Unit 6: Quantitative Techniques for Economics: 3 ×1 + 5 = 8 Marks

6.1 Basic Statistics

6.1.1 Review of Basic Statistics: Definition, Scope, Importance and Limitation of Statistics

6.1.2 Collection of Data: Method of Collecting Primary Data and Sources of Secondary Data

6.1.3 Standard Deviation, Coefficient of Variation (CV) and Characteristics of Variance

6.1.4 Index Number: Price Index Number - Laspeyre's and Paasche's Price Index Number

MEASURES OF DISPERSION:

6.3 Deviations, coefficient of variation and characteristics of variance

Course contents: range, mean deviation, quartile deviation, standard deviation and variance

Some Useful Formula

1. Range (*Note: Avoid frequency in case of discrete and continuous serious*)

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

Where, L = largest value of series, S = Smallest value of series

2. Quartile Deviation

Quartile Deviation (QD) = $\frac{Q3-Q1}{2}$. Coefficient of QD = $\frac{Q3-Q1}{Q3+Q1}$

3. Mean Deviation (MD) from mean, median and mode

Series / MD	Individual	Discrete	Continuous	Coefficient of MD
MD from **mean**	$\frac{\sum\|X-\bar{X}\|}{n}$	$\frac{\sum f\|X-\bar{X}\|}{N}$	$\frac{\sum f\|m-\bar{X}\|}{N}$	$\frac{\text{MD from mean}}{\bar{X}}$
MD from **Median**	$\frac{\sum\|X-Md\|}{n}$	$\frac{\sum f\|X-Md\|}{N}$	$\frac{\sum f\|m-Md\|}{N}$	$\frac{\text{MD from Median}}{\text{Median}}$
MD from **Mode**	$\frac{\sum\|X-Mo\|}{n}$	$\frac{\sum f\|X-Mo\|}{N}$	$\frac{\sum f\|m-Mo\|}{N}$	$\frac{\text{MD from mode}}{\text{Mode}}$

Where mean, median, mode and lower/upper quartile can be calculated by using following formulae:

Series / Measures	Individual	Discrete	Continuous
Arithmetic Mean (AM) or ($\bar{X}$)	$=\frac{\sum X}{N}$	$=\frac{\sum fX}{N}$	$=\frac{\sum fm}{N}$
Median (M_d)	$=\frac{n+1}{2}$ th item	$=\frac{n+1}{2}$ th item lies on corresponding value of equal or just greater than item in c.f.	$=L+\frac{\frac{N}{2}-cf}{f}\times h$ n/2 th item lies on corresponding class of Equal or just greater than item in cf
Lower Quartile Q1	$=\frac{n+1}{4}$ th item	$=\frac{n+1}{4}$ th item lies on corresponding value either equal or greater than the item in c.f.	$=L+\frac{\frac{N}{4}-cf}{f}\times h$ $\frac{n}{4}$ th item = either equal or greater than item lies on class for Q_1.
Upper Quartile (Q3)	$=\frac{3(n+1)}{4}$ th item	$\frac{3(n+1)}{4}$ th item lies on corresponding value either equal or greater than the item in CF	$=L+\frac{\frac{3N}{4}-cf}{f}\times h$

			$\frac{3n}{4}$ th item = either equal or greater than item lies on class for Q_3,
Mode (M_o)	= Repeated value Or, $3M_d - 2\bar{X}$ (from median and mean) = Value of maximum frequency		$= L + \frac{\Delta 1}{\Delta 1 + \Delta 2} \times h$ $(\Delta_1 = f_1 - f_0, \Delta_2 = f_1 - f_2)$

4. Standard Deviation (SD), Variance and Coefficient

Series/ Class	SD from Actual Mean-	SD from direct method
Individual Series	$\sigma = \sqrt{\frac{\Sigma(X-\bar{X})^2}{n}} = \sqrt{\frac{\Sigma x^2}{n}}$	$= \sqrt{\frac{\Sigma X^2}{N} - \left(\frac{\Sigma X}{N}\right)^2}$
Discrete Series	$\sigma = \sqrt{\frac{\Sigma f(X-\bar{X})^2}{N}} = \sqrt{\frac{\Sigma f x^2}{N}}$	$= \sqrt{\frac{\Sigma f X^2}{N} - \left(\frac{\Sigma f X}{N}\right)^2}$
Continuous Series	$\sigma = \sqrt{\frac{\Sigma f(m-\bar{X})^2}{N}} = \sqrt{\frac{\Sigma f d^2}{N}}$	$= \sqrt{\frac{\Sigma f m^2}{N} - \left(\frac{\Sigma f m}{N}\right)^2}$
Coefficient and Coefficient Variation of SD	**Coefficient of (SD)** $= \frac{\sigma}{\bar{X}}$	Coefficient of Variation of SD **CV** $= \frac{\sigma}{\bar{X}} \times 100\%$

Where,

$x = X - \bar{X}$

$N = \Sigma f$ = number of frequency in series

f = frequency of series

$d = m - \bar{X}$

m = Mid-value of class

$\bar{X}$ = mean

6.4. Index Number

Course contents: meaning, price index number (simple and weighted), Laspeyres's and Paache's price index numbers

Some Useful Formulae

Calculation of Index Number	Formulae	Definition of term used in formula
Simple aggregative method	$P_{01} = \frac{\sum P_1}{\sum P_0} \times 100$	P_0 = price level for base year P_1 = price level for current year $\sum p_0$ = *Sum of price level for base year* $\sum p_1$ = sum of price level for current year
Average of price relative method (When AM and GM used)	$P_{01} = \frac{\sum P}{n}$ $P_{01}(AM) = \frac{\sum P}{n}$ $P_{01}(GM) =$ Antilog $\left[\frac{\sum \log P}{N}\right]$	n = number of items $P = \frac{P_1}{P_0} \times 100$ $\sum P$ = Sum of current year price
Weighted average of price relative method (When AM and GM used)	$P_{01} = \frac{\sum PW}{\sum W}$ $P_{01}(AM) = \frac{\sum PW}{\sum W}$ $P_{01}(GM) =$ Antilog $\left[\frac{\sum W \log P}{\sum W}\right]$	P = price relative = $\frac{P_1}{P_0} \times 100$ W = weight of the commodity on base y $\sum W$ = Sum of the weight of commodities $\sum PW$ = Sum of the weight × price relativ
Laspeyre's price index method	$P_{01}L = \frac{\sum p_1 q_0}{\sum p_0 q_0} \times 100$	P_0 = price of base year P_1 = price level for current year q_0 = quantity of base year q_1 = quantity of current year
Paasche's price index method	$P01(P) = \frac{\sum p_1 q_1}{\sum p_0 q_1} \times 100$	

Numerical Questions: (1 mark)

20. **Find the value of K if the mean of given data is 9.**
Income (in Rs.): 8, 4, 12, K, 10, 13

Solution: Given

$\sum X = 8 + 4 + 12 + K + 10 + 13 = 47 + K$

N = 6,

Mean $(\bar{X})$ = ?

We have,

$\bar{X} = \frac{\sum X}{N}$

Or, $9 = \frac{47+K}{6}$

Or, $47 + K = 54$

$K = 54 - 47$

$K = 7$

∴ The value of K is 7.

21. Find the median from the following data.
Length (in cm): 8, 4, 12, 7, 10, 13, 9, 6

Solution,

Arranging the given data in the ascending order: 4, 6, 7, 8, 9, 10, 12, 13

Here,

N = 7

Median (Md) = ?

We have,

$M_d = \frac{n+1}{2}$ th item $= \frac{7+1}{2} = 4$

4 th item in data series = 8

$\therefore M_d = 8$

22. Find the mode from the following data.

Marks (X): 4, 5, 6, 3, 5, 7, 9, 5,

Sol^n:

We have,

Mode is the maximum repeated number in series.

∴Mode = 5

23. If the difference and sum of first (lower) quartile and third (upper) quartile are 20 and 48 respectively. Find the coefficient of quartile deviation.

Sol^n: Given

Difference of upper and lower quartile $(Q_3 - Q_1) = 20$

Sum of upper and lower quartile $(Q_3 + Q_1) = 48$

Coefficient of Quartile Deviation (C.QD) =?

We have

$C.QD = \frac{Q3 - Q1}{Q3 + Q1} = \frac{20}{48} = 0.42$

∴ Coefficient of quartile deviation = 0.42

24. If coefficient of variance (CV) is 0.39 and standard deviation is 7.48, find the mean.

Soln: Given

CV = 0.39

SD(σ) = 7.48

$\bar{X}$ = ?

We have

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

Or, $0.39 = \frac{7.48}{\bar{X}}$

Or, $\bar{X} = \frac{7.48}{0.39} = 19.18$

∴ Mean = 19.18

25. If the mode of asymmetrical distribution is 370 and median is 300. Find the mean.

Soln : Given

Mode (Mo) = 370

Median (Md) = 300

Mean ($\bar{X}$) = ?

In case of asymmetrical distribution of data series, we have

$M_o = 3 M_d - 2 \bar{X}$

Or $370 = 3 \times 300 - 2 \bar{X}$

Or $2\bar{X} = 900 - 370$

$\bar{X} = \frac{530}{2} = 265$

∴ Mean = 265

26. Find the range and coefficient of range from the following data.

45, 20, 25, 15, 40, 50, 35, 30

Solution,

Data in ascending order: 15, 20, 25, 30, 35, 40, 45, 50

Here,

Largest item (L) = 50

Smallest item (S) = 15

Range = ?

Coefficient of Range = ?

We have,

Range = L – S = 50-15 = 35

∴ Range = **35**

Similarly,

Coefficient of Range $= \frac{L-S}{L+S} = \frac{50-1}{50+1} = \frac{35}{65} = 0.54$

∴ Coefficient of Range = **0.54,**

Short answers (5 marks)

27. If the coefficient of variance of factory A and B are 0.78 and 0.96 respectively, then find out:

a. In which factory is there greater variation in the distribution of wage per –employee?

b. Which factory shows more consistency?

Solution: a.

$CV_A = 0.78$

$CV_B = 0.96$

Coefficient of variance of factory A = 0.78 × 100% = 78%

Coefficient of variance of factory B = 0.96 × 100% = 96%

Since, coefficient of variation is more of factory B, there is greater variation in the distribution of wage per employee.

Solution b: Since the coefficient of variation of factory A is less than of coefficient of variation of factory B. So, factory A has more consistency than factory B.

28. Find the quartile deviation and coefficient of quartile deviation from the following data series.

Wages (Rs.)	0-10	10-20	20-30	30-40	40-50	50-60	60-70
No. of workers	5	3	7	5	10	3	2

Solution: Calculation of Quartile Deviation (QD) and Coefficient of Quartile Deviation (CQD)

Wages (X)	No. of frequency (f)	Cumulative frequency (CF)
0-10	5	5
10-20	3	8
20-30	7	15
30-40	5	20
40-50	10	30
50-60	3	33

Price Index Number

1. Find the price index number by using simple aggregative method, taking 2020 as the current year and 2019 as base year and interpret the result.

Commodities:	Tomato	Potato	Wheat	Paddy
Price in 2019 (Rs.)	50	70	100	67
Price in 2020 (Rs.)	100	130	80	150

Solution: Calculation of Simple aggregative price index

Commodities	Price in 2019 (P_0)	Price in 2020 (P_1)
Tomato	50	100
Potato	70	130
Wheat	100	80
Rice	67	150
	$\sum P_0 = 287$	$\sum P_1 = 460$

$P_{01} = \frac{\sum P1}{\sum P0} \times 100$

We know,

Here, simple aggregative price index (P_{01}) $= \frac{\sum P_1}{\sum P0} \times 100 = \frac{460}{287} \times 100 = 160.28\%$

Interpretation: The general price level has been increased by 160.28 - 100 = 60.28% in 2020 in comparison to 2019

2. From the given data, find the price index number for the year 2020 taking 2019 as a base year by using average of price relative method.

Commodities	Price in 2019 (Rs.)	Price in 2020 (Rs.)
A	6	10
B	2	2
C	4	6
D	10	12
E	8	12

Solution: Calculation of price index by using average of price relative method

Commodities	Price in 2019 (P_0)	Price in 2020 (P_1)	$P = \frac{P_1}{P_0} \times 100$
A	6	10	166.67
B	2	2	100
C	4	6	150
D	10	12	120
E	8	12	150
N = 5			$\sum P = 686.67$

We know, for simple average of price relative index number

$$P_{01} = \frac{\sum P}{n} = \frac{686.67}{5} = 137.33\%$$

Interpretation: The price has been increased by 137.33- 100 = 37.33% in 2020 in comparison to 2019.

3. **Calculate the price index from the following data by using weighted average of price relative for the year 2020.**

Commodities	2019		2020	
	Price	Quantity	Price	Quantity
A	10	100	20	120
B	11	150	25	180
C	12	180	30	210
D	14	200	40	250

Solution: Computation for Price Index using weighted average of price relative

Commodities	p_0	p_1	q_0	q_1	$P = \frac{P_1}{P_0} \times 100$	$W = p_0 q_0$	PW
A	10	20	100	120	200	1000	200000
B	11	25	150	180	227.2	1650	374880
C	12	30	180	210	250	2160	540000
D	14	40	200	250	285.7	2800	799960
Total						**$\sum W = 7610$**	**$\sum PW = 1914840$**

$P_{01} = \frac{\sum PW}{\sum W} = \frac{1914840}{7610} = 251.6\%$ (If weight is not given, $W = P_0Q_0$)

Interpretation: The price has been increased by 251.6- 100 = 151.6% in 2020 in comparison to 2019.

4. **Calculate the price index number by using Laspeyre's method and Paasche's method from the following data and interpret the result.**

Commodities	Base year 2021		2023	
	Price	Quantity	Price	Quantity
A	2	20	5	15
B	4	4	8	5
C	1	10	2	12
D	5	5	10	6

Solution: Computation of price index numbers by using Laspeyre's and Paasche's method

Commodities	p_0	q_0	p_1	q_1	$p_0 q_0$	$p_1 q_0$	$p_0 q_1$	$p_1 q_1$
A	2	20	5	15	40	100	30	75
B	4	4	8	5	16	32	20	40
C	1	10	2	12	10	20	12	24
D	5	5	10	6	25	50	30	60
Total					$\sum p_0 q_0 = 91$	$\sum p_1 q_0 = 202$	$\sum p_0 q_1 = 92$	$\sum p_1 q_1 = 199$

For Laspeyre's price index number, we have

P_{01} (L) $= \frac{\sum p_1 q_0}{\sum p_0 q_0} \times 100 = \frac{202}{91} \times 100 = 221.29\%$

Interpretation: The price has been increased by 221.29- 100 = 121.29% in 2023 in comparison to 2021

For Paasche's price index number, we have

P01 (P) $= \frac{\sum p_1 q_1}{\sum p_0 q_1} \times 100 = \frac{199}{92} \times 100 = 216.36\%$

Interpretation: The price has been increased by 216.36- 100 = 116.36% in 2023 in comparison to 2021

Best of Luck!!!!!