First Semester Examination
2021/2022 Academic Session

February 2022

EMT211 – Engineering Probability & Statistics

Duration : 4 hours

Please ensure that this examination paper contains **FOUR (4)** pages and **FIVE (5)** question before you begin the examination.

Instructions : Answer **ALL FIVE (5)** questions.

Answer all questions in **English**.

Each question must begin from a new page.

1. (a) Given $S = A \cup B$. Prove or disprove the following using

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

    i.   set Algebra.

    ii. Venn diagram.

    (8 marks)

    (b) A box contains three coins: two regular coins and one fake two-headed coin $(P(H) = 1)$.

    i.   You pick a coin at random and toss it. What is the probability that it lands heads up?

    ii. You pick a coin at random and toss it, and get heads. What is the probability that it is the two-headed coin?

    (8 marks)

2. The following two samples are eight measurements recorded on length of leaves randomly picked from a residential garden.

Sample 1:	15	12	9	8	9	7	15	7
Sample 2:	15	7	15	7	9	15	9	7

    (a) Sketch side by side box plots for both samples.

    (b) Calculate the range for both the samples and determine whether they exhibit the same variability.

    (c) Calculate the standard deviation for both the samples and determine whether they exhibit the same variability.

    (d) Determine the skewness of both the samples.

    (16 marks)

3. (a) On average, about 90% of guests who arrived at a hotel were given rooms on reservations. The hotel has 200 rooms and 215 reservations were made for one-night accommodation. The problem is to find the probability that all guests were accommodated this night. If X= number of guests arriving at the hotel, find the probability that all guests can be accommodated using

    i.   Binomial distribution.

    ii.   The normal approximation to the Binomial distribution.

(**6 marks**)

(b)   State the assumptions for a good normal approximation to the Binomial distribution.

(**4 marks**)

(c)   To test the hypothesis that eating fish makes one smarter, a random sample of 12 persons take a fish oil supplement for one year and then are given an IQ test. Here are the results:

116 111 101 120 99 94 106 115 107 101 110 92

    i.   State the hypotheses for the test.

    ii.   Report the test statistic at $\alpha = 0.05$ and conclude the hypothesis results.

(**8 marks**)

4.   The article "Effect of Environmental Factors on Steel Plate Corrosion Under Marine Immersion Conditions" (C. Soares, Y. Garbatov and A. Zayed, Corrosion Engineering, Science and Technology, 2011:524-541) describes an experiment in which nine steel specimens were submerged in seawater at various temperatures, and the corrosion rate were measured. The results are presented in Table Q4.

Table Q4

Specimen	Temperature (° C)	Corrosion rate (mm/year)
1	26.6	1.58
2	26.0	1.45
3	27.4	1.13
4	21.7	0.96
5	14.9	0.99
6	11.3	1.05
7	15.0	0.82
8	8.7	0.68
9	8.2	0.56

a)   Construct a scatterplot of corrosion and temperature and compute the least-squares line for the predicting response of the data provided.

(**7 marks**)

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b)   Another two steel specimens whose temperature is 10^oC are submerged in seawater. Justify why the predicted corrosion rate was different from the current results and extrapolate the corrosion rate when the temperature is at 40^oC.

(8 marks)

c)   Determine the correlation between temperature and corrosion, the regression and the maximum point with the largest residual magnitude.

(10 marks)

5.   The article "Application of Radial Basis Function Neural Networks in Optimization of Hard Turning of AISI D2 Cold-Worked Tool Steel with a Ceramic Tool" (S. Basak, U. Dixit and J. Davim, Journal of Engineering Manufacture, 2007:987-998) reported the results of experiment in which tool wear computed for various values of three factors. The results are given in Table Q5.

Table Q5

Speed (m/min)	Time (min)	Wear (mm/s)					
80	5	5	5	5	5	4	3
80	10	8	8	8	8	8	8
80	15	11	10	9	9	10	9
150	5	9	11	9	8	10	9
150	10	14	14	15	13	17	18
150	15	16	15	26	24	24	25
220	5	34	33	19	21	18	20
220	10	60	59	29	31	28	31
220	15	65	64	31	33	75	80

a)   Besides the two factors such as cutting speed and cutting time in designing the above experiment, analyse all main effects and interactions that may affect the wear of the materials.

(7 marks)

b)   Construct an ANOVA table and determine the hypothesis of the study.
(8 marks)

c)   Analyse the effect of speed on wear by interpreting the main effect of speed using box-plot.

(10 marks)

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