

National Exams May 2011

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 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 5 questions.
4. All questions are of equal value. Part marks are as shown.
5. Questions 4 and 5 are open-ended questions. Marks will be based on the thoroughness of your answer.

Answer all five (5) 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. Give an example where another sampling scheme may be better. [5 marks]
- b) List 5 other methods used in environmental sampling besides SRS. [5 marks]
- c) List 5 typical characteristics of environmental data. [5 marks]
- d) 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) The Pearson r is a measure of linear correlation only.
- (iii) We can increase the power of a statistical test by decreasing 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) The mean square error is a measure of precision of a statistical estimate.

2. Air pollution concentrations at a location were measured. Eleven measurements were taken using two different methods and the following values in parts per million of CO₂ 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 using Method B at the 5% significance level. The following three tests were carried out in using a computer.

Test 1: Paired T for Method A - Method B (Paired test)

	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

T-Test of mean difference = 0 (vs < 0): P-Value = 0.037

Test 2: Two-sample T for Method A vs Method B (One-tailed test)

	N	Mean	StDev	SE Mean
Method A	11	64.92	1.88	0.57
Method B	11	66.73	3.24	0.98

Difference = μ Method A - μ Method B

Estimate for difference: -1.81

T-Test of difference = 0 (vs <): P-Value = 0.064 DF = 16

Test 3: Two-sample T for Method A vs Method B (Two-tailed test)

	N	Mean	StDev	SE Mean
Method A	11	64.92	1.88	0.57
Method B	11	66.73	3.24	0.98

Difference = μ Method A - μ Method B

Estimate for difference: -1.81

T-Test of difference = 0 (vs not =): P-Value = 0.129 DF = 16

- Which of the above results is the appropriate one? Explain why this is so. What is the conclusion from the test? [10 marks]
- What is the main assumption of the t-test used? Describe a simple method to verify the assumption of the t-test. [5 marks]
- Calculate the value of the test statistic for each of the above tests. [5 marks]

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

- Background or ambient concentration [2 marks]
- Remote sensing [2 marks]
- Grab sampling versus a composite sampling [3 marks]
- Colorimetric analysis versus instrumental analysis [3 marks]
- Bioassay [2 marks]
- Maximum Contaminant Level (MCL) versus Quantification Limit (QL) [3 marks]
- Assessment monitoring versus compliance monitoring [3 marks]
- Data QA/QC [2 marks]

4. 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: sample collection methods, sample preparation and preservation techniques, quality assurance and control, data management including data coding, dealing with non-detects, data verification procedures, and sources of errors. [20 marks]
5. Consider an environmental monitoring program that you have been involved with. What were the short and long term objectives of the monitoring program? What physical, chemical and biological variables were sampled? How were the samples collected? What types of sampling equipment or instruments were used? What sampling design schemes and criteria 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 and using what statistical software? 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. [20 marks]