Ex : Calculate standard deviation from the following. Also find coefficient of standard deviation. (BS Annual)

Marks	No. of students
4.5–12.5	4
12.5–20.5	24
20.5–28.5	21
28.5–36.5	18
36.5–44.5	5
44.5–52.5	3
52.5–60.5	5
60.5–68.5	8
68.5–76.5	2

$u = \frac{x - 40.5}{8}$

Marks	x_i	f	$u = \frac{x-a}{8}$	fu	fu^2
4.5 - 12.5	8.5	4	−4	−16	64
12.5 - 20.5	16.5	24	−3	−72	216
20.5 - 28.5	24.5	21	−2	−42	84
28.5 - 36.5	32.5	18	−1	−18	18
36.5 - 44.5	40.5	5	0	0	0
44.5 - 52.5	48.5	3	1	3	3
52.5 - 60.5	56.5	5	2	10	20
60.5 - 68.5	64.5	8	3	24	72
68.5 - 76.5	72.5	2	4	8	32
		$N = 90$		$\Sigma fu = -103$	$\Sigma fu^2 = 509$

$\Sigma fu = -103$

$\Sigma fu^2 = 509$

$N = 90$

Here, $\text{Mean} = a + h\frac{\Sigma fu}{N} = 40.5 + 8 \times \frac{(-103)}{90}$

$= 31.35$

Correct formula

$$\text{Standard Deviation} = h\sqrt{\frac{1}{N}\Sigma f_i u_i^2 - \left(\frac{\Sigma f_i u_i}{N}\right)^2}$$

$$= 8\sqrt{\frac{1}{90} \times 509 - \left(\frac{-103}{90}\right)^2}$$

$= 16.68$

1) Moments about mean (μ)

For individual series

Moments about mean is defined as

$$\mu_r = \frac{\sum (x-\bar{x})^r}{n} = \frac{\sum d^r}{n}, \quad d = x-\bar{x}$$

For $r = 0, 1, 2, 3, 4$

$$\mu_0 = \frac{\sum d^0}{n} = \frac{\sum 1}{n} = \frac{n}{n} = 1$$

$$\mu_1 = \frac{\sum (x-\bar{x})}{n} = 0, \text{ for symmetrical distribution}$$

$$\mu_2 = \frac{\sum (x-\bar{x})^2}{n} = \frac{\sum d^2}{n}$$

For continuous or discrete series

r^{th} moment is defined as

$$\mu_r = \frac{\sum f.(x-\bar{x})^r}{N}, \quad N = \sum f$$

Here, also, $\mu_0 = 1$

$\mu_1 \ldots$

Moments about any point (μ'_r)

r^{th} moment about any point is defined as $\mu'_r = \frac{\sum f (a-A)^r}{N}$,

$N = \sum f$

$A =$ any point

Here, $\mu_0' = 1$

0^{th} moment about any point is always 1.

$\mu_0' = 1$

$\mu_0 = 1$

Relation between moments about mean in terms of moments about any point

(Symmetrical distribution)

$$\mu_1 = 0, \quad \mu_2 = \mu_2' - (\mu_1')^2$$

$$\mu_3 = \mu_3' - 3\mu_1'\mu_2 + 2(\mu_1')^3$$

$$\mu_4 = \mu_4' - 4\mu_1'\mu_3' + 6\mu_2'(\mu_1')^2 + 4(\mu_1')^4$$