even when individually they are large in magnitude; This is because, deviation of opposite signs cancel each other. So, we take only the magnitudes of the deviations and subsequently calculate the arithmetic mean of those absolute various deviations. It is termed as mean deviation of x about c and is denoted by MD_c. Thus

$$MD_c = \frac{1}{n} \sum_{i=1}^{n} |x_i - c| \quad \cdots (5a)$$

In particular, when $c = \bar{x}$, mean deviation about mean is

$$MD_{\bar{x}} = \frac{1}{n} \sum_{i=1}^{n} |x_i - \bar{x}| \quad \cdots (5b)$$

For a frequency distribution,

$$MD_c = \frac{1}{n} \sum_{i=1}^{r} f_i |x_i - c| \quad \cdots (5c)$$

where $n = \sum_{i=1}^{r} f_i$.

Example 5.3

Compute the mean deviation of a variable assuming the values 3, 5, 9, 1 and 2 about the median

Solution: Here the given values are 1, 2, 3, 5, 9 when arranged in increasing order of magnitude

Here median (me) = 3

So, using 5(a), we have

$$MD_{me} = \frac{1}{5}\left(|1-3| + |2-3| + |3-3| + |5-3| + |9-3|\right)$$

$$= \frac{11}{5} = 2.2$$

Example 5.4

The frequency distribution of age (in years) of 80 persons is given below

Age (in years)	Frequency
30-34	12
35-39	15
40-44	18
45-49	16
50-54	10
55-59	9
Total	80

Calculate the mean deviation about median

Table 5.1
Calculations

Age (in years)	Frequency (f_i)	class-boundaries	cumulative frequency	class mark (x_i)	$\lvert x_i - me \rvert f_i$
30-34	12	29.5-34.5	12	32	133.32
35-39	15	34.5-39.5	27	37	91.65
40-44	18	39.5-44.5	45	42	19.98
45-49	16	44.5-49.5	61	47	62.24
50-54	10	49.5-54.5	71	52	88.90
55-59	9	54.5-59.5	80	57	125.01
Total	80	—	—	—	521.10

Here Median $= me = 39.5 + \dfrac{\frac{80}{2} - 27}{18} \times 5 = 39.5 + \dfrac{65}{18}$

$= 39.5 + 3.61 = 43.11$

Hence Mean deviation about median

$= MD_{me} = \dfrac{52.10}{80} = 6.5$ years

If two variables x and y are related as $y = a + bx$ ...(i)

then $MD(y)_{A(y)} = |b| \, MD(x)_{A(x)}$

where $A(x)$ and $A(y)$ are corresponding values of x and y satisfying the given relation (i)

[For example, when $A(x) = \bar{x}$, $A(y) = \bar{y} = a + b\bar{x}$]

Example 5.5 Find the mean deviation about mean for the following frequency distribution:

Height (in inches)	Frequency
60 – 62	5
63 – 65	18
66 – 68	42
69 – 71	27
72 – 74	8

Solution: First we construct the following table:

Table 5.2

Necessary Calculation

class boundaries	Frequency (f_i)	class marks (x_i)	$y_i = \frac{x_i - 67}{3}$	$f_i y_i$
59.5 – 62.5	5	61	–2	–10
62.5 – 65.5	18	64	–1	–18
65.5 – 68.5	42	67	0	0
68.5 – 71.5	27	70	1	27
71.5 – 74.5	8	73	2	16
Total	100	—	—	15

Here $\bar{y} = \frac{\sum_i f_i y_i}{n} = \frac{15}{100} = 0.15$

Table 5.3

Necessary Calculation

y_i	$y_i - \bar{y}$	f_i	$f_i \lvert y_i - \bar{y} \rvert$
-2	-2.15	5	10.75
-1	-1.15	18	20.70
0	-0.15	42	6.30
1	0.85	27	22.95
2	1.85	8	14.80
Total	-	-	75.50

Hence $MD_{\bar{y}}(y) = \frac{75.5}{100} = 0.755$

Since $x_i = 67 + 3y_i$.

$\therefore$ $MD_{\bar{x}}(x) = 3 \times 0.755 = 2.265$ (inches)

(c) Standard Deviation :

Root mean square deviation is defined as the positive square root of the arithmetic mean of the squares of the deviations of variable values from a chosen average. Thus, the root mean square deviation of n values x_i, $i = 1, 2, \ldots, n$, of variable x about c is :

$$\sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - c)^2} \quad \ldots (5d)$$

Although the mean-square deviation indicates the scatter of the variable, the square root is obtained for expressing the measure in the same unit as that of the variable.