

Measures of Dispersion

PART 1

Objective Questions

• Multiple Choice Questions

1. Standard deviation is always computed from
(a) mean (b) mode
(c) median (d) geometric mean

Ans. (a) mean

2. Coefficient of variation is given by
(a) $\frac{\sigma}{\bar{X}}$ (b) $\frac{\bar{X}}{\sigma}$ (c) $\frac{\bar{X}}{\sigma} \times 100$ (d) $\frac{\sigma}{\bar{X}} \times 100$

Ans. (d) $\frac{\sigma}{\bar{X}} \times 100$

3. Which of the following is a unit free number?
(a) SD (b) Variance
(c) MD (d) CV

Ans. (d) Coefficient of variation measures the variation in the given series from their average values without considering any unit.

4. The standard deviation of a data set is expressed in the
(a) same unit as the observations in the data set
(b) square of the unit of the observation
(c) square root of the unit of the observation
(d) None of the above

Ans. (a) same unit as the observations in the data set

5. Standard deviation is of the arithmetic average of the squares of the deviations measured from the mean.
(a) square root (b) cube root
(c) sum total (d) None of these

Ans. (a) square root

6. Standard deviation is measure of dispersion.
(a) absolute
(b) relative
(c) crude
(d) Both (a) and (b)

Ans. (a) absolute

7. Which of the following mathematical sign is used to denote standard deviation?

(a) Ω (b) σ (c) σ^2 (d) Σ

Ans. (c) σ^2

8. Greater the value of standard deviation, is the consistency of data.

(a) lesser (b) greater
(c) constant (d) None of these

Ans. (b) Standard deviation is a measure of consistency of the series, thus higher value of standard deviation indicates greater consistency.

9. **Statement I** Variance is the square of standard deviation for any type of statistical series.

Statement II As the sample size increases, variance becomes equal to standard deviation.

Alternatives

- (a) Statement I is correct and Statement II is incorrect
(b) Statement II is correct and Statement I is incorrect
(c) Both the statements are correct
(d) Both the statements are incorrect

Ans. (a) Variance is the square of standard deviation and thus never becomes equal to standard deviation.

10. Which of the following statement is true about the most important disadvantage of standard deviation?

(a) It is used in many other statistical techniques
(b) It doesn't take into account all the values in the data set
(c) It is a sensitive measure of dispersion
(d) It is difficult to calculate manually

Ans. (d) It is difficult to calculate manually

11. **Statement I** Coefficient of variation is used to check the consistency of the data.

Statement II Standard deviation can never be calculated without arithmetic mean.

Alternatives

- (a) Statement I is correct and Statement II is incorrect
(b) Statement II is correct and Statement I is incorrect
(c) Both the statements are correct
(d) Both the statements are incorrect

Ans. (a) Calculation of standard deviation does not always require using actual mean, it can be calculated using assumed mean as well.

12. The calculated value of standard deviation can never be

- (a) less than one (b) more than one
- (c) negative (d) more than variance

Ans. (c) Standard deviation is calculated by squaring up the difference between the variable, thus can never be negative.

13. Which of the following is not true about the measures of dispersion?

- (a) It serve to locate the distribution
- (b) Indicates high or low uniformity of the items
- (c) Reveals how items are spread out on either side of the centre
- (d) Difference or variation among the values

Ans. (a) Dispersion is not used to locate the position of the variable rather it is used to measure the fluctuations in the given series.

14. Given below are the relative measures of dispersion except

- (a) coefficient of variation
- (b) coefficient of standard deviation
- (c) standard deviation
- (d) Both (a) and (b)

Ans. (c) Standard deviation is an absolute measure of dispersion as it is presented as a proportionate number.

15. When the actual mean is multiplied with the coefficient of variation, it becomes equal to

- (a) variance
- (b) coefficient of standard deviation
- (c) standard deviation
- (d) coefficient of arithmetic mean

Ans. (c) standard deviation

16. The minimum value or the lower limit of variance can be

- (a) -1 (b) 0
- (c) 1 (d) None of these

Ans. (b) The minimum value of variance is zero, which indicates no fluctuation in a given series.

17. Standard deviation remains unchanged due to change in which of the following?

- (a) Change of Origin (b) Change of Scale
- (c) Change of Data (d) All of these

Ans. (a) Standard deviation remains unchanged due to change in origin and it takes the square of the difference in the variables.

18. Choose the incorrect statement from the options given below.

- (a) Standard deviation is not based upon all the items of the series
- (b) Standard deviation is the square root of variance

- (c) Coefficient of standard deviation is a relative measure of dispersion
- (d) All of the above

Ans. (a) Standard deviation is calculated considering all the items of a given series.

19. For calculation standard deviation by step deviation method which of the following mean is used?

- (a) Actual mean (b) Assumed mean
- (c) Combined mean (d) Any of these

Ans. (b) Assumed mean

• Assertion-Reasoning MCQs

Direction (Q. Nos. 1 to 4) *There are two statements marked as Assertion (A) and Reason (R). Read the statements and choose the appropriate option from the options given below.*

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A)
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A)
- (c) Assertion (A) is false, but Reason (R) is true
- (d) Both are false

1. Assertion (A) Any measure of central tendency can be used to compute standard deviation.

Reason (R) Standard deviation gives best result when calculated from median.

Ans. (d) Standard deviation is only calculated using arithmetic mean.

2. Assertion (A) If the Variance of a series is 36, its standard deviation will be 6.

Reason (R) Variance is the square of standard deviation.

Ans. (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A)

3. Assertion (A) Standard deviation cannot be calculated in a mid-value frequency distribution.

Reason (R) Mid-value frequency distribution need to be converted into exclusive frequency distribution to calculate standard deviation.

Ans. (d) Standard deviation is the most useful measure of dispersion which can be calculated in all types of frequency distributions.

4. Assertion (A) When two statistical series are compared, a series with lower coefficient of variation is considered as consistent.

Reason (R) Lower value of coefficient of variation indicates lower fluctuation in the given distribution.

Ans. (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A)

• Case Based MCQs

1. **Direction** Read the following case study and answer the question no. (i) to (vi) on the basis of the same.

You're given the following information about the average salaries of people working in different fields.

	Marketing	Education	Banking	Technology
Mean Salary	4,000	4,500	6,000	8,500
Variance	10,000	25,000	90,000	40,000

- (i) Based upon the above data, what will be the standard deviation of the banking sector?
 (a) 90,000 (b) 9,000
 (c) 300 (d) 30

Ans. (c) Standard deviation is the under root of variance thus, when variance is 90,000, standard deviation will be 300.

- (ii) The coefficient of standard deviation of the education sector will be equal to
 (a) 0.03 (b) 0.3
 (c) 3.33 (d) Can't be determined

Ans. (a) Coefficient of standard deviation is calculated as the ratio of standard deviation and its arithmetic mean. Here, standard deviation will be 158.113 and mean is given as 4,500, therefore, coefficient of standard deviation will be 0.03.

- (iii) **Statement I** Coefficient of variation of marketing sector as per the above data is 2.5.

Statement II Coefficient of variation presents information in percentage form.

Alternatives

- (a) Statement I is correct and Statement II is incorrect
 (b) Statement II is correct and Statement I is incorrect
 (c) Both the statements are correct
 (d) Both the statements are incorrect

Ans. (c) Both the statements are correct

- (iv) Which of the following sectors from the above data is most consistent?

- (a) Marketing (b) Education
 (c) Banking (d) Technology

Ans. (d) Technology sector shows the lowest coefficient of variation thus, considered as most consistent among all other.

- (v) **Assertion (A)** Marketing sector shows the least value of coefficient of variation in the given data.

Reason (R) Lower value of coefficient of variation makes it least consistent among all the given sectors.

Alternatives

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A)

- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A)
 (c) Assertion (A) is false, but Reason (R) is true
 (d) Both are false

Ans. (d) Marketing sector doesn't have the least value of CV and lower CV indicates higher consistency.

- (vi) Which of the following sectors pays highest salary on an average?

- (a) Marketing (b) Education
 (c) Banking (d) Technology

Ans. (d) Technology

PART 2

Subjective Questions

• Short Answer (SA) Type Questions

1. Mention the objectives of various measures of dispersion.

Ans. Objectives of measures of dispersion are

- (i) Measures of dispersion help in statistical investigation.
 (ii) They help to determine the reliability of an average.
 (iii) They help to compare the variability of two or more series.
 (iv) They serve as the basis of computation of other statistical measures such as correlation, etc.
 (v) They help to control the variation of the data from the central value.

2. What features should a good measure of dispersion possess?

Ans. Features/Properties of a good measure of dispersion are

- (i) It should be rigidly defined.
 (ii) It should be simple to understand.
 (iii) It should be easy to calculate.
 (iv) It should be based on all the observations of the series.
 (v) It should be least affected by sampling fluctuations.
 (vi) It should be capable of further algebraic treatment.
 (vii) It should not be affected by extreme values.

3. Briefly explain the concept of standard deviation using its formula to calculate the same.

Ans. The positive square root of the sum of square of deviations of various values from their mean divided by the sample size is called standard deviation. The idea of standard deviation was first given by Karl Pearson in 1893.

$$\text{Symbolically, } \sigma = \sqrt{\frac{\sum d^2}{n}}$$

It fulfils all the requisites of a good measure of dispersion except that it is sensitive to extreme values.

4. State some important merits of standard deviation.

Ans. Some important merits of standard deviation

- It is based on all values of the series.
- It is an exact and definite measure of dispersion.
- It is least affected by fluctuations in sampling because samples are based on all values of the series.
- It is suitable for further algebraic treatment.

5. State some important demerits of standard deviation.

Ans. Some important demerits of standard deviation are

- It is difficult to calculate as compared to other measures of dispersion.
- It is unduly affected by extreme values of the series as it is based on all the items.
- It cannot be used to compare two series expressed in different units.

6. What are the properties of standard deviation?

Ans. The properties of standard deviation are as follows

- Standard deviation is the most popular measure of dispersion.
- It is not affected by change in origin, but is affected by change in scale.
- A distribution with lesser coefficient of variation shows greater consistency, homogeneity and uniformity, whereas a distribution with greater coefficient of variation is considered more scattered.
- For two or more groups, it is possible to measure the combined standard deviation.

7. Write the correct formula of calculating following measures of dispersion

- Coefficient of Standard Deviation
- Coefficient of Variation
- Variance

Ans. Formula for computing

(i) Coefficient of Standard Deviation = $\frac{\sigma}{\bar{X}}$

(ii) Coefficient of Variation = $\frac{\sigma}{\bar{X}} \times 100$

(iii) Variance = σ^2 , where
 σ = Standard Deviation, and
 \bar{X} = Arithmetic Mean

8. The sum of square of deviations for 10 observations taken from mean 50 is 25. Find the coefficient of variation.

Ans. Given,

Number of observations (n) = 10

Mean (\bar{X}) = 50

Sum of square of deviations (Σd^2) = 25

We know that $\sigma = \sqrt{\frac{\Sigma d^2}{n}}$

On substituting the variables, we get

$$\sigma = \sqrt{\frac{25}{10}} = 1.58$$

$$\text{Coefficient of Variation} = \frac{\sigma}{\bar{X}} \times 100$$

$$= \frac{1.58}{50} \times 100 = 3.16$$

9. Calculate the standard deviation from the given data.

10, 15, 20, 25, 30, 35, 40

Ans. Calculation of Standard Deviation

S.No.	X	d (X - A), A = 25	d ²
1	10	-15	225
2	15	-10	100
3	20	-5	25
4	25	0	0
5	30	5	25
6	35	10	100
7	40	15	225
n = 7		$\Sigma d = 0$	$\Sigma d^2 = 700$

$$\sigma = \sqrt{\frac{\Sigma d^2}{n} - \left(\frac{\Sigma d}{n}\right)^2} = \sqrt{\frac{700}{7} - \left(\frac{0}{7}\right)^2} = \sqrt{100}$$

$$\therefore \sigma = 10$$

10. Find out mean and standard deviation of the marks obtained by 10 students in statistics.

S.No.	1	2	3	4	5	6	7	8	9	10
Marks	43	48	65	57	31	60	37	48	78	59

Ans. Let the assumed mean be 53 i.e., $A = 53$.

Calculation of Mean and Standard Deviation

Marks (X)	d (X - A), A = 53	d ²
43	-10	100
48	-5	25
65	+12	144
57	+4	16
31	-22	484
60	+7	49
37	-16	256
48	-5	25
78	+25	625
59	+6	36
n = 10	$\Sigma d = -4$	$\Sigma d^2 = 1,760$

$$\bar{X} = A + \frac{\Sigma d}{n} = 53 + \frac{-4}{10} = 53 - 0.4 = 52.6$$

$$\begin{aligned}\sigma &= \sqrt{\frac{\Sigma d^2}{n} - \left(\frac{\Sigma d}{n}\right)^2} \\ &= \sqrt{\frac{1,760}{10} - \left(\frac{-4}{10}\right)^2} \\ &= \sqrt{176 - 0.16} = \sqrt{175.84}\end{aligned}$$

$$\therefore \sigma = 13.26$$

11. Calculate standard deviation and coefficient of variation from the following data with the help of direct method

S. No.	1	2	3	4	5
Marks	10	12	13	15	20

Ans. Calculation of Standard Deviation and Coefficient of Variation

Marks (X)	X ²
10	100
12	144
13	169
15	225
20	400
$\Sigma X = 70, n = 5$	$\Sigma X^2 = 1,038$

$$\bar{X} = \frac{\Sigma X}{n} = \frac{70}{5} = 14$$

$$\begin{aligned}\sigma &= \sqrt{\frac{\Sigma X^2}{n} - \left(\frac{\Sigma X}{n}\right)^2} = \sqrt{\frac{1,038}{5} - \left(\frac{70}{5}\right)^2} \\ &= \sqrt{207.6 - 196} = \sqrt{11.6} = 3.41\end{aligned}$$

$$\begin{aligned}\text{Coefficient of Variation (CV)} &= \frac{\sigma}{\bar{X}} \times 100 = \frac{3.4}{14} \times 100 \\ &= 24.35\%\end{aligned}$$

12. Find the standard deviation by assumed mean method.

X	10	20	30	40	50	60
Frequency	4	6	9	8	5	10

Ans. Calculation of Standard Deviation

X	Frequency (f)	d (X - A), A = 30	fd	fd ²
10	4	-20	-80	1,600
20	6	-10	-60	600
30	9	0	0	0
40	8	10	80	800
50	5	20	100	2,000
60	10	30	300	9,000
$\Sigma f = 42$			$\Sigma fd = 340$	$\Sigma fd^2 = 14,000$

$$\begin{aligned}\sigma &= \sqrt{\frac{\Sigma fd^2}{\Sigma f} - \left(\frac{\Sigma fd}{\Sigma f}\right)^2} \\ &= \sqrt{\frac{14,000}{42} - \left(\frac{340}{42}\right)^2} \\ &= \sqrt{333.3 - (8.09)^2} \\ &= \sqrt{333.3 - 65.45} \\ &= \sqrt{267.85}\end{aligned}$$

$$\therefore \sigma = 16.37$$

13. Find the standard deviation from the given data, using step deviation method.

X	7.5	17.5	27.5	37.5	47.5
Frequency	10	8	15	6	4

Ans. Calculation of Standard Deviation

X	Frequency (f)	d' $\left(\frac{X-A}{c}\right)$, A = 27.5, c = 10	fd'	fd' ²
7.5	10	-2	-20	40
17.5	8	-1	-8	8
27.5	15	0	0	0
37.5	6	1	6	6
47.5	4	2	8	16
$\Sigma f = 43$			$\Sigma fd' = -14$	$\Sigma fd'^2 = 70$

$$\begin{aligned}\sigma &= \sqrt{\frac{\Sigma fd'^2}{\Sigma f} - \left(\frac{\Sigma fd'}{\Sigma f}\right)^2} \times c \\ &= \sqrt{\frac{70}{43} - \left(\frac{-14}{43}\right)^2} \times 10 \\ &= \sqrt{1.63 - 0.106} \times 10 \\ &= \sqrt{1.524} \times 10\end{aligned}$$

$$\therefore \sigma = 1.23 \times 10 = 12.3$$

14. If the coefficient of variation of X-series is 14.6% and that of Y-series is 36.9% and their mean are 101.2 and 101.25 respectively, find their standard deviation.

Ans. (i) For series X

$$\text{Coefficient of Variation (CV)} = \frac{\sigma}{\bar{X}} \times 100$$

$$\therefore \text{CV} = 14.6 \text{ and } \bar{X} = 101.2,$$

on substituting the values, we get

$$\begin{aligned}\therefore 14.6 &= \frac{\sigma}{101.2} \times 100 \\ \Rightarrow \sigma &= \frac{14.6 \times 101.2}{100}\end{aligned}$$

$$\Rightarrow \sigma = \frac{1,477.52}{100} = 14.78$$

(ii) For series 'Y'

$$CV = \frac{\sigma}{\bar{X}} \times 100$$

$$\therefore CV = 36.9 \text{ and } \bar{X} = 101.25,$$

on substituting the values, we get

$$\therefore 36.9 = \frac{\sigma}{101.25} \times 100$$

$$\Rightarrow \sigma = \frac{36.9 \times 101.25}{100}$$

$$\Rightarrow \sigma = \frac{3,736.125}{100} = 37.36$$

- 15.** The coefficient of variations of two series are 58% and 69% and their standard deviations are 21.2 and 15.6. What are their mean?

Ans. (i) For Ist series, Coefficient of Variation (CV)

$$= \frac{\sigma}{\bar{X}} \times 100, CV = 58 \text{ and } \sigma = 21.2$$

On substituting the values,

$$\text{we get } 58 = \frac{21.2}{\bar{X}} \times 100$$

$$\therefore \bar{X} = \frac{21.2}{58} \times 100 = 36.55$$

(ii) For IInd series, $CV = \frac{\sigma}{\bar{X}} \times 100$, $CV = 69$ and

$$\sigma = 15.6$$

On substituting the values,

$$\text{we get } 69 = \frac{15.6}{\bar{X}} \times 100,$$

$$\therefore \bar{X} = \frac{15.6}{69} \times 100 = 22.6$$

- 16.** The sum of 10 values is 100 and the sum of their squares is 1,090. Find out the coefficient of variation. (NCERT)

Ans. Given that, $\Sigma X = 100$, $n = 10$, $\Sigma X^2 = 1,090$

$$\therefore \bar{X} = \frac{\Sigma X}{n} = \frac{100}{10} = 10 \quad \therefore \Sigma X^2 = 1,090$$

$$\therefore \sigma = \sqrt{\frac{\Sigma X^2}{n} - (\bar{X})^2} = \sqrt{\frac{1,090}{10} - (10)^2}$$

$$= \sqrt{9} = 3$$

$$\text{Coefficient of Variation (CV)} = \frac{\sigma}{\bar{X}} \times 100$$

$$= \frac{3}{10} \times 100 = 30$$

• Long Answer (LA) Type Questions

- 1.** Find the standard deviation by the step deviation method.

Class Interval	0–10	10–20	20–30	30–40	40–50	50–60
Frequency (f)	16	12	10	15	12	8

Ans.

Calculation of Standard Deviation

Class Interval	Frequency (f)	Mid-value (m)	d(m - A), A = 25	d' $\left(\frac{d}{c}\right)$, c = 10	d' ²	fd'	fd' ²
0–10	16	5	-20	-2	4	-32	64
10–20	12	15	-10	-1	1	-12	12
20–30	10	25	0	0	0	0	0
30–40	15	35	10	1	1	15	15
40–50	12	45	20	2	4	24	48
50–60	8	55	30	3	9	24	72
$\Sigma f = 73$						$\Sigma fd' = 19$	$\Sigma fd'^2 = 211$

$$\sigma = \sqrt{\frac{\Sigma fd'^2}{\Sigma f} - \left(\frac{\Sigma fd'}{\Sigma f}\right)^2} \times c = \sqrt{\frac{211}{73} - \left(\frac{19}{73}\right)^2} \times 10 = \sqrt{2.89 - 0.067} \times 10 = \sqrt{2.82} \times 10 = 1.68 \times 10$$

$$\therefore \sigma = 16.8$$

2. Calculate the coefficient of variation for the following data.

Weight (in kg)	0–20	20–40	40–60	60–80	80–100
Number of Persons	81	40	66	49	14

Ans.

Calculation of Coefficient of Variation						
Weight	Frequency (f)	Mid-value (m)	$d = m - A$ ($A = 50$)	$d' = \frac{d}{c}$ ($c = 20$)	fd'	fd'^2
0–20	81	10	– 40	– 2	– 162	324
20–40	40	30	– 20	– 1	– 40	40
40–60	66	50	0	0	0	0
60–80	49	70	+ 20	+ 1	+ 49	49
80–100	14	90	+ 40	+ 2	+ 28	56
$\Sigma f = 250$					$\Sigma fd' = -125$	$\Sigma fd'^2 = 469$

$$\bar{X} = A + \frac{\Sigma fd'}{\Sigma f} \times c = 50 + \frac{(-125)}{250} \times 20 = 50 - \frac{2,500}{250} = 50 - 10$$

\therefore

$$\bar{X} = 40$$

$$\sigma = \sqrt{\frac{\Sigma fd'^2}{\Sigma f} - \left(\frac{\Sigma fd'}{\Sigma f}\right)^2} \times c = \sqrt{\frac{469}{250} - \left(\frac{-125}{250}\right)^2} \times 20 = \sqrt{1.876 - 0.25} \times 20 = \sqrt{1.626} \times 20$$

\Rightarrow

$$\sigma = 1.275 \times 20 = 25.50$$

$$\therefore \text{Coefficient of Variation (CV)} = \frac{\sigma}{\bar{X}} \times 100 = \frac{25.50}{40} \times 100 = 63.75\%$$

3. Calculate standard deviation and coefficient of variation from the following data.

Marks	Below 20	Below 40	Below 60	Below 80	Below 100
Number of Students	8	20	50	70	80

Ans. Since, less than distribution (marks) is given, we first convert it into an exclusive distribution (marks).

Calculation of Standard Deviation and Coefficient of Variation						
Marks	Number of Students (f)	Mid-value (m)	$d = m - A$ ($A = 50$)	$d' = \frac{d}{c}$ ($c = 20$)	fd'	fd'^2
0–20	8	10	– 40	– 2	– 16	32
20–40	12	30	– 20	– 1	– 12	12
40–60	30	50	0	0	0	0
60–80	20	70	+ 20	+ 1	+ 20	20
80–100	10	90	+ 40	+ 2	+ 20	40
$\Sigma f = 80$					$\Sigma fd' = 12$	$\Sigma fd'^2 = 104$

$$\bar{X} = A + \frac{\Sigma fd'}{\Sigma f} \times c = 50 + \frac{12}{80} \times 20 = 53$$

$$\sigma = \sqrt{\frac{\Sigma fd'^2}{\Sigma f} - \left(\frac{\Sigma fd'}{\Sigma f}\right)^2} \times c = \sqrt{\frac{104}{80} - \left(\frac{12}{80}\right)^2} \times 20 = \sqrt{1.3 - 0.0225} \times 20 = \sqrt{1.2775} \times 20 = 1.130 \times 20 = 22.60$$

$$\text{Coefficient of Variation (CV)} = \frac{\sigma}{\bar{X}} \times 100 = \frac{22.60}{53} \times 100 = 42.64\%$$

4. Calculate the coefficient of variation of the given continuous series.

More than	0	10	20	30	40	50	60	70
Cumulative Frequency	100	90	75	50	20	10	5	0

Ans. Since, 'more than' distribution is given, we first convert it into exclusive distribution.

Calculation of Coefficient of Variation

Class Interval	Frequency (f)	Mid-value (m)	d = m - A (A = 35)	d' = $\frac{d}{c}$ (c = 10)	fd'	fd' ²
0-10	10	5	-30	-3	-30	90
10-20	15	15	-20	-2	-30	60
20-30	25	25	-10	-1	-25	25
30-40	30	35	0	0	0	0
40-50	10	45	10	1	10	10
50-60	5	55	20	2	10	20
60-70	5	65	30	3	15	45
70-80	0	75	40	4	0	0
$\Sigma f = 100$					$\Sigma fd' = -50$	$\Sigma fd'^2 = 250$

$$\bar{X} = A + \frac{\Sigma fd'}{\Sigma f} \times c = 35 + \frac{-50}{100} \times 10 = 35 - \frac{500}{100} = 35 - 5$$

\therefore

$$\bar{X} = 30$$

$$\sigma = \sqrt{\frac{\Sigma fd'^2}{\Sigma f} - \left(\frac{\Sigma fd'}{\Sigma f}\right)^2} \times c = \sqrt{\frac{250}{100} - \left(\frac{50}{100}\right)^2} \times 10 = \sqrt{2.5 - 0.25} \times 10 = \sqrt{2.25} \times 10 = 1.5 \times 10 = 15$$

$$\text{Coefficient of Variation (CV)} = \frac{\sigma}{\bar{X}} \times 100 = \frac{15}{30} \times 100$$

\therefore

$$CV = 50\%.$$

5. Calculate the standard deviation from the following series

Class	0-10	10-20	20-30	30-40	40-50	50-60	60-70
Frequency	2	4	6	8	6	4	2

Ans.

Calculation of Coefficient of Variation

Class Interval (X)	Frequency (f)	Mid-value (m)	fm	m ²	fm ²
0-10	2	5	10	25	50
10-20	4	15	60	225	900
20-30	6	25	150	625	3,750
30-40	8	35	280	1,225	9,800
40-50	6	45	270	2,025	12,150
50-60	4	55	220	3,025	12,100
60-70	2	65	130	4,225	8,450
$\Sigma f = 32$			$\Sigma fm = 1,120$		$\Sigma fm^2 = 47,200$

$$\text{Mean, } \bar{X} = \frac{\Sigma fm}{\Sigma f} = \frac{1,120}{32} = 35$$

$$\text{Standard Deviation, } (\sigma) = \sqrt{\frac{\Sigma fm^2}{\Sigma f} - (\bar{X})^2} \Rightarrow (\sigma) = \sqrt{\frac{47,200}{32} - (35)^2} \Rightarrow (\sigma) = \sqrt{1,475 - 1,225}$$

or, $(\sigma) = \sqrt{250} = 15.81$

Hence, standard deviation of the above series is 15.81.

6. A batsman is to be selected for a cricket team. The choice is between X and Y on the basis of their five previous scores which are

X	25	85	40	80	120
Y	50	70	65	45	80

Which batsman should be selected if we want,

- (i) a higher scorer, or
(ii) a more reliable batsman in the team? (NCERT)

Ans. Batsman X

Calculation of Mean and Coefficient of Variation

X	d(X - \bar{X}), $\bar{X}=70$	d²
25	-45	2,025
85	+15	225
40	-30	900
80	10	100
120	50	2,500
$\Sigma X=350$		$\Sigma d^2 = 5,750$

$$\bar{X} = \frac{\Sigma X}{n} = \frac{350}{5} = 70 \Rightarrow \sigma = \sqrt{\frac{\Sigma d^2}{n}} = \sqrt{\frac{5,750}{5}} = 33.91$$

7. To check the quality of two brands of light bulbs, their life in burning hours was estimated as under for 100 bulbs of each brand.

Life (in hrs)	Number of Bulbs (Brand A)	Number of Bulbs (Brand B)
0-50	15	2
50-100	20	8
100-150	18	60
150-200	25	25
200-250	22	5
Total	100	100

- (i) Which brand gives higher life? (ii) Which brand is more dependable? (NCERT)

Ans. For Brand A

Calculation of Mean and Coefficient of Variation

Life (in hrs)	Number of Bulbs (f)	Mid-value (m)	d (m - A), A = 125	d' $\left(\frac{d}{c}\right)$, c = 50	d²	fd'	fd'²
0-50	15	25	-100	-2	4	-30	60
50-100	20	75	-50	-1	1	-20	20
100-150	18	125	0	0	0	0	0
150-200	25	175	50	1	1	25	25
200-250	22	225	100	2	4	44	88
	n = 100					$\Sigma fd' = 19$	$\Sigma fd'^2 = 193$

$$CV = \frac{\sigma}{\bar{X}} \times 100 = \frac{33.91}{70} \times 100 = 48.44$$

Batsman Y

Calculation of Mean and Coefficient of Variation

Y	d(Y - \bar{Y}), $\bar{Y} = 62$	d²
50	-12	144
70	8	64
65	3	9
45	-17	289
80	18	324
$\Sigma Y = 310$		$\Sigma d^2 = 830$

$$\bar{Y} = \frac{\Sigma Y}{n} = \frac{310}{5} = 62$$

$$\sigma = \sqrt{\frac{\Sigma d^2}{n}} = \sqrt{\frac{830}{5}} = 12.88$$

$$CV = \frac{\sigma}{\bar{Y}} \times 100 = \frac{12.88}{62} \times 100 = 20.78$$

- (i) Average of Batsman X is higher than that of Batsman Y, so he should be selected if we want a high scorer.
(ii) Batsman Y is more reliable than Batsman X. This is because the coefficient of variation of Batsman Y is less than that of Batsman X. So, on the basis of reliability, Batsman Y should be selected.

$$\bar{X} = A + \frac{\Sigma fd'}{\Sigma f} \times c = 125 + \frac{19}{100} \times 50 = 134.5$$

$$\sigma = \sqrt{\frac{\Sigma fd'^2}{n} - \left(\frac{\Sigma fd'}{n}\right)^2} \times c = \sqrt{\frac{193}{100} - \left(\frac{19}{100}\right)^2} \times 50$$

$$= \sqrt{1.93 - 0.0361} \times 50 = \sqrt{1.8939} \times 50 = 1.376 \times 50$$

∴

$$\sigma = 68.8$$

$$\text{Coefficient of Variation (CV)} = \frac{\sigma}{\bar{X}} \times 100 = \frac{68.8}{134.5} \times 100 = 51.15$$

For Brand B

Calculation of Mean and Coefficient of Variation

Life (in hrs)	Number of Bulbs (f)	Mid-value (m)	d(m - A), A = 125	d' $\left(\frac{d}{c}\right)$, c = 50	d' ²	fd'	fd' ²
0-50	2	25	-100	-2	4	-4	8
50-100	8	75	-50	-1	1	-8	8
100-150	60	125	0	0	0	0	0
150-200	25	175	50	1	1	25	25
200-250	5	225	100	2	4	10	20
n = 100						Σfd' = 23	Σfd'² = 61

$$\bar{X} = A + \frac{\Sigma fd'}{N} \times c = 125 + \frac{23}{100} \times 50 = 125 + 11.5 = 136.5$$

$$\sigma = \sqrt{\frac{\Sigma fd'^2}{n} - \left(\frac{\Sigma fd'}{n}\right)^2} \times c = \sqrt{\frac{61}{100} - \left(\frac{23}{100}\right)^2} \times 50 = \sqrt{0.61 - 0.0529} \times 50 = \sqrt{0.5571} \times 50 = 0.75 \times 50$$

∴

$$\sigma = 37.5$$

$$\text{Coefficient of Variation (CV)} = \frac{\sigma}{\bar{X}} \times 100 = \frac{37.5}{136.5} \times 100 = 27.47$$

- (i) The average life of bulb of Brand B is comparatively higher than that of Brand A, therefore Brand B gives higher life.
- (ii) The bulbs of Brand B are more dependable as CV of Brand B is less than CV of Brand A.

Chapter Test

Multiple Choice Questions

- is an absolute measure of dispersion.
(a) Range (b) Mean deviation (c) Standard deviation (d) All of these
- When dispersion of the series is expressed in terms of some relative value, it is called
(a) Relative measure (b) Absolute measure (c) Range (d) None of these
- of dispersion expresses the variability of data in terms of the original unit.
(a) Relative measure (b) Absolute measure (c) Standard deviation (d) None of these
- If the standard deviation of a data is 0.12, find the variance.
(a) 0.144 (b) 0.0144 (c) 1.44 (d) 0.00144
- For calculation of coefficient of variation, which of the following is/are required?
(a) Standard deviation (b) Mean (c) Both (a) and (b) (d) None of these

Short Answer (SA) Type Questions

- What are the types of measures of dispersion?
- Calculate standard deviation and its coefficient from the following data through assumed mean method.

Values	10	15	25	20	30	40	50	10
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- Calculate the standard deviation by direct method. Values are 5, 8, 7, 9, 6.
- Calculate standard deviation using assumed mean method

Size	4	5	6	7	8
Frequency	9	12	17	8	4

- Which measure of dispersion is the best and why? State four reasons.

Long Answer (LA) Type Questions

- Calculate standard deviation from the following data using step-deviation method.

Items	10-20	20-30	30-40	40-50	50-60	60-70	70-80
Frequency	4	8	8	16	12	6	4

- Compute the following parts.
 - Mean and standard deviations of two distributions of 100 and 150 items are 50 and 5 and 40 and 6 respectively. Find the combined standard deviation.
 - Write two merits and two demerits of standard deviation.

Answers

Multiple Choice Questions

1. (d) 2. (a) 3. (b) 4. (b) 5. (c)