CONFIDENTIAL

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	STATISTICS FOR ENGINEERING TECHNOLOGY
COURSE CODE	:	BWM 22502
PROGRAMME	:	1BNA/ 2 BNA/ 1BNB/ 2 BNB/ 1BNC/ 2BNC/ 2 BNN
EXAMINATION DATE	:	DECEMBER 2014/JANUARY 2015
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

Q1 (a) Poisson distribution is a discrete random variable. (True / False)

(1 mark)

(b) State two properties of normal distribution.

(2 marks)

(c) In 2010 World Cup tournament, the weight of the balls used is normally distributed with the mean weight 435 grams and standard deviation 10 grams. A ball is selected at random.

(i) What is the probability the weight is between 400 grams and 450 grams.

(3 marks)

(ii) If 10% of the balls are considered heavy, what is the minimum weight of the ball in that category?

(3 marks)

(d) About 4.4% of motor vehicle crashes are caused by defective tyres. If a highway safety study begins with the random selection of 750 cases of motor vehicle crashes, estimate the probabilty that more than 40 of them were caused by defective tyres by using normal approximation.

(7 marks)

(e) On average, Good Construction can build 8 units of playground during 2-months period.

(i) State the variance for this distribution

(1 mark)

(ii) Find the probability that Good Construction can only build 3 units of playground during 30 days period.

(3 marks)

Q2(a) For the following statements, determine if the calculation requires the use of population distribution or sampling distribution.

(i) Computing a confidence interval for a mean.

(1 mark)

(ii) Computing an interval that contains 95% of individual's weights.

(1 mark)

(b) Explain one property of a good estimator.

(2 marks)

(c) A process engineer is comparing two different etching solutions for removing silicon from the backs of wafers. Table **Q2(c)** contains etch rates from 10 wafers for two etch solutions.

Table Q2(c) :Etch rates from two solutions

Solution 1		Solution 2	
9.7	10.5	10.1	9.9
9.3	10.2	10.5	10.1
9.1	9.9	10.6	10.2
9.5	10.3	10.3	10.3
10.0	10.1	10.3	10.1

(i) The etch rates follow a normal distribution and have equal population variances of 0.35^2. Find a 90% confidence interval for the difference in mean etch rates between Solution 1 and Solution 2.

(8 marks)

(ii) Find a 95% confidence interval for the ratio of variance etch rates of Solution 1 and Solution 2.

(8 marks)

Q3 (a) State the definition of *critical region.*

(1 mark)

(b) β error is Type II error. (True / False)

(1 mark)

(c) Assume that we are conducting a hypothesis test of the claim that $\mu < 0.06$. Here are the null and alternative hypotheses: $H_0 : \mu = 0.06$ and $H_1 : \mu < 0.06$.Give the statements identifying

(i) Type I error.

(1 mark)

(ii) Type II error.

(1 mark)

(d) A researcher wonders whether attending a private high school leads to higher or lower performance on a test of social skills. The national mean score for students from public school is 75.62, if given the standard deviation is 28.0. A sample of 100 students from a private school produces a mean score of 71.30 on the test. Using these results, test the claims at 5% level of significance.

(7 marks)

(e) Two types of drugs were used on 5 and 7 patients for reducing their weight in Jerry's 'slim-beauty' health club. Drug A was allopathic and drug B was Herbal. The decreased in the weight after using drugs for six months was as follows.

Drug A :	10	12	13	11	14		
Drug B :	8	9	12	14	15	10	9

Test the hypothesis if there are significant differences in drug B and drug A by using 0.001 of significance level. Assume that the variances of population are unknown but equal.

(9 marks)

Q4 (a) A survey claims that the standard deviation of cost of a hotel room in Kuching, Sarawak is greater than RM9.90. In order to test the claim, a researcher selects a sample of 24 hotel rooms and finds that the average cost is RM13.20. At $\alpha = 0.05$, test the hypothesis if there is enough evidence to reject the claim.

(8 marks)

(b) A post office manager wanted to know whether the variances for the waiting time at two counters are different. Random samples of customers are taken and their waiting times are recorded for both counters, which are shown in Table **Q4(b)**.

Table Q4(b): Waiting Times for Counter *A* and Counter *B* (in minutes)

Counter *A*	2.0	5.6	6.7	2.1	4.5	3.0	5.5
	2.5	3.1	3.5	4.0	3.9	2.2	

Counter *B*	3.9	4.1	5.3	6.0	5.9	4.1
	5.2	3.8	4.5	5.7	5.6	

Test the hypothesis of the post office manager problem at significance level of 0.02.

(12 marks)

Q5 The data below indicates the lifetime (in hours) of particular bacteria that used in cheese production. Suppose that there exist a linear relationship between the lifetime of bacteria and the moisture (in percentage) in bacteria container. A sample of 18 containers that contains the bacteria is selected;

$$\sum x = 196, \quad \sum x^2 = 4844, \quad \sum xy = 1060.8, \quad \sum y = 42.2, \quad \sum y^2 = 240$$

(a) Find the regression line that describes the relationship between the lifetime of bacteria and the moisture.

(5 marks)

(b) Calculate the coefficient of determination for the experiment and the sample Pearson correlation coefficient. Interpret the result.

(6 marks)

(c) Test the hypothesis to claim that the slope value of the regression line is greater than zero at 0.01 level of significance.

(9 marks)

- END OF QUESTION -

FINAL EXAMINATION

SEMESTER / SESSION: SEM I / 2014/2015

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Formula

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 $v=n_1+n_2-2$,

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

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

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

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

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 :

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

$$\hat{\beta}_1=\frac{S_{xy}}{S_{xx}},\ \hat{\beta}_0=\bar{y}-\hat{\beta}_1\bar{x},\ \hat{y}=\hat{\beta}_0+\hat{\beta}_1x,\ r=\frac{S_{xy}}{\sqrt{S_{xx}\cdot S_{yy}}},\ SSE=S_{yy}-\hat{\beta}_1S_{xy},\ MSE=\frac{SSE}{n-2},$$

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