UTHM
Universiti Tun Hussein Onn Malaysia

FINAL EXAMINATION
SEMESTER I
SESSION 2014/2015

COURSE NAME	:	ENGINEERING STATISTICS
COURSE CODE	:	BWM 20502
PROGRAMME	:	4BDD/ 4BEJ/ 4BEV/ 4BFF/ 3BDD/ 3BEJ/ 3BEV/ 3BFF/ 2BFF/ 2BEJ
EXAMINATION DATE	:	DECEMBER 2014 / JANUARY 2015
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

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

Q1 (a) A process that produces titanium forgings for automobile turbocharger wheels is to be controlled through use a fraction nonconforming chart. **Table Q1(a)** shows the probability distribution of X which x is nonconforming units per day that has been recorded for a period of time.

Table Q1(a): Probability density function of X

x	1	2	r	10	15
$P(x)$	0.45	0.31	0.17	0.06	0.01

(i) Solve the value of r if the expected value is 3.18.

(2 marks)

(ii) Find the standard deviation of the nonconforming unit per day.

(4 marks)

(b) The continuous random variable Y has the probability distribution function as below:

$$f(y) = \begin{cases} \frac{1}{k}(y+\frac{1}{2}) & 0 < y < 3, \\ 0 & \text{otherwise.} \end{cases}$$

(i) Find the value of k.

(3 marks)

(ii) Find $P(Y > 2)$.

(3 marks)

(iii) Construct the cumulative distribution function of Y then find $F(2)$.

(8 marks)

Q2 (a) Suppose that during period of sleeping the number of reduction of a person's oxygen consumption is a random variable that has a normal distribution with an average of 36.6 cc per minute and a variance of 20.16 cc per minute. Find the probability that during a period of sleeping, a person's oxygen consumption will be reduced by

(i) at least 44.5 cc per minute,

(3 marks)

(ii) at most 35.0 cc per minute,

(3 marks)

(iii) anywhere from 30.0 to 40.0 cc per minute.

(3 marks)

(b) The midterm test of a subject has 80 questions, each question with 4 possible answers of which only 1 answer is correct. Find the probability that the student obtains

(i) from 25 to 30 answers are correct,

(7 marks)

(ii) less than 15 answers are correct.

(4 marks)

Q3 (a) The average volume of soda drink dispensed by a machine before it is serviced is 260 ml with standard deviation of 11 ml. The average volume dispensed by the machine after it is serviced is 250 ml with a standard deviation of 8 ml. 40 cans of soda before the machine is serviced was chosen at random and 38 cans of soda after the machine is serviced was also chosen at random. Find the probability that the mean volume of a can of soda before the machine is serviced is larger than the average volume after the machine is serviced by more than 5 ml.

(7 marks)

(b) A company has purchased eight resistors from Supplier A and seven resistors from Supplier B. The results of the resistance (in ohms) are as follows:

Table Q3(b): The number of resistors purchased from Supplier A and B

Supplier A	99	98	101	103	99	98	101	99
Supplier B	100	102	104	99	100	102	103	

Assume that the resistance follows normal distribution. Construct a 95% confidence interval for the difference between the mean resistances. Assume the variances for resistors produced by both suppliers are the same.

(13 marks)

Q4 (a) In a manufacturing plant, plastic sheathing is specified to be at least two mils thick by one of the many quality measures. Set up the null and alternative hypothesis for a quality monitoring system that ensures the desired level of quality.

(2 marks)

(b) An ice cream company claimed that its product contain on average 500 calories per pint.

(i) Test the claim if 24 pint containers were analyzed, giving the mean is 507 calories and standard deviation of 21 calories at 1% level of significance.

(7 marks)

(ii) If 42 pint containers were analyzed, giving the mean is 509 calories and a variance of 18 calories. Test the claim at 1% level of significance.

(6 marks)

(iii) A manufacturer of car batteries claims that the life of his batteries is approximately normally distributed with a standard deviation equal to 0.7 year. If a random sample of 15 of these batteries has a standard deviation of 0.5 years, test the hypothesis of variance population greater than 0.49 year by using 0.01 of significance level.

(5 marks)

Q5 Ten patients given varying doses of allergy medication and asked to report back when the medication seems to wear off. The medication data is shown in **Table Q5**.

Table Q5: Medication data for ten patients

Dosage of Medication (mg)	Hours of Relief (h)
3	9.1
3	5.5
4	12.3
5	9.2
6	14.2
6	16.8
7	22.0
8	18.3
8	24.5
9	22.7

Refer to the **Table Q5**, answer the following questions.

(a) Find the equation of the least squares line that will enable us to predict the hours of relief in terms of the relative dosage. Interpret the results.

(14 marks)

(b) Estimate the hours of relief when the relative dosage is 2 mg.

(2 marks)

(c) Find and interpret the Pearson correlation coefficient.

(4 marks)

- END OF QUESTION -

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Formula

Special Probability Distributions :

$$P(x=r)={}^{n}C_r\cdot p^r\cdot q^{n-r},\ r=0,1,\ldots,n,\ X\sim B(n,p),\ P(X=r)=\frac{e^{-\mu}\cdot\mu^r}{r!},\ r=0,1,\ldots,\infty,$$

$$X\sim P_0(\mu),\ Z=\frac{X-\mu}{\sigma},\ Z\sim N(0,1),\ X\sim N(\mu,\sigma^2).$$

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 :

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

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

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

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

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

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 $v=n_1+n_2-2$,

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

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

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

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Formula

Hypothesis Testing :

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

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

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

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

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

Simple Linear Regressions :

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

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