THE OPEN UNIVERSITY OF SRI LANKA

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

APPLIED MATHEMATICS-LEVEL 05

ADU5318 – Biostatistics

FINAL EXAMINATION 2020/2021

Duration: Two Hours.

Date: 21.03.2022	Time: 1.30p.m- 3.30 p.m.

Instructions:

- " This question paper consists of 06 questions. Answer only four questions.
- Statistical Tables are provided in the Appendix. When reading values, 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 (Appendix) is to be used, you are required to clearly indicate how to read the values and as an illustration present three values that you read.
- Non-programmable calculators are permitted.

1. A resercher claims that in a newly improved variety of tomatoe plants, the mean time for fruits to be ready for harvesting after flowering, is less than 40 days. On a sample of 30 plants, the researcher found that the sample mean and sample standard deviation of the times for fruits to be ready for harvesting after flowering are 38.2 and 4.4 respectively.

   i) Clearly describing your notation, write down the null and the alternative hypotheses you would examine to test the validity of the researcher's claim.

   ii) Using an appropriate statistical test, examine the validity of the researcher's claim using a 5% significance level and clearly state the findings in relation to this study.

   iii) Clearly state the assumptions needed for the test carried out in part (ii).

   iv) Explain the following terms in relation to this study:

      a) Type 1 error

      b) Significance level

2. A medical practitioner is interested in comparing the effets of three cough syrups say CS1, CS2 and CS3. Two methods of drug administration are to be tested with each syrup, which are one tea spoon each after breakfast and dinner and one tea spoon after dinner only. Ninety five persons suffering from cough and are already using one of the cough syrups have volunteered to participate in the study. Among them, 25 use CS1, 35 use CS2 and the rest use CS3. The medical practitioner decided to continue with the drug that the participants use and assign a drug administration method. All participants were willing to take the drug as assigned by the medical practitioner.

Suppose that the medical practitioner seeks your advice to design this study.

i) Clearly describe how you advise the medical practitioner to design this study. If you use the random number table, clearly state how you read the values.

ii) Suppose the users of cough syrup CS1 are much younger to the users of the other two drugs. Will this cause sampling errors, non-sampling errors or neither? Give reasons for your answer.

iii) Is this an observational study or an experimental study? Give reasons for your answer.

iv) Explain the following terms in relation to this study.
   a) replicate
   b) confounding
   c) interaction

3. The following table summarises the yield of paddy per acre, measured to the nearest bushel, of a group of farmers selected for a research study.

Yield (bushels per acre)	Number of farmers
15 – 19	5
20 – 24	16
25 - 29	48
30 – 34	36
35 – 39	5

i) Calculate the sample mean and explain what it measures in relation to this study.

ii) Calculate the sample median.

iii) Based on the measures calculated in parts (i) and (ii), what can you say about the distribution of the data?

iv) Construct a suitable graph that can be used to find the percentiles of the data.

v) Using the graph constructed in part (iv), find the 10th percentile and explain what it measures in relation to this study.

4. The management of a hospital wants to assess the satisfaction of persons regarding the facilities available. The data are to be collected on two days from persons attending the eye clinic, diabetic clinic and the wellness clinic. From past experience, on each day, the hospital expects around 300, 600 and 300 persons for the eye clinic, diabetic clinic and the wellness clinic respectively. Resources are available to sample 200 persons for data collection on each day. Around 60% of persons attending each clinic are females and the researcher suspects gender differences in their opinion on facilities.

i) Suggest a suitable sampling design. You need to clearly explain how you sample the persons.

ii) State the data type as nominal, ordinal, interval or ratio in each of the following variables:

   a) Type of clinic recorded using codes: 1: Eye clinic; 2: Diabetic clinic: 3: Wellness clinic

   b) Gender of the person attending the clinic

   c) Age of the person recorded as 1: less than 20 years; 2: 21 to 30 years; 3: 31 to 40 years; 4: above 40 years

   d) Weight of the person recorded to the nearest kilogram

iii) State whether each of the following statements is true or false.

   a) Bias can be reduced by increasing the sample size.

   b) Non-sampling error cannot occur in a census.

5. The following table summarises the lengths of medicinal plants four weeks after planting in plots receiving one of the two fertilizers (*A* and *B*).

Length (cm)	Number of plants that received	
	Fertilizer *A*	Fertilizer B
6 – 8	5	7
9 - 11	8	20
12 – 14	23	32
15 – 17	36	16
18 – 20	24	6
21 – 23	10	3

Based on the data summarized in the table, the researcher is interested in examining how the lengths of plants receiving the two fertilizers differ with respect to the mean length and dispersion.

i) Consider the plants that received Fertilizer *A*.

 a) Calculate the relative frequency corresponding to the third-class interval and explain what it measures in relation to this study.

 b) Estimate the percentage of plants with lengths exceeding 17cm.

 c) Calculate the sample median an explain what it measures in relation to this study.

ii) Construct a suitable graph that is appropriate to compare how the lengths of plants receiving the two fertilizers differ with respect to the central tendency and dispersion.

iii) Clearly state all the findings from the graph constructed in part (ii).

6. A production process of nails is said to be in satisfactory condition if the percentage of defectives produced is at most 3%. The management samples nails to find out whether the production process is in satisfactory condition, whether there is a difference in the performance of the two production crews and how the performance has changed over time. The following table presents the data collected from the two production crews over a period of two years.

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Description		Jan 2006	May 2006	Aug. 2006	Jan 2007	June 2007	Oct 2007	Jan 2008	Sep 2008
Crew 1	No. of nails sampled	107	184	102	109	111	97	81	98
	No. of defectives	2	3	2	3	2	1	1	2
Crew 2	No. of nails sampled	201	210	190	109	220	164	208	185
	No. of defectives	4	4	3	3	5	4	6	4

a) Construct a suitable graphical summary to meet the objectives of the management.

b) Clearly state the findings from the graphical summary constructed in part (i).

c) Briefly explain the following terms in relation to this study.

    i) parameter
    ii) estimate
    iii) sampling unit

Appendix I

III

සිසුවන්ගේ *t* ව්‍යාප්තිය
සිවිලත අංක වැඩිවීම වඩා නිදු උපරිමයක් ලැබේ.

மாணாக்கனின் *t* பரம்பல்
சுயாதீனப்படி அதிகரிக்கையில் ஒடுங்கும்

The Student's *t* Distribution
Narrows with increasing degrees of freedom (*d.f.*)

t ව්‍යාප්තියේ *P* ක්‍ෂ ප්‍රතිශතයක් −*t* හා +*t* පරාසයට පිටතින් පිහිටන අගයන *t* හි අගයන්ය මෙම සුවිත අගයවලට පහත වගුවර ඇත.

இம் கோட்டணையால், மாணாக்கனின் பரம்பலின் ஒரு −*t* கும் +*t* கும் எல்லைக்கு உள்ளே, ஒரு குறிப்பிட்ட சதவிதமாகும் *P* கூறும் *t* யின் பெறுமதிகளைத் தகுவிக்கும். இவ் *t* பெறுமதிகள் வேறுபட்ட சுயாதீனப்படிகளுக்கு கட்டமைவான இருக்கப் தந்தன.

This table gives the values of *t* for which a particular percentage, *P*, of the Student's *t* distribution lies outside the range −*t* to +*t*. These values of *t* are tabulated for various degrees of freedom.

P	50%	20%	10%	5%	2%	1%	0.2%	0.1%
Degrees of freedom (සිවිලත අංක සුයාතීනප්පாடි)								
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

Appendix II

VIII

සමීයාවි අංක වශු
எழுமாற்று எண்கள்
Random Numbers

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60 00   35 14   40 32   13 51   70 88   32 24   76 63   34 55   62 84   12 93
28 34   84 00   17 85   73 77   41 73   09 44   99 67   18 69   29 88   48 01
66 24   78 36   31 53   15 61   18 57   11 75   93 36   18 68   54 06   93 61
95 02   41 71   12 68   44 61   26 09   84 53   62 43   53 06   39 47   88 98
26 91   71 89   01 81   85 93   81 13   47 79   80 42   71 18   13 86   60 17

37 15   77 23   18 75   74 03   07 24   35 09   20 95   49 36   98 24   58 34
37 54   76 16   43 21   08 60   57 20   85 23   50 10   11 15   13 65   07 27
16 44   00 34   91 78   78 10   51 01   39 20   66 57   43 77   81 69   60 67
70 87   60 75   81 16   38 25   75 97   61 47   53 16   62 17   83 43   88 81
76 54   28 65   74 36   09 79   97 13   08 15   70 52   85 09   19 15   74 59

56 44   43 89   24 12   68 15   90 99   06 94   57 25   55 14   62 80   04 82
40 88   90 57   18 92   26 65   61 94   55 65   18 61   60 75   93 46   29 43
19 86   69 67   46 12   55 09   84 13   99 01   11 66   96 95   42 17   43 25
29 14   36 16   85 89   86 51   53 77   12 40   79 08   77 17   58 93   85 37
73 57   55 86   66 51   77 58   57 86   88 53   48 54   33 75   59 85   63 15

71 27   89 59   58 56   48 00   23 24   39 46   28 88   25 76   29 70   97 05
19 08   19 11   54 15   50 48   46 66   24 40   04 76   88 50   96 85   15 02
76 14   15 90   04 19   16 47   24 70   72 69   13 02   14 23   22 86   02 20
20 14   03 02   15 00   53 41   65 80   21 70   21 64   77 31   50 72   27 16
10 86   75 96   90 16   67 45   01 71   97 26   04 57   25 85   96 23   22 86
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19 32   79 41   20 84   81 21   92 88   43 42   19 10   15 05   82 23   16 60
88 85   22 80   25 18   85 35   44 04   37 40   02 87   74 57   11 24   09 66
49 55   88 89   99 78   56 55   60 90   12 37   46 48   62 98   89 00   08 82
91 20   11 42   31 06   49 78   80 44   22 34   44 88   69 04   97 99   17 14
04 13   62 00   63 28   70 48   08 72   32 05   57 06   04 98   27 01   56 05

30 46   36 61   38 95   80 69   80 71   85 22   66 23   13 01   51 58   30 18
08 04   59 13   90 88   89 85   84 57   01 24   01 60   33 99   20 52   50 91
05 44   40 09   21 47   12 50   97 69   19 61   36 50   71 28   92 48   44 42
38 66   94 28   74 07   98 11   61 05   24 42   41 18   48 06   16 68   43 56
27 10   66 30   35 45   51 78   43 87   44 67   04 26   09 43   54 44   37 87

69 48   90 28   50 88   12 07   52 75   39 05   33 04   24 61   91 07   45 01
45 30   79 17   16 51   77 52   09 79   09 75   98 79   68 69   18 20   14 89
91 15   24 25   51 15   38 65   38 86   24 06   24 79   81 03   43 83   61 76
28 47   25 08   90 04   98 79   93 82   74 44   52 66   98 65   34 36   42 33
66 23   48 17   70 55   87 58   76 81   94 32   12 78   69 90   65 71   18 55

20 98   62 65   89 10   06 57   60 70   63 17   12 83   01 08   20 87   18 51
83 75   45 20   06 84   17 93   13 43   02 72   94 34   69 67   22 77   61 33
55 56   09 38   05 16   14 72   64 69   08 92   60 75   29 91   24 38   75 19
60 30   81 40   01 12   27 25   55 41   91 13   63 95   46 55   59 27   67 03
05 73   31 10   04 69   21 01   53 59   16 34   43 66   79 94   04 24   39 69

09 27   24 66   76 86   30 19   47 05   76 93   58 57   45 91   71 33   77 36
71 02   71 61   97 19   77 09   83 31   19 84   69 54   98 20   84 21   88 90
15 28   35 19   28 23   14 11   90 33   49 22   31 66   82 80   69 62   02 07
35 39   83 49   44 96   01 77   65 95   61 64   03 85   46 24   06 14   24 05
59 29   75 57   57 38   66 28   90 53   56 76   61 08   87 70   44 45   79 55
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