First Semester Examination
2022/2023 Academic Session

February 2023

EMT 211 – Engineering Probability & Statistics
(Kebarangkalian dan Statik Kejuruteraan)

Duration: 3 hours
(Masa: 3 Jam)

Please check that this examination paper consists of SIX (6) pages of printed material before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi ENAM (6) muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

Instructions: Answer ALL **FOUR (4)** questions.

*[**Arahan**: Jawab **EMPAT (4)** soalan]*

1. (a) Given $S = A \cup B$. Show if

$$A - (A \cap B) = (A \cup B) - B$$

(i) using set Algebra.
(ii) using Venn diagram

(40 marks)

(b) A sick student went to see a doctor. The doctor has prior information that 90% of sick students in the campus is tested positive for COVID, while the other 10% are sick with common flu. Let F stand for an event of a child being sick with COVID and M stand for an event of a child being sick with common flu. Assume for simplicity that $F \cup M = S$, i.e., that there no other maladies in the campus. A well-known symptom of common flu is throat itchiness (the event of having which we denote R). Assume that the probability of having throat itchiness if one has common flu is $P(R/M) = 0.95$. However, occasionally student tested positive for COVID also develop throat itchiness, and the probability of having throat itchiness if one with confirmed COVID is $P(R/F) = 0.08$. Upon examining the student, the doctor finds him having throat itchiness. Calculate the probability that the student has common flu.

(60 marks)

2. (a) A factory produces screws and packs them in boxes of 200. The Quality Assurance (QA) officer found the probability that a screw defect is 0.006, evaluate the probability that in a box selected at random, there is at most two screws which are defect.

(40 marks)

(b) Three coloured marbles are randomly transferred from a jar into a box. Table Q2 (b) shows the time (s) used to transfer the marbles.

Table Q2 (b)

Colour	Time (s)				
Red	9	11	10	9	15
Yellow	20	21	23	17	30
Green	6	5	8	14	7

(i) Construct one-way ANOVA test to determine if there is any significant difference of the transferring time due to the marble colours.

(ii) Sketch a boxplot for the coloured marbles transfer time.

(60 marks)

3. (a) The study was conducted for 10 workers over their study duration (in years of education) and their starting salary (in RM thousands) was shown in Table 3 (a).

Table 3 (a)

Starting salary (RM thousands)	Years of Education
35	12
46	16
48	16
50	15
40	13
65	19
28	10
37	12
49	17
55	14

(i) Construct a scatter diagram of the data.

(10 marks)

(ii) Find the least-squares regression line of the data by solving the normal equations.

(15 marks)

(iii) In order to investigate the connection between the year of study and starting salary, the paired data need to be verified using product-moment formula. Find the correlation coefficient of the two variables and verify it by using the product-moment formula. You may use the Pearson correlation Sig. (2 tailed) and N=10.

(15 marks)

(iv) Determine the standard deviation of the data and comment the results.

(10 marks)

...4/-

(b) The relationship between overweight and level of high blood pressure was researched in 10 adults. Table 3 (b) gives the number of weight (in kilogram) and the number of units over 80 of the diastolic blood pressure.

Table 3b

Weight (kg)	Units over 80 of Diastolic Blood Pressure
75	15
86	13
88	10
125	27
75	20
30	5
47	8
150	31
114	28
68	22

(i) Plot the scatter diagram and get the regression formulation of the data.

(15 marks)

(ii) Determine the correlation coefficient of the two variables and verify it by using the product-moment formula.

(15 marks)

(iii) Give TWO (2) inferences that one could deduce from the value determined in b (ii). Comment on the results.

(20 marks)

4. (a) In a football game, the quantitative outcome is the scores on the games (in tenths of points) and the explanatory variables are age of group and “trial” which represents which time the subjects play the game (1-5). The plotted graph is as shown in Figure 4a.

...5/-

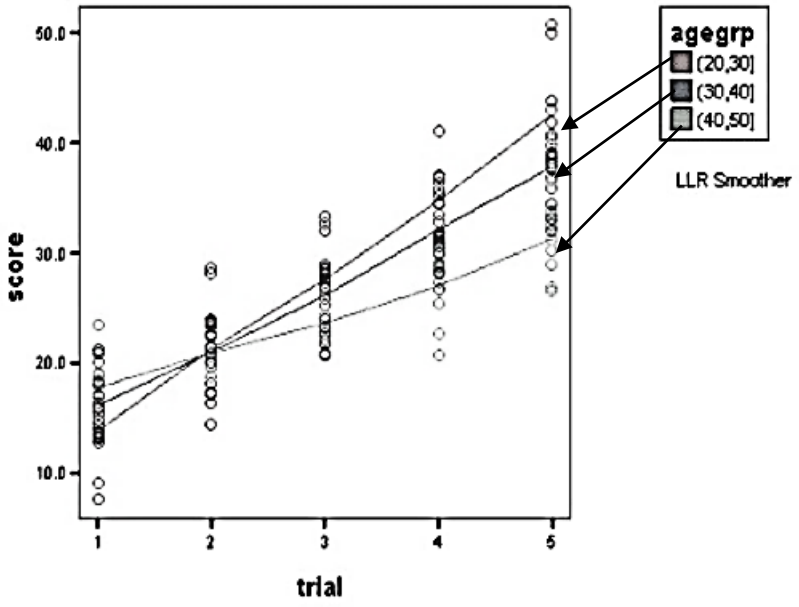

Figure 4a

(i) State TWO (2) inferences that can be deduced from Figure 4a.

(15 marks)

(ii) Determine TWO (2) main errors that might be occurred during measuring with the mix-mode modelling on the represented data.

(15 marks)

(iii) Derive the conclusion that you may get from the mix-mode method used.

(20 marks)

(b) As a consultant engineer in a company, you are assigned to carry out an experiment on the performance of a turbine engine. The experiment was conducted to analyse the independent variables A (brand), B (blade type), C (fuel used) and D (gaseous used) on 2 dependent results (turbine's air/gaseous flow and voltage).

(i) Based on Taguchi method and using Orthogonal arrays, design an appropriate experiment to be conducted on this research. State clearly the type of orthogonal array to be used and the hypothesis of the experiment**.**

(30 marks)

(ii) Evaluate and justify your results in Q5b(i) with discussion.

(20 marks)

- oooOooo -

...6/-

Appendix 1: FORMULAE

Sample mean of responses from i[th] group, $\overline{x_i} = \frac{\sum_{j=1}^{n_i} x_{ij}}{n_i}$

x_{ij}= the *j*[th] response sampled from the *i*[th] group (population)
n_i= total number of sample (sample size) of group *i*

Grand mean, $\overline{\overline{x_i}} = \frac{\sum X_{ij}}{N}$

X_{ij}= *i*[th] observation/data in the *j*[th] column
N= total number of observations

Sample standard deviation of responses from *i*[th] group,$s_i = \frac{\sum_{j=1}^{n_i} (x_{ij} - \overline{x_i})^2}{n_i - 1}$

Sum of Squares Total, SST = $\sum_{i=1}^{k} \sum_{j=1}^{n_i} \left(x_{ij} - \overline{\overline{x_i}}\right)^2$

Sum of Squares Groups, SSG = $\sum_{i=1}^{k} n_i (\overline{x_i} - \overline{\overline{x_i}})^2$

Sum of Squares Error, SSE = $\sum \sum \left(x_{ij} - \overline{x_j}\right)^2$

Mean Square Groups (MSG) = $\frac{SSG}{k-1}$

Mean Square Error (MSE) = $\frac{SSE}{n-k}$

k = number of groups
n = number of observation/data