THE OPEN UNIVERSITY OF SRI LANKA

B.Sc. /B.Ed. Degree Programme, Continuing Education Programme

APPLIED MATHEMATICS-LEVEL 05

ADU5318 – Biostatistics

FINAL EXAMINATION 2024/2025

Duration: Two Hours.

Date: 11.05.2025	Time: 1.30p.m- 3.30 p.m.

Instructions:

- **This question paper consists of 06 questions. Answer only four questions.**

- **Statistical Tables are provided at the end of the paper. When reading values, where applicable, you may use the closest degrees of freedom given in the table.**

- **In all tests, use the significance level as 0.05.**

- **If the random number table is to be used, you are required to clearly indicate how to read the values and as an illustration present the first three values that you read.**

- **Non-programmable calculators are permitted.**

1. To test a claim that a newly improved fertilizer (A) gives higher yield of bean compared to a fertilizer (B), yield (grams per plot) were measured on 80 similar experimental plots. Summary statistics computed from 40 plots for each fertilizer are given below.

Descriptive statisitic	Fertilizer	
	A	B
Sample mean	34.7	32.9
Standard deviation	2.4	2.3

   i) Clearly describing the notation you use, write down the appropriate null hypothesis and the alternative hypothesis appropriate to examine the validity of the claim.

   ii) Clearly stating the assumptions you make, suggest a suitable test statistic that can be used to test the claim.

   iii) Using a 5% significance level, test the validity of the claim and clearly state the findings in relation to this study.

   iv) Define each of the following terms and explain each in relation to this study.

      a) Type II error

      b) Critical value

2. The following table summarises the final examination marks obtained by a sample of students for a certain course.

Range of marks	Number of students
0 - 19	2
20 - 39	8
40 - 59	50
60 - 79	35
80 - 99	25

i) Calculate the sample mean.

ii) Calculate the median of the data.

iii) Based on the values computed in part (i) and part (ii), what can be concluded about the shape of the distribution of the data?

iv) Based on your answer to part (iii), recommend a measure of central tendency for this data.

v) If the cut off mark for an A grade is 75, estimate the percentage of students who will receive A grades.

vi) After computing each of the following statistics, a mark of 80 was corrected as 85. State whether the values you obtained for each of the following statistics would change, associated with this correction of marks. In each case, give reasons for your answer.

     a)   Sample mean

     b)   Median

     c)   Mode

3. The sample mean and the standard deviation of 30 dried weights (grams) of a certain medicinal plant, four weeks after planting in the field are 5.3 grams and 0.9 grams respectively. A researcher claims that the mean dried weight of the said plant, four weeks after planting exceeds 5 grams.

i) Clearly stating any assumptions you make, test the validity of the researcher's claim, using a 5% significance level and state your findings in relation to this study.

ii) Explain the difference between a population parameter and a statistic. Define each term in relation to this study.

iii) Define each of the following terms and briefly describe each in relation to this study.

    a) Null hypothesis

    b) Critical region

4. A study is to be designed to evaluate the effectiveness of a training programme for technicians. The aim is to determine whether participants who receive the training are able to complete a specific task in less time compared to those who do not receive the training.

The training programme can be offered to 40 technicians, to be selected from a pool of 70 technicians who are willing to participate in the study. The 30 technicians who will not be selected for the training will be used as a control group. After the training is completed, all 70 technicians will be asked to perform the task, and the time taken to complete the task (in minutes) will be recorded for each technician. Among the 70 technicians in the pool, 50 are males and the rest are females. All the females and 15 male technicians are new recruits and the rest have more than five years of experience. Time to complete the task may depend on the experience of the technician and the gender.

i) If you are asked to design this study, describe how you design, clearly indicating how participants are selected for the training. If the random number table is used, explain how you use it.

ii) Is the study described an observational study or an experimental study? Give reasons for your answer.

iii) Suppose data were collected according to your design, but a measurement error occurred: the recorded task completion time for each technician was 15 minutes more than the actual time. Would this error affect the evaluation of the effectiveness of the training programme? Justify your answer.

iv) Define each of the following terms and describe each in relation to this study:
   a)   Confounding
   b)   Response variable
   c)   Random variation

5. A disease that spreads gradually, causing yellowing of coconut leaves, has recently been observed in a plantation of approximately 2,000 coconut trees. The pattern of leaf discoloration suggests that the affected trees are spatially clustered. However, since the change in leaf color occurs slowly, some trees that are already infected may still appear healthy. To estimate the number of infected trees, the management has decided to test a

sample of 300 trees using a diagnostic test that detects a specific antigen associated with the disease.

i) Describe the types of errors that may occur under each of the following data collection designs:

   a)   Simple random sampling

   b)   Judgemental sampling

ii) If you were to propose a design for this study, how would you advice? Justify your proposal referring to its advantages and disadvantages over judgemental sampling.

iii) Explain the importance of using a suitable statistical design for data collection in a statistical study.

iv) Define each of the following terms and describe each in relation to this study:

   a) Population

   b) Sampling

6. The following data represent the average weekly online learning hours of 40 students, arranged in ascending order.

2	2	2	2	3	3	3	3	4	4
4	4	5	5	5	5	5	6	6	6
6	7	7	7	13	13	14	15	15	15
16	16	17	19	19	19	21	21	21	40

i) Clearly state the findings from the box and whisker plot of the data given below.


Weekly online learning hours
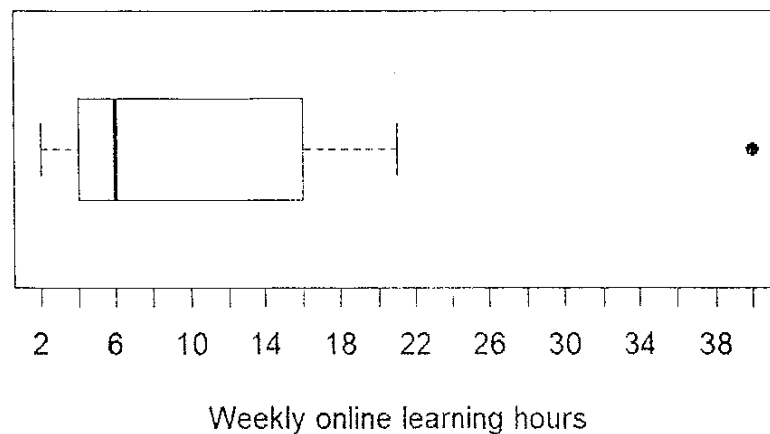
ii) Calculate the following using the data table given to you. Do not use information from the given plot. You should clearly show your calculations.

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a)   Inter-quartile range (IQR)

b)   Range

c)   Mean absolute deviation (MAD)

iii) Out of the measures you computed in part (ii), which one would you recommend as a measure of dispersion of this data? Give reasons for your choice.

iv) If it is necessary to examine whether the data provide evidence of natural groupings of students based on weekly online learning hours, would you recommend using a box and whisker plot? If yes, clearly explain how the box and whisker plot can be used for this purpose. If not, recommend a more suitable graph. You are **not** required to construct the graph.

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Table A2: Student's t - Distribution
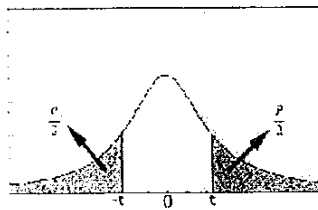
P	50	20	10	5	2	1	0.2	0.1
Degrees of freedom								
1	1.00	3.08	6.31	12.7	31.8	63.7	318	637
2	0.82	1.89	2.92	4.30	6.96	9.92	22.3	31.6
3	0.76	1.64	2.35	3.18	4.54	5.84	10.2	12.9
4	0.74	1.53	2.13	2.78	3.75	4.60	7.17	8.61
5	0.73	1.48	2.02	2.57	3.36	4.03	5.89	6.87
6	0.72	1.44	1.94	2.45	3.14	3.71	5.21	5.96
7	0.71	1.42	1.89	2.36	3.00	3.50	4.79	5.41
8	0.71	1.40	1.86	2.31	2.90	3.36	4.50	5.04
9	0.70	1.38	1.83	2.26	2.82	3.25	4.30	4.78
10	0.70	1.37	1.81	2.23	2.76	3.17	4.14	4.59
12	0.70	1.36	1.78	2.18	2.68	3.05	3.93	4.32
15	0.69	1.34	1.75	2.13	2.60	2.95	3.73	4.07
20	0.69	1.32	1.72	2.09	2.53	2.85	3.55	3.85
24	0.68	1.32	1.71	2.06	2.49	2.80	3.47	3.75
30	0.68	1.31	1.70	2.04	2.46	2.75	3.39	3.65
40	0.68	1.30	1.68	2.02	2.42	2.70	3.31	3.55
60	0.68	1.30	1.67	2.00	2.39	2.66	3.23	3.46
∞	0.67	1.28	1.64	1.96	2.33	2.58	3.09	3.29

Random Number Table

Row No.	Column Nos. 1 - 10	Column Nos. 11 - 20	Column Nos. 21 - 30	Column Nos. 31 - 40
1	13 50 63 04 23	25 47 57 91 13	52 62 24 19 94	91 67 48 57 10
2	78 66 28 55 80	47 46 41 90 08	55 98 78 10 70	49 92 05 12 07
3	51 57 32 22 27	12 72 72 27 77	44 67 32 23 13	67 95 07 76 30
4	66 86 65 64 60	56 59 75 36 75	46 44 33 63 71	54 50 06 44 75
5	19 83 52 47 53	65 00 51 93 51	30 80 05 19 29	56 23 27 19 03
6	51 78 57 26 17	34 87 96 23 95	89 99 93 39 79	11 28 94 15 52
7	79 68 96 26 60	70 39 83 66 56	62 03 55 86 57	77 55 33 62 02
8	73 52 93 70 50	48 21 47 74 63	17 27 27 51 26	35 96 29 00 45
9	63 99 25 69 02	09 04 03 35 78	19 79 95 07 21	02 84 48 51 97
10	86 28 30 02 35	71 30 32 06 47	93 74 21 86 33	49 90 21 69 74
11	97 96 47 59 97	56 33 24 87 36	17 18 16 90 46	76 27 28 52 13
12	93 41 69 96 07	97 50 81 79 59	42 37 13 81 83	92 42 85 04 31
13	40 24 74 36 42	40 33 04 46 24	35 63 02 31 61	34 59 48 36 96
14	06 06 16 25 98	17 78 80 36 85	26 41 77 63 37	71 63 94 94 33
15	97 81 26 03 89	39 46 67 21 17	98 10 39 33 15	61 63 00 25 92
16	65 99 59 97 84	90 14 79 61 55	56 16 88 87 60	32 15 99 67 43
17	16 91 21 32 41	60 22 66 72 17	31 85 33 69 07	68 49 20 43 29
18	62 03 89 26 32	35 27 99 18 25	78 12 93 09 70	50 93 19 35 56
19	92 27 73 40 38	37 11 05 75 16	98 81 99 37 29	62 20 32 39 67
20	45 51 94 69 04	00 84 14 36 37	95 66 39 01 09	21 68 40 95 79
21	00 81 06 28 48	12 08 05 75 26	03 35 63 05 77	13 81 20 67 58
22	05 06 42 24 07	60 60 29 99 93	73 93 78 04 36	25 76 01 54 03
23	12 68 46 55 89	60 09 71 87 89	70 81 10 95 91	83 79 68 20 66
24	07 79 26 69 61	67 85 72 37 41	85 79 76 48 23	61 58 87 08 05
25	52 16 16 23 56	62 95 80 97 63	32 25 34 03 36	48 84 60 36 56
26	16 01 92 58 21	48 79 74 73 72	08 64 80 91 38	07 28 66 61 59
27	89 84 05 34 47	88 09 31 54 88	97 96 86 01 69	46 13 95 65 96
28	51 99 98 44 39	12 45 10 60 36	80 66 39 94 97	42 36 31 16 59
29	08 12 60 39 23	61 73 84 89 18	26 02 04 37 95	96 18 69 06 30
30	69 99 47 26 52	48 06 30 00 18	03 30 28 55 59	66 10 71 44 05
31	88 91 28 79 50	71 42 14 95 55	98 59 96 01 36	88 77 90 45 59
32	59 45 27 08 51	85 64 23 85 41	64 72 08 59 55	67 98 36 65 56
33	84 27 17 30 37	48 69 49 02 58	98 02 50 58 11	95 39 06 35 63

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