UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	STATISTICS FOR ENGINEERING TECHNOLOGY
COURSE CODE	:	BWM 22502
PROGRAMME	:	2BNG
EXAMINATION DATE	:	JUNE 2015/ JULY 2015
DURATION	:	2 HOURS 30 MINUTE
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

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

Q1 (a) A discrete random variable has a probability distribution as shown in **Table Q1(a)**.

Table Q1(a): Probability distribution function

x	1	2	5	r	14
$P(X=x)$	t	$2t$	$3t$	$2t$	t

(i) Find the value of t.

(3 marks)

(ii) Find the value of r if the expected value is 6.

(3 marks)

(iii) Find the cumulative distribution function, $F(x)$.

(4 marks)

(b) In a driving license test, the score of the candidates were approximately normal distributed with mean 20 point and standard deviation 50 points. Find the probability of the candidates who received scores less than 180 points.

(3 marks)

(c) About 4.4% of motor vehicles crashed are caused by defective tires. If highway safety study begins with the random selection of 750 cases of motor vehicles crashes, estimate the probability that exactly 35 of them were caused by defective tires by using normal approximation.

(7 marks)

Q2 (a) In a study of water pollution in construction area, a random sample in industrial area 1 size 18 is selected from normal population with a mean of 80 and a standard deviation of 8. A second random sample in industrial area B size 10 is selected from another normal population with mean 75 and standard deviation 5. Let $\bar{X}_1$ and $\bar{X}_2$ be the two sample means. Find

(i) $P(\bar{X}_1 > 80.4)$,

(3 marks)

(ii) $P(74.9 < \bar{X}_2 < 75.3)$,

(3 marks)

(iii) $P(|\bar{X}_1 - \bar{X}_2| > 2.3)$.

(4 marks)

(b) Quality control engineer is measuring of their finishing product in two different machine. The distribution of the finishing product is normally distributed with mean and standard deviation such as below (refer **Table Q2(b)**).

Table Q2(b): The distribution of the finishing product

	Finishing product in Machine I	Finishing product in Machine II
Sample mean	14.2	12.3
Sample standard deviation	2.1	1.9
Sample size	33	29

Find the probability that,

(i) the mean of finishing product in Machine I is greater than 15,

(3 marks)

(ii) the mean of finishing product in Machine II is between 11.9 to 13,

(3 marks)

(iii) the mean of finishing product in Machine I is greater than the mean of finishing product in Machine II by 1.8.

(4 marks)

Q3 (a) A machine produces metal rods used in an automobile suspension system. A random sample of 10 rods was selected, and diameter was measured. The resulting data in millimeter is shown in **Table Q3(a)**.

Table Q3(a): Diameter of metal rods

8.23	8.30	8.27	8.22	8.29
8.39	8.21	8.38	8.35	8.37

Find the 98% confidence interval of the mean rod diameter.

(7 marks)

(b) A study was performed to determine whether men and women differ in their repeatability in assembling components on printed circuit boards. Two samples of 11 men and 9 women were selected, and each subject assembled the units. The two sample standard deviations of assembly time were 1.21 minutes and 1.35 minutes.

(i) Construct 95% confidence interval of variance assembly time for men.
(6 marks)

(ii) Construct 90% confidence interval for ratio of two variances assembly times for men and women, $\frac{\sigma^2_{men}}{\sigma^2_{women}}$.
(7 marks)

Q4 (a) Define the Type I and Type II errors in terms of hypothesis testing.
(2 marks)

(b) The compressive strength of concrete is being tested by a civil engineer. Eight specimens and the following data are obtained (in spi).

11.0 10.7 9.4 7.8 11.3 9.1 10.2 10.5

Test the hypothesis whether the mean compressive strength of the concrete is less than 11 spi at 0.10 level of significant.
(10 marks)

(c) A manufacturer of video display departments is testing two microcircuit designs to determine whether they produce equivalent mean current flow. Development engineering departments has the following data.

Design 1 : $n_1 = 45$ $\bar{x}_1 = 5.2$ $s_1 = 2.4$

Design 2 : $n_2 = 40$ $\bar{x}_2 = 4.8$ $s_2 = 1.2$

By using $\alpha = 0.05$, determine whether the design 1 performs better than design 2 in mean current flow. Assume that both populations are normally distributed.
(8 marks)

Q5 Medical researchers have noted that adolescent females are much more likely to deliver low birth weight babies than adult females. Because low birth weight babies have higher mortality rates, there have been a number of studies examining the relationship between birth weight and mother's age for babies born to young mother. The summary statistics are shown below:

$$n=10 \quad \sum x=170 \quad \sum x^2=2910$$
$$\sum y=30{,}041 \quad \sum y^2=91{,}785{,}351 \quad \sum xy=515{,}600$$

(i) Find the equation of the regression line. Then, find the average birth weight of babies born to 18 year-old mothers.

(7 marks)

(ii) Find the correlation coefficient, r and coefficient of determination, r^2. Interpret the results for each coefficient.

(8 marks)

(iii) Test the null hypothesis $\beta_1=100$ against the alternative hypothesis $\beta_1>100$ at the 0.05 level of significance.

(5 marks)

- END OF QUESTION –

STATISTICAL FORMULAE

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

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

$E(X^2) = \sum_{\forall x} x^2 p(x)$ $\quad$ $E(X^2) = \int_{-\infty}^{\infty} x^2 f(x)\ dx$

$p(x) = \binom{n}{x} p^x (1-p)^{n-x},\ x = 0, 1, 2, \ldots, n$ $\quad$ $p(x) = \frac{e^{-\mu}\mu^x}{x!},\ x = 0, 1, 2, \ldots$

$X \sim N(\mu, \sigma^2)$ $\quad$ $\bar{X} \sim N(\mu, \frac{\sigma^2}{n})$ $\quad$ $Z = \frac{\bar{X}-\mu}{\sigma/\sqrt{n}} \sim N(0, 1)$

$Z \sim N(0, 1)$ $\quad$ $Z = \frac{X-\mu}{\sigma}$

$\bar{X}_1 - \bar{X}_2 \sim N(\mu_1 - \mu_2, \frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2})$ $\quad$ $Z = \frac{\bar{X}_1 - \bar{X}_2 - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} \sim N(0, 1)$

$T = \frac{\bar{X} - \mu}{S/\sqrt{n}} \sim t_{\alpha, n-1}$ $\quad$ $F = \frac{S_1^2}{S_2^2} \sim f_{\alpha, n_1-1, n_2-1}$

$\chi^2 = \frac{(n-1)S^2}{\sigma^2} \sim \chi^2_{\alpha, n-1}$ $\quad$ $s^2 = \frac{1}{n-1}\left(\sum x^2 - \frac{(\sum x)^2}{n}\right)$

$T = \frac{\bar{X}_1 - \bar{X}_2 - (\mu_1 - \mu_2)}{S_P\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \sim t_{\alpha,\ n_1+n_2-2}$ $\quad$ $S_P^2 = \frac{(n_1-1)S_1^2 + (n_2-1)S_2^2}{n_1+n_2-2}$

$T = \frac{\bar{X}_1 - \bar{X}_2 - (\mu_1 - \mu_2)}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} \sim t_{\alpha, v}$ $\quad$ $v = \frac{\left(S_1^2/n_1 + S_2^2/n_2\right)^2}{\frac{\left(S_1^2/n_1\right)^2}{(n_1-1)} + \frac{\left(S_2^2/n_2\right)^2}{(n_2-1)}}$ or $v = 2(n-1)$

$\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 x$ $\quad$ $\hat{\beta}_0 = \bar{y} - \hat{\beta}_1 \bar{x}$ $\quad$ $\text{SSE} = S_{yy} - \hat{\beta}_1 S_{xy}$ $\quad$ $\text{MSE} = \frac{\text{SSE}}{n-2}$

$\hat{\beta}_1 = \frac{S_{xy}}{S_{xx}}$

$s_{xx} = \sum_{i=1}^{n} x_i^2 - \frac{\left(\sum_{i=1}^{n} x_i\right)^2}{n}$ $\quad$ $s_{yy} = \sum_{i=1}^{n} y_i^2 - \frac{\left(\sum_{i=1}^{n} y_i\right)^2}{n}$ $\quad$ $s_{xy} = \sum_{i=1}^{n} x_i y_i - \frac{\sum_{i=1}^{n} x_i \sum_{i=1}^{n} y_i}{n}$

$\hat{\beta}_1 \sim N\left(\beta_1, \frac{\sigma^2}{S_{xx}}\right)$ $\quad$ $T = \frac{\hat{\beta}_1 - \beta_1^*}{\sqrt{\text{MSE}/S_{xx}}} \sim t_{\alpha, n-2}$ $\quad$ $r^2 = \frac{(S_{xy})^2}{S_{xx}S_{yy}}$

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