



Research Methodology and Statistics for Chemists (IARSCS-813)

First Semester, Marks: 100, Time allowed: 3 hours

Note: Attempt any five questions

1. Define the following terms.

1. Accuracy
2. Precision
3. Error
4. Standard Deviation
5. Relative Standard Deviation
6. Coefficient of Variation

2. Describe Confidence Limits, Student's t -test, and Paired T -test.

3. The following results were obtained in a comparison between a new method and a standard method for the determination of nickel in special steel.

$$\text{Mean } \bar{x}_1 = 7.85\%, \bar{x}_2 = 8.03\%$$

$$\text{Standard Deviation } s_1 = \pm 0.130\%, s_2 = \pm 0.095\%.$$

$$\text{Number of samples } n_1 = 5, n_2 = 6$$

Test at 95% probability value if the new method mean is significantly different from the standard reference mean.

4. Quinine may be determined by measuring the fluorescence intensity in 1M H_2SO_4 solution. The standard solution gave the following fluorescence values, calculate the coefficient of correlation.

| | | | | | |
|---|------|------|------|------|------|
| Concentration of Quinine x_1 ($\mu\text{g/ml}$) | 0.00 | 0.10 | 0.20 | 0.30 | 0.40 |
| Fluorescence intensity (arb. unit) | 0.00 | 5.20 | 9.90 | 15.3 | 19.1 |

5. In the determination of strontium in river water by flame emission spectrometry using the method of standard additions; The following results were obtained,

| | | | | | | |
|--|------|------|------|------|------|------|
| Std. Solution added ($\mu\text{g/ml}$) | 0.00 | 10.0 | 15.0 | 20.0 | 25.0 | 30.0 |
| Emission signal | 2.30 | 4.40 | 5.30 | 6.10 | 7.50 | 8.70 |

Determine the concentration in the river water and evaluate the 95% confidence limit for this value.

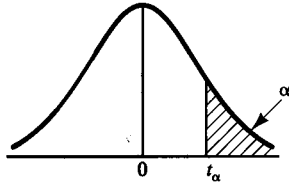
6. Three analyst were each asked to perform four replicate titration using the same solutions. The litres (ml) are given below,

| Analyst A | Analyst B | Analyst C |
|-----------|-----------|-----------|
| 22.53 | 22.48 | 22.57 |
| 22.60 | 22.40 | 22.62 |
| 22.54 | 22.48 | 22.61 |
| 22.62 | 22.43 | 22.65 |

Compare the performance of three analyst all using the same titration method. Please report if there is a significant difference between the analyst at 95% confidence limit.

7. Describe two-way analysis of variance (ANOVA) with a suitable example.

Table A.5. Percentage Points of the Students t Distribution with ν Degrees of Freedom



| ν | $t_{0.005}$ | $t_{0.01}$ | $t_{0.025}$ | $t_{0.05}$ | $t_{0.10}$ |
|----------|-------------|------------|-------------|------------|------------|
| 1 | 63.66 | 31.82 | 12.71 | 6.31 | 3.08 |
| 2 | 9.92 | 6.92 | 4.30 | 2.92 | 1.89 |
| 3 | 5.84 | 4.54 | 3.18 | 2.35 | 1.64 |
| 4 | 4.60 | 3.75 | 2.78 | 2.13 | 1.53 |
| 5 | 4.03 | 3.36 | 2.57 | 2.02 | 1.48 |
| 6 | 3.71 | 3.14 | 2.45 | 1.94 | 1.44 |
| 7 | 3.50 | 3.00 | 2.36 | 1.90 | 1.42 |
| 8 | 3.36 | 2.90 | 2.31 | 1.86 | 1.40 |
| 9 | 3.25 | 2.82 | 2.26 | 1.83 | 1.38 |
| 10 | 3.17 | 2.76 | 2.23 | 1.81 | 1.37 |
| 11 | 3.11 | 2.72 | 2.20 | 1.80 | 1.36 |
| 12 | 3.06 | 2.68 | 2.18 | 1.78 | 1.36 |
| 13 | 3.01 | 2.65 | 2.16 | 1.77 | 1.35 |
| 14 | 2.98 | 2.62 | 2.14 | 1.76 | 1.34 |
| 15 | 2.95 | 2.60 | 2.13 | 1.75 | 1.34 |
| 16 | 2.92 | 2.58 | 2.12 | 1.75 | 1.34 |
| 17 | 2.90 | 2.57 | 2.11 | 1.74 | 1.33 |
| 18 | 2.88 | 2.55 | 2.10 | 1.73 | 1.33 |
| 19 | 2.86 | 2.54 | 2.09 | 1.73 | 1.33 |
| 20 | 2.84 | 2.53 | 2.09 | 1.72 | 1.32 |
| 21 | 2.83 | 2.52 | 2.08 | 1.72 | 1.32 |
| 22 | 2.82 | 2.51 | 2.07 | 1.72 | 1.32 |
| 23 | 2.81 | 2.50 | 2.07 | 1.71 | 1.32 |
| 24 | 2.80 | 2.49 | 2.06 | 1.71 | 1.32 |
| 25 | 2.79 | 2.48 | 2.06 | 1.71 | 1.32 |
| 26 | 2.78 | 2.48 | 2.06 | 1.71 | 1.32 |
| 27 | 2.77 | 2.47 | 2.05 | 1.70 | 1.31 |
| 28 | 2.76 | 2.47 | 2.05 | 1.70 | 1.31 |
| 29 | 2.76 | 2.46 | 2.04 | 1.70 | 1.31 |
| 30 | 2.75 | 2.46 | 2.04 | 1.70 | 1.31 |
| 40 | 2.70 | 2.42 | 2.02 | 1.68 | 1.30 |
| 60 | 2.66 | 2.39 | 2.00 | 1.67 | 1.30 |
| 120 | 2.62 | 2.36 | 1.98 | 1.66 | 1.29 |
| ∞ | 2.58 | 2.33 | 1.96 | 1.645 | 1.28 |

Source: Robert E. Shannon, *Systems Simulation: The Art and Science*, ©1975, p. 375. Reprinted by permission of Prentice Hall, Upper Saddle River, NJ.