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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	STATISTICS FOR ENGINEERING TECHNOLOGY
COURSE CODE	:	BWM 22502
PROGRAMME CODE	:	BNA / BNB / BNC / BND / BNE/ BNF / BNM / BNN
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

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

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Q1 A random variable with cumulative discrete distribution function given by as follow:

$$F(x)=\begin{cases} 0 & ;x<0, \\ \dfrac{x}{8} & ;0\le x<1, \\ \dfrac{1}{4}+\dfrac{x}{8} & ;1\le x<2, \\ \dfrac{3}{4}+\dfrac{x}{12} & ;2\le x<3, \\ 1 & ;x\ge 3. \end{cases}$$

(a) Calculate the probability of $P(1\le X\le 2)$.

(5 marks)

(b) An employee is selected from a staff of 10 to supervise a certain project by selecting a tag at random from a box containing 10 tags numbered 1until10. Calculate the mean and variance of this random variable.

(10 marks)

(c) In testing a certain kind of truck tire over rugged terrain, it is found that 75% of the trucks manage to complete the test run without a blowout. Of the next 20 trucks tested, calculate the probability that not more than SIX (6) have blowouts.

(5 marks)

Q2 An instructor knows from the past experience that student examination scores have a normal distribution with mean of 77 and a standard deviation of 15. At present, the instructor is teaching two separate classes. The size of his first class is 45 students and the size of his second class is 64 students.

(a) Calculate the probability that the mean test score of the first class lies between 72 and 82 marks.

(8 marks)

(b) Write the sampling distribution of the difference between the mean test score of the first class and the second class.

(5 marks)

(c) Calculate the probability that the average test scores of first class is lower than the average test scores of second class by not more than 3 marks.

(7 marks)

Q3 (a) The comprehensive strength of concrete is being tested by a civil engineer. He tests eight random samples of specimens and obtains the following results:
Mean sample, $\bar{x} = 2247$ and variance sample, $s^2 = 33.22$.
Construct a 95% confidence interval on the mean strength of the concrete.

(4 marks)

(b) Two independent random samples of size 18 and 20 are taken from two normal populations respectively. The sample means are $\bar{x}_1 = 200$ and $\bar{x}_2 = 190$. It is known that the variances are 15 and 12 respectively. Construct a 95% confidence interval on $\mu_1 - \mu_2$.

(6 marks)

(c) A study on powered wheelchair driving performance are focus on the effects of two types of joysticks, the force sensing (FS) and position sensing (PS). The power wheelchair control on both joysticks was investigated. The response of interest is the time (in seconds) to complete a predetermined course with equal variance assumption. The data of the 10 sample responses are in **Table Q3(c)**.

Table Q3(c)

Subject	PS	FS
1	25.9	33.4
2	30.2	37.4
3	33.7	48.0
4	27.6	30.5
5	33.3	27.8
6	34.6	27.5
7	33.1	36.9
8	30.6	31.1
9	30.5	27.1
10	25.4	38.0

Construct a 90% confidence interval on the difference in mean completion time for PS and FS.

(10 marks)

Q4 (a) The study on 130 participants on their body temperature is summarized in **Table Q4(a)**.

Table Q4(a)

	Number of participant	Mean body temperature	Std. Deviation
Male	65	98.105	0.699
Female	65	98.394	0.743

Is there any significant difference between the mean body temperatures for men and women under significant level of 0.05?

(10 marks)

(b) A new manufacturer claims that its new brand of bulbs has a mean life of 6000 hours. They decided to conduct a significance test at the 0.05 significance level. 25 bulbs are tested and the mean lifetime is found to be 5910 hours. The manufacturers report that the standard deviation for the lifespan of a light is 400 hours. Determine whether the mean lifetime of the bulbs is less than the manufacturer claim.

(10 marks)

Q5 A marketer is interested in the relation between the width of the shelf space for the brand of coffee and weekly sales of the product in a city supermarket (assume the height is always at eye level). Marketers are well aware of the concept of "compulsive purchases", and know that the more shelf space their product takes up, the higher the frequency of such purchases and they believe that in the range of 3 to 9 feet, the mean weekly sales will be linearly related to the width of the shelf space. Suppose the marketer conducted the experiment over a twelve-week period (4 weeks with 3 feet of shelf space, 4 weeks with 6 feet and 4 weeks with 9 feet), and observed the sample data in **Table Q5**.

Table Q5

Shelf Space (x)	6	3	6	9	3	9	6	3	9	6	3	9
Weekly Sales (y)	526	421	581	630	412	560	434	443	590	570	346	672

(a) Assuming a linear relationship, use the least-squares method to find the regression coefficients of β_0 and β_1.

(13 marks)

(b) Interpret meaning of the slope β_1 in this problem.

(2 marks)

(c) Calculate and interpret the coefficient of determination.

(2 marks)

(d) Calculate the Pearson's correlation coefficient between shelf space and sales. Interpret your result.

(3 marks)

-END OF QUESTIONS -

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Formulae

Special Probability Distributions :

$$P(X=r)=\frac{e^{-\lambda}\cdot\lambda^{r}}{r!},\ r=0,1,\ldots,\infty,\ X\sim P_0(\lambda),\ Z=\frac{X-\mu}{\sigma},\ Z\sim N(0,1),\ X\sim N(\mu,\sigma^2).$$

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 :

$$n=\left(\frac{Z_{\alpha/2}\cdot\sigma}{E}\right)^2,\ \bar{x}\pm z_{\alpha/2}(\sigma/\sqrt{n}),\ \bar{x}\pm z_{\alpha/2}(s/\sqrt{n}),\ \bar{x}\pm t_{\alpha/2,v}\left(\frac{s}{\sqrt{n}}\right)$$

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

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

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

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

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 $v=n_1+n_2-2$,

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

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

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

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

Hypothesis Testing :

$$Z_{Test} = \frac{\bar{x}-\mu}{\sigma/\sqrt{n}},\quad Z_{Test} = \frac{\bar{x}-\mu}{s/\sqrt{n}},\quad T_{Test} = \frac{\bar{x}-\mu}{s/\sqrt{n}}$$

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

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

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

$$F = \frac{s_1^2}{s_2^2},\quad \text{with } \frac{1}{f_{\alpha/2}(v_2,v_1)} \quad \text{and} \quad f_{\alpha/2}(v_1,v_2)$$

Simple Linear Regressions :

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

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

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