UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2008/2009

SUBJECT	:	ENGINEERING STATISTICS
CODE	:	BSM 2922 /BSM 2622
COURSE	:	3 BER/BET/BEM/BFF/BEE/BEI/BDD
DATE	:	APRIL 2009
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 The number of pounds of steam used per month (January – June) by a chemical plant is thought to be related to the average ambient temperature (in^0 F) for that month. The past year's usage and temperature are shown in the following table:

Table Q1 : The number of pounds of steam used per month

Month	Temperature, x	Usage/1000, y
Jan	21	185.79
Feb	24	214.47
March	32	288.03
April	47	424.84
May	50	454.58
June	59	539.03

$$\sum_{i=1}^{n} x_i = 233, \quad \sum_{i=1}^{n} y_i = 2106.74, \quad \sum_{i=1}^{n} x_i y_i = 92{,}765.08,$$

$$\sum_{i=1}^{n} x_i^{2} = 10{,}231, \quad \sum_{i=1}^{n} y_i^{2} = 841{,}161.928$$

(a) Sketch a scatter plot for the data above.
(2 marks)

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

(c) By using the least square method, estimate the regression line. Interpret the result.
(7 marks)

(d) What is the estimate of expected steam usage when the average temperature is 10 ^{0}F.
(1 marks)

(e) Test the intercept whether it is not equal to – 8.3 at 1% level of significance.
(8 marks)

Q2 (a) State the definitions of Type-I and Type-II error?
(2 marks)

(b) A company management claimed that the average maintenance cost in this year for SME industries will be more than RM3500 per month. A random sample of 100 SME industries has an average maintenance cost of RM3650 per month. The standard deviation of the population is RM470. At significant level of 5%, test the company management claim that maintenance cost in this year will be increased.
(8 marks)

(c) There are two 'Hotz Pizza' outlets that run their business in Batu Pahat. The top management wanted to compare the delivery service that the two outlets had done. Their time of delivery (in minute) was recorded and measured as below:

Table Q2(c) : Hot Pizza

	Outlet A	Outlet B
sample size	14	24
sample mean	85	74
sample standard deviation	12	9

Test the claim that the mean of delivery time between outlet A and outlet B. (Use 0.1 level of significance).

(10 marks)

PART B

Q3 (a) The probability distribution function for the random variables X is given in **Table Q3(a).**

Table Q3(a): Probability Distribution Function

x	-3	6	9
$P(X=x)$	k	$\frac{1}{2}$	$\frac{1}{3}$

Find
(i) the value of k
(ii) the cumulative probability distribution, $F(x)$
(iii) the value of $E(X)$, $E(X^2)$ and then by using these values, evaluate $E[(X+2)^2]$
(iv) the value of $V(4X+1)$

(15 marks)

(b) The length of time X in seconds has probability density function as below :

$$f(x) = \begin{cases} \frac{1}{5}e^{-x/5}, & 0 \le x < \infty \\ 0, & \text{otherwise} \end{cases}$$

(i) Show that $f(x)$ is a pdf.
(ii) Find $P(-1 \le X < 2)$.

(5 marks)

Q4 (a) A trading company has 10 computers that trades on the Kuala Lumpur Stock Exchange (KLSE). The probability of a computer failing in a day is 0.08 and the computer fails independently.
(i) What is the probability that the all ten computers fail in a day ?
(ii) What is the mean number of computer fail in a day ?

(5 marks)

(b) The number of flaws in a plastic panels used in the interior of automobiles has a mean of 2.2 flaws per square meter of the plastic panel.
   (i) What is the probability that there are less than 20 surface flaws in 10 square meter of plastic panel ?
   (ii) Calculate the mean and variance for the flaws in 100 square meters of plastic panel.

(6 marks)

(c) Suppose a certain manufacturer thermometers that are supposed to give readings of 0 degrees at the freezing point. A large sample was been tested and find that the mean of the sample is zero degrees with a standard deviation of one degree and that the distribution is bell-shaped. If one thermometer is randomly selected what is the probability that the reading at the freezing point is
   (i) at most 1.32 degrees
   (ii) between -0.3 and 1.02 degrees

(9 marks)

Q5 (a) The compressive strength of concrete is normally distributed with mean 2500 psi and standard deviation is 50 psi. Find the probability that a random sample of five specimens will have a sample mean diameter that falls
   (i) in the interval from 2499 psi to 2510 psi
   (ii) less than 2550 psi
   (iii) at least 2450 with the new sample which is ten

(10 marks)

(b) The elasticity of a polymer is affected by the concentration of a reactant. When low concentration is used, the true mean elasticity is 55, and when high concentration is used the mean elasticity is 60. The standard deviation of elasticity is 4, regardless of concentration. If two random samples of size 16 are taken, find the probability that
   (i) mean high concentration is more than 58
   (ii) mean low concentration is less than 54
   (iii) mean high concentration is higher than mean low concentration.

(10 marks)

Q6 (a) The quality control manager at a television factory needs to estimate the mean life of a large shipment of television. The process standard deviation is known to be 100 hours and assumes that the shipment contains a total of 200 televisions.
   (i) Determine the sample size needed to estimate the average life to within 20 hours with 99% confidence.
   (ii) Find the 98% confidence interval of the population mean life of television in this shipment if the random sample of 27 televisions selected from the shipment indicates a sample average life of 290 hours.

(7 marks)

(b) (i) A group of research student with 14 academic staff and 17 administration staff involve in a study to find mean of attendance time in January 2009. The mean time of attendance recorded by academic staff was 9.2 and the standard deviation was 1.3. While, the mean time of attendance recorded by administration staff was

7.9 and the standard deviation was 1.5. Construct a 95% confidence interval for the difference between means time of attendance record by academic staff to administration staff. Assume that the population variances are equal but unknown.

(ii) Table **Q6(b)(ii)** shows the price of laptop (in RM) from a selected sample of computer shop.

Table Q6(b)(ii) : Probability Distribution Function

1599	1699	1799	1899	1999	2099	2299	2499	2699

Find the 98% confidence interval for the variance of the laptop price. Assume that the population is normally distributed.

(13 marks)

Formulas

$\sum_{i=-\infty}^{\infty} p(x_i) = 1$, $E(X) = \sum_{\forall x} xp(x)$, $\int_{-\infty}^{\infty} f(x)\ dx = 1$, $E(X) = \int_{-\infty}^{\infty} xp(x)\ dx$, $Var(X) = E(X^2) - [E(X)]^2$,

$P(x) = \binom{n}{x} \cdot p^x \cdot (1-p)^{n-x} \quad x = 0, 1, \ldots, n$, $P(X = r) = \dfrac{e^{-\mu} \cdot \mu^r}{r!} \quad r = 0, 1, \ldots, \infty$,

$X \sim N(\mu, \sigma^2)$, $Z \sim N(0, 1)$ and $Z = \dfrac{X - \mu}{\sigma}$, $\bar{X} \sim N\left(\mu, \dfrac{\sigma^2}{n}\right)$, $Z = \dfrac{\bar{X} - \mu}{\sigma/\sqrt{n}} \sim N(0, 1)$, $T = \dfrac{\bar{x} - \mu}{s/\sqrt{n}}$,

$\bar{X}_1 - \bar{X}_2 \sim N\left(\mu_1 - \mu_2, \dfrac{\sigma_1^2}{n_1} + \dfrac{\sigma_2^2}{n_2}\right)$,

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

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

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

The pooled estimate of variance is $S_p^2 = \dfrac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$ and $v = n_1 + n_2 - 2$,

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

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

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

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

$$T = \frac{(\overline{X}_1 - \overline{X}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \text{ where } v = \frac{\left(s_1^2/n_1 + s_2^2/n_2\right)^2}{\frac{\left(s_1^2/n_1\right)^2}{n_1 - 1} + \frac{\left(s_2^2/n_2\right)^2}{n_2 - 1}}$$

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

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

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

$$\hat{\beta}_1 = \frac{S_{xy}}{S_{xx}}, \quad \hat{\beta}_0 = \bar{y} - \hat{\beta}_1 \bar{x}, \quad r = \frac{S_{xy}}{\sqrt{S_{xx} S_{yy}}},$$

$$\text{SSE} = S_{yy} - \hat{\beta}_1 S_{xy}, \quad \text{MSE} = \frac{\text{SSE}}{n-2}, \quad T = \frac{\hat{\beta}_1 - \beta_1^*}{\sqrt{\text{MSE}/S_{xx}}} \sim t_{n-2}$$

$$T = \frac{\hat{\beta}_0 - \beta_0^*}{\sqrt{\text{MSE}\left(1/n + \bar{x}^2/S_{xx}\right)}},$$

$$\hat{\beta}_1 - t_{\alpha/2,v}\sqrt{\text{MSE}/S_{xx}} < \beta_1 < \hat{\beta}_1 + t_{\alpha/2,v}\sqrt{\text{MSE}/S_{xx}},$$

$$\hat{\beta}_0 - t_{\alpha/2,v}\sqrt{\text{MSE}(1/n + \bar{x}^2/S_{xx})} < \beta_0 < \hat{\beta}_0 + t_{\alpha/2,v}\sqrt{\text{MSE}(1/n + \bar{x}^2/S_{xx})}$$