Chapter # 4: **Measures of Dispersion**

1. **Write any two advantages of the range.**

Ans:

1. It is easy to calculate.
2. It is useful measure in small samples.

2. **What are the demerits of range?**

Ans:

1. It is not based on all observations.
2. It depends only upon the extremes observations.

3. **Define relative dispersion.**

Ans: Relative measures of dispersion are calculated as ratios or percentages; for example, one relative measure of dispersion is the ratio of the standard deviation to the mean. Relative measures of dispersion are always dimensionless, and they are particularly useful for making comparisons between separate data sets or different experiments that might use different units. They are sometimes called coefficients of dispersion.

4. **What is quartile deviation?**

Ans: Half of the difference between the upper and the lower quartiles is called as quartile deviation or semi-inter quartile range. It is denoted by 'Q.D'

Formula: $Q.D. = \frac{Q_3 - Q_1}{2}$

5. **Write down the merits of quartile deviation.**

Ans:

1. It is easy to calculate.
2. It is not affected by extreme values.

6. **Write down the demerits of quartile deviation.**

Ans:

1. If is not based on all the observations.
2. Q.D. will be the same values for all the distribution having the same quartiles.

7. **Define mean deviation**

Ans: It is defined as the mean of the absolute deviation of observations from mean, median or mode. By absolute deviations we mean that we consider all the deviations as positive. It is denoted by M.D. and calculated as:

$$M.D. = \frac{\sum |Y - M|}{n}$$ (Here, M is mean/median/mode)

8. Properties of mean deviation.

Ans:

1. M.D. from median is less than any other values i.e., $M.D. = \frac{\sum |Y - median|}{n}$ is least.
2. It is always greater than or equal to zero. $M.D. \geq 0$
3. For symmetrical distribution, the following relation holds; $M.D. = \frac{4}{5}\sigma$

9. Write down the merits of mean deviation.

Ans:

1. It is easy to calculate.
2. It is based on all the observations.

10. Write down the demerits of mean deviation.

Ans:

1. It is affected by the extreme values.
2. It is not readily capable of mathematical development.
3. It does not take into account the negative signs of the deviations from some average.

11. Write any two properties of standard deviation.

Ans:

1. The standard deviation of a constant is zero. $S.D.(a) = 0$
2. The standard deviation is independent of origin. $S.D.(y \pm a) = S.D.(y)$
3. When all the values are multiplied with a constant the standard deviation is multiplied by the constant i.e., $S.D.(ay) = |a|S.D.(y) \quad and \quad S.D.(y/a) = |1/a|S.D.(y)$
4. The standard deviation of the sum or difference of two independent variables is the sum of their respective standard deviation for independent variables x and y.

$$S.D.(y \pm x) = S.D.(y) + S.D.(x)$$

12. Give two properties of variance.

Ans:

1. The variance of a constant is zero. $\text{Var}(a) = 0$
2. The variance is independent of origin. $Var\ (y \pm a) = Var(y)$
3. When all the values are multiplied with a constant the variance is multiplied by the square of the constant i.e., $var(ay) = a^2 var(y) \quad and \quad var(y/a) = \frac{1}{a^2 var\,(y)}$

13. Given that mean = 156.17, median = 153.50 and standard deviation = 19.03. Calculate coefficient of skewness.

Ans: Karl pearson's second co-efficient of skewness:

$$= \frac{3(Mean - Median)}{S.D.}$$

$$= \frac{3(156.17 - 153.50)}{19.03}$$

$= 0.421$ **Ans.**

14. What is the use of coefficient of variation?

Ans: Co-efficient of variation is a relative measure of dispersion and independent of units of measurement and expressed in percentage. It is used to compare the variability of different sets of data. The group which has lower value of coefficient, coefficient of variation is comparatively more consistent.

15. What do you say about the relative dispersion of 5, 5, 5 and 5?

Ans: Relative dispersion would be zero, because the absolute dispersion of constant is zero.

16. If S^2 = 36 and $\overline{X}$ = 18, what is coefficient of variation?

Ans: By definition:

$$C.V. = \frac{S}{\bar{x}} \times 100$$

Solution;

S^2 = 36 ; S = 6 and $\overline{X}$ = 18 put in above equation

$$\boldsymbol{C.V. = 33.333}$$

17. If variance of the value of '*X*' is 25, what is the standard deviation of *X*?

Ans: By taking square root of variance of x we get standard deviation of x. S.D.(x) = 5.

18. If S.D(X) = 10, then find the standard deviation of 5X?

Ans: By property of Standard deviation: $S.D.(ax) = |a|S.D.(x)$

$$S.D.(5x) = |5|S.D.(x)$$

$$S.D.(5x) = (5)(10)$$

$$\boldsymbol{S.D.(5x) = 50}$$

19. What is meant by symmetry?

Ans: In a symmetrical distribution, a deviation below the mean is equal to the corresponding deviation above the mean. This is called symmetry.

20. Define skewness.

Ans: Skewness is the lack of symmetry in a distribution around central (men, median or mode).

21. What are the types of measures of dispersion?

Ans: There are two types of measures of dispersion:

- Absolute Measure
- Relative Measure

22. Define the term variance.

Ans: Mean of squares of deviation of all the observations from their mean is called as variance. It is denoted by S^2.

$$S^2 = \frac{\sum(x-\bar{x})^2}{n}$$

OR

$$S^2 = \frac{\sum x^2}{n} - \left(\frac{\sum x}{n}\right)^2$$

23. For a symmetrical distribution S.D. = 2. What is value of 4th moment about mean for mesokurtic data?

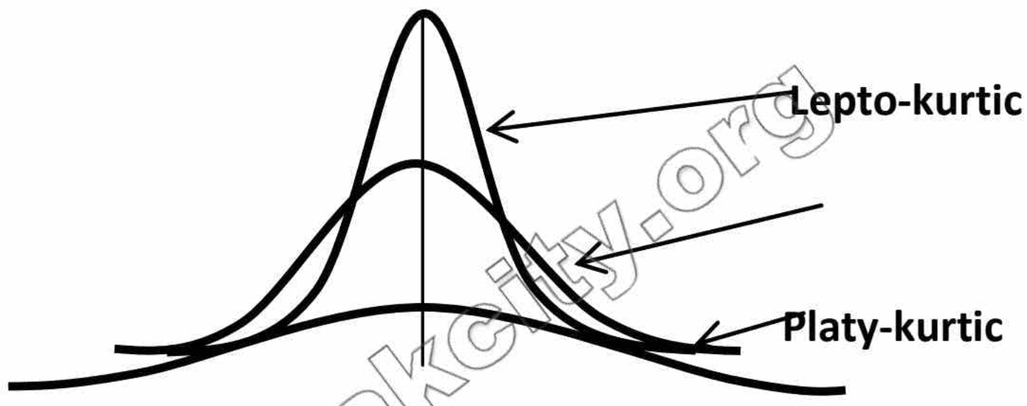
Ans: The dimensionless measure of kurtosis based on the moments is $\beta_2 = \frac{\mu_4}{\mu_2^2}$. If $\beta_2 = 3$, the distribution is mesokurtic (normal).

Variance = 4 by using S.D. = 2;

Forth moment about mean = $\mu_4 = 48$ **Ans.**

24. What do you know about kurtosis?

Ans: The word kurtosis is used to indicate the length of the tails and peakedness of symmetrical distributions. Symmetrical distribution may be platykurtic (more peaked), mesokurtic (normal) or leptokurtic (bit flat).



25. If $b_2 = 3$ and $m_4 = 1875$, then what will be the standard deviation?

Ans: By using formula;

$\beta_2 = \frac{\mu_4}{\mu_2^2}$

$\mu_2 = 25$ (Variance)

S.D. = 5 **Ans.**

26. What is meant by absolute dispersion?

Ans: It can be defined as such a way that they have units (meters, grams) same as those of original measurements. There are following measures of absolute dispersion:

1. Range
2. Quartile Deviation
3. Mean Deviation
4. Variance
5. Standard Deviation

27. Write four measures of relative dispersion.

Ans: The relative measures of dispersion are given below:

1. Co-efficient of Range $= \frac{X_{max} - X_{min}}{X_{max} + X_{min}}$

2. Co-efficient of Quartile deviation $= \frac{Q_3 - Q_1}{Q_3 + Q_1}$
3. Mean Co-efficient of Dispersion $= \frac{M.D_{(\bar{X})}}{\bar{X}}$
4. Median Co-efficient of Dispersion $= \frac{\sum|x - \tilde{x}|}{n}$
5. Co-efficient of Standard Deviation $= \frac{S.D}{\bar{X}} \times 100$

28. If $s_x^2 = 5$, and y =2x, then what will be the value of variance of y?

Ans:

$$y = 2x$$

$$var(y) = var(2x)$$

$$var(y) = 2var(x)$$

$$\boldsymbol{var(y) = 10}$$

29. Write down the Bowley's and Karl Pearson's formula of coefficient of skewness.

Ans:

Bowley's coefficient of skeweness based on quartiles:

$$S_k = \frac{Q_3 + Q_1 - 2median}{Q_3 - Q_1}$$

Karl Pearson's second coefficient of skeweness:

$$S_k = \frac{3(Mean - Median)}{S.D}$$

Karl Pearson's first coefficient of skeweness:

$$S_k = \frac{Mean - Mode}{S.D}$$

30. Calculate lower quartile from the given data: 13, 3, 7, 15, 17, 5, 23

Ans: First step is to arrange the data into ascending order.

3, 5, 7, 13, 15, 17 and 23 ; n = 7

For ungrouped data: $Q_1 = \left(\frac{n+1}{4}\right)^{th}\ value$

$Q_1 = 2^{nd}\ value$

$Q_1 = 5$ **Ans.**

31. Compute coefficient of quartile deviation if $\boldsymbol{Q_1 = 10.20}$ and $\boldsymbol{Q_3 = 58.29}$

Ans: By using formula as we know;

Co-efficient of Quartile deviation $= \frac{Q_3 - Q_1}{Q_3 + Q_1}$

Co-efficient of Q.D. = 0.7022 **Ans.**

32. Define standard deviation.

Ans: The standard deviation is defined as the positive square root of the mean of the squares of the deviations of values from their mean. In other words, standard deviation is a positive square root of variance. It is denoted by 'S'.

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

33. What is meant by dispersion?

Ans: The degree to which numerical data tend to spread about an average value of the data is called as dispersion.

34. Define measure of dispersion.

Ans: A numerical quantity called measure of dispersion that describes the spread of the values in a set of data.

35. Define range.

Ans: The difference between the largest and the smallest observation is called as range. It is denoted by 'R'.

$$R = X_{max} - X_{min}$$

36. What is the range of Bowley's coefficient of skewness?

Ans: It lies between -1 to +1.

37. If $u_2 = 4$ and $u_4 = 56$, find β_2.

Ans: By using given formula;

$$\beta_2 = \frac{\mu_4}{\mu_2^2}$$

$$\beta_2 = \frac{56}{16}$$

$$\boldsymbol{\beta_2 = 3.5}$$

38. If var(X) = 4, then find var(3X).

Ans: By using of variance property:

$$var(3x) = 9var(x)$$

$$var(y) = 9(4)$$

$$\boldsymbol{var(y) = 36}$$

39. What are the measures of absolute dispersion?

Ans: Some absolute measures of dispersion are:

1. Range
2. Quartile Deviation
3. Mean Deviation
4. Variance
5. Standard Deviation

40. If var(x) = 10 and y = 5x + 20, then find var(y).

Ans: By property of S.D. ;

$$y = 5x + 20$$

$$var(y) = var(5x + 20)$$

$$var(y) = 25var(x)$$

$$var(y) = 25(10)$$

$$\boldsymbol{var(y) = 250}$$

41. S.D. of a distribution is 4. Find second moment about mean.

Ans: As we know that second moment a bout mean is equals to variance then; variance = 16 (if S.D. = 4)