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Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2018/2019

COURSE NAME	:	ENGINEERING MATHEMATICS V
COURSE CODE	:	BEE 31702
PROGRAMME CODE	:	BEJ/BEV
EXAMINATION DATE	:	DECEMBER 2018/ JANUARY 2019
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	1. ANSWER ALL QUESTIONS. 2. PROVIDE YOUR ANSWER IN **4 DECIMAL NUMBER.**

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

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Q1 Dolbear's law states the relationship between the air temperature and the rate at which crickets (cengkerik) chirp. An experiment of this phenomenon has been performed. Let the following data on the number chirps per second, x by the ground cricket and the temperature, y in Fahrenheit is shown in **Table Q1**.

Table Q1

Sample	Independent Variable	Dependent Variable
	Number chirps per second, x	Temperature in Fahrenheit, y
1	20	89
2	16	72
3	20	93
4	18	84
5	17	81
6	16	75
7	15	70
8	17	82
9	15	69
10	16	83

(a) (i) Find the equation of regression line for the data.

(18 marks)

(ii) Predict the Temperature when the cricket chirped 10 times per second.

(3 marks)

(b) (i) Find the coefficient of determination for the given data.

(2 marks)

(ii) Based on the value of the coefficient of determination, interpret the mathematical relationship between the number chirps, x and the temperature, y.

(2 marks)

Q2 (a) At a computer manufacturing company, the actual size of computer chips is normally distributed with a mean of 1 centimeter and a standard deviation of 0.1 centimeter. A random sample of 15 computer chips is taken.

(i) What is the standard deviation for the sample?

(3 marks)

(ii) Above what value $\bar{X}$ do 2.5% of the sample means fall?

(7 marks)

(b) Shafts were manufactured to go through a hole in an engine block. The shafts vary in diameter according to the Normal distribution with mean 1.5 cm and standard deviation 0.2 cm. Assuming that the hole diameter also varies, independently of the shaft diameter, following the Normal distribution with mean 2.5 cm and standard deviation of 0.3 cm.

(i) What is the probability that shaft will fit into the hole?

(13 marks)

(ii) How did the variance of sampling distribution of $\bar{X}$ change when the number of steel samples manufactured increased?

(2 marks)

Q3 (a) An electrical firm manufacturing light bulbs that have a length of life that is normally distributed with a standard deviation of 5 hours. As an engineer, you want to estimate the mean lifespan of a certain light bulbs.

(i) Determine the sample size needed on order that the researcher will be 90% confident that the error will not exceed 2 hours when he uses the sample mean as a point estimate for the true mean.

(5 marks)

(ii) If a sample of 30 bulbs were selected randomly and found to have an average of 120 hours. Let μ be the population mean of life lengths of all bulbs manufactured by this firm. Produce the 90% confidence interval of the mean lifespan of a certain light bulbs.

(8 marks)

(b) The average mean recovery time for medication A is 80, while the average mean recovery time for medication B is 75. A random sample of a group of 14 patients in a certain medical study were observed under medication A. In another random sample for medication B consists of a group of 16 patients. The standard deviations are 5 and 3 respectively. Construct a 90% confidence interval for the difference between the mean recovery times for the two medications, assuming normal populations with equal variances.

(12 marks)

Q4 (a) Identify the type I and type II error that correspond to the given hypothesis:

"The mean score of Engineering Mathematic V test is less than 85"

(2 marks)

(b) A site engineer recorded the amount of time to install streetlight at 8 different locations. The time in minutes is tabulated in **Table Q4(b).** Assume that the measurements were taken from the population with a normal distribution. It is of interest to know if a sample data suggest that the average time it takes to install streetlight is less than 13.5 minutes.

Table Q4(b)

Location	**Time (minutes)**
1	14.0
2	13.8
3	13.6
4	13.1
5	10.2
6	11.9
7	13.0
8	12.5

(i) State the null and alternative hypothesis.

(2 mark)

(ii) Determine the claim of 0.05 of significance level by using an appropriate test.

(12 marks)

(c) A manufacturer wishes to determine whether there is less variability in the silicon rubber coating done by Machine A and Machine B. Given that the sample size and sample standard deviation of Machine A is 13 and 0.035, respectively while Machine B is 11 and 0.062, respectively. Analyze if the populations have different variances.

(9 marks)

-END OF QUESTIONS -

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Random Variables :

$$\sum_{i=-\infty}^{\infty} P(x_i) = 1, \quad E(X) = \sum_{\forall x} x \cdot P(x), \quad E(X^2) = \sum_{\forall x} x^2 \cdot P(x), \quad \int_{-\infty}^{\infty} f(x)\,dx = 1,$$

$$E(X) = \int_{-\infty}^{\infty} x \cdot P(x)\,dx, \quad E(X^2) = \int_{-\infty}^{\infty} x^2 \cdot P(x)\,dx, \quad Var(X) = E(X^2) - [E(X)]^2.$$

Special Probability Distributions :

$$P(x=r) = {}^nC_r \cdot p^r \cdot q^{n-r},\ r = 0, 1, \ldots, n,\ X \sim B(n,p),\ P(X=r) = \frac{e^{-\mu} \cdot \mu^r}{r!},\ r = 0, 1, \ldots, \infty,$$

$$X \sim P_0(\mu),\ Z = \frac{X-\mu}{\sigma},\ Z \sim N(0,1),\ X \sim N(\mu, \sigma^2).$$

Sampling Distributions :

$$\bar{X} \sim N(\mu, \sigma^2/n),\ Z = \frac{\bar{X}-\mu}{\sigma/\sqrt{n}} \sim N(0,1),\ T = \frac{\bar{x}-\mu}{s/\sqrt{n}},\ \bar{X}_1 - \bar{X}_2 \sim N\left(\mu_1 - \mu_2, \frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}\right).$$

Estimations :

$$n = \left(\frac{Z_{\alpha/2} \cdot \sigma}{E}\right)^2,\ \left(\bar{x}_1 - \bar{x}_2\right) - Z_{\alpha/2}\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}} < \mu_1 - \mu_2 < \left(\bar{x}_1 - \bar{x}_2\right) + Z_{\alpha/2}\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}},$$

$$\left(\bar{x}_1 - \bar{x}_2\right) - Z_{\alpha/2}\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} < \mu_1 - \mu_2 < \left(\bar{x}_1 - \bar{x}_2\right) + Z_{\alpha/2}\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}},$$

$$\left(\bar{x}_1 - \bar{x}_2\right) - t_{\alpha/2,v} \cdot S_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}} < \mu_1 - \mu_2 < \left(\bar{x}_1 - \bar{x}_2\right) + t_{\alpha/2,v} \cdot S_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$$

where Pooled estimate of variance, $S_p^2 = \frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}$ with $v = n_1 + n_2 - 2$,

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$$\left(\bar{x}_1-\bar{x}_2\right)-t_{\alpha/2,v}\sqrt{\frac{1}{n}\left(s_1^2+s_2^2\right)}<\mu_1-\mu_2<\left(\bar{x}_1-\bar{x}_2\right)+t_{\alpha/2,v}\sqrt{\frac{1}{n}\left(s_1^2+s_2^2\right)} \text{ with } v=2(n-1),$$

$$\left(\bar{x}_1-\bar{x}_2\right)-t_{\alpha/2,v}\sqrt{\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}}<\mu_1-\mu_2<\left(\bar{x}_1-\bar{x}_2\right)+t_{\alpha/2,v}\sqrt{\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}} \text{ with } v=\frac{\left(\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}\right)^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{n_1-1}+\frac{\left(\frac{s_2^2}{n_2}\right)^2}{n_2-1}},$$

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

$$\frac{s_1^2}{s_2^2}\cdot\frac{1}{f_{\alpha/2,v_1,v_2}}<\frac{\sigma_1^2}{\sigma_2^2}<\frac{s_1^2}{s_2^2}\cdot f_{\alpha/2,v_2,v_1} \text{ with } v_1=n_1-1 \text{ and } v_2=n_2-1.$$

Hypothesis Testing :

$$Z=\frac{(\bar{X}_1-\bar{X}_2)-(\mu_1-\mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1}+\frac{\sigma_2^2}{n_2}}},\ T=\frac{(\bar{X}_1-\bar{X}_2)-(\mu_1-\mu_2)}{S_p\cdot\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}} \text{ with } v=n_1+n_2-2,$$

$$Z=\frac{(\bar{X}_1-\bar{X}_2)-(\mu_1-\mu_2)}{\sqrt{\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}}},\ T=\frac{(\bar{X}_1-\bar{X}_2)-(\mu_1-\mu_2)}{\sqrt{\frac{1}{n}\left(s_1^2+s_2^2\right)}},\ T=\frac{(\bar{X}_1-\bar{X}_2)-(\mu_1-\mu_2)}{\sqrt{\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}}} \text{ with}$$

$$v=\frac{\left(\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}\right)^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{n_1-1}+\frac{\left(\frac{s_2^2}{n_2}\right)^2}{n_2-1}}.\ ;\ S_p^2=\frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2}\ ;\ \chi^2=\frac{(n-1)s^2}{\sigma^2}$$

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$$S_{xy} = \sum x_i y_i - \frac{\sum x_i \cdot \sum y_i}{n},\ S_{xx} = \sum x_i^2 - \frac{\left(\sum x_i\right)^2}{n},\ S_{yy} = \sum y_i^2 - \frac{\left(\sum y_i\right)^2}{n},\ \bar{x} = \frac{\sum x}{n},\ \bar{y} = \frac{\sum y}{n},$$

$$\hat{\beta}_1 = \frac{S_{xy}}{S_{xx}},\ \hat{\beta}_0 = \bar{y} - \hat{\beta}_1 \bar{x},\ \hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x,\ R^2 = \frac{S_{yy} - SSE}{S_{yy}} = 1 - \frac{SSE}{S_{yy}},\ r = \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}},$$

$$SSE = S_{yy} - \hat{\beta}_1 S_{xy},\ MSE = \frac{SSE}{n-2},\ T = \frac{\hat{\beta}_1 - \beta_1^*}{\sqrt{\frac{MSE}{S_{xx}}}} \sim t_{n-2},\ T = \frac{\hat{\beta}_0 - \beta_0^*}{\sqrt{MSE\left(\frac{1}{n} + \frac{\bar{x}^2}{S_{xx}}\right)}} \sim t_{n-2}.$$