Mean Deviation

Mean Deviation of a series is the arithmetic average of the absolute deviation of various items from a measure of the central tendency (either mean, median or mode)

Calculation of Mean Deviation - Individual Series:

$$\text{Mean Deviation or M.D.} = \frac{\Sigma |D|}{N}$$

Steps:-

① Take deviations of items from median ignoring ± signs and denote these deviation by |D|.

② Divide the total obtained of deviations (i.e $\Sigma|D|$) by the no. of observations.

$$\text{Coefficient of Mean Deviation} = \frac{MD}{\text{Median}}$$

Example: From the following data calculate median Deviation and coefficient of mean Deviation (From median).

S.No.	1	2	3	4	5	6	7	8	9
Marks	68	49	32	21	57	38	59	66	41

Soln:- Mean Deviation = $\frac{\Sigma |D|}{N}$

$$D = X - \text{Med}$$

Median is the value of $\left[\frac{N+1}{2}\right]^{th}$ item

$\left[\frac{9+1}{2}\right] = 5^{th} = 49$ marks

(Arranging series in ascending order)

S.No.	marks.	Deviation
1	21	28
2	32	17
3	38	11
4	41	08
5	49	00
6	54	5
7	59	10
8	66	17
9	68	68
		115 ← Σ|D|

Mean Deviation = $\Sigma|D| / N$

$= \frac{115}{9} = 12.8$ marks.

Coefficient of Mean Deviation = $\frac{M.D}{Median}$

$= \frac{12.8}{49} = 0.26$

Mean Deviation in case of Discrete series

Mean Deviation = $\frac{\Sigma f|D|}{N}$

Steps:- Cal. Median

Take Deviation from median

Multiply Deviations with their respective frequencies and get total $\Sigma f|D|$

Ques-: The no. of telephone calls received at an exchange in 245 successive one-minute internal are shown in the follo. frequency distribution. Compute Mean Deviation about the median.

No. of calls	0	1	2	3	4	5	6	7
Frequency	14	21	25	43	51	40	39	12

Soln

No. of Calls.	Freq.	C.f.	|D|	Freq. |D|
0	14	14	4	56
1	21	35	3	63
2	25	60	2	50
3	43	103	1	43
4	51	154	0	0
5	40	194	1	40
6	39	233	2	78
7	12	245	3	36
	245			$\Sigma f\|D\| = 366$

Median = Size of $\frac{N+1}{2}$ th item

$= \frac{245+1}{2} = 123$ rd item

Hence median value is 4

Mean Deviation $= \frac{\Sigma f|D|}{N}$

$= \frac{366}{245}$.

$= 1.494$

Calculation of Mean Deviation - continuous series

b) Procedure remains the same as in case of continuous series. The only difference is that we have to obtain the midpoints of the various classes and take deviations of these mid-points from median

$$\text{Mean Deviation} = \frac{\Sigma f |D|}{N}$$

Ques: Calculate mean-deviation from the following data:

Marks	10-20	20-30	30-40	40-50	50-60	60-70	70-80
No. of Students	4	6	10	20	10	6	4

Soln:

Marks	f	M	Cf	|D|	f|D|
10-20	4	15	4	3	12
20-30	6	25	10	2	12
30-40	10	35	20	1	10
40-50	20	45	40	0	0
50-60	10	55	50	1	10
60-70	6	65	56	2	12
70-80	4	75	60	3	12
					68

Median = Size of $N/2$ the item

= $60/2 = 30$ th item

= Median lies in class 40-50

$$\text{Median} = L + \frac{N/2 - cf}{f} \times i$$

$$= 40 + \frac{30 - 20}{20} \times 10$$

$$= 45$$

$$\text{Mean Deviation} = \frac{\Sigma f|D|}{N} \times i$$

$$= \frac{68}{60} \times 10 = 11.33$$

$$\text{Coefficient of Mean Deviation} = \frac{MD}{\text{Median}}$$

$$= \frac{11.33}{45}$$

Standard Deviation

↳ Standard Deviation is the square root of the arithmetic average of the squares of the deviations measured from the mean.

Computation of standard Deviation (Individual series)

① **Actual Mean Method**

$$SD \text{ or } \sigma = \sqrt{\frac{\Sigma d^2}{N}}$$

'd' taken from actual mean

② **Assumed Mean Method**

$$SD \text{ or } \sigma = \sqrt{\frac{\Sigma d^2}{N} - \left[\frac{\Sigma d}{N}\right]^2}$$

(Deviation taken from assumed mean)

Ques Cal. Standard Deviation from the following observations of marks of 5 students :

S.No.	1	2	3	4	5
Marks	8	12	13	15	22

Soln

X	$X-\bar{X}$	$(X-\bar{X})^2$
8	-6	36
12	-2	4
13	-1	1
15	1	1
22	8	64
70		

$$\text{Mean } (\bar{X}) = \frac{\Sigma X}{N} = \frac{70}{N} = 14$$

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

$$= \sqrt{\frac{106}{5}} = \sqrt{21.2} = 4.604$$

Ques: Calculate the standard deviation of the heights of 10 students given below

S.No.	1	2	3	4	5	6	7	8	9	10
Heights	160	160	161	162	163	163	163	164	164	170

Heights	160	160	161	162	163	163	163	164	164	170
$d = (X-\bar{X})$	-2	-2	-1	0	1	1	1	2	2	8
d^2	4	4	1	0	1	1	1	4	4	64

Deviation 'd' taken from Assumed Mean (162)

Std. Deviation or $\sigma = \sqrt{\frac{\Sigma d^2}{N} - \left[\frac{\Sigma d}{N}\right]^2}$

$= \sqrt{\frac{84}{10} - \left[\frac{10}{10}\right]^2}$

$= \sqrt{8.4 - 1} = \sqrt{7.4} = 2.72$ cm

Computation of Std. Deviation (Discrete Series)

① Actual Mean Method :- $\sqrt{\frac{\Sigma fd^2}{N}}$

Deviation taken from actual mean

② Assumed Mean Method :-

$\sqrt{\frac{\Sigma fd^2}{N} - \left[\frac{\Sigma fd}{N}\right]^2}$ Deviation taken from assumed mean

③ step-Deviation Method :-

$SD \text{ or } \sigma = \sqrt{\frac{\Sigma fd^2}{N} - \left[\frac{\Sigma fd}{N}\right]^2} \times i$

Deviation taken from assumed mean and common factor 'i' used to divide the deviations.

Ques :- Calculate Std. Deviation from the following data :-

Size of item	6	7	8	9	10	11	12
Frequency	3	6	9	13	8	5	4

Soln (Actual mean Method)

Size	Freq.	fx	Deviation	d^2	fd^2
6	3	18	-3	9	27
7	6	42	-2	4	24
8	9	72	-1	1	9
9	13	117	0	0	0
10	8	80	1	1	8
11	5	55	2	4	20
12	4	48	3	9	36
	$\Sigma = 48$	$\Sigma fx = 432$	Total →		124

Arithmetic mean $= \frac{\Sigma fx}{N} = \frac{432}{48} = 9$

Std. Deviation $= \sqrt{\frac{\Sigma fd^2}{N}} = \sqrt{\frac{124}{48}} = 1.6$

Soln (Assumed Mean Method)

X	F	~~Dx~~	fD	D^2	fD^2
6	3	~~-12~~	-6	4	12
7	6	-1	-6	1	06
8	9	0	0	0	00
9	13	1	13	1	13
10	8	2	16	4	32
11	5	3	15	9	45
12	4	4	16	16	64
	$N = 48$		$\Sigma fd = 48$		$\Sigma = 172$

Std. Deviation or $\sigma = \sqrt{\frac{\Sigma fd^2}{N} - \left[\frac{\Sigma fd}{N}\right]^2}$

$= \sqrt{\frac{172}{48} - \left[\frac{48}{48}\right]^2}$

$= \sqrt{2.58} = 1.6$

Computation of Std. Deviation in case of continuous series :

(1) Actual Mean Method

$\sigma = \frac{\Sigma fd^2}{N}$ 'd' taken from actual mean

(2) Assumed Mean Method

$\sigma = \sqrt{\frac{\Sigma fd^2}{N} - \left[\frac{\Sigma fd}{N}\right]^2}$ 'd' taken from assumed mean.

(3) Step Deviation Method

$\sigma = \sqrt{\frac{\Sigma fd^2}{N} - \left[\frac{\Sigma fd}{N}\right]^2} \times i$

Ques :- Cal. Std. Deviation of the following table giving the marks of 50 students

Marks	0-10	10-20	20-30	30-40	40-50	50-60	60-70	
No. of Students	6	5	8	15	7	6	3	

Soln (Actual Mean Method)

Marks	Mid(X) value	F	fM	D (M.V - $\bar{X}$)	D2	fd2
0-10	5	6	30	-28.4	806.56	4839.36
10-20	15	5	75	-18.4	338.56	1692.8
20-30	25	8	100	-8.4	70.56	564.48
30-40	35	15	525	1.6	2.56	38.4
40-50	45	7	315	11.6	134.56	941.92
50-60	55	6	330	21.6	466.56	2799.36
60-70	65	3	195	31.6	998.56	2995.68
		N = 50	$\Sigma fM = 1670$			13872

Airthmetic Mean $(\bar{X}) = \frac{\Sigma fm}{\Sigma f} = \frac{1670}{50} = 33.4$

Std. Deviation $(\sigma) = \sqrt{\frac{\Sigma fd^2}{N}} = \sqrt{\frac{13872}{50}} = 16.6$

Soln: Assumed Mean Method

Marks	x	f	d	fd	d2	fd2
0-10	5	6	-30	-180	900	5400
10-20	15	5	-20	-100	400	2000
20-30	25	8	-10	-80	100	800
30-40	35	15	0	0	0	0
40-50	45	7	10	70	100	700
50-60	55	6	20	120	400	2400
60-70	65	3	30	90	900	2700
		N=50		$\Sigma fd = -80$		14000

$$Sd(\sigma) = \sqrt{\frac{\Sigma d^2}{N} - \left[\frac{\Sigma d}{N}\right]^2} = \sqrt{\frac{14000}{50} - \left[\frac{-80}{50}\right]^2}$$

$$= \sqrt{277.44} = 16.6$$