MEASURES OF DISPERSION :-

1. Dispersion refers to the variation of the items around an average. According to Dr Bowley : “Dispersion is the measure of variations of items.” To quote CONNOR : - “Dispersion is a measure of the extent to which the individual items vary.”

2. Objectives of Dispersion :
   (i) To determine the reliability of an average
   (ii) To compare the variability of two or more series
   (iii) It serves the basis of other statistical measures such as correlation etc.
   (iv) It serves the basis of statistical quality control.

3. Properties of a good measure of dispersion:
   (i) It should be easy to understand.
   (ii) It should be simple to calculate
   (iii) It should be uniquely defined.
   (iv) It should be based on all observations.
   (v) It should not be unduly affected by extreme items.

4. Measures of dispersion may be either absolute or relative.

   Absolute measures of dispersion are expressed in the same units in which data of the series are expressed i.e., rupees kgs, tons etc. where as relative measures of dispersion are independent of the units of measurement. They are expressed in percentage these are used to compare two or more series which are expressed in different units.

5. Absolute measures of dispersion are:-
   (i) Range
   (ii) Quartile Deviation
   (iii) Mean Deviation
   (iv) Standard deviation and variance.
6. Relative measures of dispersion are:-
   (i) Coefficient of Range.
   (ii) Coefficient of Quartile Deviation
   (iii) Coefficient of mean Deviation
   (iv) Coefficient of standard Deviation
   (v) Coefficient of variation

7. Besides the above measures of dispersion there is a graphic method of studying dispersion, known as Lorenz curve.

8. Range is the simplest measure of dispersion : -
   It is the difference between the largest and smallest value of the distribution.
   Computation of range:- It is calculated as
   \[\text{Range} = L - S\]
   \[\text{Coefficient of Range} = \frac{L - S}{L + S} .\]

9. Merits of Range :-
   (i) It is simple to understand and easy to calculate
   (ii) It is widely used in statistical quality control.

10. Demerits of Range=
    (i) It is affected by extreme values in the series.
    (ii) It can not be calculated in case of open-ended series.
    (iii) It is not based on all the items of the series.

11. **Inter quartile range and quartile deviation** are another measures of dispersion.
    Inter-quartile range is the difference between the upper quartile \(Q_3\) and lower quartile \(Q_1\). Quartile deviation is half of the difference between the upper quartile and lower quartile i.e. half of the inter-quartile range.
    Computation of Inter-quartile Range and Quartile Deviation:-
    Inter- quartile Range:- \(Q_3 - Q_1\)
Quartile Deviation (Q.D) : \[ \frac{Q_3 - Q_1}{2} \]

Co. efficient of Q.D : \[ \frac{Q_3 - Q_1}{Q_3 + Q_1} \]

12. Merits of Quartile Deviation:–
   (i) It is easy to compute.
   (ii) It is less affected by extreme items
   (iii) It can be computed in open-ended series.

13. Demerits of Quartile Deviation:–
   (i) It ignores half i.e. 50% of the items.
   (ii) It is useful only for rough study.
   (iii) It is not based on all observations.

14. Mean deviation:– It is defined as the arithmetic average of the absolute deviations (ignoring signs) of the various items from a measure of central tendency ; i.e. mean or median. Generally, mean deviation is calculated from median because the sum of the absolute deviations taken from median is minimum or least.

15. Computation of mean Deviation:– It is computed as:

   Individual series /ungrouped data:–
   \[ MD = \frac{\sum |D|}{N} \]

   Discrete/Continuous series:– \[ MD = \frac{\sum f|D|}{N} \]

   Coefficient of M.D. \[ = \frac{MD}{X \text{ or } M} \]

16. Merits of mean Deviation:–
   (i) It is based on all observations.
   (ii) It is least affected by extreme items.
   (iii) It is simple to understand and easy to calculate.
17. Demerits of mean Deviation:-

(i) It ignores ± signs in deviations
(ii) It can not be computed with open - ended series.
(iii) It is not well defined measure because it is calculated from different averages (Mean, Median & Mode)
(iv) It is difficult to compute when X or M comes in fractions.

18. **Standard deviation** =- It is the most widely used measure of dispersion. It is defined as the positive square root of the arithmetic average of the squares of deviations taken from the mean. Variance is another measure of dispersion. It

\[ \sigma^2 = \frac{\sum (X - \bar{X})^2}{N} \]

**Computation of standard Deviation**: It is computed as:-

For Individual series/un-grouped Data:-

(i) \[ \sigma = \sqrt{\frac{\sum (X - \bar{X})^2}{N}} \] Actual mean method

(ii) \[ \sigma = \sqrt{\frac{\sum d^2}{n} - \left( \frac{\sum d}{n} \right)^2} \] Assumed mean method

(iii) \[ \sigma = \sqrt{\frac{\sum d'^2}{n} - \left( \frac{\sum d'}{n} \right)^2 \times i} \] Step deviation method

(iv) \[ \sigma = \sqrt{\frac{\sum X^2}{n} - \left( \frac{\sum X}{n} \right)^2} \] Or \[ \sigma = \sqrt{\frac{\sum X^2}{n} - (\bar{X})^2} \]

Direct Method/Actual Mean method

For Discrete continuous series:-

(i) \[ \sigma = \sqrt{\frac{\sum F(X - \bar{X})^2}{n}} \] Actual mean method
(ii) Assumed Mean Method

$$\sigma = \sqrt{\frac{\sum f d^2}{n} - \left(\frac{\sum fd}{n}\right)^2}$$

(iii) Step - deviation Method

$$\sigma = \sqrt{\frac{\sum f d'^2}{n} - \left(\frac{\sum fd'}{n}\right)^2} \times C$$

(iv) Direct Method.

$$\sigma = \sqrt{\frac{\sum f X^2}{n} - \left(\frac{\sum fX}{n}\right)^2}$$

19. The important properties of standard deviation are:-

(i) The standard deviation of 1st n natural number is given by

$$\sigma = \sqrt{\frac{1}{12} (n^2 - 1)}$$

(ii) The standard deviation is computed from A.M. because the sum of squares of the deviations taken from the A.M. is least.

(iii) If a constant ‘a’ is added or subtracted from each item of a series then S.D. remains unaffected i.e. S.D. is independent of the change of origin.

(iv) If each item of a series is multiplied or divided by a constant ‘a’ the S.D. is affected by the same constant i.e. S.D. is affected by change of scale.

20. Merits of standard Deviation :-

(i) It is rigidly defined.

(ii) It is based on all observations where as range and quartile- deviations are not based on all items.

(iii) It takes algebraic signs in consideration where as these are ignored in mean-Deviation.

(iv) It can be algebraically manipulated , i.e. we can find the combined S.D. of two or more series.

(v) It serves the basis of other measures like correlation etc.
21. Demerits of standard deviation:-

(i) As compared to range and quartile deviation, it is difficult to understand and compute.

(ii) It gives more importance to extreme items.

22. **Coefficient of variation** is a relative measure of dispersion. It is used in comparing the variability of two or more series. Computation of coefficient of variation:- It is computed as:

\[ \text{Coefficient of variation (C.V.)} = \frac{\sigma}{X} \times 100 \]

23. **Lorenz curve**:- It is a graphical method of measuring dispersion. It has great utility in the study of degree of inequality in the distribution of income and wealth between the countries. It is also useful for comparing the distribution of wages, profits etc over different business groups. It is a cumulative percentage curve in which the percentage of frequency (persons or workers) is combined with the percentage of other items such as income, profits, wages etc.

**Selected Questions**

1. What do you mean by dispersion?
2. What is range?
3. What is meant by quartile deviation?
4. What do you mean by mean deviation?
5. What do you mean by standard deviation?
6. What is variance?
7. What is relative measure of dispersion?
8. What is coefficient of variation?"
9. What is a Lorenz curve?
10. If \( Q_1 = 41, \ Q_3 = 49 \), find the value of coefficient of Quartile deviation.
11. Name the important absolute and relative measures of dispersion.
12. Why standard deviation is measured from the mean?"
13. Find out the standard deviation, if variance is, 1444 ?
14. Write the formula of calculating mean deviation from mean.
15. Distinguish between absolute and relative measures of dispersion.

16. Name the various measures of dispersion. Explain the merits and demerits of any two.

17. From the following data, calculate range and coefficient of range.

<table>
<thead>
<tr>
<th>Marks</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of students</td>
<td>8</td>
<td>12</td>
<td>7</td>
<td>30</td>
<td>10</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

18. Calculate quartile deviation and coefficient of quartile deviation from the data given below.

320, 400, 450, 530, 550, 580, 600, 610, 700, 780, 800

19. Find out mean deviation of the following data (use median method)

<table>
<thead>
<tr>
<th>Item</th>
<th>12</th>
<th>18</th>
<th>25</th>
<th>35</th>
<th>47</th>
<th>55</th>
<th>62</th>
<th>75</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>8</td>
<td>12</td>
<td>15</td>
<td>23</td>
<td>16</td>
<td>18</td>
<td>31</td>
<td>12</td>
</tr>
</tbody>
</table>

20. Calculate mean and standard deviation from the following data:

<table>
<thead>
<tr>
<th>Class interval:</th>
<th>0-10</th>
<th>10-20</th>
<th>20-30</th>
<th>30-40</th>
<th>40-50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency:</td>
<td>8</td>
<td>13</td>
<td>16</td>
<td>8</td>
<td>5</td>
</tr>
</tbody>
</table>

21. Draw a Lorenz curve from the data given below.

<table>
<thead>
<tr>
<th>Income</th>
<th>100</th>
<th>200</th>
<th>400</th>
<th>500</th>
<th>800</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of persons:</td>
<td>80</td>
<td>75</td>
<td>50</td>
<td>30</td>
<td>20</td>
</tr>
</tbody>
</table>

22. Explain the characteristics of a good measure of dispersion.

23. Find the mean deviation from the median and its coefficient for the following data:

<table>
<thead>
<tr>
<th>Class interval:</th>
<th>10-19</th>
<th>20-29</th>
<th>30-39</th>
<th>40-49</th>
<th>50-59</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency:</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

24. Calculate mean and standard deviation from the following data:

<table>
<thead>
<tr>
<th>C.I.</th>
<th>10-20</th>
<th>20-30</th>
<th>30-40</th>
<th>40-50</th>
</tr>
</thead>
<tbody>
<tr>
<td>F:</td>
<td>13</td>
<td>16</td>
<td>8</td>
<td>5</td>
</tr>
</tbody>
</table>