UNIT-3

Measurement of dispersion.

Definition of dispersion :- "According to A.L. Bowley dispersion is the measurement of the variation of the items."
" According to L.R. Conner dispersion is the measure of the extent to which the individual items vary.

★ objective of measure of dispersion -

1- To judge the reablibity of average.
2- To make a comparitive study of the variability of two or more series.
3- To control variability.
4- To facilitate further mathematical analysis.
5- To help in quantity control.

★ Type of measure of dispersion.

1) Absolute dispersion.
2). Relative dispersion.

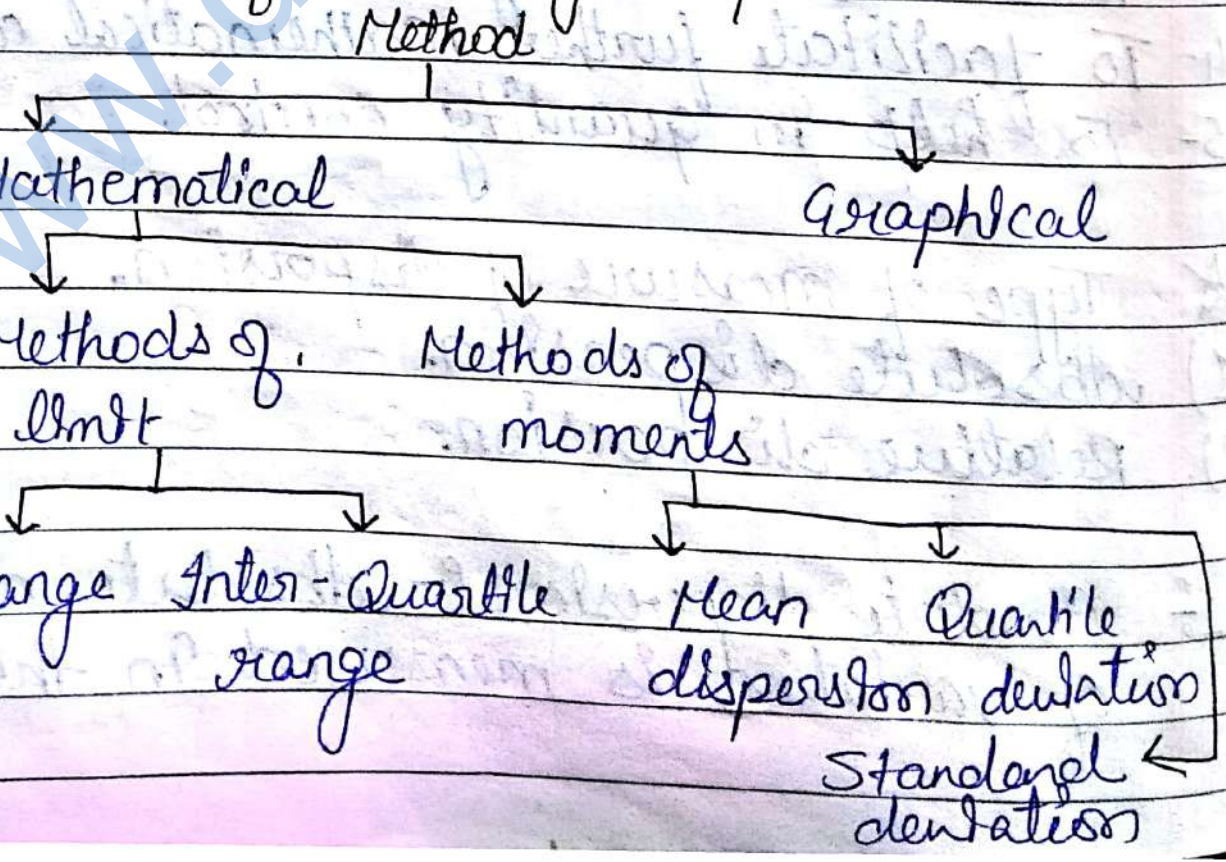
1:- Absolute dispersion :- Absolute measure of variation is measured in the same

PAGE NO. // //
DATE // //

Statistical unit in which original data exist.
For example:- If the data is given in rupees or Kilogram the result may be measure in terms of money and Kilogram.

2- Relative dispersion - Absolute dispersion is not suitable for comparative study of variability between two series specialy when the statistical unit is not same.

★ Methods of measuring dispersion :-



PAGE NO. // .
DATE // //

1- Range :-

Range = L-S → Smallest Item.
↓ largest Item

Coefficient of Range ⇒ $\frac{L-S}{L+S}$

Ques :- Find the range and Coefficient of range in individual series.

Series - 11, 7, 9.5, 7.2, 10.3, 8.4, 6.7, 5.6, 7.5, 8.7

Asc. - 5.6, 6.7, 7, 7.4, 7.5, 8.4, 8.7, 9.5, 10.3, 11.

Range = L-S
= 11 - 5.6
= 5.4 Ans

Coefficient of range = $\frac{L-S}{L+S} = \frac{5.4}{11+5.6} = \frac{54}{166}$

$= \frac{27}{83} = 0.32$ Ans

★ Range in discrete series.

Variables	F
82	6
87	7
92	9
97	13
102	12

107	5	Range = L-S
112	3	= 112 - 82
		= 30.

Coefficient of range = $\frac{30}{194}$ = 0.1 Ans

★ Range in continuous series :-

C-I	F
0-10	2
10-20	4
20-30	6
30-40	8
40-50	11
50-60	4

Range = L-S
= 60 - 0 = 60

Coefficient of range = $\frac{60}{60}$ = 1

Ques:- Find range and its coefficient from the following data.

C-I	F	C-I
11-15	3	10.5-15.5
16-20	5	15.5-20.5
21-25	6	20.5-25.5
26-30	9	25.5-30.5
31-35	10	30.5-35.5
36-40	7	35.5-40.5

Range = 40.5 - 10.5
= 30
= $\frac{30}{51}$
= 0.5 Ans

PAGE NO. // //
DATE // //

★ Merits of range -

1- Range is the simplest measure of disperstion.
2- Range is the rigidly define.

★ Demerits of range -

1- It is based on the 2 ~~en~~ extreme values.
2- It take low account of the form of distribution with in the two extreme values.

Ques:- And the minimum value of the maximum value is 80 and the coefficient of range is 60%.

Solution :- Max = L = 80

C.O.R = 60% = $\frac{60}{100}$ = 0.6

$$C.O.R = \frac{L-S}{L+S}$$

$$\frac{0.6}{10} = \frac{80-S}{80+S}$$

$$480 + 6S = 800 - 10S$$

$$S = 320$$

$$S = \frac{320}{16} = 20$$

$$\boxed{S = 20}$$

PAGE NO. // //
DATE // //

Range = L-S
= 80-20
= 60 Ans

★ Quartile deviation -

Quartile dev. = $\frac{Q_3 - Q_1}{2}$

Inter Quartile range = $Q_3 - Q_1$

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

Its range from 0 to 1

Where Q_3 is third Quartile or upper Quartile and Q_1 is first Quartile or lower Quartile.

Ques:- Quartile deviation in Individual Series

Series	asc.
87	36
36	49
95	50
99	52
52	63
63	65
49	70

70	87
50	95
65	98
98	99

$Q_1 \Rightarrow$ Size of $\left(\frac{N+1}{4}\right)$ Item.

$= \frac{11+1}{4} = \frac{12}{4} = 3$ Item

$Q_1 = 50$

$Q_3 = 3\left(\frac{N+1}{4}\right)^{th}$ Item.

$= 3 \times 3 = 9$ Item, $\boxed{Q_3 = 95}$

Quartile deviation $= \frac{95-50}{2} = \frac{45}{2} = 22.5$

range $= 95 - 50 = 45$

coefficient $= \frac{45}{145} = \frac{9}{29} = 0.31$

Ques:-

Series	asse.
48	37
45	38
54	41
43	42
51	43
49	45
38	46

$Q_1 = \frac{N+1}{4} = \frac{11+1}{4} = \frac{12}{4}$

$Q_1 = 3$

$\boxed{Q_1 = 41}$

$Q_3 = 3 \times 3 = 9.$

$\boxed{Q_3 = 49}$

41	48
37	49
42	57
46	54

$$Q_D = \frac{Q_3 - Q_1}{2} = \frac{49-41}{2}$$

$$= \frac{8}{2} = 4.$$

Range = 8.

$$\text{Coefficient of } Q_D = \frac{8}{49+41} = \frac{8}{90} = \frac{4}{45}$$

$$= 0.08 \text{ Ans.}$$

Ques:- Quartile deviation in discrete series.

x	f	cf
2	2	2
3	3	5
4	5	10
5	6	16
6	8	24
7	12	36
8	16	52
9	7	59
10	5	64
11	4	68
	68	

$$Q_1 = \frac{68+1}{4} = \frac{69}{4} = 17.25$$

$$\boxed{Q_1 = 6}$$

$$Q_3 = \frac{3 \times 69}{4} = 3 \times 17.25$$

$$= 51.75$$

$$\boxed{Q_3 = 9}$$

Quartile range $= Q_3 - Q_1$

$= 9 - 6 = 2$

$$Q.D. = \frac{Q_3 - Q_1}{2} = \frac{2}{2} = 1$$

$$\text{Coefficient of } Q.D = \frac{2}{9+6} = \frac{2}{14}$$

$$= \frac{1}{7} = 0.14 \text{ Ans}$$

PAGE NO. // //
DATE // //

Ques:- Quartile deviation in continuous series -

C.I	f	C.f.
0-5	29	29
5-10	95	124
10-15	225	349
15-20	93	442
20-25	29	471
25-30	7	478
30-35	9	487
35-40	6	493
40-45	4	497
45-50	3	500

$Q_1 = \frac{N+1}{4} = \frac{500+1}{4} = \frac{501}{4}$

$= 125.25$ Item.

$Q_1 = l_1 + \frac{i}{f}\left(\frac{n}{2} - cf\right)$.

$= 10 + \frac{5}{225}\left(\frac{500}{2} - 124\right)$.

$= 10 + \frac{1}{45}(250 - 124)$

$= 10 + \frac{1}{45} \times 126$.

$= 10 + \frac{126}{45} = 10 + 2.7$

$\boxed{Q_1 = 12.7}$

$Q_3 = 3\left(\frac{n+1}{4}\right) = 3 \times 125.25 = 375.75$

$Q_3 = 15 + \frac{5}{98}(250 - 349)$

$= 15 + \frac{5}{98} \times \left(\frac{33}{-99}\right) = 15 + \frac{5}{31} \times -33$

$\boxed{Q_3 = 9.63}$

$$Q_D = \frac{Q_3 - Q_1}{2} = \frac{9.6 - 12.7}{2} = \frac{3.1}{2}$$

$$\boxed{Q_D = 1.55.}$$

Range $= Q_3 - Q_1 = 3.1$

Coefficient of Range $= \frac{3.1}{22.3} = \frac{31}{223} = 0.13.$

Ques

C.I	C.I	F	CF
11-20	10.5-20.5	4	4
21-30	20.5-30.5	8	12
31-40	30.5-40.5	20	32
41-50	40.5-50.5	12	44
51-60	50.5-60.5	6	50
		50	

$Q_1 = \frac{N+1}{4} = \frac{50+1}{4}$

$\boxed{Q_1 = 12.75}$

$Q_3 = 3 \times 12.75$

$\boxed{Q_3 = 38.25}$

$Q_1 = l_1 + \frac{i}{f}\left(\frac{n}{2} - CF\right)$

$= 30.5 + \frac{10}{20}\left(\frac{50}{4} - 12\right)$

$= 30.5 + \frac{1}{2}\left(\frac{50-40}{4}\right)$

$= 30.5 + \frac{1}{4}$

$= 30.5 + 0.25$

$Q_1 = 30.75$

$Q_3 = 40.5 + \frac{10}{12}\left(\frac{50}{4} - 32\right)$

$= 40.5 + \frac{10}{12}(50 - 120)$

$= 40.5 + \frac{5}{12} \times -78$

$= 40.5 + 5 \times (-13).$

$Q_3 = 105.5$

$Q_D = \frac{105.5 - 38.25}{2}$

$Q_D = \frac{67.25}{2} = 33.625$

Range = 67.25

Coefficient $= \frac{67.25}{143.75} = 0.4$.

PAGE NO. // //
DATE // //

Ques:

x	f	cf	c.i
5	12	12	0-10
15	15	27	10-20
25	18	45	20-30
35	21	66	30-40
45	36	102	40-50
55	22	124	50-60
65	17	141	60-70
75	13	154	70-80
85	10	164	80-90
95	11	175	90-100
	175		

$Q_1 = \frac{N+1}{4} = \frac{176}{4} = 44.$

$Q_1 = 20 + \frac{10}{18}\left(\frac{175}{4} - 27\right).$

$Q_1 = 20 + \frac{5}{9}\left(\frac{175 - 108}{4}\right)$

$= 20 + \frac{5}{9}\left(\frac{67}{4}\right)$

$= 20 + \frac{335}{36}$

$Q_1 = 29.3$

$Q_3 = 3 \times 44 = 132$

$Q_3 = 60 + \frac{10}{17}\left(\frac{175}{4} - 124\right)$

$= 60 + \frac{10}{17}\left(\frac{175 - 596}{4}\right)$

$= 60 + \frac{2105}{34}$

$= 60 + 6.32$

$= 66.32$

$Q_D = \frac{66.32 - 29.3}{2}$

$Q_D = \frac{37.02}{2} = 18.51.$

$Q_R = 37.02$

$C.O.R = \frac{37.02}{95162} = 0.38.$

PAGE NO. // //
DATE // //

Mean deviation or average deviation :-

$$\text{Mean deviation} = \frac{1}{N} \Sigma |x - M|$$

$$\text{Coefficient of M.D.} = \frac{M.D}{\text{Mean}}, \frac{M.D}{\text{Median}}, \frac{M.D}{\text{Mode}}$$

Ques Find mean deviation from mean from the following data.

Series	3	5	6	7	8	10	11	14	
$x - M$	-5	-3	-2	-1	0	2	3	6	
$\lvert x - M \rvert$	5	3	2	1	0	2	3	6	$\Sigma \lvert x - M \rvert = 22$

$$\bar{X} = \frac{\Sigma X}{N} = \frac{64}{8} = 8.$$

Mean = 8.

$$M.D = \frac{1}{N} \Sigma |x - M| = \frac{1}{8} \times 22 = \frac{11}{4} = 2.75$$

$$C.O.M.D. = \frac{M.D}{\text{Mean}} = \frac{2.75}{8} = 0.34.$$

Ques Find out mean deviation from median from the following data.

Series.	5	7	9	10	12	13	15	
$x - M$	-5	-3	-1	0	2	3	5	
$\lvert x - M \rvert$	5	3	1	0	2	3	5	19

Median = 10, Median no. = $\frac{N+1}{2} = \frac{8}{2} = 4$

$M.D. = \frac{1}{N} \Sigma |X-M|$

$= \frac{1}{7} \times 19 = \frac{19}{7} = 2.71$

C.of $M.D. = \frac{2.71}{1000} = 0.27.$

Ques:- Find out mean deviation from mode from the following data:

Series	X-M	|X-M|
0	0	0
3	-5	5
5	-3	3
0	0	0
7	-1	1
9	1	1
5	-3	3
8	0	0
6	-2	2
2	-6	6
		21

Mode = 8.

$M.D = \frac{1}{10} \times 21 = \frac{21}{10} = 2.1$

C.of $M.D. = \frac{21}{8} = 0.26.$

PAGE NO. // //
DATE // //

★ Calculation of M.D in discrete series-

$$M.D. = \frac{1}{N} \Sigma f|x-M|.$$

Ques:- Find out mean deviation from median and its coefficient from the following data.

x	f	cf	x-M	|x-M|	f|x-M|
10	3	3	-2	2	6
11	12	15	-1	1	12
12	18	33	0	0	0
13	12	45	1	1	12
14	3	48	2	2	6
		48			36

$M.no. = \frac{48}{2} = 24.$

Median = 12.

$$M.D = \frac{1}{48}(36) = \frac{3}{4} = 0.75$$

$$\text{Coefficient of } M.D = \frac{0.75}{12} = 0.62.$$

Ques:- Determine Quartile deviation from the following.

C-I	f	cf
0-5	5	5
5-15	8	13
15-40	10	23
40-50	12	35
50-70	8	43
70-100	7	50

$$Q_1 = \frac{N+1}{4} = \frac{51}{4} = 12.75$$

$Q_3 = 3 \times 12.75$

$Q_3 = 38.25$

$Q_1 = l_1 + \frac{f}{f}\left(\frac{n}{4} - c\right)$

$= 5 + \frac{10}{8}\left(\frac{50}{4} - 5\right)$

$= 5 + \frac{10}{8}\left(\frac{50-20}{4}\right)$

$= 5 + \frac{10}{8}\left(\frac{30}{4}\right)$

$= 5 + \frac{75}{8}$

$Q_1 = 14.37$

$Q_3 = 50 + \frac{20}{8}\left(\frac{3 \times 50}{4} - 35\right)$

$= 50 + \frac{10}{4}\left(\frac{150 - 140}{4}\right)$

$= 50 + 5 \times \frac{10}{4}$

$= 50 + \frac{25}{4}$

$= 50 + 6.25$

$= 56.25$

$Q.D. = \frac{Q_3 - Q_1}{2} = \frac{56.25 - 14.37}{2}$

$Q.D. = \frac{41.88}{2} = 20.94.$

Range = 41.88.

Coefficient of Range $= \frac{41.88}{70.62} = 0.5$

Ques:- Calculate mean deviation and its coefficient from mean median and mode.

X	f	fx	cf	x-M	|x-M|	x-M	~~x-M~~
12	1	12	1	-5	5	-4	
14	2	28	3	-3	3	-2	
16	3	48	6	-1	1	0	
18	2	36	8	1	1	2	
22	1	22	9	5	5	6	
24	1	24	10	7	7	8	
	10	170			22	22	

$$\text{Mean} = \frac{\Sigma fx}{N} = \frac{170}{10} = 17$$

$$\text{M. no.} = \frac{10}{2} = 5, \quad \text{Median} = 16$$

Mode = 16

(i) M.D = $\frac{1}{N}\Sigma|x-M|$ for mean

$= \frac{1}{10} \times 22 = 2.2$

C of M.D = $\frac{2.2}{170} = 0.12$

(ii) M.D = $\frac{1}{10} \times 22$ for Median

$= 2.2$

Co of M.D = $\frac{2.2}{160}$

$= 0.13$

(iii) M.D for Mode = $\frac{1}{10} \times 22 = 2.2$

C of M.D = $\frac{2.2}{160} = 0.13$

PAGE NO. // //
DATE // //

Ques :- Calculation of Mean deviation in continuous series, Mean deviation from mean.

Marks.	F	X	FX	X-M	|X-M|	F|X-M|
140-150	4	145	580	26.2	26.2	104.8
150-160	6	155	930	16.2	16.2	97.2
160-170	10	165	1650	6.2	6.2	62
170-180	18	175	3150	-3.8	3.8	68.4
180-190	9	185	1665	-13.8	13.8	124.2
190-200	3	195	585	-23.8	23.8	71.4
	50		8560			528

$$\text{Mean} = \frac{\Sigma fx}{N} = \frac{8560}{50} = 171.2$$

$$M.D = \frac{1}{N} \Sigma f|X-M| = \frac{1}{50} \times 528 = 10.56.$$

$$\text{Coefficient of M.D.} = \frac{M.D}{\text{Mean}} = \frac{10.56}{171.20} = 0.06.$$

Ques :- Find out mean deviation from median.

C.I	C.F	F	X-M.	|X-M|	X	F|X-M|
0-10	10	10	-25	25	5	250
10-20	12	2	-15	15	15	80
20-30	25	13	-5	5	25	65
30-40	35	10	5	5	35	50
40-50	40	5	15	15	45	75
50-60	50	10	25	25	55	250
						720

PAGE NO. // //
DATE // //

$$M.no. = \frac{50}{2} = 25$$

$$\text{Median} = 20 + \frac{10}{13}(25-12)$$

$$= 20 + \frac{10}{13}(13)$$

$$\text{Median} = 20 + 10 = 30$$

$$M.D = \frac{1}{N} \Sigma f|x-M|$$

$$= \frac{1}{50} \times 720 = 14.4$$

Ques- Find out mean deviation from mode.

C.I	F	C.F.	x-M	x	F|x-M|
0-10	5	5	-39	5	195
10-20	15	20	29	15	435
20-30	20	40	19	25	380
30-40	20	60	9	35	180
40-50	32	92	1	45	32
50-60	14	106	11	55	154
60-70	14	120	21	65	294
70-80	5	125	31	75	155
	125				1825

PAGE NO. // //
DATE // //

$$\text{Mode} = l_1 + \frac{f_1 - f_0}{2f_1 - f_0 - f_2} \times l$$

$$= 40 + \frac{32 - 20}{64 - 20 - 14} \times 10$$

$$= 40 + \frac{12}{64 - 34} \times 10$$

$$= 40 + \frac{120}{30}$$

$$= 40 + 4 = 44.$$

$$M.D. = \frac{1}{N} \Sigma f|X - M|$$

$$= \frac{1}{125} \times 1825 = \frac{73}{5} = 14.6.$$

★ Standard deviation :-

Standard deviation in individual series :-

$$\sigma = \sqrt{\frac{\Sigma (X - \bar{X})^2}{N}} \text{ or } \sqrt{\frac{\Sigma d^2}{N}}$$

$$\text{or } \sqrt{\frac{\Sigma X^2}{N} - \frac{\Sigma (X)^2}{N}}$$

$$\text{Coefficient of S.D.} = \frac{\text{S.D.}}{\text{Mean}}$$

$$\text{Coefficient of variation} = \frac{\text{SD.}}{\text{Mean}} \times 100$$

Calculate SD. and its coefficient from the following data -

Ques:

x	$x-\bar{x}$	$(x-\bar{x})^2$
10	-20	400
12	-18	324
18	-12	144
22	-8	64
26	-4	16
30	0	0
32	2	4
45	15	225
50	20	400
55	25	625
300		2205

$$\text{Mean} = \frac{300}{10} = 30$$

$$\sigma = \sqrt{\frac{\Sigma(x-\bar{x})^2}{N}}$$

$$= \sqrt{\frac{2202}{10}} = \frac{46.92}{5.16}$$

$$= 14.84$$

$$\text{Co-eff S.D} = \frac{14.8}{30} = 0.494.$$

Ques:- Calculate S.D. from the following information.

$N=7,\ \Sigma x=84,\ \Sigma x^2=1130$

$$\sigma = \sqrt{\frac{\Sigma x^2}{N} - \left(\frac{\Sigma x}{N}\right)^2} = \sqrt{\frac{1130}{7} - \left(\frac{84}{7}\right)^2}$$

$$= \sqrt{\frac{1130}{7} - \frac{7056}{49}} = \sqrt{\frac{7910 - 1056}{49}}$$

$$= \sqrt{\frac{854}{49}} = \sqrt{7.42} = 4.17$$ Ans

PAGE NO. // //
DATE // //

★ Shortcut method in individual series –

$$S.D = \sqrt{\frac{\Sigma d^2}{N} - \left(\frac{\Sigma d}{N}\right)^2}$$

Ques:-

	X	d=x-A	d^2
	10	3	9
	11	4	16
	17	10	100
	25	18	324
A=	7	0	0
	13	6	36
	21	14	196
	10	3	9
	12	5	25
	14	7	49
		70	764

$$\sigma = \sqrt{\frac{764}{10} - \left(\frac{70}{10}\right)^2} = \sqrt{\frac{7640 - 4900}{100}}$$

$$= \sqrt{\frac{2740}{10}} = \frac{52.34}{10} = 5.23$$

Ques:- Calculate S.D. and its coefficient from the following.

x	d(x-A)	d^2
30	-70	4900
50	-50	2500
60	-40	1600
70	-30	900
90	-10	100
A=100	0	0
105	5	25
120	20	400
125	25	625
130	30	900
150	50	2500
170	70	4900
		19350

$$\sigma = \sqrt{\frac{\Sigma d^2}{N} - \left(\frac{\Sigma d}{N}\right)^2}$$

$$= \sqrt{\frac{19350}{12} - 0}$$

$$= 40.15 \text{ Ans}$$

$$\text{Co.q.SD} = \frac{\text{S.D}}{\text{Mean}}$$

$$= \frac{40.15}{100} = 4.015 \text{ Ans}$$

Ques:- Calculate SD & its coefficient —

x	$(x-\bar{x})$	$(x-\bar{x})^2$
25	-19	361
34	-10	100
48	4	16
36	-8	64
42	-2	4
70	26	676
30	-14	196
60	16	256
45	1	1
50	6	36
		1774

$$\bar{x} = \frac{\Sigma x}{N} = \frac{440}{10} = 44.$$

$$\sigma = \sqrt{\frac{\Sigma (x-\bar{x})^2}{N}}$$

$$= \sqrt{\frac{1774}{10}} = \sqrt{177.4}$$

$$= 13.12$$

$$\text{C.q.SD.} = \frac{13.12}{44} = 0.29$$

Ques:-

x	$(x-\bar{x})$	$(x-\bar{x})^2$
155	-9.6	92.16
158	-6.6	43.56
163	-1.6	2.56
169	4.4	19.36
170	13.6	178.48
823	0.2	336.12

$$\bar{X} = \frac{823}{5} = 164.6$$

$$\sigma = \sqrt{\frac{\Sigma(x-\bar{x})^2}{N}} = \sqrt{\frac{336.12}{5}}$$

$$= \sqrt{67.22} = 8.19$$

$$\text{C.of } S.D. = \frac{8.19}{164.6} = 0.04 \text{ Ans.}$$

PAGE NO. // //
DATE // //

Standard deviation in descrete series -

$$S.D. = \sqrt{\frac{1}{N}\Sigma f(x-\bar{x})^2} \text{ or } \sqrt{\frac{\Sigma fd^2}{N}}$$

Ques:-

x	f	d = x-A	d^2	fd^2
10	5	-30	900	4500
20	15	-20	400	6000
30	30	-10	100	3000
40	35	0	0	0
50	25	10	100	2500
60	17	20	400	6800
70	8	30	900	7200
	135			30000

$$S.D = \sqrt{\frac{\Sigma fd^2}{N}} = \frac{30000}{135} = \frac{6000}{27}$$

Que:- Standard deviation in shortcut method of descrete series -

$$S.D. \ (\sigma) = \sqrt{\frac{\Sigma fd^2}{N} - \left(\frac{\Sigma fd}{N}\right)^2}$$

Ques:-

x	F	d	d^2	Fd^2	Fd
21	5	-2	4	20	-10
22	8	-1	1	8	-8
23	12	0	0	0	0
24	8	1	1	8	8
25	7	2	4	28	14
	40			64	4

$$S.D. = \sqrt{\frac{64}{40} - \left(\frac{4}{40}\right)^2}$$

$$= \sqrt{\left(\frac{64}{40} - \frac{16}{1600}\right)} = \sqrt{\frac{16}{10} - \frac{1}{100}}$$

$$= \sqrt{\frac{160-1}{100}} = \sqrt{\frac{159}{100}} = \sqrt{1.59}$$

$S.D. = 1.26$ Ans

Ques:- Find out S.D. by shortcut method from the following information.

Series	F	d	fd	d^2	Fd^2
10	1	-10	-10	100	100
20	2	0	0	0	0
30	4	10	40	100	400
40	3	20	60	400	1200
	10		90		1700

PAGE NO. // //
DATE // //

$$S.D = \sqrt{\frac{1700}{10} - \left(\frac{40}{10}\right)^2} = \sqrt{170 - 81}$$

$$= \sqrt{89} = 9.44 \text{ Ans.}$$

Ques:- Find out S.D. from the step-deviation method-

x	f
8	2
9	4
10	5
11	8
12	6
13	3
14	2
	30

★. Direct method in continuous series -

$$\sigma = \sqrt{\frac{\Sigma f (x - \bar{x})^2}{N}} \quad \text{or} \quad \sqrt{\frac{\Sigma f d^2}{N}}$$

Ques:-

C.I	f	x	fx	$(x-\bar{x})^2$	$(x-\bar{x})$	$f(x-\bar{x})^2$
0-10	1	5	5	361	-19	361
10-20	2	15	30	81	-9	162
20-30	4	25	100	1	1	4
30-40	3	35	105	121	11	363
	10		240			890

$$\bar{x} = \frac{\Sigma fx}{\Sigma f} = \frac{240}{10} = 24.$$

$$\sigma = \sqrt{\frac{\Sigma f(x-\bar{x})^2}{N}} = \sqrt{\frac{890}{10}} = \sqrt{89}$$

$$\sigma = 9.43 \text{ Ans.}$$

Ques:- Find out S.D. by shortcut method in continuous series -

C.I.	f	x	$d(x-A)$	d^2	fd	fd^2
0-10	1	5	-20	400	-20	400
10-20	2	15	-10	100	-20	200
20-30	4	25 A	0	0	0	0
30-40	3	35	10	100	30	300
	10				-10	900

$$\sigma = \sqrt{\frac{\Sigma fd^2}{N} - \left(\frac{\Sigma fd}{N}\right)^2}$$

$$= \sqrt{\frac{900}{10} - \left(\frac{-10}{10}\right)^2} = \sqrt{89} = 9.43 \text{ Ans.}$$

Ques:- Find out S.D. by shortcut method -

C.I.	f	x	d (X−A)	d^2	fd	fd^2
0-10	3	5	-20	400	-60	1200
10-20	5	15	-10	100	-50	500
20-30	8	25	0	0	0	0
30-40	3	35	10	100	30	300
40-50	1	45	20	400	20	400
	20				60	2400

$$\sigma = \sqrt{\frac{\Sigma f d^2}{N} - \left(\frac{\Sigma f d}{N}\right)^2}$$

$$= \sqrt{\frac{2400}{20} - \left(\frac{60}{20}\right)^2} = \sqrt{120 - 9}$$

$$= \sqrt{111} = 10.53 \text{ Ans.}$$

Ques:- Calculate S.D. from direct and shortcut method -

C.I.	f	x	d	fd	d^2	fd^2
0-20	40	10	-60	-2400	3600	144000
20-40	64	30	-40	-2560	1600	102400
40-60	56	50	-20	-1120	400	22400
60-80	96	70 = A	0	0	0	0
80-100	56	90	20	1120	400	22400
100-120	24	110	40	960	1600	38400
120-140	40	130	60	2400	3600	144000

140-160	24	150	80	1920	6400	153600
	400			320		497600.

(iii) Direct method –

$$\sigma = \sqrt{\frac{\Sigma f d^2}{N}} = \sqrt{\frac{497600}{400}}$$

$$= \sqrt{1244} = 35.27.$$

(iv) Shortcut method –

$$\sigma = \sqrt{\frac{\Sigma f d^2}{N} - \left(\frac{\Sigma f d}{N}\right)^2}$$

$$= \sqrt{\frac{497600}{400} - \left(\frac{320}{400}\right)^2}$$

$$= \sqrt{1244 - \frac{64}{100}} = \sqrt{1244 - 0.64}$$

$$= \sqrt{1243.36} = 35.26$$