

National Exams December 2019

18-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 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 workbook.
3. Answer all 5 questions.
4. Part marks are as shown.
5. Use the statistical tables provided.

Table Provided:

F-distribution

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. [5 marks]
 - b) Give two examples each of parameters to be sampled from say a water body, air, and soil. [3]
 - 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) An ANOVA is for testing differences among means.
 - (iii) We can increase the power of a statistical test by reducing α .
 - (iv) As the sample size of a set of data increases, the data tend to be more normally distributed.
 - (v) Pearson's correlation coefficient r can be used as a measure of only linear association.
 - (vi) The attained significance level of a sample statistic is dependent on sample size.
 - (vii) Nonparametric statistical tests are usually more powerful than parametric tests for environmental data analysis.

2. Fill in the blanks in the following output for data from a completely randomized, two factor field study. Factor A has 3 levels (Locations) and Factor B has 4 levels (Seasons). Two replications were available for each treatment combination. Test for statistical significance at the 5% level. State clearly the conclusions from the study. [20 marks]

2-Way ANOVA

Source	SS	DF	MS	F
Location (A)	_____	___	80.17	_____
Season (B)	12.46	___	_____	_____
Interaction (AB)	_____	___	_____	_____
Error	_____	___	3.79	
Total	262.96	___		

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: the sampling protocol, types of sample collection methods, sample preparation and preservation techniques, quality assurance and control, data management, and sources of errors. [20 marks]
4. Provide a brief explanation/definition of the following terms commonly used in environmental sampling and analysis:
- | | |
|---|-----------|
| a) Background or baseline concentration | [2 marks] |
| b) Censored data | [2 marks] |
| c) Composite sample | [3 marks] |
| d) Colorimetric analysis versus instrumental analysis | [2 marks] |
| e) BACI (Before-After-Control Impact) design | [3 marks] |
| f) Maximum Contaminant Level (MCL) | [2 marks] |
| g) Assessment monitoring versus compliance monitoring | [2 marks] |
| h) Data QA/QC | [2 marks] |
| i) Bioassay | [2 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 were sampled? How were the samples collected? What sampling design(s) were used? How often was sampling done and optimized? 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]

F - Distribution ($\alpha = 0.05$ in the Right Tail)

df ₂ \ df ₁		Numerator Degrees of Freedom								
		1	2	3	4	5	6	7	8	9
1	161.45	199.50	215.71	224.58	230.16	233.99	236.77	238.88	240.54	
2	18.513	19.000	19.164	19.247	19.296	19.330	19.353	19.371	19.385	
3	10.128	9.5521	9.2766	9.1172	9.0135	8.9406	8.8867	8.8452	8.8123	
4	7.7086	9.9443	6.5914	6.3882	6.2561	6.1631	6.0942	6.0410	6.9988	
5	6.6079	5.7861	5.4095	5.1922	5.0503	4.9503	4.8759	4.8183	4.7725	
6	5.9874	5.1433	4.7571	4.5337	4.3874	4.2839	4.2067	4.1468	4.0990	
7	5.5914	4.7374	4.3468	4.1203	3.9715	3.8660	3.7870	3.7257	3.6767	
8	5.3177	4.4590	4.0662	3.8379	3.6875	3.5806	3.5005	3.4381	3.3881	
9	5.1174	4.2565	3.8625	3.6331	3.4817	3.3738	3.2927	3.2296	3.1789	
10	4.9646	4.1028	3.7083	3.4780	3.3258	3.2172	3.1355	3.0717	3.0204	
11	4.8443	3.9823	3.5874	3.3567	3.2039	3.0946	3.0123	2.9480	2.8962	
12	4.7472	3.8853	3.4903	3.2592	3.1059	2.9961	2.9134	2.8486	2.7964	
13	4.6672	3.8056	3.4105	3.1791	3.0254	2.9153	2.8321	2.7669	2.7144	
14	4.6001	3.7389	3.3439	3.1122	2.9582	2.8477	2.7642	2.6987	2.6458	
15	4.5431	3.6823	3.2874	3.0556	2.9013	2.7905	2.7066	2.6408	2.5876	
16	4.4940	3.6337	3.2389	3.0069	2.8524	2.7413	2.6572	2.5911	2.5377	
17	4.4513	3.5915	3.1968	2.9647	2.8100	2.6987	2.6143	2.5480	2.4943	
18	4.4139	3.5546	3.1599	2.9277	2.7729	2.6613	2.5767	2.5102	2.4563	
19	4.3807	3.5219	3.1274	2.8951	2.7401	2.6283	2.5435	2.4768	2.4227	
20	4.3512	3.4928	3.0984	2.8661	2.7109	2.5990	2.5140	2.4471	2.3928	
21	4.3248	3.4668	3.0725	2.8401	2.6848	2.5727	2.4876	2.4205	2.3660	
22	4.3009	3.4434	3.0491	2.8167	2.6613	2.5491	2.4638	2.3965	2.3419	
23	4.2793	3.4221	3.0280	2.7955	2.6400	2.5277	2.4422	2.3748	2.3201	
24	4.2597	3.4028	3.0088	2.7763	2.6207	2.5082	2.4226	2.3551	2.3002	
25	4.2417	3.3852	2.9912	2.7587	2.6030	2.4904	2.4047	2.3371	2.2821	
26	4.2252	3.3690	2.9752	2.7426	2.5868	2.4741	2.3883	2.3205	2.2655	
27	4.2100	3.3541	2.9604	2.7278	2.5719	2.4591	2.3732	2.3053	2.2501	
28	4.1960	3.3404	2.9467	2.7141	2.5581	2.4453	2.3593	2.2913	2.2360	
29	4.1830	3.3277	2.9340	2.7014	2.5454	2.4324	2.3463	2.2783	2.2229	
30	4.1709	3.3158	2.9223	2.6896	2.5336	2.4205	2.3343	2.2662	2.2107	
40	4.0847	3.2317	2.8387	2.6060	2.4495	2.3359	2.2490	2.1802	2.1240	
60	4.0012	3.1504	2.7581	2.5252	2.3683	2.2541	2.1665	2.0970	2.0401	
120	3.9201	3.0718	2.6802	2.4472	2.2899	2.1750	2.0868	2.0164	1.9588	
∞	3.8415	2.9957	2.6049	2.3719	2.2141	2.0986	2.0096	1.9384	1.8799	