National Exams May 2016

04-Env-B7: Environmental Sampling and Analysis

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is a closed book exam. Use either an approved non-programmable Sharp or Casio calculator. Write the name and model designation of the calculator, on the first inside left hand sheet, of the exam work book.
3. Answer all 3 questions in Part A and any 2 questions in Part B.
4. All questions are of equal value. Part marks are as shown.
5. Use the statistical tables provided.

Table Provided:

t-distribution table

Part A: Answer all three questions

1. a) List the two properties which make Simple Random Sampling (SRS) the standard by which other sampling methods are judged. Explain why SRS is not always used in practice. List 4 other methods used in environmental sampling besides SRS.[8 marks]

   b) List 5 typical characteristics of environmental data [5 marks].

   c) Indicate whether each of the statements below is true or false: [1 mark each]

   (i) For statistical significance, the α-value must be greater than the p-value.

   (ii) An ANOVA is for testing differences among variances.

   (iii) We can increase the power of a statistical test by increasing α or increasing the sample size n.

   (iv) As the sample size of a set of data increases, the data tend to be normally distributed.

   (v) Pearson's correlation coefficient r is a measure of linear or nonlinear association.

   (vi) The attained significance of a sample statistic is independent on sample size.

   (vii) Nonparametric statistical tests are usually preferred over parametric tests for environmental data analysis.

2. Air pollution concentrations at 11 locations were measured. Measurements were taken using two different methods and the following values in parts per million of CO_2 were obtained:

Method A:	66.3	63.5	64.9	61.8	64.3	64.7	65.1	64.5	68.4	63.2	67.4
Method B:	71.3	60.4	64.6	63.9	68.8	70.1	64.8	68.9	65.8	66.2	69.2

It is desired to show that the pollution values obtained using Method A are not significantly different from that of Method B at the 10% significance level. Partial results are shown below.

T-test for Method A - Method B

	N	Mean	StDev	SE Mean
Method A	11	64.918	1.885	0.568
Method B	11	66.727	3.238	0.976
Difference	11	-1.809	3.016	0.909

   a) Conduct the appropriate t-test for the situation at hand? Explain why you use this test. What is the conclusion from the test? [10 marks]

   b) What is the main assumption of the t-test used? Use a simple graphical method to verify the assumption of the t-test used? [10 marks]

3. Samples of soil, water, or air collected in the field are often sent to a certified laboratory for analysis. Discuss the protocol that should be followed so that the field data collected would be an accurate representation of the actual contaminants found in the samples. Points you should address include: types of sample collection methods, sample preparation and preservation techniques, quality assurance and control, data management, and sources of errors. [20 marks]

Part B: Answer any 2 questions

4. Ten samples of nitrate concentrations were taken from a well site. The data are as follows:

13 5 8 120 9 2 45 24 57 16

The summary statistics obtained from a computer package are given below.

N	Mean	Median	StDev	Minimum	Maximum	Q1	Q3
10	29.9	14.5	36.4	2.0	120.0	7.3	48.0

a) Draw accurately a dotplot and a standard boxplot for the data. Indicate clearly where the fences are for the boxplot. Indicate whether any outliers exist. [10 marks]

b) From the numerical summary and the boxplot, what can you conclude about the characteristics of the data? Compute also the quartile skew and coefficient of skewness. [10 marks]

5. Provide a brief explanation/definition of the following terms commonly used in environmental sampling and analysis:

a) Background or baseline concentration [2 marks]
b) Detection limit [2 marks]
c) Grab sample versus a composite sample [3 marks]
d) Colorimetric analysis versus instrumental analysis [3 marks]
e) Hotspots [2 marks]
f) Maximum Contaminant Level (MCL) versus Quantification Limit (QL) [3 marks]
g) Assessment monitoring versus compliance monitoring [3 marks]
h) Data QA/QC [2 marks]

6. Consider an environmental monitoring program that you have been involved with. What were the short and long term objectives of the monitoring program? What were sampled? How were the samples collected? What sampling design(s) were used? How often was sampling done? How many samples were collected and over what period? What statistical hypotheses were being tested? What statistical analyses were carried out? What kinds of laboratory analyses were done? What relevant standards were used and compared to? Discuss any other relevant issues related to this monitoring program. Marks will be awarded based on the thoroughness of your answer. [20 marks]

t-distribution table

Critical Values of the t-Distribution

	α						
v	0.40	0.30	0.20	0.15	0.10	0.05	0.025
1	0.325	0.727	1.376	1.963	3.078	6.314	12.706
2	0.289	0.617	1.061	1.386	1.886	2.920	4.303
3	0.277	0.584	0.978	1.250	1.638	2.353	3.182
4	0.271	0.569	0.941	1.190	1.533	2.132	2.776
5	0.267	0.559	0.920	1.156	1.476	2.015	2.571
6	0.265	0.553	0.906	1.134	1.440	1.943	2.447
7	0.263	0.549	0.896	1.119	1.415	1.895	2.365
8	0.262	0.546	0.889	1.108	1.397	1.860	2.306
9	0.261	0.543	0.883	1.100	1.383	1.833	2.262
10	0.260	0.542	0.879	1.093	1.372	1.812	2.228
11	0.260	0.540	0.876	1.088	1.363	1.796	2.201
12	0.259	0.539	0.873	1.083	1.356	1.782	2.179
13	0.259	0.537	0.870	1.079	1.350	1.771	2.160
14	0.258	0.537	0.868	1.076	1.345	1.761	2.145
15	0.258	0.536	0.866	1.074	1.341	1.753	2.131
16	0.258	0.535	0.865	1.071	1.337	1.746	2.120
17	0.257	0.534	0.863	1.069	1.333	1.740	2.110
18	0.257	0.534	0.862	1.067	1.330	1.734	2.101
19	0.257	0.533	0.861	1.066	1.328	1.729	2.093
20	0.257	0.533	0.860	1.064	1.325	1.725	2.086
21	0.257	0.532	0.859	1.063	1.323	1.721	2.080
22	0.256	0.532	0.858	1.061	1.321	1.717	2.074
23	0.256	0.532	0.858	1.060	1.319	1.714	2.069
24	0.256	0.531	0.857	1.059	1.318	1.711	2.064
25	0.256	0.531	0.856	1.058	1.316	1.708	2.060
26	0.256	0.531	0.856	1.058	1.315	1.706	2.056
27	0.256	0.531	0.855	1.057	1.314	1.703	2.052
28	0.256	0.530	0.855	1.056	1.313	1.701	2.048
29	0.256	0.530	0.854	1.055	1.311	1.699	2.045
30	0.256	0.530	0.854	1.055	1.310	1.697	2.042
40	0.255	0.529	0.851	1.050	1.303	1.684	2.021
60	0.254	0.527	0.848	1.045	1.296	1.671	2.000
120	0.254	0.526	0.845	1.041	1.289	1.658	1.980
∞	0.253	0.524	0.842	1.036	1.282	1.645	1.960

Marking Scheme

1. 20 marks total (3 parts: 8 + 5 + 7 marks)
2. 20 marks total (2 parts, 10 marks each)
3. 20 marks total (descriptive)
4. 20 marks total (a) 10 marks (b) 10 marks
5. 20 marks total 8 items, (4 x 2 marks, 4 x 3 marks)
6. 20 marks total descriptive