UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2009/2010

SUBJECT	:	ENGINEERING STATISTICS
CODE	:	BSM 2922
COURSE	:	2 BFI/BDD/BEE/BEI, 3 BDD/BFF/BEE & 4 BDD/BEE/BFF
DATE	:	APRIL 2010
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **ALL** QUESTIONS IN **PART A** AND **THREE (3)** QUESTIONS IN **PART B**.

THIS EXAMINATION PAPER CONSISTS OF 7 PAGES

PART A

Q1 An engineer is interested on the effect of cutting speed (A), metal hardness (B), and cutting angle (C) on the life of a cutting tool. Two levels of each factor is chosen, and the tool life data (in hours) are shown in the **Table Q1** below. From the previous experience, Level II was always dependent to Level I.

Table Q1 : The tool life (in hours) for two levels.

Treatment combination	None	A	B	AB	C	AC	AB	ABC
Level I, X	22	32	35	55	44	40	60	39
Level II, Y	31	43	34	47	45	37	50	41

(a) Find the value of Σx_i, Σy_i, Σx_i^2, $\Sigma x_i y_i$, and Σy_i^2.

(4 marks)

(b) Calculate the sample correlation coefficient and interpret the result.

(3 marks)

(c) Using the least square method, estimate the regression line that approximates the regression of the tool life for level two.

(5 marks)

(d) Calculate the value of *SSE* and *MSE*.

(2 marks)

(e) Test the null hypothesis $\beta_1 = 0.45$ against the alternative hypothesis $\beta_1 > 0.45$ at the 0.01 level of significance.

(6 marks)

Q2 (a) To compare the two kinds of bumper guards, six of each kind was mounted on a certain make of compact car. Then, each car was run into a concrete wall at five miles per hour. The costs of the repair for two kinds of bumper guard yielded as follow:

$$\bar{x}_1 = 144, s_1 = 19.057, n_1 = 6 \text{ and } \bar{x}_2 = 149, s_2 = 14.212, n_2 = 6.$$

Assume that the variances for both bumper guards are unknown and not equal. Test at the 0.01 level of significance whether the means of bumper guard 1 is more than the mean of bumper guard 2.

(7 marks)

(b) In a random sample of 30 women who took the written test for their driving licenses, the sample variance is 2.53 minutes. At the 0.05 level of significance, test the claim that the population variance for all women who complete the written test is less than 2.35 minutes.

(6 marks)

(c) In comparing the variability of the tensile strength of two kinds of structural steel, an experiment yielded the following results: $n_1 = 13, s_1^2 = 19.2,$

$n_2 = 11$, $s_2^2 = 3.5$, where the unit of measurement is 1000 pounds per square inch. Test the hypothesis that the variability of the tensile strength of two kinds of structural steel is not equal at 0.02 level of significance.

(7 marks)

PART B

Q3 Given the probability density function of Y:

$$f(y) = \begin{cases} ky^2, & 1 \le y \le 4 \\ 0, & otherwise \end{cases}$$

(a) Find the value of k.

(3 marks)

(b) Find the cumulative distribution function of Y.

(4 marks)

(c) Find $P(\, 0 \le y \le 3\,)$.

(3 marks)

(d) $E(Y)$ and $E(10Y + 2)$.

(5 marks)

(e) $Var(\, 2Y - Y\,)$.

(5 marks)

Q4 (a) Based on the past experience, 32 students out of 400 statistics students failed in the examination. There are 40 candidates who are taking the examination.

(i) Find the mean and standard deviation of the candidates that failed in the exam.

(ii) Using the suitable approximation, find the probability that at least three of the candidates failed in the exam.

(iii) Find the probability that between two and five of the candidates failed in the exam.

(10 marks)

(b) Suppose the weights of female students are normally distributed with mean 50 kg and standard deviation 3.5 kg.

(i) Write down the distribution of normal probability.

(ii) Find the probability that the weights of female students are less than 62 kg.

(iii) Find the probability that the weights of the female students are between 48 kg and 55 kg.

(iv) Find the number of students for probability in (iii) if there are 150 female students are selected.

(10 marks)

Q5 (a) A lecturer in a college found that his students allocate an average of five hours with a standard deviation of 2.3 hours per week for revision. A study was done for his 36 students. Find the probability that the mean hours for revision is

(i) more than 5.7 hours per week,

(ii) less than 4.9 hours per week,

(iii) between 5 and 5.3 hours per week.

(8 marks)

(b) A study was conducted to see if there was a difference between spouses and significant others in coping skills when living with or caring for a person with multiple sclerosis. These skills were measured by questionnaire responses. The results of the two groups are given in **Table Q5(b)** below:

Table Q5(b) : The difference between spouses and significant others in coping skills.

Spouses	Significant others
$\bar{x}_1 = 2.0$	$\bar{x}_2 = 1.7$
$s_1 = 0.6$	$s_2 = 0.7$
$n_1 = 120$	$n_1 = 34$

Find the

(i) sampling distribution for the difference between the two means for both groups,

(ii) probability that mean sampling for spouses is more than mean sampling for significant others,

(iii) probability that mean sampling for spouses is 0.5 greater than mean sampling for significant others when $n_1 = 100$ and $n_2 = 50$.

(12 marks)

Q6 In a study on comparison of automobiles pollution between Manufacturer *A* and Manufacturer *B*, a sample of 9 automobiles from Manufacturer *A* and a sample of 11 ~~12~~ automobiles from Manufacturer *B* were taken. **Table Q4** below shows pollution by-product release (in milliliter) when 1 liter of gasoline is used.

Table Q4: Pollution by-product release (in milliliter) when 1 liter of gasoline is used.

Manufacturer *A*	1.5	1.0	1.7	1.2	1.2	1.1	1.5	1.3	1.0		
Manufacturer *B*	1.3	1.2	1.0	1.2	1.5	1.1	1.7	1.5	1.1	1.3	1.5

(a) Construct 99% confidence interval for the difference between two means of Manufacturer A and Manufacturer B when the population variances for both manufacturers are equal.

(13 marks)

(b) Construct 95% confidence interval for the ratio population variances, $\dfrac{\sigma^2 \, Manufacturer\ A}{\sigma^2 \, Manufacturer\ B}$.

(7 marks)

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Formulae

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 $v = n_1 + n_2 - 2$,

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

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

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

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

Hypothesis Testings :

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

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

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

Simple Linear Regressions :

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

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

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