UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2012/2013

COURSE NAME	:	ENGINEERING STATISTICS
COURSE CODE	:	BWM 20502/BSM2922
PROGRAMME	:	2/3/4 BFF, 4 BEE, 2/3/4 BDD, 2/3 BEU, 2/3 BED, 2/3 BEB, 2/3 BEC, 2/3 BEH, 2/3 BEF
EXAMINATION DATE	:	JANUARY 2013
DURATION	:	2 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS.

THIS EXAMINATION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 (a) A normal distribution is a type of discrete random variable. (True / False)

(1 mark)

(b) Give **two** characteristics of a normal distribution curve.

(2 marks)

(c) A research scientist reports that mice will live an average of 40 months when their diets are sharply restricted and then enriched with vitamins and proteins. Assuming that the lifetimes of such mice are normally distributed with a standard deviation of 6.3 months.

(i) Find the probability that a given mouse will live more than 32 months.

(4 marks)

(ii) Find the probability that a given mouse will live less than 28 months.

(3 marks)

(iii)Find the probability that a given mouse will live between 37 and 49 months.

(3 marks)

(d) A coin is tossed 400 times. Use the normal curve approximation to find the probability of obtaining

(i) Between 185 and 210 heads inclusively.

(8 marks)

(ii) Exactly 205 heads.

(4 marks)

Q2 Travel expenses paid by companies can increase or decrease dramatically when there are changes in the daily rates for hotel rooms. The data in **Table Q2** give typical daily rates for seven three-star hotels in Johor Bahru and six three-star hotels in Muar.

Table Q2 : Daily rates (in RM) for 7 three-star hotels in Johor Bahru and 6 three-star hotels in Muar

Johor Bahru	120	110	130	90	115	95	140
Muar	110	100	110	80	100	110	

(a) Give **one** example of point estimate and point interval.

(2 marks)

(b) State the point estimate for daily rates for three-star hotel in Johor Bahru.

(1 mark)

(c) Find the 95% confidence interval for different average of daily rates for three-star hotel in Johor Bahru and Muar. Assume that the populations are approximately normal distributed with unequal variances. What is your conclusion?

(8 marks)

(d) Find the 90% confidence interval for variance daily rates for three-star hotel in Johor Bahru. What is your conclusion?

(6 marks)

(e) Find a 95% confidence interval for the ratio of variance daily rates for three-star hotel in Johor Bahru and Muar. What is your conclusion?

(8 marks)

Q3 (a) The Civil Engineering students just had their examination on Engineering Statistics under the supervision of Dr Bobo. A random sample of 36 marks was selected and assumed to be normally distributed. **Table Q3** below shows their marks.

Table Q3: Marks of Civil Engineering students

60	77	75	95	80	55	52	45	88
100	65	80	85	85	45	75	62	93
70	50	95	100	90	75	85	89	67
90	63	95	100	85	65	91	70	76

(i) Dr Bobo claims that the average mark for his students is less than 73. Test the hypothesis with 0.10 level of significance.

(10 marks)

(ii) While in another class, with a random sample of 33 marks, Dr Hajar claims that the average mark for her students is 70 and the standard deviation is 14.6804. Using alpha 0.01, perform the hypothesis testing whether any significant difference in average marks between the two classes.

(7 marks)

(b) Past data indicate that the variance of measurements made on sheet metal stampings by experienced quality control inspectors is 0.18 $(\text{inch})^2$. Such measurements made by an inexperienced inspector could have too large or too small variance. If a new inspector measures 25 stampings with a variance of 0.13 $(\text{inch})^2$, test the hypothesis of variance population different than 2.0 by using 0.05 of significance level. Assume that the population has normal distribution.

(8 marks)

Q4 (a) Pull-strength tests on 11 soldered leads for a semiconductor device yield the following results in pounds-force required to rupture the bond before encapsulation. Another set of 8 leads was tested after encapsulation to determine whether the pull strength has been increased by encapsulation of the device. The statistics results are summarized in **Table Q4**.

Table Q4: The result of pull-strength before and after encapsulation.

Before	After
Average = 14.2900 Variance = 7.4988	Average = 22.0875 Variance = 2.6813

Use the 0.05 level of significance to test the ratio of population variance.

(8 marks)

(b) A rocket motor is manufactured by bonding together two types of propellants, an igniter and a sustainer. The shear strength of the bond y is thought to be linear function of the age of the propellant x when the motor is cast. Ten observations are shown in the following **Table Q4.**

Table Q4: Strength of bond y against age of propellant x

Observation Number	Strength, y (psi)	Age, x (weeks)
1	2158	15
2	1678	23
3	2316	8
4	2061	17
5	2207	5
6	1708	19
7	1784	24
8	2575	2
9	2357	7
10	2277	11

(i) Assuming a linear relationship, use the least squares method to find the simple linear regression model and interpret the meaning of β_1.

(11 marks)

(ii) What is the approximate number of strength of bond if the age of propellant is 27?

(2 marks)

(iii) Determine the value of Pearson correlation. Interpret the result.

(4 marks)

- END OF QUESTIONS -

FINAL EXAMINATION

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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, $S_p^2=\dfrac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2}$ 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 :

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

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

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