

DATA ANALYSIS & SAMPLING

1. Nature of Quantitative Measurements:

- Numerical data from experiments/observations.
- Ensure accuracy, precision, reliability.

2. Mean & Median:

- Mean ($\bar{x}$) = $(\sum x)/n$
- Median = middle value of ordered data
- Mean sensitive to outliers; median less affected.

3. Precision & Accuracy:

- Precision: closeness of repeated measurements.
- Accuracy: closeness to true value.
- High precision $\neq$ high accuracy.

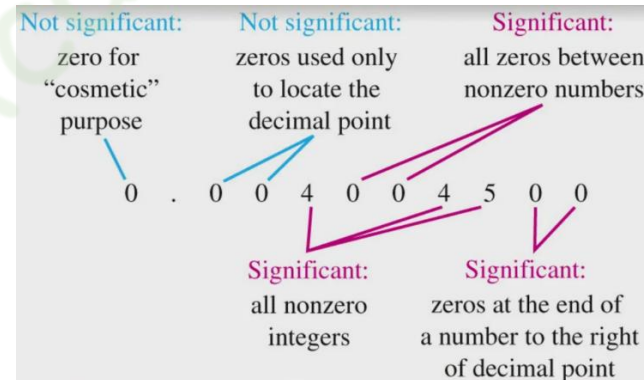
4. Standard Deviation (σ or s):

- Measures spread of data.

$$s = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n - 1}}$$

5. Significant Figures:

- Digits carrying meaning about precision.
- Non-zero digits always significant.
- Zeros between digits significant.
- Trailing zeros are significant only if they appear to the right of a decimal point.



6. Gaussian Distribution:

- Bell-shaped curve, mean μ .
- 68.3% within $\pm 1\sigma$, 95.5% $\pm 2\sigma$, 99.7% $\pm 3\sigma$.

7. Null Hypothesis (H_0):

- Assumes no significant difference.
- Statistical tests decide rejection/acceptance.

8. Confidence Interval of Mean:

- Range where true mean lies with certain confidence.

$$CI = \bar{x} \pm z \frac{s}{\sqrt{n}}$$

CI = confidence interval

$\bar{x}$ = sample mean

z = confidence level value

s = sample standard deviation

n = sample size

9. Rejection of Data (Q-Test):

- Detects outliers in small datasets.
- $Q = |\text{suspect} - \text{nearest}| / |\text{largest} - \text{smallest}|$
- If $Q_{\text{calc}} > Q_{\text{tab}}$, reject point.

10. Student's t-Test:

- Determines if two means differ.
- Used when $n < 30$ or σ unknown.

11. F-Test:

- Compares variances: $F = (s_1^2 / s_2^2)$ (larger on top)
- Checks homogeneity of variances.

12. Errors:

- Absolute error = $|\text{measured} - \text{true}|$

- Relative error = $(\text{absolute error} / \text{true value}) \times 100\%$
- Sources: instrumental, personal, method, environmental.

13. Linear Regression:

- Relation between y (dependent) and x (independent).
- $y = a + bx$; $b = \text{slope} = \text{cov}(x, y) / \text{var}(x)$; $a = \bar{y} - b \times \bar{x}$

14. Covariance & Correlation Coefficient:

- $\text{Cov}(x, y) = [\Sigma(x_i - \bar{x})(y_i - \bar{y})] / [(n-1)]$
- $r = \text{cov}(x, y) / (s_x \times s_y)$, $r = +1 \rightarrow$ perfect positive correlation, $r = -1 \rightarrow$ perfect negative correlation, $r = 0 \rightarrow$ no correlation

15. Sampling Principles:

- Goal: representative sample.
- Solids: coning & quartering, riffle splitter.
- Liquids: grab or composite sampling.
- Gases: bulbs, pumps, cylinders.
- Gross sampling: all increments collected before reduction.
- Sampler's responsibility: randomness, avoid contamination, label.
- Pitfalls & Hazards: inadequate mixing, segregation, contamination, evaporation, toxic exposure.