^2}{n_2}}}\sim Z_\alpha$$

$$Z=\frac{(\bar{x}_1-\bar{x}_2)-(\mu_1-\mu_2)}{\sqrt{\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}}}\sim Z_\alpha$$

$$T=\frac{(\bar{x}_1-\bar{x}_2)-(\mu_1-\mu_2)}{\sqrt{\frac{1}{n}(s_1^2+s_2^2)}}\sim T_\alpha(v)$$

$$T=\frac{(\bar{x}_1-\bar{x}_2)-(\mu_1-\mu_2)}{S_p\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}}\sim T_\alpha(v)$$

$$T=\frac{(\bar{x}_1-\bar{x}_2)-(\mu_1-\mu_2)}{\sqrt{\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}}}\sim T_\alpha(v)$$

$$\frac{s_1^2}{s_2^2}\frac{1}{f_{\alpha/2}(\nu_1,\nu_2)}<\frac{\sigma_1^2}{\sigma_2^2}<\frac{s_1^2}{s_2^2}f_{\alpha/2}(\nu_2,\nu_1)$$

$$S_{xx}=\sum_{i=1}^n x_i^2-\frac{1}{n}\left(\sum_{i=1}^n x_i\right)^2$$

$$S_{yy}=\sum_{i=1}^n y_i^2-\frac{1}{n}\left(\sum_{i=1}^n y_i\right)^2$$

$$S_{xy}=\sum_{i=1}^n x_i y_i-\frac{1}{n}\left(\sum_{i=1}^n x_i\right)\left(\sum_{i=1}^n y_i\right)$$

$$r=\frac{n\Sigma xy-(\Sigma x)(\Sigma y)}{\sqrt{[n\Sigma x^2-(\Sigma x)^2]}\sqrt{[n\Sigma y^2-(\Sigma y)^2]}}=\frac{S_{xy}}{\sqrt{S_{xx}S_{yy}}}$$

$$\int_{-\infty}^{\infty}f(x)dx=1 \qquad \sum_{i=1}^n \Pr(X_i)=1$$

$$E(X)=\sum_{i=1}^n x_i\times\Pr(X=x_i)$$

$$E(X)=\int_{-\infty}^{\infty}xf(x)dx$$

$$Z=\frac{x-\mu}{\sigma}\sim Z_\alpha$$

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

$$T=\frac{\bar{x}-\mu}{s/\sqrt{n}}\sim T_\alpha(v=n-1)$$

$$\chi^2=\frac{(n-1)s^2}{\sigma^2}\sim\chi_\alpha^2(v=n-1)$$

$$F=\frac{s_1^2}{s_2^2}\sim F_\alpha(v_1=n_1-1,v_2=n_2-1)$$

$$S_p^2=\frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2}$$

$$v=\frac{(s_1^2/n_1+s_2^2/n_2)^2}{\frac{(s_1^2/n_1)^2}{n_1-1}+\frac{(s_2^2/n_2)^2}{n_2-1}}$$

$$v=n_1+n_2-2$$

$$\frac{(n-1)s^2}{\chi^2_{\alpha/2,v}}<\sigma^2<\frac{(n-1)s^2}{\chi^2_{1-\alpha/2,v}}$$

$$\hat{\beta}_1=\frac{S_{xy}}{S_{xx}} \qquad \bar{y}=\frac{1}{n}\sum_{i=1}^n y_i$$

$$\hat{\beta}_0=\bar{y}-\hat{\beta}_1\bar{x} \qquad \bar{x}=\frac{1}{n}\sum_{i=1}^n x_i$$

$$s^2=\frac{1}{n-1}\left[\sum_{i=1}^n x_i^2-\frac{1}{n}\left(\sum_{i=1}^n x_i\right)^2\right]$$

$$r^2=\frac{(S_{xy})^2}{S_{xx}S_{yy}}=R^2$$