

CHUKA



UNIVERSITY

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**EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF
SCIENCE IN CHEMISTRY, BACHELOR OF SCIENCE INDUSTRIAL
CHEMISTRY AND BACHELOR OF SCIENCE**

CHAL 101: STATISTICAL METHODS FOR ENVIRONMENTAL CHEMISTRY I

STREAMS: BSc. (Y1S2)

TIME: 2 HOURS

DAY/DATE: WEDNESDAY 17/04/2024

11.30 A.M. – 1.30 P.M.

INSTRUCTIONS

- Answer question **ONE** and any other **TWO** questions.
- Use of calculators and statistical tables is allowed.
- Do not write anything on the question paper.

QUESTION ONE (30 MARKS): COMPULSORY QUESTIONS

(a) Explain the following terms as used in analytical chemistry:

- | | |
|-----------------------|-----------|
| (i) Analyte. | (1 marks) |
| (ii) Matrix. | (1 marks) |
| (iii) Mean centering. | (1 marks) |
| (iv) Accuracy. | (1 marks) |
| (v) Precision. | (1 marks) |

(b) A target population is divided into strata such that the sizes of $N_A = 567$, $N_B = 389$, $N_C = 1080$, $N_D = 509$, $N_E = 912$ and $N_K = 870$. Show how a sample size of $n = 197$ should be allocated to the four strata if stratified random sampling was applied. (6 marks)

(c) (i) A repeated sampling from a certain process resulted in standard deviation of 0.302 in measurements of the property of interest. Determine the sample size required to ensure 95% confidence that the average quality of a shipment lies within the limits ± 0.23 of the mean. Take $t_{n-1, \alpha/2} = 1.96$ (2 marks)

(ii) In a chemical analysis laboratory samples arrives at a random of 6 samples per hour. A sample arrives at 3:30 pm, find the probability that the next sample arrives at 3.45 pm.

(4 marks)

(d) An experiment was carried to determine the concentration of iron in soils in a given area. Eighty one soil samples were obtained and the mean iron concentration was found to be 38 mg/Kg of soil.

(i) It had been claimed that the mean iron concentration 36 mg/Kg of soil with a variance of 36 mg/Kg of soil. Is the claim justified at $\alpha = 0.05$ based on the sample information?

(4 marks)

(ii) If the claim is that the mean iron concentration is at least 36 mg/Kg of soil, is the claim justified at $\alpha = 0.05$ based on the sample information?

(3 marks)

(e) To determine the contamination of a river by lead, samples were collected during the wet and dry season giving the following results in ppm:

Sample	1	2	3	4	5	6	7	8
Dry season	211	185	182	175	154	152	149	144
Wet season	215	211	193	183	190	156	144	143

Assuming that you do not know the underlying distribution of data collected, determine if the two measurements are not significantly different. Take $\alpha = 0.05$

(6 marks)

QUESTION TWO (20 MARKS)

The following set of measurements was taken from a soil sample on determination of amount of iron in mg/kg of soil,

Amount (mg/kg soil)	0 - 5	6 - 11	12 -17	18-23	24 - 29	30 - 35
Number of samples	6	13	29	41	36	27

(i) Calculate the mean, mode, median, standard deviation, coefficient of variation and Pearson measure of skewness clearly show your workings.

(18 marks)

(ii) Comment on the results obtained in 4(i) above.

(2 marks)

QUESTION THREE (20 MARKS)

(a) The records taken from samples in five sites is as follow:

Site	Number of samples
A	33
B	29
C	24
D	21
E	18

Assuming that the number of contaminated samples are equally expected in all sites, does the observed information agree with the expected ratios at 5% significance level? (6 marks)

(b) The following data were obtained before and after a treatment was applied.

Samples	1	2	3	4	5	6	7	8
Before	130	190	200	110	160	190	180	230
After	170	220	170	140	140	210	170	240

At a 5% level of significance, determine if there is significant change before and after the application of the treatment. (7 marks)

(c) The following data was obtained from an experiment: 170, 184, 220, 84, 178, 250, 204, 258, 212, 172, 122, 238, 134, 164, 196, 206 and 172. Construct a 95% and 99% confidence interval for the population mean. (7 marks)

QUESTION FOUR (20 MARKS)

(a) In the determination of chromium in borehole water by flame emission spectrometry using the methods of standard additions, the following results were obtained:

Cr standard added (μmL^{-1})	0.0	10.0	15.0	20.0	25.0	30.0
Emission signal	12.3	14.4	15.3	16.1	17.5	18.7

- (i) Fit a simple linear regression model. (8 marks)
- (ii) Determine the chromium concentration in the river water. (2 marks)
- (iii) Obtain a correlation coefficient. (4 marks)

(b) To test the amount of a given contaminant in two sites, samples were taken and analysed giving following statistics calculated:

	Site	
	Chuka	Embu
Sample size	70	76
Sample mean	98	80
Variance	400	676

Using the statistics provide, test the claim that site Chuka is more contaminated than site Embu at 5% probability level. (6 marks)

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