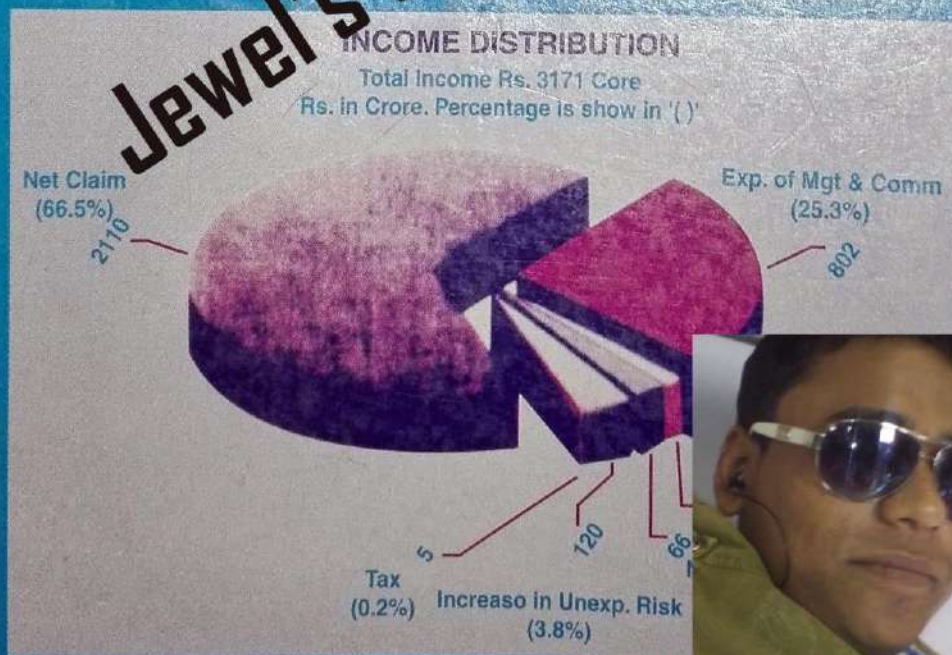


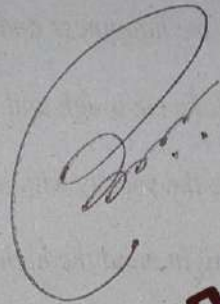
S.P. GUPTA - M.P. GUPTA

# BUSINESS STATISTICS

New Edition  
Jewel's Care Collected



# BUSINESS STATISTICS



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# BUSINESS STATISTICS

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- 4. The Personalistic Approach†

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Roster or Tabulation Method

Rule or Defining Property Method

Universal set

Null Set

Subset

Equal Sets

Set Operations

Intersection of Sets

Disjoint sets

Union of sets

Difference of Two Sets

Counting Techniques

Factorials

Permutations

Combinations

Random Experiment

Events

Elementary Events

Compound Events

Mutually Exclusive Events

Collectively Exhaustive Events

Complementary Events

Equally likely Events

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Addition Law

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4. *Statistics is only a means.* Statistical methods furnish only one method of studying a problem. They may not provide the best solution under all circumstances. Very often it may be necessary to supplement the conclusions arrived at by the help of statistics with the other methods that may be used to study a problem. It should be carefully noted that statistics is only a means and not an end. It analyses the facts and throws light on the real situation. In deciding a course of action it may be necessary to take into account the country's culture, religions, philosophy, personal, political or other non-quantitative considerations. Exclusive dependence on statistics may lead to fallacious conclusion in many situations.

5. *Statistics can be misused.* The greatest limitation of statistics is that it is liable to be misused. The misuse of statistics may arise because of several reasons. For example, if statistical conclusions are based on incomplete information, one may arrive at fallacious conclusions. Thus the arguments that drinking beer is bad for longevity since 99% of the persons who take beer die before the age of 100 years is statistically defective, since we are not told what percentage of persons who do not drink beer and die before reaching that age. Statistics are like clay, as they can be moulded in any manner so as to establish right or wrong conclusion. Moreover, any Tom, Dick and Harry cannot deal with statistics. It requires experience and skill to draw sensible conclusions from the data; otherwise, there is every likelihood of wrong interpretations. Also statistics cannot be used to full advantage in the absence of proper understanding of the subject to which it is applied.

### Distrust of Statistics

By distrust of statistics we mean lack of confidence in statistical statements and statistical methods. It is often believed that "Statistics can prove anything." "There are three types of lies—lies, damn lies and statistics—wicked in the order of their naming." The following three main reasons account for such notions being held by people about statistics :

1. Figures are convincing and, therefore, people are easily led to believe them.
2. They can be manipulated in such a manner as to establish foregone conclusions.
3. Even if correct figures are used, these may be presented in such a manner that the reader is misled. For example, note the following statement : "The profits of firm A are Rs. 4 lakhs for the year 2004-05 and that of firm B Rs. 5 lakhs for the same period." On the basis of this information only one would form the opinion that firm B is better than firm A. However, if we examine the amount of capital invested in both the firms, the quality or work done, etc., we might reach a different conclusion.

It should be noted that statistics neither proves anything nor disproves anything. It is only a tool. If properly used, tools can do wonders and, if misused, can be disastrous. The same is true of statistical tools. If used properly, they help in taking wise decisions and if misused they can do more harm than good. But the fault does not lie with the science of statistics as such.

### PROBLEMS

1-A. Answer the following questions, each question carries one mark :

- (i) What is business statistics ?
- (ii) Give any two uses of statistics.
- (iii) Can statistics prove anything ?
- (iv) Comment : Figures do not lie but liars figure.
- (v) Can single and isolated figures be called statistics ?
- (vi) What are the limitations of business statistics ?
- (vii) Why there is lot of distrust about statistics ?
- (viii) Is statistics science or art ?
- (ix) How statistics are useful to managers ?
- (x) Is comparison of statistical data desirable ?

## 14 Business Statistics

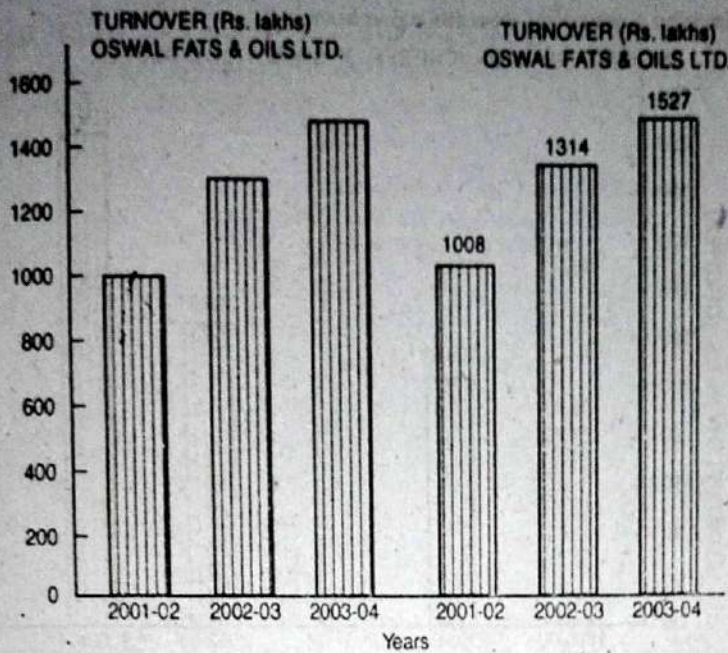
1-B. Answer the following questions, each question carries four marks :

- (i) Explain some important functions of statistics.
  - (ii) With the help of few examples point out the role of statistics in Business and management.
  - (iii) How statistics and computers are related ?
  - (iv) "Statistics is the foundation of sound decision-making". Elucidate giving suitable examples.
  - (v) What are the limitations of statistics ?
2. Define statistics. How does it help a manager ?
3. How far can statistics be applied for business decision ? Discuss briefly bringing out limitations, if any.  
[MBA, DU, 2000]
4. What is statistics ? How do you think the knowledge of statistics is essential in management decisions. Illustrate your answer through examples.  
[MBA, Vikram Univ., 1998]
5. Are statistical methods likely to be of any use to a business firm ? Illustrate your answer with some typical business problems and the statistical techniques to be used there.  
[MBA, HPU, 1999; B.A. Roorkee Univ. 2000, MBA, Delhi Univ. 2002]
6. Comment on the following statements :
- (i) "Figures do not lie but liars use figures to lie."
  - (ii) "The science of statistics is a most useful science and not only of great value to those who understand its proper use."  
[MBA, HPU, 1987]
  - (iii) "Statistics is the science of averages."
7. "Statistics is a body of method for making wise decisions in the face of uncertainty." Comment on the statement bringing out how clearly does statistics help in business decision-making.  
[MBA, Osmania Univ., 1996]
8. "There are three kinds of lies : the damn lies and statistics." Comment on this statement and point out the limitations of statistics.
9. (a) "Statistics is all-permeating." Elaborate.  
(b) "Statistics is what statisticians do." Examine critically.
10. "Statistics are numerical statements of facts but all facts numerically stated are not statistics." Comment upon the statement.
11. How will you explain in brief the meaning of statistics to a layman ?
12. Define statistics, and statistical methods. Explain the uses of statistical methods in modern business organizations.  
[MBA, Vikram Univ., 1993]
13. Critically examine the following statements :
- (a) "Statistics can prove anything."
  - (b) "Statistics only furnishes a tool, necessary though imperfect."
  - (c) Explain how statistics plays an important role in management planning and decision-making.
14. Discuss briefly the applications of business statistics pointing out their limitations, if any.
15. Describe the main areas of business and industry where statistics are extensively used.  
[MBA, Delhi Univ., 1991]
16. "Statistics are like clay of which you can make a God or Devil as you please." In the light of this statement discuss the uses and limitations of statistics.
17. With the help of a few examples explain the role of statistics as a managerial tool.  
[MBA, Osmania Univ., 1996; MBA, Vikram Univ., 1999]
18. "Statistical thinking will one day be as necessary for efficient citizenship as the ability to read and write." Comment. Also give two examples of how the science of statistics could be of use in managerial decision-making.  
[MBA, HPU, 1998]
19. Whether the statements are true or false : (i) Statistics are affected to marked extent by a multiplicity of causes. (ii) No volume of statistics can replace the knowledge and experience of executives.
20. "Statistics is a method of decision-making in the face of uncertainty on the basis of numerical data and calculated risks." Comment and explain with suitable illustration.  
[MBA, Delhi Univ., 1993; MBA, Vikram Univ., 1991]
21. "Statistical Methods are most dangerous tools in the hands of the inept." Examine this statement. How are statistics helpful in business and industry ? Explain.  
[MBA, Delhi Univ.]
22. (a) Define statistics. Discuss its applications in the management of business enterprises. What are its limitations, if any ?  
[MBA, Jodhpur Univ., MBA, HPU, 1999]
- (b) "Without adequate understanding of statistics, the investigator in social sciences may frequently be like the blind man groping in a dark closet for a black cat that is not there." Comment.

23. (a) Explain the utility of statistics as managerial tool. Also discuss its limitations. [MBA, Osmania Univ., 1998]  
(b) "Modern statistical tools and techniques are basically important for improving the quality of managerial decisions." Explain this statements and discuss the role of statistics in planning and control of business. [MBA, HPU, 2002]
24. What role does Business Statistics play in the management of a business enterprise? Examine its scope and limitations. [MBA, Delhi Univ., 1998]
25. "The fundamental gospel of statistics is to push back the domain of ignorance, rule of thumb, arbitrary or premature decisions, traditions and dogmatism and to increase the domain in which decisions are made and principles are formulated on the basis of analysed quantitative facts." Explain the statement with the help of a few business examples. [MBA, Osmania Univ., 2002]
26. "Quantitative tools and techniques are basically important for improving the quality of managerial decisions." Examine the statement and discuss the role of quantitative techniques in planning and control of business activity. [MBA, KU, 2003]

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It is clear from the above two diagrams that from the left one it is difficult to read precise values whereas the right side diagram makes it clear.

**Types of Bar Diagrams**

Bar diagrams are of the following types:

- (a) Simple bar diagrams
- (b) Subdivided bar diagrams\*
- (c) Multiple bar diagrams
- (d) Percentage bar diagrams
- (e) Deviation bars
- (f) Broken bars

**(a) Simple Bar Diagrams**

A simple bar diagram is used to represent only one variable. For example, the figures of sales, production, population, etc., for various years may be shown by means of a simple bar diagram. Since the bars are of the same width and only the length varies, it becomes very easy for the reader to study the relationship. Simple bar diagrams are very popular in practice. However, an important limitation of such diagrams is that they can present only one classification or one category of data. For example, while presenting the population for the last five decades, one can only depict the total population in the simple bar diagrams and not its sex-wise distribution.

**Illustration 6.** The funds flow of Goodwill India Ltd. from 1999-00 to 2003-04 are given below :

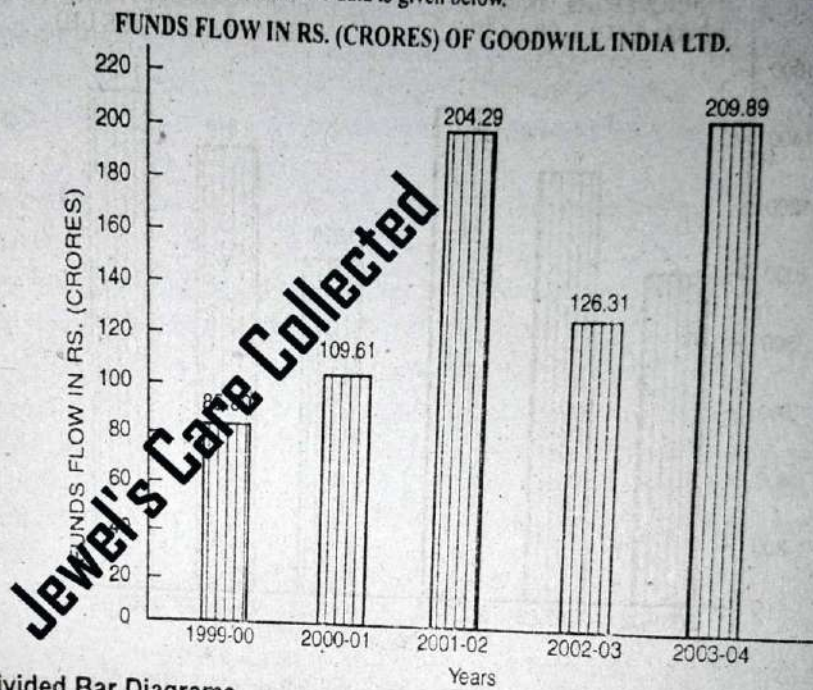
Year	Funds Flow (Rs. crores)
1999-00	85.80
2000-01	109.61
2001-02	204.29
2002-03	126.31
2003-04	209.89

Represent this data by a suitable bar diagram.

\*Such diagrams are also known as component bar diagrams.

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Solution. The simple bar diagram of the above data is given below.



**(b) Subdivided Bar Diagrams**

These diagrams are used to represent various parts of the total. For example, the number of employees in various departments of a company may be represented by a subdivided bar diagram. While constructing such a diagram, the various components in each bar should be kept in the same order. A common and helpful arrangement is that of presenting each bar in the order of magnitude from the largest component at the base of the bar to the smallest at the end. To distinguish between the different components, it is useful to use different shades or colours. Index or key should be given explaining these differences. Subdivided bar diagrams can be vertical as well as horizontal.

Subdivided bar diagrams should not be used where the number of components is more than 10 or 12, for, in that case, the diagram would be overloaded with information which cannot be easily compared and understood.

The component bar diagrams can be used to represent either the absolute data or distribution ratios such as percentage distribution ratios is, in fact, an excellent method for presenting a set of distribution ratios diagrammatically.\*

Illustration 7. Represent the following data by subdivided bar diagram.

**INSTITUTIONWISE ASSISTANCE SANCTIONED UNDER REFINANCE SCHEME (JULY—JUNE)**

Year	Banks	SFCs	STDCs	Total
1999-00	233.8	365.3	283.4	882.5
2000-01	301.8	484.7	473.8	1260.3
2001-02	303.2	668.6		
2002-03	365.3			

## PROBLEMS

- 1-A. Answer the following questions, each question carries one mark.
- State the use of pie diagram.
  - What is the use of histogram?
  - What do you mean by a pictogram?
  - Explain how the ogives are drawn for any frequency distribution.
  - What is tabulation?
  - What is a percentile?
  - What is cumulative frequency curve?
  - What is open end distribution?
  - What is histogram?
  - What is frequency polygon?
- (MBA, Madurai Kamraj, Nov. 2001)  
(MBA, Madurai Kamraj, Nov. 2003)
- 1-B. Answer the following questions, each question carries four marks.
- Distinguish between classification and tabulation of data.
  - Give at least two uses each of classification and tabulation.
  - Distinguish between discrete and continuous variable with suitable examples.
  - Distinguish between one dimensional and two dimensional diagrams.
  - What are the important steps in forming a frequency distribution?
- (a) Explain the role of tabulation in presenting business data, and discuss briefly the different methods of presentation.  
(b) What are the different types of graphs and charts known to you? What are their uses?
  - (a) Explain the term 'classification' and 'tabulation'. Point out their importance in a statistical investigation. What precautions would you take in tabulating statistical data?  
(b) "In classification and tabulation, commonsense is the chief requisite and experience the chief teacher." Comment.  
(c) Explain pie diagram and histogram as methods of diagrammatic and graphic presentation of data with suitable examples.
  - (a) What are the requisites of a good table? State the rules that serve as a guide in tabulating statistical material.  
(b) Explain briefly some of the uses of graphs and charts in presenting business data etc.  
(MBA, Osmania Univ., 1998)
  - (a) What are the chief functions of tabulation? What precautions would you take in tabulating statistical data?  
(b) What are the characteristics of a good table?  
(c) Explain Struge's rule in forming frequency distribution.
  - (a) Distinguish clearly between a continuous variable and a discrete variable. Give two examples of continuous variables and two examples of discontinuous or discrete variables that might be used by a business statistician.  
(b) Explain how tables, graphs and charts help in the effective presentation of data.  
(c) State whether the following statement is true or false :  
The heights of rectangles erected on class-intervals are proportional to the cumulative frequency of the classes.
  - (a) What are the objections to unequal class-intervals and to open classes? State the conditions under which the use of unequal class-intervals and open classes is desirable and necessary.  
(b) Mention the role of tabulation in presenting business data.
  - Point out the role of diagrammatic presentation of data. Explain briefly the different types of bar diagrams known to you.
  - (a) Explain clearly the role and limitations of diagrams and graphs in presenting business data.  
(b) Charts are more effective in attracting attention than any of the other methods of presenting data. Do you agree? Give reasons for your answer.
  - (a) "Diagrams do not add anything to the meaning of statistics but when drawn and studied intelligently they bring to view the salient characteristics of graph." Explain.  
(b) Explain briefly the various methods that are used for graphical representation of frequency distributions.  
(c) Explain the different types of graphs used for representing a frequency distribution. (MBA, KU, 1993)
11. For a frequency distribution by taking the class-intervals 15—19, 20—24,..... etc., for the following data:
- |    |    |    |    |    |    |    |    |    |    |    |
|----|----|----|----|----|----|----|----|----|----|----|
| 30 | 42 | 30 | 54 | 40 | 48 | 15 | 17 | 51 | 42 | 25 |
| 41 | 30 | 27 | 42 | 36 | 28 | 26 | 37 | 54 | 41 | 31 |
| 36 | 40 | 36 | 22 | 30 | 31 | 19 | 48 | 16 | 42 | 32 |
| 21 | 22 | 40 | 33 | 41 | 21 |    |    |    |    |    |

12. Form a frequency distribution taking a suitable class-interval for the following data giving the age of 52 employees in a government agency.

67	34	36	48	49	31	61	34	43	45	38
32	27	61	29	47	36	50	46	30	46	32
30	33	45	49	48	41	53	36	37	37	47
30	46	50	28	35	35	38	36	46	43	34
62	69	50	28	44	43	60	39			

13. Draft a blank table to show :

(a) Sex, (b) three ranks—supervisors, assistants and clerks, (c) years 1993 and 2003, and (d) Age groups—18 years and under, over 18 years but less than 55 years, over 55 years.

14. Prepare a table with a proper title, division and sub-divisions to represent the following heads of information:

- Export of Cotton piece-goods from India.
- To Burma, China, Indonesia, Iran, Iraq.
- Amount of piece-goods to each country.
- Value of piece-goods to each country.
- From 2002-03 to 2003-04, year by year.
- Total amount of exports each year.
- Total value of exports each year.

15. Represent the following data by a suitable diagram :

Year	1999	2000	2001	2002	2003	2004
Sale of steel	8	8.8	9.2	10.2	7.6	12.5

(in thousand tonnes)

16. Represent the following data by a suitable diagram:

Year	1999-2000	2000-01	2001-02	2002-03	2003-04	2004-05
Profit before taxes	28	29.4	30.2	27	32.5	40.6

(Rs. lakhs)

17. Represent the following data by a sub-division bar diagram :

Year	(in lakhs for Rs.)		
	2001-02	2002-03	2003-04
Gross Income	460	482	552
Gross expenditure	400	450	500
Net Income	60	32	22

18. Represent the following information diagrammatically :

Factory	Wages (Rs.)	Material (Rs.)	Other costs (Rs.)	Profits (Rs.)	No. of Units
A	3,000	5,000	1,000	1,000	1,000
B	2,000	3,000	800	500	700

19. Represent the following data by a suitable diagram :

**UTILIZATION OF 100 PAISE OF INCOME BY XYZ LTD.  
IN THE YEAR 2004-05**

1. Raw Material, Manufacturing and other Expenses	40 Paise
2. Wages, Salaries, Bonus and other Benefits to employees	12 Paise
3. Selling and Distribution Expenses	4 Paise
4. Interest-Financing Charges	4 Paise
5. Depreciation and Development Rebate	3 Paise
6. Excise Duty of Sales	15 Paise
7. Taxation	13 Paise
8. Dividends	6 Paise
9. Surplus retained in Business	3 Paise

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20. Represent the following data by a "Pie Diagram":

**CHEQUES CLEARED IN INDIA IN CLEARING HOUSES IN THE YEARS 2003 AND 2004**

Centres	Amount in Crores of rupees	
	2003	2004
Mumbai	829	2,670
Kolkata	1,070	2,443
Chennai	108	274
Other centres	313	615
<b>Total</b>	<b>2,320</b>	<b>6,002</b>

21. Draw a suitable diagram for the following :

	Family A Income Rs. 10000	Family B Income Rs. 12000
Food	3000	4000
Clothing	2500	2000
Education	500	3600
Others	3800	3000
Saving or deficit	+200	-600

22. Draw the histogram, frequency curve and the ogive curve for the following data pertaining to income distribution for 1500 employees.

Monthly income (in thousand Rs.)	No. of employees	Monthly income (in thousand Rs.)	No. of Employees
18-20	10	28-30	320
20-22	35	30-32	200
22-24	140	32-34	75
24-26	300	34-36	35
26-28	370	36-38	15

23. What is meant by a histogram? State briefly how it is constructed? Indicate clearly how the histogram in respect of the following data can be drawn (only a rough sketch is required). State also how you can draw histogram in respect of unequal class-intervals.

Mid-Value	Frequency	Mid-value	Frequency
115	6	165	60
125	25	175	38
135	48	185	22
145	72	195	3
155	116		

24. The following table gives the total units produced at the beginning of different years. Represent the data graphically and estimate the mid-year value for 1997 and 2001.

Years	Units produced	Years	Units Produced
1995	20	2000	811
1996	62	2001	1,104
1997	147	2002	1,425
1998	300	2003	1,755
1999	536		

25. Represent the data showing the number of companies in various ranges of subscribed capital by means of a histogram:

Subscribed capital (Rs. crores)	No. of companies	Subscribed capital (Rs. crores)	No. of companies
Up to 10	10	50-80	7
10-20	12	80-100	8
20-30	10	Above 100	5
30-50	14		

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26. The data below give the yearly profits (in thousand rupees) of two companies A and B:

Year	Profits (In '000 Rs.)	
	Company A	Company B
1999-00	120	90
2000-01	135	95
2001-02	140	108
2002-03	160	120
2003-04	175	130

Represent the data by means of a suitable diagram.

27. Below is given the frequency distribution of weekly wages of 100 workers in a factory:

Monthly wages (Rs.)	No. of workers	Monthly wages (Rs.)	No. of workers
3000-3500	3	5500-6000	10
3500-4000	5	6000-6500	8
4000-4500	12	6500-7000	5
4500-5000	23	7000-7500	3
5000-5500	31		

Draw the ogive for the distribution and use it to determine the median wage of a worker.

28. Present the following information in a suitable tabular form supplying the figures not directly given:

"In 2002, out of a total 2,000 workers in a factory 1,550 were members of a trade union. The number of women workers employed was 250, out of which 200 did not belong to any trade union."

"In 2003, the number of union workers was 1,725 of which 1,600 were men. The number of non-union workers was 380 among which 155 were women." (MBA, GUSIP Univ.)

29. Draw an Ogive for the following distribution. Read the median from the graph and verify the result by formula. How many workers earned monthly wages between Rs. 2,000 and Rs. 2,170 ?

Monthly wages (in Rs.)	No. of workers	Monthly wages (in Rs.)	No. of workers
1900-1950	6	2100-2150	16
1950-2000	10	2150-2200	12
2000-2050	22	2200-2400	15
2050-2100	30		

30. The proprietor of Goodwill Tyres Co. kept a record of the number of car tyres of each brand that were sold during 2003-04. He arranged the data as follows :

Brand	No. of Tyres Sold
Dunlop	280
Modi	270
Firestone	200
Ceat	190
Goodyear	160
J.K.	100

(a) What kind of a distribution is this? (b) What are the class boundaries of each class?

(c) Present the data by a suitable diagram/graph.

31. Draw a suitable diagram to represent the following information :

	Company A	Company B
Selling price	12,000	8,000
Raw Materials	5,000	6,000
Direct Wages	4,000	3,200
Factory and office on cost	1,000	800

32. A company dealing in 60 products, in the course of establishing an inventory control system, classified products according to price as shown in the frequency table below :

Unit cost (In hundreds of Rs.):	3-5	6-8	9-11	12-14	15-17	18-20	21-23
No. of items	6	8	10	20	8	5	3

Prepare more than ogive for the distribution on a graph paper. Use this graph to determine 20th and 80th percentiles.

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- the following terms with illustrations :
- (i) Classification and Tabulation.
  - (ii) Frequency, cumulative frequency and frequency polygon.
  - (iii) Histogram, line and bar diagrams.
  - (iv) Pie chart.

(MBA, Vikram Univ., 1998)

34. (a) Diagrams help us to visualise the whole meaning of a numerical complex at a single glance". Comment.  
 (b) Draw a suitable diagram to represent the following:

	Selling Price Per Unit (Rs.)	Qty Sold	Wages	Materials	Others
Factory A	400	20	3200	2400	1600
Factory B	600	30	6000	6000	9000

Show also profit or loss as the case may be.

(MBA, HPU, 2001)

35. From the following frequency distribution, prepare the less than and more than cumulative frequency curve (ogive curve)

Class-Interval :	0-10	10-20	20-30	30-40	40-50	50-60
Frequency :	8	12	30	25	18	17

(MBA, K.U., 2003)

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Mode : By inspection mode lies in the class 40-50.

$$\text{Mode} = L + \frac{\Delta_1}{\Delta_1 + \Delta_2} \times i$$

$$L = 40, \Delta_1 = 180 - 106 = 74, \Delta_2 = 180 - 164 = 16, i = 10$$

$$\text{Mode} = 40 + \frac{74}{74+16} \times 10 = 40 + 8.22 = 48.22.$$

Illustration 41. The following is the average amount of dollars each major airline spends per passenger on food

American	7.41
United	7.24
Northwest	5.15
TWA	5.09
Delta	4.61
Continental	2.77
US Air	2.68
American west	2.00
Southwest	0.14

What are the mean and median cost per passenger? Which would be the better figure to use for a new airline in developing its business plan? (MBA, D.U., 2003)

Solution. Calculation of  $\bar{X}$  and median.

$$\begin{aligned} \bar{X} &= \frac{7.41 + 7.24 + 5.15 + 5.09 + 4.61 + 2.77 + 2.68 + 2.00 + 0.14}{9} \\ &= \frac{37.09}{9} = \$ 4.12. \end{aligned}$$

Median. Arranging the given data in ascending order.

0.14	5.09
2.00	5.15
2.68	7.24
2.77	7.41
4.61	

$$\begin{aligned} \text{Med} &= \text{Size of } \frac{N+1}{2} \text{th observation} \\ &= \frac{9+1}{2} = 5\text{th observation} \end{aligned}$$

Size of 5th observation is 4.61. Hence median = \$ 4.61.

Median would be a better choice for new airlines in developing its business plan as median is not affected by extreme observations.

### PROBLEMS

1-A Answer following questions, each question carries one mark.

- (i) What is arithmetic mean? (MBA, Madurai Kamaraj Univ., 2001)
- (ii) What is meant by mode? (MBA, Madurai Kamaraj Univ., 2004)
- (iii) What is the empirical formula linking mean, median and mode? (MBA, Madurai Kamaraj Univ., 2004)
- (iv) Give formula for geometric mean and harmonic mean in case of a continuous frequency distribution.
- (v) When mode is ill-defined?
- (vi) What are quartiles and percentiles?
- (vii) Is sum of deviations from arithmetic mean always zero?
- (viii) What is weighted mean?
- (ix) Is harmonic mean reciprocal of arithmetic mean?
- (x) Why arithmetic mean is most affected by extreme observations?
- (xi) When is mode useful over other averages?

- 1-B Answer the following questions, each question carries four marks.
- Define average. Write down the properties of an average. (AU Ex. M.E. Univ., 2003)
  - What are the uses of geometric mean and harmonic mean?
  - What is combined mean? Explain with the help of an example.
  - Distinguish between median, quartiles, deciles and percentiles.
  - What is the arithmetic means of first  $n$  natural number,  $1, 2, \dots, n$ ?

2. What are the various measures of central tendency? Why are they called measures of central tendency? (AU Ex. U.P. Tech. Univ., 2004)

3. Give a brief description of different measures of central tendency. Why is arithmetic mean so popular?

4. (a) Is it necessarily true that being above average implies that someone is superior? Explain. (AU Ex. U.P., 1995)  
 (b) What are quartiles of a distribution? Explain their uses.

5. (a) Define arithmetic mean and median. Discuss their merits and demerits as measures of central tendency.  
 (b) How would you account for the dominant choice of arithmetic mean as a measure of central tendency? Under what circumstances would it be appropriate to use mode, median, geometric mean and harmonic mean. (AU Ex. U.P. Univ., 2000)

6. Comment on the following : (AU Ex. U.P., 2002)

- If first and third quartiles are 20 and 40 respectively the median will be 30.
- If daily wages paid to men and women employed in a factory are Rs. 100 and Rs. 50, the average wage per worker would be Rs. 90.
- A man claims that his average bank balance during the year is Rs. 5700. The bank, on the other hand, claims that he overdraw his account at least 10 times during the year and as such his claim is false.
- The increase in the price of commodity  $x$  is 20%. Then the price decreases 25% and again increases 15%. The resultant increase in the price is 10%.
- The mode of a distribution cannot be less than the arithmetic mean.
- If  $Q_1, Q_2, Q_3$  be respectively the lower quartile, the median and the upper quartile of a distribution, then  $Q_2 - Q_1 = Q_3 - Q_2$ .
- Arithmetic mean is the best measure of central tendency.

7. What is a statistical average? What are the desirable properties for an average to possess? Mention different types of averages and state why the arithmetic mean is the most commonly used amongst them.

8. (a) What are the essential requisites of a good measure of central tendency? Compare and contrast the commonly employed measure in terms of these requisites.

- (b) Prove that the arithmetic mean of two positive numbers  $a$  and  $b$  is as large as their geometric mean.

9. (a) What are the properties of a good average?  
 (b) In each of the following cases, explain whether the description applies to mean, median or both.

- Can be calculated from a frequency distribution with open-end classes?
- The values of all observations are taken into consideration in the calculation.
- The values of extreme observations do not influence the average.

10. (a) Under what circumstances would it be appropriate to use Arithmetic mean, Median or Mode? Discuss. (AU Ex. U.P. Univ., 1999)

- (b) Explain the properties of a good average. In the light of these properties which average do you think is the best and why? (AU Ex. U.P. Univ., 2000)

11. (a) Give a brief note of the measures of central tendency together with their merits and demerits. Which is the best measure of central tendency and why? (AU Ex. U.P. Univ., 2002)

- (b) "Every average has its own peculiar characteristics. It is difficult to say which average is the best." Comment briefly. (AU Ex. U.P. Univ., 2003)

12. For the following frequency table calculate mean, median and mode:

Monthly rent (in Rs.)	No. of persons paying the rent	Monthly rent (in Rs.)	No. of persons paying the rent
200-400	6	1,200-1,400	15
400-600	9	1,400-1,600	10
600-800	11	1,600-1,800	8
800-1,000	14	1,800-2,000	7
1,000-1,200	20		

[Mean = Mod. = 1,100, Mode = 1,100-1,200]

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13. Calculate the simple and weighted arithmetic mean price per bag of 20 kg. of coal purchased by an industry for the half year. Account for difference between the two.

Month	Price per bag (Rs.)	Bag purchased	Month	Price per bag (Rs.)	Bag purchased
Jan.	42.05	25	April	52.00	52
Feb.	51.25	30	May	44.25	10
Mar.	50.00	40	June	54.00	45

[ $\bar{X} = 48.93$ ;  $\bar{X}_w = 50.31$ ]

14. (a) Explain clearly the concepts of Geometric mean and Harmonic mean. Point out some of the business applications for these concepts.  
 (b) Calculate the geometric mean of the following price relatives :

Commodity	Price Relative	Commodity	Price Relative
Wheat	237	Sugar	124
Rice	198	Salt	107
Pulses	156	Oils	196

[G.M. = 163.4]

15. The following table gives the distribution of 100 accidents during seven days of the week of a given month. During the particular month there were 5 Mondays, 5 Tuesdays and Wednesdays, and only four each of the other days. Calculate the number of accidents per day.

Days	No. of accidents	Days	No. of accidents
Sunday	26	Thursday	8
Monday	16	Friday	10
Tuesday	12	Saturday	18
Wednesday	10		

[14.13]

16. At harvesting time a farmer employed 10 men, 24 women and 16 boys to lift potatoes. A woman's work was three-quarters as effective as that of a man, while a boy's work was only half. Find the daily wage bill if a man rate was Rs. 80 a day and the rates for the women and boys in proportion to their effectiveness. Calculate the average daily rate for all the workers.

17. The following table gives the daily wages (in rupees) in a certain commercial organisation :

Daily wages (Rs.)	30-32	32-34	34-36	36-38	38-40
No. of Workers	2	9	25	30	49
Daily wages (Rs.)	40-42	42-44	44-46	46-48	48-50
No. of Workers	62	39	20	11	3

Calculate from the above data :

- (i) the median and the third quartile wages; and  
 (ii) the number of wage-earners receiving between Rs. 37 and Rs. 45.  
 [(i) Med. 40.32;  $Q_3 = 42.54$ , (ii) 175]

18. Six types of workers are employed in each of two workshops but at different rates of wages as follows :

Types of workers	Workshop A Daily wages per worker	No. of workers	Workshop B Daily wages per worker	No. of workers
Mechanic	92.50	2	93.00	11
Fitter	93.50	14	93.00	50
Electrician	94.00	20	94.25	8
Carpenter	93.00	7	93.50	10
Smith	93.00	6	93.50	10
Clerk	92.00	1	95.00	2

In which of the two workshops is the average rate of wages per worker higher and by how much?

19. (a) A motor car covered a distance of 50 km four times. The first time at 50 km p.h., the second at 20 km p.h., the third at 40 km p.h. and the fourth at 25 km p.h. Calculate the average speed and explain the choice of the

[29.63]

34. From the following distribution of travel time to work of a firm's employees, find the modal travel time :

Travel time (in minutes)	Frequency
Less than 80	218
Less than 70	215
Less than 60	195
Less than 50	156
Less than 40	85
Less than 30	50
Less than 20	18
Less than 10	2

[40.29]

34. You are given the following incomplete frequency distribution. It is known that the total frequency is 1,000 and that the median is 413.11. Estimate by calculation the missing frequencies and find the value of the mode.

Sales (Rs. lakhs)	No. of companies	Sales (Rs. lakhs)	No. of companies
300-325	5	400-425	326
325-350	17	425-450	7
350-375	80	450-475	88
375-400	?	475-500	9

[127, 248; mode = 413.98]

35. (a) In a certain office a letter is typed by A in 4 minutes. The same letter is typed by B, C and D in 5, 6, 10 minutes respectively. What is the average time taken in completing one letter? How many letters do you expect to be typed in one day comprising 9 working hours?

[H.M. = 5.58 minutes per letter.

Letters typed in 8 hours (480 minutes) = 86]

(b) For an income distribution of a group of men, 20 p.c. of men have income below Rs. 3500, 35 p.c. below Rs. 7500, 60 p.c. below Rs. 17500 and 80 p.c. below Rs. 25000; the first and third quartile are Rs. 5500 and Rs. 20000. Put the above information in cumulative frequency distribution and find the median.

36. The rate of a certain commodity in the first week of January, 2000 was 0.4 kg per rupee; it was 0.6 kg per rupee in the second week and 0.5 kg per rupee in the third week. Therefore, it is correct to say that the average price was 0.5 kg per rupee. Verify.

37. Below given is the frequency distribution of weekly wages of 100 workers in a factory :

Weekly wages (Rs.)	No. of workers	Weekly wages (Rs.)	No. of workers
1120-1124	3	1145-1149	10
1125-1129	5	1150-1154	8
1130-1134	12	1155-1159	5
1135-1139	23	1160-1164	3
1140-1144	31		

Draw the ogive for the distribution and use it to determine the median wage of a worker and verify the result by the formula. (MBA, Delhi Univ.)

How many workers earned weekly wages between Rs. 1132 and Rs. 1153?

38. Find the missing frequencies in the following distribution if  $N$  is 100 and median 30 :  
Marks : 0-10 10-20 20-30 30-40 40-50 50-60  
No. of students : 10 15 ? 30 10 8 (MBA, M.D. Univ., 1999)

39. Draw an ogive for the following distribution. Read the median from the graph and verify your result by the mathematical formula. Also obtain the limits of income of central 50% of the employees.

Weekly Income (Rs.)	No. of employees	Weekly Income (Rs.)	No. of employees
Below 550	6	700-750	16
500-600	10	750-800	12
600-650	22	Above 800	15
650-700	30		

(MBA, Delhi Univ., 1999)

[Med. = 679.2; 626.7 to 747.7]

40. Following is the cumulative frequency distribution of preferred length of kitchen slabs obtained from the preference study on 50 housewives.

Length (in metres) more than	Number of housewives	Length (in metres) more than	Number of housewives
1.0	50	2.5	42
1.5	46	3.0	10
2.0	40	3.5	3

A manufacturer has to take decision on what length of slabs to manufacture. What length would you recommend and why?

41. Following are the data for marks obtained by students in a paper. The top 20% students will qualify for a prize. What is the lower limit of marks above which the student will get the prize?

Marks	No. of students	Marks	No. of students
0-10	5	50-60	10
10-20	7	60-70	4
20-30	8	70-80	4
30-40	10	80-90	2
40-50	10		

42. A factory pays workers on piece rate basis and also a bonus to each worker on the basis of individual output in each quarter. The rate of bonus payable is as follows :

Output (in units)	Bonus (in rupees)	Output (in units)	Bonus (in rupees)
70-74	400	90-94	700
75-79	450	95-99	800
80-84	500	100-104	1000
85-89	600		

The individual output of a batch of 50 workers is given below :

94	83	78	76	88	86	93	80	91	82
89	97	92	84	93	80	85	83	98	103
87	88	88	81	95	86	99	81	87	90
84	97	80	75	93	101	92	82	89	72
85	83	75	72	83	98	87	87	71	80

By suitable classification you are required to find :

- (i) Average bonus per worker for the quarter.  
 (ii) Average output per worker.

[(i) 90.03 (ii) 86.1]

(MBA, Pune Univ. 1990)

43. An individual purchases three qualities of ball-pens. The relevant data are given below :

Quality	Price per ball-pen (Rs.)	Money spent (Rs.)
A	10.00	500
B	10.50	300
C	20.00	200

Calculate an average price per ball-pen.

(MBA, Kurukshetra Univ., 2000)

44. A number of particular articles have been classified according to their weights. After drying for two weeks the same articles have been reweighed and similarly classified. It is known that the median weight in the first weighing was 17.35. Some frequencies in the first weighing ( $a$  and  $b$ ) and second weighing ( $x$  and  $y$ ) are missing. It is known that  $a = 1/3x$  and  $b = 1/2y$ . Find out the value of  $a$ ,  $b$ ,  $x$  and  $y$ .

	1st Weighing	2nd Weighing
0-5	$a$	$x$
5-10	$b$	$y$
10-15	11	40
15-20	52	50
20-25	75	30
25-30	22	28

[ $a = 3$ ,  $b = 6$ ,  $x = 9$ ,  $y = 12$ ]

(MBA, 14 Nov., Dec., 2000)

45. Describe the method of constructing ogive. How would you determine median from it? Draw ogive and find median from the following data :

Marks	0-15	15-30	30-45	45-60	60-75
No. of Students	2	15	30	9	4

(M. Com., AMU, 2000)

Calculate the median and quartiles for the following data :

Class-Interval	Frequency	Class-Interval	Frequency
0-50	20	150-200	30
50-100	60	200-250	24
100-150	50	250-300	16

46. Calculate the mean and median for the following data :

Central wage (in Rs.)	15	20	25	30	35	40	45
No. of wage earners	3	25	19	16	4	5	6

(MBA, Madurai-Kamraj Univ., Nov., 2000)



Note: Since the highest frequency is 48, the mode lies in the class 15-20.

$$M_o = L + \frac{h}{A + 2B} \times f = 15 + \frac{16}{16 + 12} \times 5 = 15 + 2.33 = 17.33$$

Illustration 30. Calculate coefficient of variation from the following data :

Marks (in scores):	10-20	20-30	30-40	40-50	50-60
No. of Candidates:	8	12	20	6	4

(MBA, Osmania Univ., 2002)

Solution. CALCULATION OF COEFFICIENT OF VARIATION

Class Interval	m.p. $X$	$f$	$(X-35)/10$ $d$	$fd$	$fd^2$
10-20	15	8	-2	-16	32
20-30	25	12	-1	-12	12
30-40	35	20	0	0	0
40-50	45	6	+1	+6	6
50-60	55	4	+2	+8	16
		50		$\Sigma fd = -14$	$\Sigma fd^2 = 66$

$$\bar{X} = A + \frac{\Sigma fd}{N} \times i = 35 - \frac{14}{50} \times 10 = 35 - 2.8 = 32.2$$

$$\sigma = \sqrt{\frac{\Sigma fd^2}{N} - \left(\frac{\Sigma fd}{N}\right)^2} \times i = \sqrt{\frac{66}{50} - \left(\frac{-14}{50}\right)^2} \times 10$$

$$= \sqrt{1.32 - 0.784} \times 10 = 11.14$$

$$C.V. = \frac{\sigma}{\bar{X}} \times 100 = \frac{11.14}{32.2} \times 100 = 34.6 \text{ per cent}$$

Illustration 31. Find the missing information from the following :

	Group I	Group II	Group III	Combined
Number	50	?	90	200
Standard Deviation	6	7	?	7.746
Mean	113	?	115	116

(MBA, HPU; MBA, Osmania Univ., 1997)

Solution. Finding the number of observations in the second group.

Let  $N_1, N_2, N_3$  denote the number of observations in the 1st, 2nd and 3rd group respectively.

We are given  $N_1 + N_2 + N_3 = 200$

$$N_1 = 50, N_3 = 90, \therefore N_1 + N_3 = 140$$

$$N_2 = 200 - 140 = 60$$

Finding Mean of the Second Group

$$\bar{X}_{123} = \frac{N_1 \bar{X}_1 + N_2 \bar{X}_2 + N_3 \bar{X}_3}{N_1 + N_2 + N_3}$$

$$\bar{X}_{123} = 116, N_1 + N_2 + N_3 = 200, \bar{X}_1 = 113, \bar{X}_3 = 115$$

We have to find  $\bar{X}_2$

Substituting the given values

$$116 = \frac{50(113) + 60(\bar{X}_2) + 90(115)}{200}$$

$$116 \times 200 = 5650 + 60 \bar{X}_2 + 10350$$

$$60 \bar{X}_2 = 23200 - 16000 = 7200 \text{ or } \bar{X}_2 = \frac{7200}{60} = 120$$

Finding S.D. of third group

$$\sigma_{123} = \sqrt{\frac{N_1\sigma_1^2 + N_2\sigma_2^2 + N_3\sigma_3^2 + N_1d_1^2 + N_2d_2^2 + N_3d_3^2}{N_1 + N_2 + N_3}}$$

$$\sigma_{123} = 7.746, N_1 = 50, \sigma_1 = 6, N_2 = 60, \sigma_2 = 7, N_3 = 90$$

$$d_1 = |\bar{X}_1 - \bar{X}_{123}| = 113 - 116 = 3$$

$$d_2 = |\bar{X}_2 - \bar{X}_{123}| = 120 - 116 = 4$$

$$d_3 = |\bar{X}_3 - \bar{X}_{123}| = 115 - 116 = 1$$

Substituting the values

$$7.746 = \sqrt{\frac{50(6)^2 + 60(7)^2 + 90\sigma_3^2 + 50(3)^2 + 60(4)^2 + 90(1)^2}{50 + 60 + 90}}$$

$$= \sqrt{\frac{1800 + 2940 + 90\sigma_3^2 + 450 + 960 + 90}{200}} = \sqrt{\frac{6240 + 90\sigma_3^2}{200}}$$

Squaring on both sides, we get

or  $(7.746)^2 = \frac{6240 + 90\sigma_3^2}{200}$

or  $12,000 = 6240 + 90\sigma_3^2$  or  $90\sigma_3^2 = 12,000 - 6240$

$$\sigma_3^2 = \frac{5760}{90} = 64 \text{ or } \sigma_3 = \sqrt{64} = 8$$

Thus the missing values are:

$$N_2 = 60, \bar{X}_2 = 120, \sigma_3 = 8.$$

Illustration 32. Given below are the daily wages, in rupees, of 60 workers in a factory manufacturing plastic products:

23	48	51	64	72	82	56	33	50	42
35	88	77	65	39	52	48	64	49	57
41	73	62	49	32	54	67	46	55	50
82	44	75	56	51	63	59	69	53	42
75	85	68	55	52	45	42	57	20	57
46	51	20	16	62	46	54	40	55	71

- (a) Form a frequency distribution, taking the lowest class-interval as 10-20.  
 (b) Calculate the Standard Deviation and Coefficient of Variation of this distribution.

(MBA, HPU, 2001)

Solution.

FORMATION OF FREQUENCY DISTRIBUTION  
 CALCULATION OF COEFFICIENT OF VARIATION

Wages (Rs.)	Tally	Frequency f	m.p. X	(X-45)/10 d	fd	fd <sup>2</sup>
10-20		1	15	-3	-3	9
20-30		2	25	-2	-4	8
30-40		4	35	-1	-4	4
40-50		13	45	0	0	0
50-60		21	55	+1	+21	36
60-70		9	65	+2	+18	54
70-80		6	75	+3	+18	64
80-90		4	85	+4	+16	64
		N = 60			Σfd = 62	Σfd <sup>2</sup> = 196

$$\bar{X} = A + \frac{\sum fd}{N} = 45 + \frac{62}{60} = 45 + 10.33 = 55.33$$

Jewel's Care Collected

## CALCULATION OF MEAN AND STANDARD DEVIATION

Age group (yrs.)	$f$	m.p. $m$	$(m-12)/3$ $d$	$fd$	$fd^2$
5-7	10	6	-2	-20	40
8-10	8	9	-1	-8	8
11-13	7	12	0	0	0
14-16	3	15	+1	+3	3
17-19	2	18	+2	+4	8
	$N = 30$			$\Sigma fd = -21$	$\Sigma fd^2 = 59$

$$\bar{X} = A + \frac{\Sigma fd}{N} \times i = 12 - \frac{21}{30} \times 3 = 12 - 2.1 = 9.9$$

$$\sigma = \sqrt{\frac{\Sigma fd^2}{n} - \left(\frac{\Sigma fd}{n}\right)^2} \times i = \sqrt{\frac{59}{30} - \left(\frac{-21}{30}\right)^2} \times 3$$

$$= \sqrt{1.967 - 0.49} \times 3 = 1.2153 \times 3 = 3.65$$

## CALCULATION OF TOTAL MONTHLY SCHOLARSHIP

No. of students	Amount of scholarship per month	Total Monthly Scholarship (Rs.)
10	300	3000
8	400	3200
7	500	3500
3	600	1800
2	700	1400
		Rs. 12900

## PROBLEMS

1-A : Answer the following questions, each question carries one mark :

- What is the formula for coefficient of variation? (MBA, Madurai-Kamraj, Nov. 2003)
- What is range?
- How quartile deviation is calculated?
- What is interquartile range?
- State the formula for standard deviation. (MBA, Madurai-Kamraj, Nov. 2003)
- What is Lorenz Curve?
- Is standard deviation independent of change of scale and origin.
- Is the sum of deviations from mean is always least?
- Is variance the square of standard deviation?
- Give the formula for combined standard deviation of two sets of data.

1-B : Answer the following questions, each question carries four marks :

- What are the various methods of measuring variation?
- Distinguish between mean deviation and standard deviation.
- What are the properties of a good measure of variation?
- Distinguish between absolute and relative measures of dispersion.
- Why standard deviation is most widely used as a measure of variations.
- What are the uses of Lorenz Curve?

2. (a) Explain the term variation. What purpose does a measure of variation serve? In the light of these, comment on some of the well-known measures of variation. (MBA, Delhi Univ., 1996, 2000)
- (b) Point out the difference between absolute and relative variation.
- (c) Under what circumstances range is more meaningful than any other measure of variation? (MBA, HPU, 2001)
3. (a) What are the requisites of a good measure of dispersion? Why is the standard deviation usually chosen as a measure of variation?
- (b) Explain how measure of central tendency and measure of variation complement each other in describing mass of data.
4. What is coefficient of variation? What purpose does it serve? Also distinguish between 'variance' and 'coefficient of variation'.
5. What do you understand by standard deviation? Explain its usefulness. Highlight its important properties.
6. With an example show that mean is dependent on both origin and scale while standard deviation is dependent on scale but not on origin.
7. (a) State the different measures of central tendency and variation.
- (b) What do you understand by "coefficient of variation"? Discuss its importance in business problems.
8. What is Lorenz Curve? How is it drawn? In what way does it help in studying variations of two or more distributions? Illustrate with the help of an example.
9. (a) Explain with suitable examples the term 'variation'. Mention some common measures of variation and describe the one which you think is the most important. (MBA, Delhi Univ., 1993)
- (b) Critically examine the different methods of measuring variation. Which of these do you consider as the best and why?

(MBA, Jodhpur Univ., 1998; MBA, HPU, 1998; MBA, KU, 2002)

10. Explain and illustrate how the measures of variation afford a supplement to the information about frequency distribution furnished by averages. (MBA, BIT, Ranchi, 1994; MBA, Delhi Univ., 1993)

11. Explain briefly what is meant by "Variation" of data. State the requisites of a satisfactory measure of dispersion and examine in their light any two measures of dispersion.

12. What are the uses of coefficient of variation in statistical analysis?

13. Describe the various methods of measuring variation along with their respective merits and demerits.

(MBA, Delhi Univ., 2002)

14. (a) Describe briefly the various methods of measuring variation in health statistics.

- (b) What are the uses of coefficient of variation in statistical analysis?

15. (a) Briefly describe the characteristics of a standard deviation as a measure of variation.

- (b) Comment on the following statements:

- (i) If the mean and standard deviation of  $n$  observations  $x_1, x_2, \dots, x_n$  be  $\bar{X}$  and  $\sigma$  respectively then the mean and the standard deviation of  $-x_1, -x_2, \dots, -x_n$  will be  $\bar{X}$  and  $-\sigma$  respectively.
- (ii) "After settlement the average daily wage in a factory had increased from Rs. 85 to Rs. 90 and the standard deviation had increased from 10 to 12.5. After settlement the wage has become higher and more uniform."

16. (a) Ten observations have mean 20 and standard deviation 5. If each of these 10 observations is doubled then the standard deviation of new observations will be...
- (b) State whether the following statement is true or false:

Range is a measure of variation which gives us information about scatter of values about the measure of a central tendency.

17. Calculate mean deviation for the following frequency distribution:

No. of colds experienced in 12 months	No. of persons	No. of colds experienced in 12 months	No. of persons
0	15	5	95
1	46	6	82
2	91	7	26
3	162	8	13
4	110	9	2

[M.D.=1.47]

18. Calculate the appropriate measure of variation from the following data:

Daily Wages (in Rs.)	No. of wage earners	Daily Wages (in Rs.)	No. of wage earners
Less than 85	14	91-93	18
85-87	62	Over 93	7
88-90	99		