Senior Secondary Course

ECONOMICS (318)

1

Course Coordinator
Dr. Manish Chugh

विद्याधनम् सर्वधनं प्रधानम्

NATIONAL INSTITUTE OF OPEN SCHOOLING
(An Autonomous Institution under MHRD, Govt. of India)
A-24-25, Institutional Area, Sector-62, NOIDA-201309 (U.P.)
Website: www.nios.ac.in, Toll Free No. 18001809393

Printed on 60 GSM Paper with NIOS Watermark.

© National Institute of Open Schooling

May, 2015 (35,000 Copies)

Published by the Secretary, National Institute of Open Schooling, A-24-25, Institutional Area, Sector-62, Noida and printed at M/s A-One offset Printers, 5/34, Kirti Nagar, Industrial Area, New Delhi.

ADVISORY COMMITTEE

Prof. C.B. Sharma
Chairman
NIOS, NOIDA (UP)

Dr. Kuldeep Agarwal
Director (Academic)
NIOS, NOIDA (UP)

Dr. Rachna Bhatia
Assistant Director (Academic)
NIOS, NOIDA (UP)

CURRICULUM COMMITTEE

Dr. O.P. Agarwal
(Former Director of the Eco. Deptt.)
NREC College, Meerut University
Khurja (UP)

Sh. J. Khuntia
Associate Professor (Economics)
School of Open Learning
Delhi University, Delhi

Dr. Padma Suresh
Associate Professor (Economics)
Sri Venkateshwara College
Delhi University, Delhi

Prof. Renu Jatana
Associate Professor, MLSU,
Udaipur (Rajasthan)

Sh. H.K. Gupta
Rtd.PGT, From NCT
New Delhi.

Sh. A.S. Garg
Rtd.Vice Principal, From NCT
New Delhi.

Sh. Ramesh Chandra
Retd. Reader (Economics)
NCERT, Delhi.

Dr.Manish Chugh
Academic Officer (Economics),
NIOS, NOIDA

LESSON WRITERS

Sh. J. Khuntia
Associate Professor (Eco.),
School of Open Learning,
Univ. of Delhi

Dr. Anupama Rajput
Associate Professor,
Janki Devi Memorial College
Univ. of Delhi.

Ms.Sapna Chugh
PGT
S.V. Public School, Jaipur

Dr. Bhawna Rajput
Associate Professor,
AditiMahavidyalay,
Univ. of Delhi.(M) 9868095363

Sh. A.S. Garg
Retd. Vice Principal
RPVV, Gandhinagar, Delhi

Dr. Bharat Singh
Associate Professor,
Satyawati Co-educational College,
Univ. of Delhi. (M) 9868540018

Sh. Hari Kishore Gupta
Retd. PGT, Govt. Babu Ram School,
Shadra, Delhi

Dr. Bharat Bhushan
Assistant Professor,
Shyamlal College,
Univ. of Delhi.

Dr. Manish Chugh
Academic Officer
NIOS

EDITORS

Sh. J. Khuntia
Associate Professor (Eco.),
School of Open Learning,
Univ. of Delhi. (M) 9868047023

Prof. Renu Jatana
Associate Professor,
MLSU, Udaipur (Rajasthan)

Sh. A.S. Garg
Retd. Vice Principal
RPVV, Gandhinagar, Delhi

Sh. Hari Kishore Gupta
Retd. PGT, Govt. Babu Ram School,
Shadra, Delhi

COURSE COORDINATOR

Dr. Manish Chugh
Academic Officer (Economics)
NIOS

GRAPHIC ILLUSTRATORS

Sri Krishna Graphics
C-90, West Vinod Nagar
Delhi-110092

Chairman's Message

Dear learner,

As the needs of the society in general, and some groups in particular, keep on changing with time, the methods and techniques required for fulfilling those aspirations also have to be modified accordingly. Education is an instrument of change. The right type of education at right time can bring about positivity in the outlook of society, attitudinal changes to face the new/fresh challenges and the courage to face difficult situations.

This can be very effectively achieved by regular periodic curriculum renewal. A static curriculum does not serve any purpose, as it does not cater to the current needs and aspirations of the individual and society.

For this purpose only, educationists from all over the country come together at regular intervals to deliberate on the issues of changes needed and required. As an outcome of such deliberations, the National Curriculum Framework (NCF 2005) came out, which spells out in detail the type of education desirable/needed at various levels of education – primary, elementary, secondary or senior secondary.

Keeping this framework and other national and societal concerns in mind, we have currently revised the curriculum of Economics course at Senior Secondary level, as per the Common Core Curriculum provided by National Council of Educational Research and Training (NCERT) and the Council of Boards of School Education in India (COBSE) making it current and need based. Textual material production is an integral and essential part of all NIOS programmes offered through open and distance learning system. Therefore, we have taken special care to make the learning material user friendly, interesting and attractive for you.

I would like to thank all the eminent persons involved in making this material interesting and relevant to your needs. I hope you will find it appealing and absorbing.

On behalf of National Institute of Open Schooling, I wish you all a bright and successful future.

Prof. C.B. Sharma
Chairman, NIOS

A Note From the Director

Dear Learner,

The Academic Department at the National Institute of Open Schooling tries to bring you new programmes every now and then in accordance with your needs and requirements.

The Economics course at Senior Secondary level has now been revised as per the Common Core Curriculum developed by COBSE (Council of Boards of School Education) and NCERT (National Council for Educational Research and Training) making it current and need based.

The National Curriculum Framework developed by the National Council for Educational Research and Training was kept as a reference point. Leading expertsin the subject of the country were involved and with their active involvement, study materials based on the new curriculum have been updated.

Old, outdated information has been removed and new, relevant things have been added.

I am happy to place this new revised study material in Senior Secondary Economics in your hand. I hope you will find the new material that is now in your hands interesting and exciting. Any suggestions for further improvement are welcome.

Let me wish you all a happy and successful future.

(Dr. Kuldeep Agarwal)
Director (Academic)
National Institute of Open Schooling

A Letter to Learner

Dear Learner

I welcome you all to this Senior Secondary Course in Economics. It gives me immense pleasure that you have opted Economics as one of your subjects of study. The study of economics contributes to the development of systematic framework for analyzing, researching and writing about a wide array of financial and regional economic issues and also making sense of our complex environment.

An earnest attempt has been made to revise this book as per Common Core Curriculum developed by COBSE (Council of Boards of School Education) and NCERT (National Council for Educational Research and Training) making it current and need based.

The present curriculum in Economics has been distributed into two parts and eleven modules.

Part I Consists of three modules, namely: Indian Economic Development, Current challenges before the Indian Economy and Economic growth and Economic Development. Similarly Part-II consists of eight modules, namely: Statistical Tools, Introduction to Economics, Consumer's Behaviour, Producer's Behaviour, Market and Price Determination, National Income Accounting, Theory of Income and Employment and money, Banking and Government Budget. Each module has been divided further into different lessons.

All efforts have been made to give related illustrations and examples for your better understanding. You should go through all solved examples and try to solve all problems under "Check Your Progress" and "Terminal Exercise" independently given at the end of each lesson.

If you face any difficulty, please do not hesitate to write to me. Your suggestions and doubts are most welcome.

Wish you a bright future!

Yours,

Dr. Manish Chugh
Academic Officer (Economics), NIOS
aoeco@nios.ac.in

How to use the Study Material

Your learning material has been developed by a team of economics experts in open and distance learning. A consistent format has been developed for self-study. The following points will give you an idea on how to make best use of the print material.

Title is an advance organisor and conveys an idea about the contents of the lesson. Reflect on it.

Introduction highlights the contents of the lesson and correlates it with your prior knowledge as well as the natural phenomena in operation in our immediate environment. Read it thoroughly.

Objectives relate the contents to your desired achievements after you have learnt the lesson. Remember these.

Content of the lesson has been divided into sections and sub-sections depending on thematic unity of concepts. Read the text carefully and make notes on the side margin of the page. After completing each section, answer intext questions and solve numerical problems yourself. This will give you an opportunity to check your understanding. You should continue reading a section till such time that you gain mastery over it.

At some places you will find some text in **italics and bold**. This indicates that it is important. You must learn them.

Intext Questions are based on the concepts discussed in every section. Answer these questions yourself in the space given below the question and then check your answers with the model answers given at the end of the lesson. This will help you to judge your progress. If you are not satisfied with the quality and authenticity of your answers, turn the pages back and study the section again.

What have you learnt is essentially summary of the learning points for quick recapitulation. You may like to add more points in this list.

Terminal exercises in the form of short, long and numerical question will help you to develop a perspective of the subject, if you answer these meticulously. Discuss your responses with your peers or counsellors.

Answers to intext questions : These will help you to know how correctly you have answered the intext questions.

Audio: For understanding difficult or abstract concepts, audio programmes are available on certain content areas. You may listen to these on FM Gyanvani or may buy the CDs from Priced Publication Unit, NIOS

Video: Video programmes on certain elements related to your subject have been made to clarify certain concepts. You may watch these at your study center or may purchase these CDs from Priced Publication Unit, NIOS.

www These are few selected websites that you can access for extended learning.

Studying at a distance requires self-motivation, self-discipline and self-regulation. Therefore you must develop regular study habit. Drawing a daily schedule will help you in this endeavour. You should earmark a well-ventilated and well-lighted space in your home for your study.

Course Overview

Part I: [For Tutor Marked Assignment]

Module-I: Indian Economic Development

1. Overview of Indian Economy
2. Economic Planning in India

Module-II: Current Challenges before the Indian Economy

3. Economic Growth and Economic Development
4. The Problem of Unemployment, Poverty and Inequality

Module-III: Introduction to Statistics

5. Meaning, Scope and its Need in Economics
6. Collection and Classification of Data
7. Presentation of Data

Important Note: All contents of Part-I will be assessed/examined through Tutor Marked Assignment (TMA). TMA is compulsory and contains 20% marks as weightage. The marks/grades of TMA will be reflected in the mark sheet.

Part-II [For Public Examination]

Module IV: Statistical Tools

8. Measures of Central Tendency
9. Measures of Dispersion
10. Correlation Analysis
11. Index Numbers

Module V: Introduction to Economics

12. Introduction to the study of Economics
13. Central Problems of an Economy

Module VI: Consumer's Behaviour

14. Consumer's Equilibrium
15. Demand
16. Price Elasticity of Demand

Module VII: Producer's Behaviour

17. Production Function
18. Cost of Production
19. Supply
20. Price Elasticity of Supply

Module VIII: Market and Price Determination

21. Forms of Market
22. Price Determination Under Perfect Competition
23. Revenue and Profit Maximization of a Competitive Firm

Module-IX: National Income Accounting

24. National Income and related Aggregates
25. National Income and its Measurement

Module X: Theory of Income and Employment

26. Consumption, Saving and Investment
27. Theory of Income Determination

Module XI: Money, Banking and Government Budget

28. Money and Banking
29. Government and the Budget

Important Note: All Contentsof Part-2 will be assessed/examined through Public/ FinalExamination. Public Examination is compulsory and contains 80% marks as weightage.

Contents

About Economy and Economics (i)-(iv)

Module-I: Indian Economic Development

1. Overview of Indian Economy 1
2. Economic Planning in India 9

Module-II: Current Challenges before the Indian Economy

3. Economic Growth and Economic Development 27
4. The Problem of Unemployment, Poverty and Inequality 39

Module-III: Introduction to Statistics

5. Meaning, Scope and its Need in Economic 57
6. Collection and Classification of Data 68
7. Presentation of Data 84

Module IV: Statistical Tools

8. Measures of Central Tendency 109
9. Measures of Dispersion 146
10. Correlation Analysis 178
11. Index Numbers 204

Curriculum 221

Feedback form 231

ABOUT ECONOMY AND ECONOMICS

ECONOMY AND ECONOMICS

Our very existence depends on various Economic Activities that involves production, distribution, exchange and consumption of goods and services. The primary aim of the economic activity is the production of goods and services with a view to make them available to masses. "Human activities which are performed in exchange for money or money's worth are called economic activities". The environment that facilitates these activities is known as Economy.

Living in society also means that we must know how to organize our lives in perfect manner. We must know to economise our precious time and scare resources. You must also learn how to manage time also because in present scenario time is money.Similarly, when we make budget for our home; we make the best use of the resources which are available to us. We can avoid many problems in this way. This way of Management of Household is called Economics but it is much more than making a Budget. A study of economics can describe all aspects of a country's economy, such as how a country uses its resources, how much time labourers devote to work and leisure, the outcome of investing in industries or financial products, the effect of taxes on a population, and why businesses succeed or fail and many more.

Thus, Economics is the branch of social science that deals in the study of making decisions in the presence of scarcity of resources in the economy particularly with regard to the human activities such as production, consumption, saving and investment. It is a complex social science subject that uses principles of mathematics, physics, statistics, politics, history, sociology, anthropology, psychology and philosophy etc.In the true sense, Economics is an inter-disciplinary subject which addresses both the positive (fact based) and normative (value based) issues. The term 'Economics' is derived from two Greek words OIKOS and NEMEIN, meaning the rule or law of the household. Economics therefore is concerned with not just how a nation allocates its resources to various uses but it ideals with the process by which the productive capacity of these resources can be further increased and with the factors which in the past have led to sharp fluctuations in the rate of utilization of resources.

HOW DO WE DEFINE ECONOMICS?

The Modern Science of Economics was born with the publication **of Adam Smith's "An Enquiry into the Nature and Causes of Wealth of the Nation -1776".That is why, Adam Smith is known as the Father of Modern Economics.**

Economics has been defined by various economists in different ways. This is because 'economics is an unfinished science'. With the passage of time there has been significant development is theories of Economics.

The various definitions of economics may be classified as under:-

- Economics as the Science of wealth.
- Economics as the Science of material well being.
- Economics as the Science of choice making.
- Economics as the Science of dynamic growth and development.

Economics as the Science of Wealth.

Adam Smith who is considered to be the father of economics wrote a book entitled' "An Enquiry in to the Nature and Causes of the wealth of the Nations", in 1776.

Economics as the Science of Material Well Being

Marshall shifted the emphasis of economics from wealth to welfare. He formulated the definition of economics strictly in accordance with his ideas of human welfare. His definition is as follows:

'Economics is the study of mankind in the ordinary business of life. It examines that part of individual and social action which is most closely connected with the attainment and with the use of material requisites of well being.

Economics as the Science of Choice Making or Scarcity definition

Robbins wrote a famous book" "An Essay on the Nature and significance of Economic Science", in 1932. He introduced the 'Scarcity' definition of economics in his book.

"Economics is the science which studies human behaviour as a relationship between ends and scarce means which have alternative uses.

Economics as the Science of Dynamic Growth and Development

Prof. Robbins has excluded from the purview of economics the problem of economic growth and has taken a more static view of an essentially dynamic problem. This inherent defect in Prof. Robbins definition has been sought to be removed by Prof. Samuelson's definition. The definition is as follows**:**

"Economics is the study of how men and society choose, with or without the use of money, to employ scarce productive resources which could have alternative uses, to produce various commodities over time and distribute them for consumption now and in the future amongst various people and groups of society."

'Political economy' was the earlier name for the subject, but economists in the late 19th century suggested "economics" as a shorter term for "economic science" to establish itself as a separate discipline outside of political science and other social sciences. Economics has two main streams – **Microeconomics and Macroeconomics**. Through these two major fields, economics analyses how economies work and affect - market, business, government, people, and other parts of the society. Economic theories are based on extensive studies and analysis.

INDIAN ECONOMISTS AND THEIR CONTRIBUTION

The study of every discipline starts with the process of defining it and Economics is no exception to this. Economy is Economics at play in certain region. In Indian Economy, role of Indian Economists is known throughout the world for their contribution in the economic prosperity of the country. Indian Economists mainly deal with the various concepts of Economics.

Though Economics today studies a wide spectrum of issues and topics but if we take an overall view, its essence has been very simple i.e. the betterment of human life on this beautiful planet earth. In making the lives of masses, the Economists have been devising a number of theories and propositions as to how an Economy may maximise its worth and potential.

Since ancient times many masterpieces were produced by great Economists who were trying to improvise better ways of maximising the fruits of Economic activities. The study of Economics has a common goal to search for possible ways and alternatives for the betterment of human life. Apart from this, economists also contribute in formulating some broad rational theories to make a more balanced world.

Some of the renowned Indian Economists are:

- **Chanakya (Kautilya):** He was an Indian teacher, philosopher, and royal advisor. Originally, a professor of economics and political science at the ancient Takshashila University.Chanakya is traditionally identified as "Kautilya" or "Vishnu Gupta", who authored the ancient political treatise called Arthashastra (Economics).
- **Mahavira:** Economics in Jainism is influenced by the Mahavira and his principles and philosophies. His philosophies have been used to explain the economics behind it. He was the last of the 24 Tirthankars, who spread Jainism.
- **Shri DadaBhai Naroji:** He is fondly called the Grand Old Man of India. He was a pioneer in the field of Economics. He prepared the first estimates of National Income in 1876.
- **Prof. V.K.R.V. Rao:** He was a prominent Indian Economist, Politician, Professor & Educator. He was the first person to adopt scientific procedure in estimating National Income in 1931.

- **Prasant Chandra Mahalanobis:** He was a renowned Indian Statistician and was instrumental in formulating India's strategy for Industrialization in Second Five Year Plan (1956-61).
- **Jagdish Natwarlal Bhagwati:** He is an India-born, naturalized American, economist. He is a professor of Economics and Law at Columbia University. Bhagwati is notable for his researches in International Trade and advocacy of Free Trade
- **Prof. Amartya Sen:** He is a renowned Economist and social worker. He was awarded Nobel Prize for the welfare Economics in Market oriented Economics in 1998.

CAREER VISTAS IN ECONOMICS

Economics offers good number of career options in both public and private sector. Major opportunities exist in banking and finance sector. Economists also play important roles in international organisations like the World Bank, International Development Agency, Asian Development Bank, International Monetary Federation, United Nation's Development Programme (UNDP) and many other agencies.

Indian Institutions such as Planning Commission, Central Statistical Organisation (CSO), National Sample Survey Organisation (NSSO), National Council of Applied Economic Research (NCAER) and Institute of Applied Manpower Research (IAMR), Indian Statistical Institute (ISI), Institute of Economic Growth (IEG) and Central and State Universities offer good career opportunities in the field of research.

The Indian Economics Service (IES)and Indian Statistical Service (ISS)conducted by the Union Public Service Commission (UPSC) is a popular civil service.

Economic journalism is another career opportunity for students holding a degree in Economics and interest in journalism.

Some of the specialisation areas under Economics

Banking Economics, Environmental Economics, Industrial Economics, Rural Economics, Econometrics, Game Theory, Development Economics etc.

MODULE - I
INDIAN ECONOMIC DEVELOPMENT

1. Overview of Indian Economy
2. Economic Planning in India

CURRICULUM OF SENIOR SECONDARY COURSE IN ECONOMICS (318)

1. RATIONALE

Economics has become a very sought after subject in the field of Social Science. The knowledge of Economics is very important in pursuing various activities in everyday life such as production, consumption and investment. In Consumption, every individual wants to utilize his/her income in the best possible manner so as to get maximum satisfaction from the goods and services purchased. Similarly, as producer, the individual/firm/industry uses the resources to minimize cost and get maximum output/profit. At the economy level, everybody wants that there should be economic growth and development through higher income and employment. Study of economics is very useful to achieve these goals.

At NIOS, students are introduced to the subject of Economics at Secondary stage. The level at this stage is elementary in nature. However, at the Sr. Secondary level, students will be exposed to more areas of economics. They are also expected to know the use of tables and graphs/statistical tools to understand and explain various concepts and theories of economics. Indian students can be trained in their field in the Indian context as well as in the context of globalization process going in today's world.

2. OBJECTIVES

The main objectives of learning Economics at Senior Secondary level are to enables the learners to:

- To help the learners understand the structure, problems, working and recent changes in the Indian economy.
- To help the learners understand principles, laws and concepts of Economics.
- To help the learners understand national income analysis and methods used in calculating national income.
- To develop positive attitudes for economic justice among the masses and socio-economic reconstruction of the country.
- To develop skills among the learners the use of statistical tools to analyse, interpret and explain data and information.

3. COURSE STRUCTURE

The present curriculum in Economics has been distributed into two parts and eleven modules. Part I Consists of three modules, namely: Indian Economic Development, Current challenges before the Indian Economy and Economic growth and Economic Development. Similarly Part-II consists of eight modules, namely: Statistical Tools, Introduction to Economics, Consumer's Behaviour, Producer's Behaviour, Market and Price Determination, National Income Accounting, Theory of Income and Employment and money, Banking and Government Budget. Each module has been divided further into different lessons.

The number of lessons and suggested study time are as follows:

Part-1

Module/ Lesson	No. of Lessons	Study Time (in hours)
Module-I: Indian Economic Development	**02**	**35**
1. Overview of Indian Economy		
2. Economic Planning in India		
Module-II: Current challenges before the Indian Economy	**02**	**35**
3. Economic growth and Economic Development		
4. The Problem of Unemployment, Poverty and Inequality		
Module III: Introduction to Statistics	**03**	**50**
5. Meaning, Scope and its Need in Economics		
6. Collection and Classification of data		
7. Presentation of Data		
Total	**7**	**120**

Part-2

Module/lesson	No. of lessons	Study time (in hours)
Module-IV: Statistical tools	**04**	**35**
8. Measures of Central tendencies 9. Measures of Dispersion 10. Correlation Analysis 11. Index Numbers		
Module-V: Introduction to Economics	**02**	**16**
12. Introduction to the Study of Economics 13. Central Problems of an Economy		
Module-VI: Consumer's Behaviour	**03**	**25**
14. Consumer's equilibrium 15. Demand 16. Price Elasticity of Demand		
Module-VII: Producer's Behaviour	**04**	**40**
17. Production Function 18. Cost of Production 19. Supply 20. Price Elasticity of Supply		
Module-VIII: Market and Price Determination	**03**	**16**
21. Forms of Market 22. Price Determination under Perfect Competition 23. Revenue and Profit Maximization of a Competitive Firm		
Module-IX: National Income Accounting	**02**	**16**
24. National Income and Related aggregates 25. National Income and its Measurement		
Module-X: Theory of Income an Employment	**02**	**16**
26. Consumption, Saving and Investment 27. Theory of Income Determination		
Module-XI: Money, Banking and Government Budget	**02**	**16**
28. Money and Banking 29. Government and the Budget		
Total	**19**	**180**

4. COURSE DESCRIPTION

Part-1

Module 1: Indian Economic Development

Approach: This module de is with the parameters of development and gives brief account of India's economy on the eve of Independence. It also deals with the planning and economic development in India including its achievements and drawbacks.

Lesson-1: Overview of Indian Economy

Features of Indian Economy-National and Per capita Income, Status of the Social sector, State of agriculture, Industry and foreign trade.

Lesson-2: Economic Planning in India

Meaning of Economic Planning, need for planning, objectives of planning, strategies of economic planning, achievements and drawbacks of Five Year Plans in India, New Economic Policy 1991-Liberalization, Privatization & Globalization.

Module 2: Current Challenges before the Indian Economy

Approach: This module provides the knowledge about the current challenges before the India economy and focuses mainly on poverty, unemployment, population and human capital formation.

Lesson 3: Economic Growth and Economic Development

Meaning of Economic Growth and Economic Development. Difference between Economic Growth and Economic Development; Concept of Sustainable Economic Development; Concept of Human Development, Human Development Index, factors affecting economic growth, Common features of underdeveloped countries

Lesson 4: The Problem of Unemployment, Poverty and Inequality

Meaning, Types and measures of unemployment, Causes of unemployment in India, Concept of Poverty line and estimates of Poverty, Causes of Poverty in India, Poverty alleviation and employment generation programmes in India, Inequality in income and Regional Inequality.

Module 3: Introduction to Statistics

Approach: Statistical data are very useful in economics. This module will help learners to understand the meaning of data, methods of their collection, and their presentation.

Lesson-5: Meaning, Scope and its Need in Economics

Need and scope of statistics**,** Meaning, functions and importance of statistics in economics, limitations of statistics.

Lesson-6: Collection and Classification of Data

Primary and secondary data, collection of primary data, sources of secondary data; organization of data into arrays and frequency distribution.

Lesson-7: Presentation of data

Tabulation, Bar diagrams and pie diagrams, Graphs - Line graph, histogram, Polygon and Ogive.

Part-2

Module 4: Statistical Tools

Approach: After collection of data, it becomes necessary to draw conclusion from them. Different statistical tools are used to analyse the data and draw conclusions. This module will enable the learners to understand the use of certain tools to analyse the data.

Lesson-8: Measures of Central Tendencies

Meaning of central tendency, computation of arithmetic mean, combined mean, weighted arithmetic mean, median, quartiles and mode.

Lesson-9: Measures of Dispersion

Meaning of dispersion, Measures and methods of computing dispersion, Range, quartile deviation mean deviation, standard deviation (Absolute and Relative measures), Lorenz curve.

Lesson-10 Correlation Analysis

Meaning, Scatter diagram, Karl Pearson's coefficient of correlation, Spearman's Rank correlation

Lesson-11: Index Numbers

Meaning, types, Construction of simple and weighted index numbers, Laspeyer's, Paasche's and Fischer's wholesale price index, Consumer price index and index of industrial production, uses of index numbers.

Module 5: Introduction to Economics

Approach: This module will enable the learners to understand the meaning of micro- economics and its relationship with macroeconomics. In addition to this, it will also discuss about the problems which all economics have to face.

Lesson-12: Introduction to the Study of Economics

Meaning of Economics, Meaning of Microeconomics and Macroeconomics, relationship and distinction between the two, positive and normative economics.

Lesson-13: Central Problems of an Economy

Meaning of economic problem, why Economic Problem arises, Central Problems, What to produce, How to produce and for Whom to produce; Concept of production possibility frontier, Opportunity Cost and marginal opportunity cost.

Module 6: Consumer's Behaviour

Approach: This module will enable the learners to understand the concept of utility and indifference curves and how consumers get maximumm satisfaction from their purchases.

Lesson-14: Consumer's Equilibrium

Meaning of Utility, Marginal and Total utility, Law of Diminishing Marginal Utility, Consumer's Equilibrium based on utility analysis. Meaning of Indifference curve and budget line, consumer's equilibrium using indifference curve and budget line.

Lesson-15: Demand

Meaning, factors affecting demand, law of demand, Individual and market demand, demand schedule and demand curve movement along the demand curve and shift in demand curve.

Lesson-16: Price Elasticity of Demand

Meaning, Factors affecting price elasticity of demand. Methods of Calculating price elasticity of demand

(a) Percentage method

(b) Total expenditure method

(c) Geometric method

Simple numerical problems based on each method.

Module 7: Producer's Behaviour

Approach: This module deals with the objectives of the producer, production function and different types of cost. Besides this, it will also deal with supply of a commodity and price elasticity of supply.

Lesson-17: Production Function

Meaning of production function, Production function in the Short Run-Law of Variable Proportion.

Lesson-18: Cost of Production

Meaning of Cost, Fixed and Variable cost, Explicit and Implicit cost, Monetary cost, Real cost, Private and Social costs, Short run costs.

Lesson-19: Supply

Meaning, determinants of supply, law of supply, individual and market supply, supply schedule and supply curve, movement along the supply curve and shift in supply curve.

Lesson 20: Price Elasticity of Supply

Meaning, measurement of price elasticity of supply by (a) Percentage method (b) Geometric method Factors affecting price elasticity of supply

Module 8: Market and Price Determination

Approach: This module will enable the learners to understand the meaning of market, forms of market-Perfect competition, monopoly, monopolistic competition and oligopoly- their meaning and features. This module also helps the learners to understand the concept of revenue and profit maximization condition of a competitive firm. Beside this, this module also deal with the equilibrium price computation

Lesson-21: Forms of Market

Meaning of market, Different forms of market - Perfect competition, monopoly, monopolistic competition and oligopoly- their meaning and features

Lesson-22. Price determination Under Perfect Competition

Meaning of equilibrium price, Determination of equilibrium price, excess demand and excess supply; Effect of changes in demand and supply on equilibrium price and quantity; Simple applications of demand and supply analysis - ceiling price, floor price.

Lesson-23: Revenue and Profit maximization of a Competitive Firm

Concept of revenue - Total Revenue, Average Revenue Marginal Revenue. Various concepts of profit; profit; Maximizaiton of a competitive firm Total revenue and total cost approach, Marginal revenue and Marginal cost approach

INTRODUCTION TO MACROECONOMICS

Module-9: National Income Accounting

Approach: National income is a central concept in economics. It provides a quantitative view of a country's economic performance. This module will enable the learners to understand various concepts related to national income and different methods of its measurement.

Lesson-24: National Income and Related Aggregates

Meaning of income, four factors of production, factor incomes and non-factor incomes, final goods and intermediate goods, basic economic activities, closed and open economy, stock and flow, circular flow of income, concept of domestic territory and normal residents, value of output and value added, market price vs factor cost, domestic income vs national income, real & nominal GDP concept of depreciation. Concepts of GDP, NDP GNP & NNP (at market price and factor cost)

Lesson-25: National Income and its Measurement

Methods of calculating national income-value added or product method, income method and expenditure method, private income, personal income and personal disposable income, national disposable income (gross and net), GDP and economic welfare.

Module 10: Theory of Income and Employment

Approach: This module will discuss about the determination of equilibrium level of income and employment. In addition to this it will also discuss about the problems of excess demand and deficient demand in the economy.

Lesson-26: Consumption, Saving and Investment

Consumption function, saving function and investment function, propensity to consume and save

Lesson-27: Theory of Income Determination

Concept of aggregate demand, Determination of Equilibrium level of Income, Increase in income through Multiplier Process; Excess demand and Deficiency in demand.

Module 11: Money, Banking and Government Budget

Approach: This module explains about meaning and functions of money, functions of Central Bank. This also explains how the monitory and fiscal policy are used to correct the situations of excess demand and deficient demand in the economy.

Lesson-28: Money and Banking

Barter system of exchange; Money- its meaning and functions, Supply of Money - currency held by the public and net demand deposits held by the commercial banks, Measures of Money Supply process of credit creation, Central bank-meaning, functions, Monetary Policy to control money supply.

Lesson-29: Government and the Budget

Meaning, Objectives, components, Revenue Receipts and Capital Receipts, Revenue expenditure and Capital expenditure, Measures of deficit (Revenue Deficit, Fiscal Deficit and Primary Deficit - their meaning and implications); Fiscal policy and its role.

5. SCHEME OF STUDY

The course in Economics provides you with package of learning opportunities which comprise of:

- Printed Self Learning Material (SLM) in two parts i.e. Part-1 and Part-2.
- Supplementary Materials in the form of Audio and Video Programmes.

- Video tutorials in Economics available on the NIOS website (www.nios.ac.in) as well as YouTube. The links of these tutorials have been mentioned within the SLM in the concerned lesson.
- 30 Personal Contact Programme (PCP) sessions at your study centre. Please contact your study centre for the PCP schedule
- Apart from Face-to-Face Personal Contact Programme (PCP) at your study centre, live Personal Contact Programmes (PCPs) through audio streaming are webcast on Mukta Vidya Vani, which can be accessed through NIOS website (www.nios.ac.in).

6. SCHEME OF EVALUATION

The learner will be assessed through Continuous and Comprehensive Evaluation (CCE) in the form of Tutor Marked Assignment (TMA) as well as Public Examination. The following table shows the details:

Mode of Evaluation	Syllabus/Contents	Duration	Weightage
Tutor Marked Assignment (TMA)	All Contents under SLM Part-1	Self Paced	20%
Public/Final Examination	All Contents under SLM Part-2	3 Hours	80%

1

OVERVIEW OF INDIAN ECONOMY

Every economy in the world has its own characteristics or features by which it is known or identified. Economies are compared with each other on the basis of these features. India as a distinct nation came into existence on 15th August 1947, called the independence day of India which marked the end of British rule over India. After that, Independent India has completed 66 years of self rule on 15th August 2013. This period is long enough to evaluate the position and performance of the country to enable comparison with other countries in the world as well as evaluate its own progress over the years. With this view in mind the current lesson provides the features of Indian economy.

OBJECTIVES

After completing this lesson, you will be able to:

- describe the characteristics or features of Indian economy;
- explain the problems faced by Indian economy;
- explain the role of agriculture in India; and
- describe the growth of industry in India.

1.1 FEATURES OF INDIAN ECONOMY

Let us now list the features of Indian economy as follows:

(i) Low per capita income

(ii) Heavy population pressure

(iii) Dependence of population on agriculture

(iv) Poverty and Inequality income distribution

(v) Higher level of capital formation which is a positive feature

(vi) Planned economy

let us discuss these points one by one.

(i) Low per capita income

India is known in the world as a country with low per capita income. Per capita income is defined as the ratio of national income over population. It gives the idea about the average earning of an Indian citizen in a year, even though this may not reflect the actual earning of each individual. India's per capita income for the year 2012-2013 is estimated at ₹ 39,168. This comes to about ₹ 3,264 per month. If we compare India's per capita income with other countries of the world then it can be seen that India is well behind many of them. For example, the per capita income of USA is 15 times more that of India while China's per capita income is more than three times of India.

(ii) Heavy population pressure

India is world's second largest populated country after China. As per 2011 census India's population stands at more than 121 crores. It increased at a rate of 1.03 percent during 1990-2001. The main cause of fast rise in India's population is the sharp decline in death rate while the birth rate has not decreased as fast. Death rate is defined as the number of people died per thousand of population while birth rate is defined as the number of people taking birth per thousand of population.

In 2010, the birth rate was 22.1 persons per one thousand population while the death rate was only 7.2 persons per one thousand population. Low death rate is not a problem. In fact it is a sign of development. Low death rate reflects better public health system. But high birth rate is a problem because it directly pushes the growth of population. After 1921, India's population increased very fast because birth rate declined very slowly while death rate declined very fast. From 49 in 1921 the birth rate declined to 22.1 in 2010 while during the same time period, death rate declined from 49 to 7.2. Hence the population growth was very rapid in India.

Heavy population pressure has become a major source of worry for India. It has put burden on the public exchequer to mobilize enough resources to provide public education, health care, infrastructure etc.

(iii) Dependence on Agriculture

Majority of India's working population depend on agricultural activities to pursue their livelihood. In 2011 about 58 percent of India's working population was

engaged in agriculture. In spite of this, the contribution of agriculture to India's gross domestic product is a little over 17 percent. A major concern of agriculture in India is that productivity in this sector is very less. There are many reasons for this. There is heavy population pressure on land to sustain huge number. Due to population pressure on land the per capita availability of land area is very low and not viable for extracting higher output. Two, since per capita land availability is less, a majority of people are forced to become agricultural labour working at low wages. Three, Indian agriculture suffers from lack of better technology and irrigation facilities. Four, mostly people, who are not educated or not trained properly, are engaged in agriculture. So it adds to low productivity in agriculture.

INTEXT QUESTIONS 1.1

Fill in the blanks

1. India's per capita income is ..... of that of China?
   (a) twice (b) one third
   (c) same as (d) none of the above
2. USA's per capita income is ..... of that of India?
   (a) 15 times (b) 10 times
   (c) less than (d) none of the above
3. As per 2011 census, India's population stands at
   (a) more than 100 crore (b) less than 100 crores
   (c) more than 121 crores (d) none of the above
4. India's Birth rate in 2010 was:
   (a) 20.2 (b) 21.2
   (c) 22.1 (d) 23.2
5. India's death rate in 2010 was
   (a) 7.2 (b) 7.4
   (c) 7.8 (d) 7.9
6. India's population growth was rapid because
   (a) death rate is more than birth rate
   (b) birth rate is more than death rate
   (c) birth rate is same as death rate
   (d) none of the above

7. In 2011, ... percent of India's working population was engaged in agriculture?

   (a) 70 (b) 80

   (c) 68 (d) 58

8. Contribution of agriculture to India's national income in 2011 was around

   (a) 10 percent (b) 20 percent

   (c) 17 percent (d) 25 percent

(iv) Poverty and inequality

Another very disheartening thing about India is that it has world's largest number of poor people. As per reports of government of India, in 2011-12 about 269.3 million people in India were poor. This was about 22 percent of India's population. A person is termed poor if he/she is not able to consume the required amount of food to get a minimum calorie value of 2400 in rural area and 2100 in urban area. For this the person must earn the required amount of money as well to buy the food items. The government has also estimated that the required amount of money is ₹ 816 in rural area and ₹ 1000 in urban area per head per month. This comes to about ₹ 28 in rural area and ₹ 33 in urban area per head per day. This is called poverty line. This implies that 269.9 million people of India were not able to earn such little amount in 2011-12.

Poverty goes with inequality in income and wealth distribution. Very few in India posses materials and wealth while majority have control over no or very little wealth in terms of land holding, house, fixed deposits, shares of companies, savings etc. Only top 5 percent of households control about 38 percent of total wealth in India while the bottom 60 percent of household has control over only 13 percent of the wealth. This indicates concentration of economic power in a very few hand.

Another issue linked to poverty is the problem of unemployment. One of the most important reasons of poverty in India is that there is lack of job opportunities for all the persons who are in the labour force of the country. Labour force comprises of the adult persons who are willing to work. If adequate number of jobs are not created every year, the problem of unemployment will grow. In India every year large number of people are added to the labour force due to increase in population, increase in number of educated people, lack of expansion of industrial and service sector at the required speed etc.

So far we discussed the negative features. There are certain positive features of Indian economy as well. They are discussed below.

(v) Higher rate of capital formation or investment

At the time of independence, one of the major problem of Indian economy was deficiency in capital stock in the form of land and building, machinery and equipment, saving etc. In order to continue the cycle of economic activities such as production and consumption, a certain ratio of production must go towards saving and investment. However, the required ratio was never generated in the first four to five decades after independence. The simple reason being higher consumption of necessary items by the population of whom most happened to be poor and lower middle income class. Collective household saving was very less due to this. Consumption of durable items was also very less. But in recent years things have charged. Economists have calculated that in order to support the growing population, India requires 14 percent of its GDP to be invested. It is encouraging to note that the saving rate of India for the year 2011 stands at 31.7 percent. The ratio of gross capital formation was 36.6 percent. This is possible because people are now able to save in banks, consume durable goods and there has been large scale investment taking place on public utilities and infrastructure.

(vi) Planned economy

India is a planned economy. Its development process has been continuing through five year plan since the first plan period during 1951-56. The advantage of planning is very well known. Through planning the country sets its priorities first and provides the financial estimates to achieve the same. Accordingly efforts are made to mobilise resources from various sources at least cost. India has already completed eleven five year plan periods and the twelfth plan is in progress. After every plan a review is made analysing the achievements and short falls. Accordingly, things are rectified in the next plan. Today India is a growing economy and recognised every where as a future economic power. The per capita income of India is growing at a higher rate than before. India is seen as a big market for various products. All these are possible due to planning in India.

1.2 ROLE OF AGRICULTURE IN INDIA

Agriculture is one of the most important sectors of Indian economy. It is the supplier of food and raw materials in the country. At the time of independence more than 70 per cent of India's population depended on agriculture to earn livelihood. Accordingly the share of agriculture in the national product/income was as high as 56.6 per cent in 1950-51. However with development of industries and service sector during the plan periods, the percentage of population depending on agriculture as well as the share of agriculture in the national product has come down. In 1960, the percentage of labour force engaged in agricultural activities was 74 which gradually came down over the years to 51 per cent in 2012. In 1960 the share of labour force in industry and service sectors stood at 11 and 15 percent

respectively. But in 2012 these shares increased to 22.4 and 26.5 percent respectively. It has been observed in most of the economies that along with economic development shift in labour force from agriculture to industry and service sector takes place.

Agriculture is the source of food supply. The production of food grains has increased from nearly 55 million tonnes in 1950-51 to 259 million tones in 2012-13. Because of the growth in food grain production, India's dependence on import of food grains has declined and almost become nil. Keeping in view the rapid growth in India's population, increase in food grain was a necessity which the country achieved significantly. Except for pulses, increase in food grains has been mode possible by increase in cereals and various cash crops.

Agriculture is also a major source of foreign exchange earning through export. The share of agriculture in India's export in the year 2011-12 was 12.3 percent. The major items of export include tea, sugar, tobacco, spices, cotton, rice, fruits and vegetables etc.

1.3 GROWTH OF INDUSTRY IN INDIA

Industry or the secondary sector of the economy is another important area of economic activity. After independence, the government of India emphasized the role of industrialization in the country's economic development in the long run. Accordingly, the blue print for industrial development was made through the Industrial Policy Resolution (IPR) in 1956. The 1956 policy emphasized on establishment of heavy industries with public sector taking the lead in this area. Adoption of heavy or basic industries strategy was justified on the ground that it will reduce the burden on agriculture, enable growth in the production of consumer goods industries as well as small industries that are helpful for employment generation and achieving self reliance. After the adoption of the IPR, 1956 there was tremendous growth in industrialization during the second and third plan periods i.e. 1956-61 and 1961-66. Public sector contributed maximum to this growth. But towards the end of 1960s, investment in industries was reduced which adversely affected its growth rate. In the 1980s, this trend was reversed and investment in industries was increased by making the infrastructure base such as power, coal, rail much stronger.

In early 1990s it was found that the public sector undertakings were not performing upto expectation. There has been reports of mismanagement in these under takings resulting in loss. So in 1991 the government of Indian decided to encourage the role of private sector in industrial development, remove the rigid licence system which is known as liberalization and allow international players to compete in the domestic country as well as domestic players to explore foreign territories. The aim of taking all these steps was to strengthen the process of

industrialization in the country. Such a model of industrial development is called Liberalization, Privatization and Globalization (LPG) model.

After the adoption of this new policy in 1991, there has been phases of growth followed by slowdown in the industrial development process. In the early years of 1990s there was significant growth in industrialization due to increase in investment in infrastructure, reduction in excise duty, availability of finance etc. But towards the end of 1990s the growth rate slowed down due to stiff competition from international companies, inadequate infrastructure support etc. However, in the beginning of the new millennium, between 2002-08 there was again some recovery due to increase in saving rate from 23.5 percent in 2001-2 to 37.4 percent in 2007-08. Even the competition from the foreign companies helped during this phase as the domestic companies could create enough internal strength in term of quality control, finance and customer care etc. to withstand the competition. However after 2008-09 there was some slow down in industrial growth due to rise in petroleum price, interest rate and borrowings from abroad which has created lot of liabilities for the domestic companies.

INTEXT QUESTIONS 1.2

1. What was share of agriculture in India's national income in 1950-51?
2. With economic development, labour force tend to shift from industry to agriculture. True or False
3. What was the share of agriculture in India's export in 2011-12?
4. Give the full form of LPG?
5. The industrial policy of 1956 emphasized on the strategy of
   (a) Light industries (b) small and medium industries
   (c) Heavy industries (d) none of the above

WHAT HAVE YOU LEARNT

In this lesson you have learnt that

- India is a developing economy with the promise to grow in future.
- India is currently among those countries whose per capita income is low.
- India is suffering from heavy population pressure
- A majority of india's populaiton is dependent on agriculture.
- There is high absolute poverty in India

- The gap between rich and poor is substantial in India
- Some positive features of Indian economy are
  - India's saving rate is high
  - Five year plannning in India is running successfully

TERMINAL EXERCISE

Short Answer Type Questions

1. Give one positive and two negative features of Indian Economy.
2. Give two reasons for low productivity in agriculture in India.
3. What is main cause of increase in population in India?
4. Why is India called planned economy?
5. Define poverty line in rural area.

Long Answer Type Questions

1. India suffers from heavy population pressure. Explain.
2. Explain two positive features of Indian economy.
3. India's per capita income is low? Do you agree. Give reasons.
4. Describe India as agricultural country.
5. Briefly discuss the poverty and inequality situation in India.
6. Explain the role of agriculture in Indian economy.
7. Explain the growth of industrialization in India?

ANSWERS TO INTEXT QUESTIONS

1.1

1. (b) 2. (a) 3. (c) 4. (c) 5. (a) 6. (b) 7. (d) 8. (c)

1.2

1. 56.5 percent
2. False
3. 12.3 percent
4. Liberalization, Privatization and Globalization
5. Heavy industries

Notes

2

ECONOMIC PLANNING IN INDIA

India is a vast country with multiple problems faced by its population. The British ruled the country for nearly two centuries and exploited its resources for their benefit leaving the country reeling under absolute poverty. When the British left India in 1947 there was nothing to be proud of or be happy except for the 'freedom'. The problems were many before the Indian government. Besides mass poverty there was the problem of food shortage and inflation. Illiteracy, lack of health care, lack of infrastructure etc. were other serious problems facing the country. As a long term strategy. 'Planning' for economic development was the answer to solve these problems.

OBJECTIVES

After completing this lesson, you will be able to:

- define "Planning";
- explain the need for planning;
- list out the objectives of planning;
- describe the strategy of planning in India;
- explain new economic policy;
- point out the targets set by our planners in terms of various objectives of planning;
- explain the achievements made with respect to the plan objectives; and
- realise the short comings or unfulfilled part of the objectives.

2.1 MEANING OF ECONOMIC PLANNING

Economic planning is a process which involves the following steps:

(i) Preparing a list of the problems facing the economy .

(ii) Rearranging the list on the basis of priority. The top priority issue which needs to be addressed immediately should be placed at number one and so on.

(iii) The next step is to identify the problems which are to be solved in the immediate short run and the other problems which are to be addressed over the long period.

(iv) Fixing a target to achieve the desired goal. The target could be a specified time period within which the problem must be solved. If the problem is to be addressed over long run, then it must be made clear that how much of the problem be solved in the first period (say a year or six months) and so on. Secondly the target could be a certain quantity to be achieved. Say in case of production, the government can fix some target in terms of quantity.

(v) Estimating the amount of resources needed for achieving the target. Resources include financial resource, human resource, physical resource etc.

(vi) Mobilizing the resources is another important task. This means that the planners must know the sources of arranging the required resources. For example, in case of financing the plan, the planners must make the budget and spell out the different sources of finding. When the government makes plan, one of its major source of getting funds in the tax revenue. For a business person, one of the sources of finance is the loan from bank. When various sources of funds are available then the planner must also decide as to how much fund to be collected from each of these sources.

Use of the human resource is another important task to execute the plan proposal. The planner must estimate the type of man power and the number of persons required to carry out the task. A proper estimate on this requirement should be given at the outset. Similarly proper estimate of physical resources should also be provided. Physical resources include office buildings, vehicles, furniture, stationeries etc.

(vii) Once the resources are arranged, implementation and execution process starts in an organize manner to achieve the desired goal. To make sure that everything is running smoothly and to rectify mistakes if any or to modify the style of working to accommodate any change, periodic review must be done till the final achievement is realised.

2.2 ECONOMIC PLANNING IN INDIA

India adopted a system of five yearly planning to address its various socio-economic problems. You have already been told about the problems of Indian

economy at the time of its independence. To remind, these problems include mass poverty and inequality, low productivity in agriculture and storage of food grains, lack of industrial and infrastructural development etc. Since these are to be solved over the long period, Indian government adopted five year plan starting from first year plan in 1951 development. The idea was to make a list of important problems to be solved keeping in view the given resources and the capacity to arrange the resources. Then make a review after five years of what has been done and rectify the mistakes accordingly in the next five year plan period and so on.

Some of the great architects of Indian planning include Jawaharlal Nehru, P.C Mahalonobis, V.R Gadgil, V.K.R.V Rao. After becoming the first prime minister of independent India, Nehru established the Planning Commission in 1950. The major function of the Planning Commission was to formulate plans keeping in view the resources of the country and suggesting the best methods to utilize them effectively and in a balanced manner. Planning commission prepared the first five year plan (FYP) for the period 1951-1956. By 2014, India has already experienced more than sixty years of planning with eleventh five year plans being completed are twelfth FYP continuing.

2.3 OBJECTIVES OF PLANNING IN INDIA

The various objectives of economic planning in India are drawn keeping in view its socio-economic problems. Accordingly the objectives as follows:

1. Economic growth
2. Increase in employment
3. Reduction in inequality of income
4. Reduction in poverty
5. Modernization of the economy
6. Ensuring social justice and equality.

Let us discuss these objectives one by one .

1. **Economic Growth :** The objective of achieving economic growth implies that the real national income and per capita income must grow every year at a targeted rate. Real national income is the measure of national income at a given years price or at a constant price. Real per capita income is the average income of individuals in the economy. It is argued that in order to achieve higher standard of living for each individual /household and the society as a whole , both per capita income and national income must grow in real terms. Since income represents purchasing power, increase in income will enhance the purchasing power of people and the country. When purchasing power will

increase then individuals can buy more goods and services to satisfy their wants. The country as a whole can pay for its purchases from abroad called import. Increase in real income also means that the output level or quantity of output is higher than before. Here output includes output in different sectors of the economy such as agricultural output, industrial output and services to satisfy the needs of India's growing population increase in output every year has to be achieved. To achieve higher rate of output the economy must increase its rate of investment to create infrastructure and capital stock. Infrastructure includes power projects, roads, railways, airports, ports, telecommunication network, buildings etc. Capital stock includes plant, machinery, banking and insurance etc. Investment in all these things is necessary to achieve economic growth in real income, hence the planners of the country set a target for growth in each five year plan keeping in view the growth of population and demand for goods and services etc.

2. **Increase in Employment:** Employment refers to engagement of the labour force in gainful economic activity such as production of goods and services. Income is generated through the production process where the production process involves employment of factors of production provided by the households. You know that factors of production include land, labour, capital and organization/entrepreneurship. These factors are owned by the households of the country. As factors are scarce resources and needed to produce goods and services, it is important for the government to create opportunities where in they can be properly used/utilized. The production capacity of an economy depends on the amount of the factor resources it possesses. The required amount of output can be generated if these factors of production get employment. The value of the output then can be distributed among the factors as their income in the form of wage for labour, rent to the owner of land and building, interest to the owner of capital and profit to the entrepreneur. If the country is not able to create employment opportunities to gainfully engage the factors of production, the required amount of output can not be produced and hence income can not be generated. Take the example of labour resources in the country. You know that the population of the country supplies labour force who are in the age group of 15 to 59 years. Every year due to increase in population the number of people in the labour force is also increasing. Most of them are also educated. If there is no enough scope to get employment then they will remain unemployed and unutilized. Infact the unemployment situation in India is very bad. Besides causing increase in consumption without corresponding increase in production, unemployment also is a cause of various social problems such as poverty and crime etc. So planners of the Indian economy put creation of employment as a major objective of five year plans.

INTEXT QUESTIONS 2.1

1. Economic growth means
   (a) Increase in real national income
   (b) Removal of inequality
   (c) Increase in price level
   (d) None of the above
2. National income can be increased by
   (a) Increase in population
   (b) Increase in the rate of investment
   (c) Increase in unemployment
   (d) Decrease in price level
3. Who are the owner of factors of production
   (a) Government
   (b) Rest of the world
   (c) Households
   (d) Firms and industries
4. Labour force comes from the population in the age group of
   (a) 4 to 14
   (b) 60 to 75
   (c) 10 to 15
   (d) 15 to 59

3. **Reduction in Inequality of Income :** India is a country with diverse economic standard of its population. This means that in terms of income level, India lacks uniformity. A large section of India's population belong to lower income group and termed as poor where as a few are very rich with very high level of income. Income disparity is a major concern of the social angle, women are the worst affected in terms of income standard irrespective of their caste or religion. Similarly the scheduled caste and scheduled tribe population belong to the marginalized section of Indian society as they are at the bottom of the pyramid of development. One of the major reasons of inequality in income is the unequal distribution of asset holding such as per capita land holding, possession movable and immovable property from inheritance etc. A majority of India's population live in rural area and work in agriculture. But a few are big land lords and majority are marginal or small farmers and agricultural labourers. Agricultural labourers are so called because they do not have their own land

to cultivate and move from one place to another in search of job on a daily or weekly wage basis. Their situation in worse because of their own illiterary and lack of scope to organize themselves. One to their low income they do not have anything to begin to their reset generation on the otherhand landlords enjoy higher returns to their property and due to existence of law of inheritance the property remains with their future generations. Hence, rich remains rich and poor remains poor in the country due to possession and lack of private property respectively. India is badly affected due to this inequality . The poor people are not able to support the market due to lack of purchasing power where too much purchasing power with the rich has caused wasteful consumption to increase. Most of the social evils are created due to inequality. Hence, our planners aimed at reducing the inequality in income distribution through planning.

4. **Reduction in Poverty :** Another major objective of planning in India is "reduction In poverty". At the time of independence more than fifty percent of India's population was poor. By the year 2014, nearly 27 to 28 percent of India's population is under poverty as per governments estimates. You will come to know about the manner in which poverty is estimated in India in the lesson on poverty and employment. For the time being let us confine our notion of poverty to the situation where in an individual is unable to satisfy his/her basic minimum needs of life. There are lot of people in the country who are not even getting a square meal a day. Lack of employment is a major cause of poverty . It is aggarated by unequal distribution of national wealth and income. Poverty is termed as a curse on human dignity and it has seriously tarnished the image of India in the world. Developed countries do not count India seriously due to its inability to remove poverty. It is proper planning to remove poverty completely from the country.

5. **Modernisation of the Economy :** India has been a country of continuous exploitation by foreign powers such as the Mughals who ruled for more than two hundred years and the British who also ruled the country for another two hundred years. The British in particular, left the country in dine poverty and underdevelopment when they handed over power to Indian government in 1947. Because of the historical reasons Indian economy could not rise from its traditional level of functioning. It remained an agrarian economy and industrially backward. There was no development in now technology and technological upgradation. Lack of modern technology is a major reason for Indian economy to suffer from low productivity in agriculture and lack of industrial development. At the time of independence and for many more years after that, the major contributor to India's GDP because of underdeveloped industrial and service sector. Combined with his lack of better education and skill development of the population, the occupational structure has also remained biased towards agriculture. Hence, to reverse such trend it is necessary to change the structure

of GDP of India by improving the quality of human resources and developing industries and service sector. This can be done by modernization of the economy.

6. **Ensuring Social Justice and Equility :** Indian planning also aimed at achieving a socialistic pattern of society. It can be achieved by ensuring its population social justice and equity. In fact all the objectives said above are necessary to achieve social justice. But the sufficient condition for sustaining social justice and equitable distribution of income is to introduce reforms in various sectors by changing the age old systems which have perpetuated poverty and inequality and obstructed development of industrial and service sector or caused low productivity in agriculture. So the planners thought to introduce reforms in agriculture and economic policy so that they facilitate growth and equitable distribution of the benefits of development.

INTEXT QUESTIONS 2.2

1. One of the reasons of inequality in income is
   a. Existence of private property
   b. Lack of equal distribution of wealth
   c. Both of the above
   d. None of the above
2. Which of the following sector used to have larger share in India's GDP at the time of its independence
   a. Industry
   b. Agriculture
   c. Service
   d. None of the above

2.4 NEED FOR PLANNING

A major part of the question about need for planning has been answered in the meaning of planning itself described above. There we said that planning involves various steps for effective implementation and execution. Infact the number of problems facing Indian economy is very high. Each problem is complex in nature and cannot be solved in a short period. Take the example of the problem of poverty. There is no method by which this problems can be solved immediately. The government must collect data to know the number of people affected by poverty and its nature. Collection of data itself is a very huge task keeping in view India's vast geographical area and lack of accessibility to many areas. In a democracy , the government is duty bound to formulate policies after proper debate and discussions which takes time. Then mobilization of adequate resources and provision of

resources to continue the programme over a long period are two most important things to solve the problem of poverty. Without proper planning it cannot be done. Planning is also necessary to avoid wasteful expenditure, minimize cost meet the target in time and optimal use of resource.

2.5 STRATEGY OF PLANNING

By strategy we mean the use of correct approach /method/formula for achieving the target under planning. In the first plan period of 1951-56, no specific strategy was adopted during this time the government of India gave more emphasis to agriculture keeping in view the fact that majority of India's population depend on agriculture and there was the immediate issue of adequate food grain supply to address food shortage. The first five year plan was a great success as the targeted growth rate was achieved so India was in a position to adopt a long term strategy for planning in future. The development strategy was accordingly spelt out explicitly in the second plan period of 1956-61. The strategy was to give emphasis on – 1. Industrialization, 2. Within industrialization more emphasis on heavy industries.

2.6 JUSTIFICATION OF THE STRATEGY OF INDUSTRIALIZATION

In order to address the problems related to poverty, unemployment, economic growth, self reliance etc. The Indian planners adopted the strategy of industrialization in the country in general and establishing heavy and basic industries in particular. **The arguments offered in favour of industrialization and heavy industries strategy are as follows:**

1. India's population has been over depended on agriculture resulting in crowding of rural area, pressure on land, fragmentation of land holding, underemployment and unemployment with fixed amount of land available for cultivation, more population makes the amount of per capita availability of land very small or nil. This has resulted in inequality in distribution of land and ultimately affecting agricultural production badly. Industrialization is the only answer to shift the surplus labour engaged in agriculture to industries and release the pressure on land.
2. Industrial activities provide more job opportunities than agricultural activities. So industrialization will help getting employment for the jobless in the country.
3. Industrialization is necessary for the growth of agriculture itself . Industries use raw materials from agriculture and agriculture sector needs industrial equipment and machinery such as pump set, tractor, electricity etc.
4. Establishment of basic and heavy industries must be given priority. Examples

of basic and heavy industries are iron and steel, aluminium, heavy chemicals, heavy electrical etc. These are capital goods industries. Every economy needs such type of industries because they procedure machinery and equipment needed to establish other industries which can produce consumer goods for the satisfaction of wants. So the heavy industries are the backbone of the economy.

It should be noted that after the adoption of heavy industry strategy the government of India created public sector to establish and manage such industries. Some of the examples are steel authority of India limited (SAIL), Bharat aluminium company (BALCO), Bharat heavy electrical limited (BHEL), National aluminium company (NALCO), etc.

5. Besides heavy and basic industries, Indian government has also given emphasis on developing the micro, small and medium industries. These industries are defined on the basis of investment limit and can be established by private individuals. The advantage of these industries include: promotion of self employment as well as generating employment furthers, use of local resources, reducing inequality of income as they can be owned by individuals etc.

2.7 NEW ECONOMIC POLICY

As said above, the heavy industry strategy was implemented under the ownership and management of the public sector. The government made budgetary provisions for the public sector to create infrastructure and establish industries. The process went on for more than three decades. However, an evaluation of the performance of the public sector by the government itself found that barring a few, more than half of the public sector units have been running on losses. There was gross mismanagement and labour problems falling the public sector units. It was a major shock to the government to find all these short comings of public sector. The failure of the public sector on various fronts was seen as one of the major reasons for lack of all round development of the country in the area of industrialisation, removal of poverty and unemployment etc. Hence in 1991, the central government came out with a new economic policy resolution. The main feature of this policy are:

(i) Liberalization

(ii) Privatization

(iii) Globalization

The policy is also popularly called LPG model of development.

Meaning of and Need for Liberalization

Liberalization means withdrawal of controls and regulations by the government on establishment and running of industries in the country. Till 1991, all the public sector units were practically under the government even if they were called

autonomous bodies. There were lot of interventions by the ministries of the government in functioning of the public sector. This resulted in politilization and fall in professionalism and inefficiency. In order to overcome this problem the government decided to stop political intervention in the running of the public sector units by signing a memorandum of understanding. According to this the management of public sector units will be given autonomy to function but they will also be accountable.

Another important feature of liberalization is to do away with the licensing system. Earlier it was mandatory for any private individual or organization to seek permission from the government to start any industrial activity. There was heavy rush and long queue before the window of the concerned government department to get a license. This system slowly gave rise to delays in getting license. Government officials started taking bribes to clear files. Such corrupt practices brought bad name to the government. So in 1991 government decided to abandon the licensing system and allowed the interested individuals to start their industrial activity without any permission. However, permission is still required only in case of strategic industries such as medicine, defence equipments etc.

Meaning of and Need for Privatization

Privatization implies opening of the door of industrial activities to the private sector which was exclusively reserved for public sector only except nuclear enemy and defence. Since basic and heavy industries were strictly under public sector there was no room for competition. The quality of product and services deteriorated due to lack of competition from other companies. As a result the consumers were the major looser because they did not get quality products and the delivery system and other services were also very poor. So the government decided to allow and encourage the entry of private sector in the areas earlier reserved for public sector only. As a result private sector entry was seen in tele communication, civil aviation etc. The government also decided to disinvest some of the public sector companies by selling part of their assets to public.

Meaning of and Need for Globalization

Globalization is a process in which attempts are made by the different countries in the world to allow free flow of goods and services, labour technology, investments etc. India is a member of world trade organization (WTO) which is the nodal agency to promote globalization. In 1991 industrial policy, India adopted soft attitude towards foreign companies to do their business in India in order to promote competition. It also committed itself to abolish or reduce tariff on import of commodities. On the otherhand, India also adopted policies to promote exports. The government also allowed foreign companies to hold 51 percent share or more

in case of their collaboration with Indian companies so that they can function freely and as the owner. This will also facilitate transfer of latest technology into Indian territory.

INTEXT QUESTIONS 2.3

1. Liberalization aims at retaining the licencing system. True or False
2. Privatization policy will help in enhancing competition in the market. True or False
3. Globalization aims at imposing tariff on imported goods. True or False

2.8 ACHIEVEMENTS OF ECONOMIC PLANNING

Economic planning in India was started in 1951. As said earlier, there were certain objective of economic planning which include: achieving economic growth in terms of increase in real national and per capita income, increase in the level of employment, removal of inequality in the distribution of income removal of poverty, ensuring social and economic justice etc. By 2014, India has completed 63 years of planning and has entered into twelfth plan period. It is high time to know the achievements of planning keeping in view its objectives. Let us discuss them.

1. Achievements in Economic Growth

Achieving economic growth was a major objectives of planning. To achieve growth it is necessary to achieve increase in national income and per capita income as well as increase in production of agricultural and industry sectors. A review of different plans shows that, the first five year plan was a success as it achieved a growth rate of 3.6 per cent against a target of 2.1 percent growth rate in national income. Then except for 5th and 6th plans, during the other plan periods i.e. from second to eleven five year plan the targeted growth rate in national income could not be achieved.

Similarly, The per capita income has attained growth but the rate of growth has been very slow. For example : During the first 30 years of planning the per capita income grew at a very slow rate of 1.2 per cent per year. Recently this growth rate has increased to some extent. Coming to agriculture, the food grain production has gone up from 51 million tones at the beginning of the first plan to 257.4 million tones in 2011-12. Particularly the production of rice, wheat has been spectacular, but production of pulses and oil seeds etc., has been below target.

In terms of industrial development, a major achievement has been the diversification of Indian industries. There has been expansion of transport and communications, growth in generation and distribution of electricity and considerable progress in steel, aluminium, engineering goods, chemicals, fertilizers and petroleum products.

During the planning period, the per capita availability consumer goods and other essential items has increased considerably. The goods worth mentioning here include-cereals, sugar, milk, egg, edible oil, tea, cloth and electricity.

2. Creation of Infrastructure

India has achieved a great deal in the area of creation of infrastructure. There has been large expansion roads and railway networks. Domestic air travel has increased significantly. Expansion of irrigation and hydro-electric projects has given boost to agricultural production. There has been growth in establishment of towns and cities due to increase in urban infrastructure. Communication network in the form of mobile telephony, internet has expanded tremendously.

3. Development in Education

One of the brightest areas of achievements of planning has been the development in education in India. There has been a significant increase in the enrolment of children at school level. There are 378 universities and 18,064 colleges in India which is a good development for higher education. India has also 1.52 lakh higher secondary and 10.43 lakh primary and upper primary schools.

4. Development of Science and Technology

Another significant area of achievement has been the growth in science and technology including the increase in technical and skilled manpower. India's march in space research has been noticed by the developed countries. It has made impact in the field of nuclear energy as well. Today India's Dependence on foreign experts for consultation has reduced. On the contrary it is now able to send technical experts to many foreign countries in the middle east, Africa etc.

5. Expansion of Foreign Trade

Due to industrialization in the country, India's dependence on import of capital goods has delivered. Many items, which were imported earlier are being produced domestically. Due to industrial progress, India is also able to export manufacturing and engineering goods.

INTEXT QUESTIONS 2.4

1. During which plan period, the actual growth rate of national income was more than the targeted growth rate.

   (a) Second plan (b) First plan

(c) Eleventh plan (d) Ninth plan

2. The growth rate of per capita income was higher in the beginning of plan period as compared to the period in the beginning of 21st century.

   True or False.

2.9 DRAWBACKS OR FAILURES OF PLANNING

Besides the achievements as told above, there are many unfulfilled tasks which the planning in India is yet to achieve completely.

1. Failure to Remove Poverty and Inequality completely :

Even after more than sixty years of planning, India has not been able to remove poverty completely. More than 240 million people are still under absolute poverty according to official estimates. The situation is worse in rural area. The government has introduced many antipoverty measures. But they have not been very successful so far.

Similarly, there is no significant improvement in the distribution of income and asset holding resulting in existence of inequality. The number of lanless agricultural labourers is very high as compared to the land holding population. The process of industrialization has helped some big industrial houses. This has resulted in concentration of economic wealth and power in few hands. This trend must be reversed if India wants to achieve equity and social justice.

2. Problem of Unemployment Persists :

Inspite of growth in income and output, India's employment situation has not improved much. Due to faster growth of population and labour force the situation has worsened further. According to official estimates India's unemployment rate is 6.6%. There is also huge backlog of unemployment due to lack of creation of required amount of jobs every year.

3. Failure to Curtail Corruption and Black Money :

Existence of rampant corruption in various public offices is a matter of grave concern in India. Common person faces a lot of problem in getting things done without giving bribe. Infact corruption has become a major political issue in elections. Various forms of corruption include paying or accepting bribe, non-payment of tax to government, political influence to get contract, secret understanding among sellers to increase price etc. Corruption has given rise to black money which is not accounted anywhere but very much in circulation. A sizeable portion of India's GDP is unaccounted . Black money creates inflation and

pressure in the society. It is also the root cause of inequality in distribution of income as people who possess black money grow richer at the cost of common citizen.

WHAT YOU HAVE LEARNT

- To solve its various economic problems India adopted Five year plans starting from 1951.
- The objectives of planning include : economic growth, increase in employment, removal of inequality and poverty and achieving social justice and equity.
- India adopted the strategy of industrialization with emphasis on basic and heavy industries to achieve the desired objectives.
- Even if the national income and the per capita income of India have recorded growth rates during planning period, the growth rates are below the target.
- India's progress in infrastructure, education, science and technology and foreign trade has been note worthy.
- Significant drawbacks of planning in India include inability to eradicate poverty, inequality and unemployment completely.
- Corruption in public places and prevalence of black money are major threats to development in India.
- In 1991 the government adopted new economic policy in order to rectify the problems associated with public sector to promote industrialization and to achieve faster economic growth.
- The new economic policy is called LPG model i.e. Liberalization, Privatization and globalization.
- LPG policy aims at removing licensing policy, promoting competition in the market and encouraging free trade in the world.

TERMINAL EXERCISE

Short answer type questions

1. Give the meaning of planning ?
2. Write two objectives of planning in India ?
3. Name two types of resources needed for planning with examples ?
4. Give one justification for adopting the strategy of industrialization ?

Long answer type questions

1. Explain the steps involved in the process of planning ?
2. Discuss the objectives of removal of inequality and poverty ?
3. Which strategy did India adopt to achieve the plan target and why ?
4. Explain the objectives of economic growth and increase in employment under planning in India ?
5. Explain 3 achievements of economic planning in India ?
6. Evaluate the performance of planning in removing poverty and inequality ?
7. Write a short note on achievement of planning with respect to economic growth?
8. Comment on the development of infrastructure in India?
9. Give reasons for adopting a new economic policy?
10. Explain the LPG model of the government to promote economic growth?

ANSWERS TO INTEXT QUESTIONS

2.1

1. (a) 2. (b) 3. (c) 4. (d)

2.2

1 (a) 2. (b)

2.3

1. False 2. True 3. False

2.4

1. (b) 2. False

MODULE - II
CURRENT CHALLENGES BEFORE THE INDIAN ECONOMY

3. Economic Growth and Economic Development
4. The Problem of Unemployment, Poverty and Inequality

3

ECONOMIC GROWTH AND ECONOMIC DEVELOPMENT

Economics is all about making smart choices to cope with scarcity. The most fundamental measurement used to evaluate the success in allocating the scarce resources is economic growth. Individuals monitor their **income** and the changing value of their **assets**. Businesses track their **profits** and their **market share**. Nations monitor a variety of statistics to measure economic growth such as **national income, productivity etc.** Moving beyond growth and productivity, some economists argue that any assessment of the nation's economy must also include measurements of distribution, equity, per-capita income etc. Further, the country should also focus on other needs of a society, like environmental justice or cultural preservation to sustain the economic growth process and allows an overall human development in the economy through creation of more opportunities in the sectors of education, healthcare, employment and the conservation of the environment.

OBJECTIVES

After completing this lesson, you will be able to:

- define the meaning of Economic Growth and Economic Development, and their differences;
- explain the concept of Sustainable Development and Human Development;
- list out the factors affecting Economic Growth; and
- describe the broad Features of the Underdeveloped countries.

3.1 ECONOMIC GROWTH

The term economic growth is defined as the process whereby the country's real national and per capita income increases over a long period of time.

This definition of economic growth consists of the following features of economic growth:

- **Economic Growth implies a process of increase in National Income and Per-Capita Income.** The increase in Per-Capita income is the better measure of Economic Growth since it reflects increase in the improvement of living standards of masses.
- **Economic Growth is measured by increase in real National Income and not just the increase in money income or the nominal national income**. In other words the increase should be in terms of increase of output of goods and services, and not due to a mere increase in the market prices of existing goods.
- **Increase in Real Income should be Over a Long Period**: The increase of real national income and per-capita income should be sustained over a long period of time. The short-run seasonal or temporary increases in income should not be confused with economic growth.
- **Increase in income should be based on Increase in Productive Capacity:** Increase in Income can be sustained only when this increase results from some durable increase in productive capacity of the economy like modernization or use of new technology in production, strengthening of infrastructure like transport network, improved electricity generation etc.

3.2 ECONOMIC DEVELOPMENT

Economic development is defined as a sustained improvement in material well being of society. Economic development is a wider concept than economic growth. Apart from growth of national income, it includes changes – social, cultural, political as well as economic which contribute to material progress. It contains changes in resource supplies, in the rate of capital formation, in size and composition of population, in technology, skills and efficiency, in institutional and organizational set-up. These changes fulfill the wider objectives of ensuring more equitable income distribution, greater employment and poverty alleviation. In short, economic development is a process consisting of a long chain of inter-related changes in fundamental factors of supply and in the structure of demand, leading to a rise in the net national product of a country in the long run.

The economic growth is a narrow term. It involves increase in output in quantitative terms but economic development includes changes in qualitative terms such as social attitudes and customs along with quantitative growth of output or national income.

Economic development without growth is almost inconceivable. The comparison between the two concepts is given in the following table:

3.3 COMPARISON CHART: ECONOMIC GROWTH VS. ECONOMIC DEVELOPMENT

	Economic Growth	Economic Development
Meaning	Economic growth refers to an increase in the real output of goods and services in the country.	Economic development implies changes in income, savings and investment along with progressive changes in socio-economic structure of country (institutional and technological changes).
Factors:	Growth relates to a gradual increase in one of the components of Gross Domestic Product: consumption, government spending, investment, net exports.	Development relates to growth of human capital, decrease in inequality figures, and structural changes that improve the quality of life of the population.
Measurement:	Economic Growth is measured by quantitative factors such as increase in real GDP or per capita income	The qualitative measures such as HDI (Human Development Index), gender- related index, Human poverty index (HPI), infant mortality, literacy rate etc. are used to measure economic development.
Effect:	Economic growth brings quantitative changes in the economy.	Economic Development leads to qualitative as well as quantitative changes in the economy.
Relevance:	Economic growth reflects the growth of national or per capita income.	Economic development reflects progress in the quality of life in a country.

INTEXT QUESTION 3.1

1. "Economic Development is a wider concept than Economic Growth". Do you agree with the statement?

3.4 SUSTAINABLE DEVELOPMENT

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development includes the protection of future economic growth and future development. In other words, it means a better quality of life for everyone, now and for generations to come. Sustainable development includes the protection of future economic growth and future development. Growth is essential, but sustainable development requires it to be different. It must become more concerned about the physical environment not only to present generation, but to the future generation also. It means that the current consumption cannot be financed for long by increasing economic debt and ecological imbalance which future generation will pay. Sustainable development constantly seeks to achieve social and economic progress in ways that will not exhaust the earth's finite natural resources. Sustainable development is a process of development in which economic and other policies are designed to bring about development which is economically, socially and ecologically sustainable. The concept thus is pro-people, pro-job and pro-nature. It gives highest priority to poverty reduction, productive employment, social integration and environmental regeneration.

The sustainable development thus requires

- Preservation of Ecological Resources and greater use of renewable resources.
- Encouragement to the use of environmentally-safe technologies for development purposes i.e. focus on reduction of all kinds of pollution involved in the economic activities.
- Formulation and implementation of policy framework for people-security and human justice, including ecological and economic security.

3.5 HUMAN DEVELOPMENT

According to the United Nation's Development Programme (UNDP), human development may be defined as "a process of enlarging people's choices." At all levels of development, the three essential choices for people include to live a long and healthy life, to acquire better knowledge and to have access to resources needed for a decent standard of living. If these essential choices are not available, many other opportunities to improve the quality of life will remain inaccessible. Human development has two dimensions: acquiring human capabilities and the use

of these acquired capabilities for productive, leisure and other purposes. The benefits of human development go far beyond the expansion of income and wealth accumulation because people constitute the very essence of human development. Human development is about much more than economic growth. The economic growth focuses on the improvement of one option i.e. income or product while human development focus on enlarging all human options including education, health, clean environment and material well being. Thus, the options available for improving people's lives are influenced by the quality of economic growth in its wider sense, and the impact is by no means confined to quantitative aspects of such growth. In other words, economic growth needs to be seen as a means, albeit an important one, and not the ultimate goal, of development. Income makes an important contribution to human well-being, broadly conceived, if its benefits are translated into more fulfilled human lives. But the growth of income is not an end in itself. It is the quality of growth, not its quantity alone, which is crucial for human well-being.

Thus, the concept of human development, is concerned mainly with enabling people to enjoy a better life as the ultimate goal of human endeavor. Highlights that this goal cannot be achieved solely through improvements in income or material well-being.

As the 1996 Human Development Report put it, growth can be jobless, rather than job creating; ruthless, rather than poverty-reducing; voiceless, rather than participatory; rootless, rather than culturally enshrined; and futureless, rather than environment-friendly. Economic growth which is jobless, ruthless, voiceless, rootless and futureless is not conducive to human development. The lack of income or income poverty is only one aspect of human impoverishment; deprivation can also occur in other areas– having a short and unhealthy life, being illiterate or not allowed to participate, feeling personal insecurity, etc. Human poverty is thus larger than income poverty.

3.6 MEASURING HUMAN DEVELOPMENT: HUMAN DEVELOPMENT INDEX (HDI)

As stated earlier three dimensions of Human Development are capabilities of people to lead a long and healthy life, to acquire knowledge and to have access to resources needed for a decent standard of living. The combined effect of various components of human development is measured through Human Development Index (HDI). The HDI contains four variables: life expectancy at birth, to represent the dimension of a long, healthy life; adult literacy rate and combined enrolment rate at the primary, secondary and tertiary levels to represent the knowledge dimension; and real GDP per capita to serve as a proxy for the resources needed for a decent standard of living. HDI thus looks not only at GDP

growth rate but takes into account education, health, gender inequality and income parameters to measure human development of a country.

As per the latest available Human Development Report (HDR) 2013 published by the United Nations Development Programme (UNDP) (which estimates the human development index [HDI] in terms of three basic capabilities: to live a long and healthy life, to be educated and knowledgeable, and to enjoy a decent economic standard of living), the HDI for India was 0.554 in 2012 with an overall global ranking of 136 (out of 186 countries) compared to 134 (out of 187 countries) as per HDR 2012. India's HDI has risen by 1.7% annually since 1980.

INTEXT QUESTION 3.2

1. Human development is a better measure of economic development as it places human-beings at the centre stage of development. Discuss.

3.7 FACTORS AFFECTING ECONOMIC GROWTH

The process of economic growth is a highly complex phenomenon and is influenced by numerous and varied factors such as political, social and cultural factors. These factors are as follows:

A. Economic Factors

1. **Natural Resources:** The principal factor affecting the development of an economy is the natural resources. The natural resources include the land area and the quality of the soil, forest wealth, good river system, minerals and oil resources, good climate, etc. For economic growth, the existence of natural resources in abundance is essential. A country deficient in natural resources may not be in a position to develop rapidly. However, the availability of rich natural resources are a necessary condition for economic growth but not a sufficient one. In less developed countries, natural resources are unutilized, underutilized or misutilised. This is one of the reasons of their backwardness. On the otherhand countries such as Japan, Singapore etc. are not endowed with abundant natural resources but they are among the developed nations of the world. These countries have shown committment towards preserving the available resources, putting best efforts to manage the resources, minimizing waste of resources etc.

2. **Capital Formation:** Capital formation is another important factor for development of an economy. Capital formation is the process by which a community's savings are channelised into investments in capital goods such as plant, equipment and machinery that increases nation's productive capacity and worker's efficiency thus ensuring a larger flow of goods and services in a

country. The process of capital formation implies that a community does not spend whole of its income on goods for current consumption, but saves a part of it and uses it to produce or acquire capital goods that greatly add to productive capacity of the nation.

3. **Technological Progress**: Technological progress is a very important factor in determining the rate of economic growth. Technological progress mainly implies the research into the use of new and better methods of production or the improvement of the old methods. Sometimes technical progress results in the availability of natural resources. But generally technological progress results in increase in productivity. In other words, technological progress increases the ability to make a more effective and fruitful use of natural and other resources for increasing production. By the use of improved technology it is possible to have greater output from the use of given resources or a given output can be obtained by the use of a smaller quantity of resources. The technological progress improves an ability to make a fuller use of the natural resources e.g. with the aid of power - driven farm equipment a marked increase has been brought about in agricultural production. The USA, UK, France, Japan and other advanced industrial nations have all acquired the industrial strength from use of advanced technology. In fact economic development is facilitated with the adoption of new techniques of production.

Entrepreneurship

Entrepreneurship implies an ability to find out new investment opportunities, willingness to take risks and make investment in the new and growing business units. Most of the underdeveloped countries in the world are poor not because there is shortage of capital, weak infrastructure, unskilled labor and deficiency of natural resources, but because of acute deficiency of entrepreneurship. It is, therefore, essential in the under-developed nations to create climate for promoting entrepreneurship by emphasizing education, new researches, and scientific and technological developments

4. **Human Resources Development:** A good quality of population is very important in determining the level of economic growth. So the investment in human capital in the form of educational and medical and such other social schemes is very much desirable. Human resource development increases the knowledge, the skills and the capabilities of the people that increase their productivity.

5. **Population Growth:** Labor supply comes from population growth and it provides expanding market for goods and services. Thus, more labor produces larger output which a wider market absorbs. In this process, output, income and employment keep on rising and economic growth improves. But the population growth should be normal. A galloping rise in population retards

economic progress. Population growth is desirable only in a under-populated country. It is, however, unwarranted in an overpopulated country like India.

6. **Social Overheads:** Another important determinant of economic growth is the provision of social overheads like schools, colleges, technical institutions, medical colleges, hospitals and public health facilities. Such facilities make the working population healthy, efficient and responsible. Such people can well take their country economically forward.

Non-Economic Factors

Non-Economic factors that include socio-economic, cultural, psychological and political factors are also equally significant as are economic factors in economic development. We discuss here some of the essential non economic factors which determine the economic growth of an economy.

1. **Political Factors:** Political stability and strong administration are essential and helpful in modern economic growth. The stable, strong and efficient government, honest administration, transparent policies and their efficient implementation develop confidence of investors and attracts domestic as well as foreign capital that leads to faster economic development.
2. **Social and Psychological Factors:** Social factors include social attitudes, social values and social institutions which change with the expansion of education and transformation of culture from one society to the other. The modern ideology, values, and attitudes bring new discoveries and innovations and consequently to the rise of the new entrepreneurs. The outdated social customs restricts occupational and geographical mobility and thus pose an obstacle to the economic development.
3. **Education:** It is now fairly recognized that education is the main vehicle of development. Greater progress has been achieved in those countries, where education is wide spread. Education plays an important role in human resource development, improves labor efficiency and removes mental block to new ideas and knowledge thus contributes to economic development.
4. **Desire for Material Betterment:** The desire for material progress is a necessary precondition for economic development. The societies that focus on self-satisfaction, self-denial, faith in fate etc. limit risk and enterprise and thus keep the economy backward.

INTEXT QUESTION 3.3

1. Non-economic factors are as much important in economic development as economic factors. Comment.

3.8 COMMON FEATURES OF UNDERDEVELOPED COUNTRIES

1. **Low per Capita Income:** The level of per capita income is very low in underdeveloped countries.
2. **Poor Level of Living:** The vast majority of people in underdeveloped nations lie under the conditions of poverty, malnutrition, disease, illiteracy, etc. Even basic necessities of life such as minimum food clothing and shelter are not easily accessible to the poor masses.
3. **High Rate of Growth of Population:** Population growth in underdeveloped countries neutralizes economic growth. High population implies greater consumption expenditure and lower investments in productive activities and slows down the economic development.
4. **Highly Unequal Income Distribution:** The income inequality between the rich and the poor people within the underdeveloped countries is also very high.
5. **Prevalence of Mass Poverty:** Low level of per capita income combined with high degree of inequalities in its distribution leads to widespread poverty in underdeveloped countries.
6. **Low Levels of Productivity:** The Productivity level (i.e. output produced per person) tends to be very low in an underdeveloped country which is mainly due to : (i) inefficient workforce which itself is a consequence of poverty, ill health and lack of education (ii) Low work culture (iii) Low use of capita in the form of machinery and equipment.
7. **Low Rate of Capital Formation:** The saving rate in an underdeveloped country is quite low and rate of capital formation is also is very slow.
8. **Technological Backwardness:** In most of the sectors, an underdeveloped economy the techniques of production employed are generally obsolete mainly due to low saving rate.
9. **High Level of Unemployment:** Unemployment levels are very high in the underdeveloped countries mainly due to lack of capital and low level of development in various economic sectors, these countries are not able to absorb the rising labor supply.
10. **Low Social Indicators of Development:** The under-developed countries have very low social indicators such as low literacy rate, high infant mortality rate, low expectancy of life, etc. as compared to the developed countries.

INTEXT QUESTIONS 3.4

1. Which of the following characteristics are most likely found in developing countries?

(a) high population growth rates.

(b) large number of people living in poverty.

(c) very traditional methods of agricultural production.

(d) all of the above

(e) none of the above

2. Economic development refers to

(a) economic growth.

(b) economic growth plus changes in output distribution and economic structure.

(c) sustainable increases in Gross National Product.

3. The common measure of economic development is

(a) The level of health and education of the population.

(b) The rate of population growth.

(c) Per Capita GDP

(d) All of the above

(e) None of the above.

4. developing nations have

(a) A lower infant mortality rate.

(b) A greater degree of equality in the income distribution.

(c) lower rate of illiteracy.

(d) None of above.

5. Sustainable development involves

(a) Reducing Consumption, increasing efficiency and using renewable energies.

(b) better transportation by building more roads

(c) Using Resources at maximum rates.

6. Sustainability is the use of a resource that doesnot cause long term depletion of resources or affect the diversity of the ecosystem.

(a) True.

(b) False.

7. Which three indicators are currently used in the Human Development Index (HDI):

(a) real GDP per capita

(b) Birth rates

(c) Life expectancy at birth

(d) Employment Rates

(e) Educational attainment.

WHAT YOU HAVE LEARNT

- Economic growth implies a process of increase in real national income and real per capita income.
- Economic development is defined as a sustained improvement in material well being of society.
- Sustainable development in development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
- Human development may be defined as "a process of enlarging people's choices".
- According to UNDP, human Development Index (HDI) includes three basic capabilities (indicators) to live a long and healthy life, to be educated and knowledgeable and to enjoy a decent economic standard of living.
- Economic factors affecting growth and development are: natural resources, capital formation, technological progress, entrepreneurship, human resource development, population growth and social overheads.
- Non-economic factors affecting growth and development are: political factors, social and psychological factors, education and desire for material betterment.
- Common features of developing countries are: (i) Low per capita income, (ii) Poor level of living, (iii) High rate of growth of population, (iv) Highly inequal income distribution, (v) Prevalence of mass poverty, (vi) Low levels of productivity, (vi) Low rate of capital formation, (viii) Technological backwardness, (ix) High level of unemployment, and (x) Low social indicators of development.

TERMINAL EXERCISE

1. What is economic growth? Do you think that economic growth and economic development are two names for the same concept?

   Hint: Meaning of economic growth and difference between economic growth and economic development.

2. There is no automatic link between economic growth and human development. Discuss.

Hint: Meaning of human development and difference between economic growth and human development.

3. What are the common features of Underdeveloped countries?

   Hint: features of underdeveloped countries.

4. What are the important components of the Human Development Index (HDI)

   Hint: meaning of HDI

5. Explain the meaning of Sustainable development.

   Hint: Concept of sustainable development.

ANSWERS TO INTEXT QUESTIONS

3.1

1. Difference between economic growth and economic development.

3.2

1. Meaning of human development.

3.3

1. Economic and Non-economic factors of growth.

3.4

1. (d) 2. (b) 3. (c) 4. (d) 5. (a) 6. (a)
7. (a), (c) and (e)

Notes

4

THE PROBLEM OF UNEMPLOYMENT, POVERTY AND INEQUALITY

In India, the problems of unemployment and poverty have always been major obstacles to economic development. Regional disparity is also crucial in this context. Economic reforms, changes in the industrial policy and better utilization of available resources are expected to reduce the problem of unemployment and poverty. The governmental bodies are also required to initiate long term measures for poverty alleviation. Generation of employment opportunities and equality in income distribution are the two key factors that are of utmost important to deal with the dual problem of unemployment and poverty.

OBJECTIVES

After completing this lesson, you will be able to:

- explain the meaning, types and important measures of unemployment;
- identify the causes of unemployment;
- know the Government policies and programmes implemented to alleviate poverty and generate employment; and
- evaluate the extent and causes of regional disparity in India.

4.1 MEASUREMENT AND MAGNITUDE OF UNEMPLOYMENT IN INDIA

4.1.1 Meaning and Types of Unemployment

The population of any country consists of two components **(i) Labor Force (ii) Non-Labor Force.** Labor force means all persons who are working (i.e. being engaged in the economic activity) as well as those who are not working but are

seeking or available for work at the current wage rate. It means the labor force consists of both employed and unemployed people.

The component of population which is not a part of the labor force is Non-Labor Force. It includes all those who are not working and are neither seeking nor available for work.

Unemployment can be defined as a state of workless ness for a person who is fit and willing to work at the current wage rate. It is a condition of involuntary and not voluntary idleness. Simply stated an unemployed person is the one who is an active member of the labor force and is seeking work, but is unable to find the same. In case of voluntary unemployment a person is out of job on his own accord or choice, doesn't work on the prevalent or prescribed wages. Either he wants higher wages or doesn't want to work at all. The involuntary unemployment on the other hand is the situation when a person is separated from remunerative work and devoid of wages although he is capable of earning his wages and is also anxious to earn them. It is the involuntary idleness that constitutes unemployment. Involuntary unemployment can be further divided into cyclical unemployment, seasonal unemployment, structural unemployment, frictional unemployment, natural rate of unemployment, disguised unemployment and under employment.

4.1.1.1 Cyclical Unemployment

Cyclical or demand deficient unemployment occurs when the economy is in need of low workforce. When there is an economy-wide decline in aggregate demand for goods and services, employment declines and unemployment correspondingly increases. Cyclical unemployment mainly occurs during recession or depression. This form of unemployment is most commonly known as cyclical unemployment since unemployment moves with the trade cycle. For instance, during the recent global slowdown in late 2008, many workers around the globe lost their jobs.

4.1.1.2 Seasonal Unemployment

This type of unemployment occurs in a particular time of the year or season and thus is known as seasonal unemployment. Seasonal unemployment is most common in industries like agriculture, tourism, hotel, catering etc.

4.1.1.3 Structural Unemployment

Structural unemployment arises when the qualification of a person is not sufficient to meet his job responsibilities. It arises due to long term change in the pattern of demand that changes the basic structure of the economy. The person is not able to learn new technologies used in the new expanding economic sectors and they thus may be rendered permanently unemployed. For instance, when computers were

introduced, many workers were dislodged because of a mismatch between the existing skills of the workers and the requirement of the job. Although jobs were available, there was a demand for a new kind of skill and qualification. So, persons with old skills did not get employment in the changed economic regime, and remain unemployed.

4.1.1.4 Frictional Unemployment

Frictional unemployment occurs when a person is out of one job and is searching for another for different reasons such as seeking a better job, being fired from a current job, or having voluntarily quit a current job. It generally requires some time before a person can get the next job. During this time he is frictionally unemployed.

4.1.1.5 Natural rate of unemployment

The sum total of frictional and structural unemployment is referred as the natural rate of unemployment.

4.1.1.6 Disguised Unemployment

The unemployment which is not visible is said to be disguised unemployment. It occurs when a person doesn't contribute anything to the output even when visibly working. This happens amongst family labor especially in agriculture who are engaged on land but are not contributing to the given level of output. Thus their marginal productivity is zero.

4.1.1.7 Underemployment

When a person is engaged in the economic activity but that fail to provide him fully in accordance to his qualification and efforts. Thus it is a situation in which a person is employed but not in the desired capacity whether in terms of compensation, hours, or level of skill and experience. While not technically unemployed the underemployed often compete for available jobs.

4.2 MEASUREMENT OF UNEMPLOYMENT

Unemployment rate is the percent of the labor force that is without work. It is calculated as below:

Unemployment rate = (Unemployed Workers/Total labor force) × 100

Measurement of unemployment is a difficult task. In India, the most comprehensive and reliable data on employment and unemployment are compiled by the National Sample Survey Organization (NSSO). Based on different reference period (a year, a week, and each day of a week), NSSO provides four different measures of

employment and unemployment. The following are some methods of measuring unemployment:

(i) **Usual Principal Status Unemployment (UPS):** This is measured as the number of persons who remained unemployed for a major part of the year. The persons covered by the survey may be classified into those working and/or available for work in their principal activity, and those working and/or available for work in a subsidiary activity, that is, a sector other than their principal activity. Hence, within the usual status concept, the estimates are now derived on the usual principal status as well as the usual principal and subsidiary status basis. The usual status unemployment rate is a person rate and indicates chronic unemployment, because all those who are found usually unemployed in the reference year are counted as unemployed. This measure is more appropriate to those in search of regular employment, e.g., educated and skilled persons who may not accept casual work. This is also referred to as 'open unemployment'.

(ii) **Usual Principal and Subsidiary Status Unemployment (UPSS):** Here person is considered unemployed, if besides UPS, those available but unable to find work on a subsidiary basis during a year.

(iii) **Current Weekly Status Unemployment (CWS):** This refers to the number of persons who did not find even an hour of work during the survey week.

(iv) **Current Daily Status Unemployment (CDS):** This refers to the number of persons who did not find work on a day, or on some days, during the survey week.

Rates of unemployment differ based on different concepts. The UPS and UPSS measure reflect only long term unemployment spells. The CWS measure captures shorter unemployment spells, but ignores unemployment for less than a week. The CDS measure is the most inclusive, capturing both open as well as partial unemployment. The unemployment rate based on different measures is given under the following table 4.1:

Table 4.1: Unemployment Rate (%)

Year	2004-05	2009-10	2010-11
UPSS	2.3	2.0	2.2
CWS	4.4	3.6	3.7
CDS	8.2	6.6	5.6

Source: NSSO Surveys, till 2014

It is clear from the above table that there is decline in the unemployment rate since 2004-05. UPSS has remained more or less same between 2004-05 to 2010-11 at marginally above 2 per cent. CWS declined from 4.4 per cent in 2004-05 to 3.6 in 2009-10 and almost remained same at 3.7 in 2010-11. CDS decreased continuously from 8.2 per cent in 2004-05 to 6.6 per cent in 2009-10 and 5.6 per cent in 2010-11

4.3 CAUSES OF UNEMPLOYMENT IN INDIA

4.3.1 Slow Economic Growth

During the planning period the trend rate of growth was considerably lower than the targeted rate. Therefore, jobs in adequate number were not created. Further, economic growth by itself does not solve the problem of unemployment. In the recent past there has been deceleration in the growth of employment in spite of the accelerated economic growth. This can be explained in terms of steady decline in the degree of response of employment to change in output in all the major sectors of economic activity except in construction. According to T.S. Papola, over a period of time, the output growth in agriculture and manufacturing sector has become more input and technology-intensive and less labor-intensive. Besides, the sectoral composition of growth is also an important determinant of unemployment. Excessive dependence on agriculture and slow growth of non-farm activities limit employment generation.

4.3.2 Increase in Labor force

There are two important factors that have caused an increase in the labor force which are as follows:

(i) **Rapid Population Growth:** Rising population has led to the growth in the labor supply and without corresponding increase in the employment opportunities for the increasing labor force has aggravated the unemployment problem.

(ii) **Social Factors:** Since Independence, education among women has changed their attitude toward employment. Many of them now compete with men for jobs in the labor market. The economy has however failed to respond to these challenges and the net result is a continuous increase in unemployment backlogs.

4.3.3 Rural-Urban Migration

The unemployment in urban area is mainly the result of substantial rural migration to urban areas. Rural areas have failed to provide subsistence living in agriculture

and allied activities and so large scale migration is taking place to cities. However, economic development in cities has failed to create enough additional jobs for the new urban entrants to the labor market. Thus only some of the migrants are absorbed in productive activities and the rest join the reserve army of unemployed workers.

4.3.4 Inappropriate Technology

In India, though capital is a scarce factor, labor is available in abundant quantity; yet producers are increasingly substituting capital for labor. This policy results in larger unemployment. Despite the abundance of labor, capital intensive technology is adopted in India mainly because of rigid labor laws. It is quite difficult to follow easy hire and fire policy and so right sizing of manpower is difficult for the enterprises. It is difficult to reduce the number of labor-Force. Further, the factors like labor-unrest and lack of work-culture leads to the increased inefficiency of labor and thus provide incentives to follow labor-saving technology by organizations.

4.3.5 Defective Educational System

The present educational system has theoretical bias and has limited utility for productive purposes. It lacks the emphasis on the development of aptitude and technical qualifications required for various types of work among job seekers. This has created a mismatch between the need and availability of relevant skills and training, which results in unemployment, especially of youth and educated while shortage of technical and specialized personnel continues.

4.3.6 Lack of Infrastructure Development

Lack of investment and infrastructure development limits the growth and productive capacity of different sectors which leads to inadequate generation of employment opportunities in the economy.

4.3.7 Lack of employability

India faces poor health and nutrition situation among masses which reduces the capacity of person to be employable and it causes unemployment.

INTEXT QUESTION 4.1

1. What is unemployment rate? How is it measured in India?
2. What are the causes of increase in labor force in India?

4.4 POVERTY IN INDIA

In general, poverty can be defined as a situation when people are unable to satisfy the basic needs of life. The definition and methods of measuring poverty differs from country to country. The extent of poverty in India is measured by the number of people living below the **Poverty Line.**

4.4.1. Poverty Line

The **Poverty Line** defines a threshold income. Households earning below this threshold are considered poor. Different countries have different methods of defining the threshold income depending on local socio-economic needs. The Planning Commission releases the poverty estimates in India.

Poverty is measured based on consumer expenditure surveys of the National Sample Survey Organisation (NSSO). A poor household is defined as the one with an expenditure level below a specific poverty line.

Earlier, India used to define the poverty line based on a method defined by a task force in 1979. It was based on expenditure for buying food worth 2,400 calories in rural areas and 2,100 calories in urban areas. In 2009, the Suresh Tendulkar Committee defined the poverty line on the basis of monthly spending on food, education, health, electricity and transport.

The Planning Commission has updated the poverty lines and poverty ratios for the year 2009-10 as per the recommendations of the Tendulkar Committee. It has estimated the poverty lines at all India level as an MPCE (monthly per capita consumption expenditure) of `. 673 for rural areas and `. 860 for urban areas in 2009-10. So a person who spends ` 673 in rural areas and `. 860 in urban area per month is defined as living below the poverty line.

Based on these cut-offs, the percentage of people living below the poverty line in the country has declined from 37.2 per cent in 2004-5 to 29.8 per cent in 2009-10. Even in absolute terms, the number of poor people has fallen by 52.4 million during this period. Of this, 48.1 million are rural poor and 4.3 million are urban poor. Thus poverty has declined on an average by 1.5 percentage points per year between 2004-5 and 2009-10. The annual average rate of decline during the period 2004-5 to 2009-10 is twice the rate of decline during the period 1993-4 to 2004-5 (Table).

Table 4.2: Poverty Ratios (figures are in %)

Year	Rural	Urban	Total
1993-94	50.1	31	45.3
2004-05	41.8	25.7	37.2
2009-10	33	20.9	29.8

Source: Economic Survey 2013

4.5 CAUSES OF POVERTY IN INDIA

4.5.1 Vicious Circle of Poverty:

It is said that "a country is poor because it is poor." This idea has come down from Ragnar Nurkse who pinpointed the problem of the vicious circle of poverty. Low level of saving reduces the scope for investment; low level of investment yields low income and thus the circle of poverty goes on indefinitely.

4.5.2 Low Resources Endowment

A household is poor if the sum total of income earning assets which it commands, including land, capital and labor of various levels of skills, cannot provide an income above the poverty line. The poor mainly consists of unskilled labor, which typically does not command a high enough level of wage income.

4.5.3 Inequality in the Distribution of Income and Assets:

The distribution of income and assets also determine the level of income. The economic inequalities are the major cause of poverty in India. It means the benefits of the growth have been concentrated and have not "trickled down" sufficiently to ensure improved consumption among the lower income groups.

4.5.4 Lack of Access to Social Services

The lack of access to social services such as health and education compound the problems arising from inequality in the ownership of physical and human assets. These services directly affect household welfare. The poor typically get much less than a fair share of such services. This is partly because governments do not invest enough to ensure an adequate supply of these services and the limited supply is mainly availed by non-poor households. Further, the poor may not have adequate access for a variety of other reasons like lack access to information about the existence of such services, lack of knowledge and corruption.

4.5.5 Lack of access to Institutional Credit

The banks and other financial institutions are biased in the provision of loans to the poor for the fear of default in the repayment of loans. Further, the rules regarding collateral security, documentary evidences etc. present constraints for the poor to avail loan facility from banks. The inaccessibility to institutional credit may force poor to take credit from the landlord or other informal sources at a very high interest rate and which in turn may weaken their position in other areas, leading, for example, to the payment of abnormally high rental shares for land, or acceptance of abnormally low wages in various types of "bonded labour"

arrangements or selling their crop at a very low price. In some cases poor people cannot make themselves free from the clutches of moneylenders. Their poverty is further accentuated because of indebtedness. Such indebted families continue to remain under the poverty line for generations because of this debt-trap.

4.5.6 Price Rise

The rising prices have reduced the purchasing power of money and thus have reduced the real value of money income. The people belonging to low income group are compelled to reduce their consumption and thus move below the poverty line.

4.5.7 Lack of Productive Employment

The magnitude of poverty is directly linked to unemployment situation. The present employment conditions don't permit a reasonable level of living causing poverty. The lack of productive employment is mainly due to problems of infrastructure, inputs, credit, technology and marketing support. The gainful employment opportunities are lacking in the system.

4.5.8 Rapid Population Growth:

The faster population growth obviously means a slower growth in per capita incomes for any given rate of growth of gross domestic product (GDP), and therefore a slower rate of improvement in average living standards. Further the increased population growth increase consumption and reduces national savings and adversely affects the capital formation thereby limiting the growth in the national income.

4.5.9 Low Productivity in Agriculture

The level of productivity in agriculture is low due to subdivided and fragmented holdings, lack of capital, use of traditional methods of cultivation, illiteracy etc. This is the main cause of poverty in the rural India.

4.5.10 Social Causes

(i) **Education:** Education is an agent of social change. Poverty is also said to be closely related to the levels of schooling and these two have a circular relationship. The earning power is affected by investment in individual's education and training. However, poor people do not have the funds for human capital investment and thus it limits their income.

(ii) **Caste system:** Caste system in India has always been responsible for rural poverty. The subordination of the low caste people by the high caste people

caused the poverty of the former. Due to rigid caste system, the low caste people could not participate in various economic activities and so remain poor.

(iv) **Social customs:** The rural people generally spend a large percentage of annual earnings on social ceremonies like marriage, death feast etc. and borrow largely to meet these requirements. As a result, they remain in debt and poverty.

4.6 POVERTY ALLEVIATION AND EMPLOYMENT GENERATION PROGRAMMES IN INDIA

The government is following a focused approach through various flagship schemes in the areas of poverty alleviation and employment generation to achieve inclusive development.

4.6.1 Mahatma Gandhi National Rural Employment Guarantee Work (MGNREGA)

This flagship programme of the government aims at enhancing livelihood security of households in rural areas by providing at least one hundred days of guaranteed wage employment in a financial year to every household whose adult members volunteer to do unskilled manual work with the stipulation of one-third participation of women. The MGNREGA provides wage employment while also focusing on strengthening natural resource management through works that address causes of chronic poverty like drought, deforestation, and soil erosion and thus encourage sustainable development.

4.6.2 National Rural Livelihood Mission (NRLM)- Aajeevika

The Swarnjayanti Gram Swarozgar Yojana (SGSY)/ NRLM a self-employment programme implemented since April 1999 aims at lifting the assisted rural poor families (swarozgaris) above the poverty line by providing them income-generating assets through a mix of bank credit and government subsidy. The rural poors are organized into self-help groups (SHGs) and their capacities are built through training and skill development.

4.6.3 Swarna Jayanti Shahari Rozgar Yojana (SJSRY)

The SJSRY launched on 1 December 1997 aims at providing gainful employment to the urban unemployed and underemployed, by encouraging them to set up self-employment ventures or creating wage employment opportunities.

INTEXT QUESTIONS 4.2

1. Explain the concept of poverty line in India.
2. How does availability of institutional credit impact the level of poverty in India
3. What do you mean by vicious circle of poverty?

4.7 INEQUALITY IN INDIA

India is a vibrant country with quite an impressive economic growth profile and as expected, improvement in economic growth and per capita income has translated, at least partly, into reduction in the level of poverty in the country. It is a fact that there has been a secular decline in the share of poor in the population. However, there exists a wide spread disparities in the levels of social-economic development between the different regions of the country. The huge differences in living standards as measured by per capita incomes, across the States of India range from 12000 rupees per head in Bihar to nearly 100,000 rupees per head in Goa. They are the product of history and past growth experience. There are also other related disparities in the levels of education, literacy, health, infrastructure, population growth, investment expenditure and the structure of regions. The regional disparity in the last decade shows that India has a vast array of richer and poorer regions with Goa being the richest region and Bihar the poorest. In 2010/11, Chandigarh was the richest, but Bihar remained the poorest. There are also substantial variations in the average annual growth rate over the period, ranging from an impressive 8.39 per cent in Chandigarh to a sluggish 2.71 per cent in Jammu & Kashmir. Further, during this decade, the top four richest regions (viz, Goa, Chandigarh, Delhi and Puducherry) have high initial levels of GDSP (Gross Domestic State Product) per head and very fast growth over the period as compared to the other regions.

4.8 CAUSES OF GROWING REGIONAL DISPARITIES IN INDIA

4.8.1. Historical Factors

Historically regional imbalance in India started from its British regime. British industrialist mostly preferred to concentrate their activities in two states like west Bengal and Maharashtra and more particularly to their metropolitan cities like Kolkata, Mumbai and Chennai. They concentrated all their industries in and around these cities neglecting the rest of the country to remain backward.

4.8.2 Geographical factors

The difficult terrain surrounded by hills rivers and dense forest, leads to increase in the cost of administration, cost of development projects, besides making mobilization of resources partially difficult. Adverse climate and floods are also responsible factors for poor rate of economic develop-ment of different regions of the country as reflected by low agricultural productivity and lack of industrialization. These factors have resulted in uneven growth of differ-ent regions of India.

4.8.3 Infrastructure

The states with well-developed basic infrastructure such as power, water, roads and airport attracts the big investment projects and so has witnessed a very high growth rate. The poorer states on other hand lacking the basic infrastructure fails to attract private investments. This has accentuated the problem of inequality in the distribution of income and concentration of economic power.

4.8.4 Decline in Public Investment

In the new economic policy the Government has been continuously limiting its role with respect to participation in economic activity and has given more space to the private sector. There has been a steady decline in the public investment. This has adversely affected the poorer states. Since the public investment is a major contributor to growth of these States through bulk investments on irrigation, power and social sector projects decline in the same has adversely affected the process of development of many regions.

INTEXT QUESTIONS 4.3

1. The percentage of labour force that is unemployed is the:
   (a) employment rate
   (b) Unemployment Population Ratio.
   (c) Unemployment rate.
   (d) Labour force rate.
2. The labour force can be defined as:
   (a) Those of workers who are seeking work and are available for work at current wage rate.
   (b) Anyone who is working or actively seeking work.
   (c) The population between school-leaving age and retrirement age.
   (d) Those who could claim benefit if they were to become unemployed.
3. Cyclical Umemployment is the:

(a) Unemployment that results when people become discouraged about their chances of finding a job so that they stop looking for work

(b) Unemployment that occurs during recessions and depressions.

(c) portion of unemployment that is due to the normal working of the labour market.

(d) portion of unemployment that is due to changes in the structure of the economy that results in a significant loss of jobs in certain industries.

4. Which among the following is the method to estimate the poverty line in India?

(a) Investment method

(b) Capital method

(c) Human method

(d) Income method.

5. Who conducts the periodical sample survery for estimating the poverty line in India?

(a) National Survery Organisation

(b) National Sample Survey Organisation

(c) Sample Survey Organisation

(d) None of the above.

6. For how many days MNREGA provides employment?

(a) 70 (b) 80

(c) 90 (d) 100

WHAT YOU HAVE LEARNT

- An able bodied person who is willing to work but he is not getting any job is called an unemployed person.
- Cyclical unemployment occurs during the time of recession where there is fall in aggregate demand in the economy.
- Seasonal unemployment is mostly found in agriculture sector, tourism etc.
- Structural unemployment is caused due to lack of adjustment of the labour force with the change in demand.
- Frictional unemployment is created when a person searches for a better job or losses his current job.
- Disguised unemployment is a situation where marginal product of labour is zero.

- Underemployment is a situation where in a person does not receive the remuneration he/she deserves from his/her present occupation and also his/her capabilities are not fully used.
- Unemployment rate is defined as the percent of the labour force that is without work.
- There are following measures of unemployment in India- Usual Principal Status (UPS), Usual Principal and Subsidiary Status Unemployment (UPSS), Current Weekly Status (CWS) and Current Daily Status (CDS).
- UPS refers to a person who could not find a job for major part of the year.
- UPSS refers to a person who could not find a job for even on a subsidiary basis for a major part of the year.
- CWS refers to a person who could not get a job even for an hour in a week.
- CDS refers to a person who could not find a job in the reference day.
- Causes of unemployment in India include: Slow Economic Growth, Rapid Population Growth, Rural-Urban Migration, Backward Technology, Lack of Education and Lack of Infrastructure.
- Poverty line is defined as the level of income or expenditure below which a person cannot sustain himself/herself at the on going market price. Poverty Line has changed over time in India.
- Causes of Poverty in India include: Lack of Resources, Income Inequality, Lack of Access to Social Services, Lack of Access to Institutional Credit, Unemployment, Inflation etc.
- Some of the antipoverty programmes of the government include: MGNREGA, NRLM, SJSRY,
- Inequality in income distribution and regional inequality are major threat to Indian economic development.

TERMINAL EXERCISE

1. What are the causes of unemployment in India?
2. Discuss the causes of poverty in India.
3. Briefly explain various poverty alleviation programmes implemented by Government of India in recent years.
4. Explain the dimension of regional inequality in India.
5. What are causes of regional inequality in India?

ANSWER TO INTEXT QUESTIONS

4.1

1. See section 4.2
2. See section 4.3.2

4.2

1. Poverty line (see section 4.4.1)
2. See sec 4.5.4
3. See section 4.5.1

4.3

1. (c)
2. (a)
3. (b)
4. (d)
5. (b)
6. (d)

MODULE - III
INTRODUCTION TO STATISTICS

5. Meaning, Scope and its Need in Economics
6. Collection and Classification of Data
7. Presentation of Data

Notes

5

MEANING, SCOPE AND ITS NEED IN ECONOMICS

All of us want to know about everyday life around us. We can know about the nature of things both quantitatively and qualitatively. Many times we can express things better in quantitative terms, that is, in numbers. For example, by comparing the per capita income of India and the United States, we can say that India is a developing economy while United States is a developed economy.

The word 'Statistics' is derived from the Latin word 'statis' or the Italian word 'statists' or German word 'statistic.' All these words mean a political state. In the olden days statistics was necessary for the proper functioning of the affairs of a state. Thus, in those days Statistics was called as 'science of state' or 'science of kings' as it was mainly used by the state or kings. Today statistics is defined as a field of study relating to the collection analysis, interpretation and presentation of data. In this lesson you will learn about the meaning of statistics and its scope and its need in economics.

OBJECTIVES

After completing this lesson, you will be able to:

- explain the need and scope of statistics in Economics;
- describe the importance of statistics in Economics;
- know the characteristics of statistical data;
- carry out statistical enquiry;
- identify sources of statistical data; and
- explain the functions and limitations of statistics.

5.1 NEED AND SCOPE OF STATISTICS

(a) Need for Statistical Data

Statistics plays a very important role in the field of economics. There is need of statistical data in every walk of life. No field of study is complete without the supporting quantitative information about that field. Some of the ways in which statistics is widely used in economics are as follows:

(i) **In Construction of Economic Theories:** An economic theory is first developed on the basis of what we observe in real life. It is then approved or disapproved by the analysis of statistical data relevant to the observation. For example, it is observed that consumers demand less at higher prices. This observation takes the shape of a theory when it is confirmed from actual statistical data that consumers really demand less at higher prices.

(ii) **In Economic Planning:** Statistics is an important tool of economic planning. Planners use statistical data to formulate policies for economic development. For example, India is an over populated country. However, the extent of over population can be revealed by data on population and resources available to support the population. Effective policies to control population can be framed only after we know how much over-populated India is.

(iii) **In evaluation of policies of the government:** It is not only enough to implement policies but also necessary to know whether the implementation has been proper or not. Statistical data helps us to evaluate the policies of the government. For example, how much revenue did the government get through higher taxes? It is through statistical investigations that the Finance Minister gets feedback on the taxes paid by the people and the revenue accrued to the government.

(iv) **To reveal the structure of an economy:** We study the structure of an economy with the help of data on population, natural resources, employment, national income, production, exports, imports etc. The statistical knowledge about these helps us to know about the structure of the economy and the changes in the structure of the economy.

(b) Scope of Statistics

In ancient times, statistics was used by the state for the purpose of administration. But now a days, it is widely used as a tool of all sciences. There is hardly any field whether it be biology, botany, astronomy, physics, chemistry, sociology, or psychology where statistical tools are not used. The word statistics is used in two senses: (a) the plural sense and (b) the singular sense. In a plural sense it refers to quantitative information or simply statistical data. In singular sense, it refers to

method or methods used in arriving at the quantitative information or dealing with it. We can explain the difference between the two with the help of following example:

Table 5.1: Growth of Population in India

Year	Population (in crores)
1951	36.1
1961	43.9
1971	54.8
1981	68.5
1991	84.6
2001	102.87
2011	121.01

Source: Census of 2011 Population.

The above table 5.1 records population of India in different years. Here we are referring only to the quantitative information about population. We are using the word statistics in the plural sense in this case.

When we say that population of India was estimated through the census method; that the figures are presented in the tabular form; that population of India is continuously rising and that it is rising on account of fall in death rate, we are referring to the methods of collection, presentation, interpretation of trend in data and analysis of data respectively. All these steps are statistical methods. Here we are using the word statistics in the singular sense.

Importance of Statistics in Economics

There are number of economic laws which have evolved due to statistical analysis in the field of economics, e.g. Engel's law of family expenditure, Malthus theory of population etc. Let us understand the importance of statistics keeping in view the various parts of economics.

(a) **Statistics and the study of consumption:** Every individual needs a certain number of things. He spends first on necessities, then on comforts and luxuries, which depend on his income. We discover how different groups spend their income on different items of consumption with the help of statistics.

(b) **Statistics and the study of production:** The progress of production every year can easily be measured by statistics. The comparative study of productivity of various elements of production (e.g. land, labour, capital and entrepreneurship) is also done with the help of statistics. The statistics of production are very helpful for adjustment of demand and supply.

(c) **Statistics and the study of exchange:** Production is based on national and international demand. A producer needs statistics for deciding the cost of production and selling price so that he can study competition and demand of commodity in a market. The law of price determination and cost price which are bared on the various market conditions and demand and supply can be studied with the help of statistics.

(d) **Statistics and the study of distribution:** Statistics are helpful in calculation of national income in the field of distribution statistical methods are used in solving the problem of the distribution of national income. Various problems arise due to unequal distribution of wealth and national income and are solved with the help of statistical data.

INTEXT QUESTIONS 5.1

1. Fill in the blanks with appropriate word from the brackets;
   (i) What was 'statistics' called in the ancient times ..... (science of knowledge, science of state).
   (ii) Statistics is an important tool of ..... (methods, economics planning).
   (iii) The word statistics in singular sense refers to statistical ..... (method, data).
2. Which of the following refers to (quantitative/qualitative) information.
   (i) Sita's height is 5'6"., where as Meera is 5'-0".
   (ii) Sita is taller than Meera.
   (iii) Foodgrain production in India was estimated at 199.5 million tones in 2000-01.
   (iv) Anju is the shortest girl in her class.

5.2 MEANING OF STATISTICS

5.2.1 Statistics in plural sense

In plural sense statistics means statistical data "By statistics we mean aggregate of facts affected to a market extent by multiplicity of causes numerically expressed enumerate or estimated according to a reasonable standard of accuracy, collected

in a systematic manner for a predetermined purpose and plural in relations to each other''

In plural sense, facts expressed numerically are called statistics such as data relating to income, production, population, prices etc. In other words, statistics mean numerical statement of facts. How do the statistical data look like? Table 5.1 is an example of statistical data.

It gives information about population of India.

Here we are referring only to the quantitative information about population. We are using the word statistics in the plural sense in this case.

5.2.1.1 Characteristics of Statistical Data

(i) **Statistical data are aggregates of facts:** A single observation is not statistics, it is a group of observations. For example, Ram scored 60 marks out of 100 is not statistics, but a series relating to the marks of a group of students will be termed as statistics. For example, when we say that Mohan, Ram, Mary and Karim scored 35, 60, 75 and 58 marks respectively, the group of figures become statistics. Now we can compare, analyse and draw some conclusions from these figures.

For example:

1. Highest marks obtained are 75.
2. Lowest marks obtained are 35.
3. Marks range between 35 and 75.
4. Average marks obtained = $\frac{35+60+75+58}{4}$ = 57 marks

(ii) **Statistics are affected by multiplicity of causes :** Generally the facts and figures are affected by a number of factors working together. For example, the production of rice depends on rainfall, method of cultivation, seeds, manure, soil fertility etc. but it is very difficult to study separately the effect of each of these factors on the production of rice.

(iii) **Statistical data are numerically expressed :** All statistics are numerically expressed. Qualitative statements such as 'the population of India is increasing rapidly' or 'India's per capita income is low' are not statistics unless they are assigned numerical values.

(iv) Collected in a systematic manner : Statistics should be collected systematically in a planned way. Before collecting data, a suitable plan for their collection should be prepared. Data collected in an unsystematic manner would lead to misleading conclusions.

(v) Statistical data must be obtained with reasonable degree of accuracy : Statistics are numerical statements which can be obtained with accuracy if the number of observations is small. Sometimes, when actual measurement of figures is not possible in a particular field of inquiry, then method of estimation or approximation is applied. For example, if we say that there are 30 students in XI class of XYZ public school, the figure is 100 percent accurate if we apply counting method. But, on the other hand, if we say that 20,000 people are watching the cricket match, this figure can be obtained only by estimation method i.e. as an approximation. But even this estimation must have a reasonable degree of accuracy to make sense.

(iv) Statistics are collected for a predetermined purpose : The purpose of collecting data should be decided in advance. The purpose should be clearly defined. Otherwise, collected data will be of no use. Suppose, we want to compare the performance of students at secondary level of National Institute of Open Schooling in one subject or more. We must specify the subjects and the year for which comparison is being carried out before collecting data.

INTEXT QUESTIONS 5.2

1. Tick (√) the correct answers Statistical data are:
   - (i) Numerical statement of facts.
   - (ii) Qualitative information.
   - (iii) Both quantitative and qualitative information.
   - (iv) Single or isolated facts and figures
   - (v) Aggregates of facts
2. State whether the following statements are true or false.
   - (i) Statistics are numerical statements of facts.
   - (ii) Statistical data are not single or isolated figures.
   - (iii) Statistical data are qualitative data.
   - (iv) Statistics are collected for a predetermined purpose.

5.2.2 Statistics in Singular Sense

In the singular sense, statistics means science of statistics or statistical methods. If refers to techniques or methods relating to collection, classification, presentation, analysis and interpretation of quantitative data. These are the stages through which every statistical enquiry has to pass through. We shall discuss these stages one by one.

5.2.2.1 Stages of Statistical Enquiry

Studying statistics in the singular sense implies the knowledge of various stages of statistical study.

(i) **Collection of data:** Collection of data is the first step of a statistical enquiry. Statistical data are mainly classified into primary and secondary data. Primary data are data collected directly through survey, directly from first hand sources by means of surveys, observations or experimentations. These are data that has not been previously published.

Secondary data are data collected from other sources including published and online resources. For example, Reserve Bank of India Bulletin and National Accounts Statistics are published data i.e. Secondary data. You will read more about primary and secondary data in the next lesson.

(ii) **Organisation of Data :** Organisation of the data refers to the arrangement of data in such a form that comparison of the mass of similar data may be facilitated and further analysis may be possible. An important method of organization of data is to distribute data into different classes or sub-classes on the basis of their characteristics. This process is called classification of data.

(iii) **Presentation of data :** The presentation of data means exhibition of the data in such a clear and attractive manner that these are easily understood and analysed. There are many forms of presentation of data of which the following three are well known: textual or descriptive presentation, tabular presentation and diagrammatic presentation. You will study more about this in the next lesson.

(iv) **Analysis of data :** After the data have been collected, organized and presented, they need to be analysed. Analysis of data is a technique through which significant facts from the numerical data are extracted. One of the most important objects of statistical analysis is to get one single value that describes the characteristic of the whole data. Analysis of an economic or other problems is not possible without the use of certain statistical tools such as measures of central tendency like mean, median or mode.

(v) **Interpretation of data :** Interpretation of data is the last stage of a statistical enquiry. After making analysis with the help of statistical tools, we interpret the data to derive some conclusions in order to formulate certain policies. Interpretation must be done carefully, as wrong interpretation will lead to formulation of wrong policies and hence do more harm than good.

5.3 FUNCTIONS OF STATISTICS

Main functions of statistics are given below:

(i) **Statistics simplifies complex data:** With the help of statistics a mass of data can be presented in such a manner that they become easy to understand e.g. the complex data may be presented in the form of totals, averages, percentages etc.

(ii) **Statistics presents the faits in a definite form:** By stating conclusions in a numerical or quantitative form, we can achieve definiteness.

(iii) **Statistics provides a technique of comparison:** By using statistical tools such as average ratios, percentages etc. data can be made comparable for drawing conclusion.

(iv) **Statistics studies relationship:** Correlation analysis is used to discover functional relationship between different phenomena e.g. the relationship between demand and supply, the relationship between advertisement and sales can easily be explained with the help of correlation analysis.

(v) Statistics helps in formulating policies: Many policies are framed on the basis of statistics like import, export, wage-policy etc.

(vi) Statistics helps in forecasting: The future behaviour of phenomena such as market situation for the future in predicted on the basis of available statistics of past and present.

(vii) Statistics help to test and formulate theories: Statistical data and techniques are useful while testing theories e.g. whether increase in demand affects the price can be tested by collecting and comparing the relevant data.

Limitation of statistics

(i) **It does not study the qualitative aspect of a problem:** Statistics studies only the facts which can be measured quantitatively but qualitative phenomena like honesty, intelligence, poverty etc. cannot be studies in statistics unless these attributes are expressed in terms of numerals.

(ii) **It does not study individuals:** Statistics studies aggregates of facts but individual values of the observation like income of a family has no specific importance.

(iii) **Statistical laws are true only on an average:** Since the results are affected by a large number of cause, laws of statistics are not universally applicable.

(iv) **Statistics can be misused:** The results obtained with the help of statistics can be manipulated according to one's own interest which can mislead the community.

(v) **Statistical results lack mathematical accuracy:** The results drawn from statistical analysis are normally in approximations. So statistical studies are a failure in the fields where cent per cent accuracy is desired.

INTEXT QUESTIONS 5.3

1. Complete the following statements:
   - (i) Statistics in plural sense means .....
   - (ii) Statistics in singular sense means .....
   - (iii) Statistical data are collected in a .....
   - (iv) The first step in statistical enquiry is .....
   - (v) The last step in statistical enquiry is .....
   - (vi) Analysis of data means drawing conclusions from data with the help of .....
   - (vii) Reserve Bank of India Bulletin and National Accounts Statistics are sources of ..... data.
2. Match the following:

(a) Collection of data	1. Mean, mode and median.
(b) Presentation of data	2. Primary or secondary sources.
(c) Analysis of data	3. Arriving at conclusions.
(d) Interpretation of data	4. Tables, diagrams and picture.

WHAT YOU HAVE LEARNT

- Statistics plays a very important role in economics
- Statistics is used (i) in construction of economic theories (ii) in planning (iii) in evaluation of policies of the government and (iv) to reveal the structure of an economy.
- The word statistics is used in two senses. In a plural sense, statistics refers to quantitative information or statistical data. In a singular sense it is termed as statistical methods. It means the science of collection, organization, presentation, analysis and interpretation of statistical data.

- Statistical data are (i) aggregates of facts, (ii) affected by multiplicity of causes, (iii) numerically expressed, (iv) collected in a systematic manner (v) accurate to a reasonable degree or standard, and (vi) collected for a predetermined purpose.
- A statistical enquiry passes through the stages of collection, presentation, analysis and interpretation of data.
- Sources of statistical data are primary and secondary.
- Statistical data is presented in the form of tables, graphs, diagrams and pictures.
- Statistics:
  - (i) simplifies complex data,
  - (ii) presents the faits in definite form
  - (iii) provides a technique of comparistic,
  - (iv) studies relationship,
  - (v) helps in formulating policies,
  - (vi) helps in forecasting,
  - (vii) helps to test and formulate theories.
- Limitations of statistics are:
  - (i) it does not study the qualitative aspect of a problem
  - (ii) it does not study individual
  - (iii) statistical laws are true only on an average
  - (iv) statistics can be misused
  - (v) statistical results lack mathematical accuracy.

TERMINAL EXERCISE

1. State the need of statistics in economics.
2. Describe in brief the scope of statistics.
3. Define statistics in plural and singular sense.
4. Define the term statistics in the plural sense and point out its main characteristics.
5. State briefly the various stages of a statistical enquiry.
6. What are the principal sources of data?
7. Describe any four limitations of statistics.

8. What are the limitation of statistics?
9. What is the importance of statistics in the field of business and economics?

ANSWERS TO INTEXT QUESTIONS

5.1

1. (i) Science of state
   (ii) Economic planning
   (iii) Methods
2. (i) Quantitative information
   (ii) Qualitative information
   (iii) Quantitative information
   (iv) Qualitative information

5.2

1. (i) and (v)
2. (i) True (ii) True (iii) False (iv) True

5.3

1. (i) Statistical data (ii) Statistical methods
   (iii) Systematic manner (iv) Collection of data
   (v) Interpretation of data (vi) Statistical tools
   (vii) Secondary
2. (a) 2 (b) 4 (c) 1 (d) 3

Terminal Exercise

1. Read Section 5.1 (a)
2. Read Section 5.1 (b)
3. Read Section 5.2 and 5.3
4. Read Section 5.2 (b)
5. Read Section 5.3 (b)
6. Read Section 5.3 (b) (i) 5.3 (b) (i)

Notes

6

COLLECTION AND CLASSIFICATION OF DATA

In the previous lesson, you have learnt about the meaning and scope of statistics and its need in Economics. In this lesson you will learn about the techniques of collecting, organizing and condensing of data. These techniques are necessary for making the statistical data meaningful.

OBJECTIVES

After completing this lesson, you will be able to:

- distinguish between primary and secondary data;
- list the methods of collecting primary data;
- give some examples of sources of secondary data;
- explain the concepts of an array, frequency array and frequency distribution;
- state different methods of constructing frequency distribution; and
- construct simple and cumulative frequency distributions from a given data.

6.1 COLLECTION OF DATA

(a) Primary vs. Secondary Data

Data can be collected in two different ways. One way is to collect data directly from the respondent. The person who answers the questions of the investigator is called respondent. Statistical information thus collected is called primary data and the source of such information is called primary source. This data are original because it is collected for the first time by the investigator himself. For example, if the investigator collects the information about the salaries of National Institute of

Open Schooling employees by approaching them, then it is primary data for him.

Another way is to adopt the data already collected by someone else. The investigator only adopts the data. Statistical information thus obtained is called secondary data. The source of such information is called secondary source. For example, if the investigator collects the information about the salaries of employees of National Institute of Open Schooling from the salary register maintained by its accounts branch, then it is secondary data for him.

(b) Methods for collecting primary data

There are several methods for collecting primary data. Some of which are:

1. **Direct personal interview :** In this method investigator (also called interviewer) has to be face-to-face with the person from whom he wants information. The person from whom this information is collected to called respondent.
2. **Indirect oral investigation :** Under this method data are collected through indirect sources. Under this method questions relating to the inquiry are put to different persons and their answers are recorded. This method is most suitable when the person from whom the information is sought is either unavailable or unwilling.
3. **Questionnaire method :** In this method a list of questions called questionnaire is prepared and sent to respondents either through post or given personally to them. This method is suitable where the field of inquiry is wide.

   There are some advantages of using primary data. The investigator can collect the data according to his requirement. It is reliable and sufficient for the purpose of investigation. However, it suffers from disadvantages also in that it involves a lot of cost in terms of money, time and energy. This make unsuitable when field of enquiry is very very large. Many a times with some modifications, same purpose may be served by using data collected by other persons or agencies.

(c) Sources of secondary data

As already discussed secondary data are not collected by the investigator himself but they are obtained by him from other source. Broadly, there area two sources: (a) Published data and (b) Unpublished data.

I. Published Sources

There are certain agencies which collect the data and publish them in the form of either regular journals or reports. These agencies/sources are known as published sources of data.

In India some of the published sources are:

1. **Central Statistical Organisation (CSO) :** It publishes data on national income, savings, capital formation etc., in a publication called National Accounts Statistics.
2. **National Sample Survey Organisation (NSSO) :** This organization which is under the Ministry of Finance provides data on all aspects of national economy, such as agriculture, industry, employment and poverty etc.
3. **Reserve Bank of India (RBI) :** It publishes financial statistics. Its publications are Report on Currency and Finance, Reserve Bank of India Bulletin and Statistical Tables Relating to Banks in India etc.
4. **Labour Bureau :** Its publications are Indian Labour Statistics, Indian Labour Year Book and Indian Labour Journal.
5. **Population Census :** It is undertaken by the office of the Registrar General, Census of India, Ministry of Home Affairs. It provides us statistics on population, per capita income, literacy rate etc.
6. **Papers and Magazines :** Journals like 'Capital', 'Commerce', Economic and Political Weekly', and newspapers likes 'The Economic Times' etc. also publish important statistical data.

II. Unpublished Sources

Secondary data are also available from unpublished sources, because all statistical data is not always published. For example, information recorded in various government and private offices, studies made by research scholars etc. can be important sources of secondary data.

INTEXT QUESTION 6.1

1. Fill in the blanks with suitable words given in brackets against each:
   (a) ..... data are original. (Primary, Secondary)
   (b) ..... Primary data are collected by the ..... himself. (respondent, vestigator)
   (c) CSO publishes data on ..... (national income, population)
2. State whether the following statements are true or false:
   (a) Secondary data are collected by the investigator himself.
   (b) Reserve Bank of India Bulletin represents an unpublished source of data.
   (c) A person from whom an investigator tries to get information is called respondent.

6.2 ORGANISING AND CONDENSING DATA

Suppose a statistical investigator wants to analyse the marks obtained by 40 students in a class. He collects data and finds that marks obtained by 40 students in the class are:

20	25	28	27	34	31	30	32	33	40
43	43	40	43	42	43	42	45	43	47
48	46	47	48	46	49	58	54	56	50
53	51	39	38	36	38	35	35	37	

Put yourself in the position of investigator. In which aspect of this data you will be interested? Perhaps you would be interested in knowing the highest marks obtained by any student. You may also be interested to know the lowest marks obtained by a student. Another point of interest can be the marks level around which most of the students have obtained.

The above data are unorganized. To refine this data for comparison and analysis it should be arranged in an orderly sequence or into groups on the basis of some similarity. This whole process of arranging and grouping the data into some meaningful arrangement is a first step towards analysis of data. Data can be arranged in two forms: (a) Arrays and (b) Frequency distributions.

(a) Arrays

A method of presenting an individual series is a simple array of data. An orderly arrangement of raw data is called 'Array'. Arrays are of two types: (i) Simple array, and (ii) Frequency array.

(i) **Simple Array :** A simple array is an arrangement of data in ascending or descending order. Let us construct the simple arrays of the data about the marks of 40 students. The data in table 6.1 is arranged in ascending order and in table 6.2 in descending order.

Table 6.1: Ascending Array of the Marks obtained by 40 students in class

20	35	42	47
25	36	43	48
27	37	43	48
28	38	43	49
30	38	43	50

31	39	43	51
32	40	45	53
33	40	46	54
34	40	46	56
35	42	47	58

Table 6.2: Descending Array of the Marks obtained by 40 students in class

58	47	42	35
56	46	40	34
54	46	40	33
53	45	40	32
51	43	39	31
50	43	38	30
49	43	38	28
48	43	37	27
48	43	36	26
47	42	35	20

The above arrays reveal information on two points clearly. One, the highest marks obtained by any student are 58. Two, the lowest marks obtained by any student are 20.

Organising the data in the form of simple array is convenient if number of items is small. As the number of items increase the series becomes too long and unmanageable. As such there is need to condense data. Making a frequency array is one method of condensing data.

(ii) Frequency Array : Frequency array is a series formed on the basis of frequency with which each item is repeated in series. The main steps in constructing frequency array are:

1. Prepare a table with three columns-first for values of items, second for tally sheet and third for corresponding frequency. Frequency means the number of times a value appears in a series. For example in table 6.1 the marks 43 appears five times. So frequency of 43 is 5.

2. Put the items in first column in a ascending order in such a way that one item is reordered once only.
3. Prepare the tally sheet in second column marking one bar for one item. Make blocks of five tally bars to avoid mistake in counting. Note that every fifth bar is shown by crossing the previous four bars like e.g., ////.
4. Count the tally bars and record the total number in third column. This column will represent the frequencies of corresponding items.

Let us now explain construction of frequency array of the marks obtained by 40 students. In table 6.3 data about the marks is arranged in an ascending order in first column. It helps to find not only the maximum and minimum values but also makes it easy to draw bars.

Now for each mark level make one bar (/) in second column and cross the item from the data.

Table 6.3 Frequency array of marks obtained by 40 students

Marks(X)	Tally Sheet	Frequency
20	/	1
25	/	1
27	/	1
28	/	1
30	/	1
31	/	1
32	/	1
33	/	1
34	/	1
35	//	2
36	/	1
37	/	1
38	//	2
39	/	1
40	///	3
41	//	2
42	//	2
43	~~////~~	5
45	/	1

46	//	2
47	//	2
48	/	1
49	/	1
50	/	1
51	/	1
53	/	1
54	/	1
56	/	1
58	/	1
		Total Frequency = 40

The main limitations of frequency array is that it does not give the idea of the characteristics of a group. For example it does not tell us that how many students have obtained marks between 40 and 45. Therefore it is not possible to compare characteristics of different groups. This limitation is removed by frequency distribution.

INTEXT QUESTIONS 6.2

Fill in the blanks with appropriate word from the brackets:

(a) A simple array is an arrangements of data in ..... (only ascending order, only descending order, either ascending or descending order).

(b) Organising data in simple array is convenient if number of items are ..... (large, small).

(c) Arranging the data in the form of ..... array is more convenient if number of items are large. (simple, frequency).

(d) Frequency array ..... the idea of characteristics of a group. (gives, does not give)

6.3 FREQUENCY DISTRIBUTION

Data in a frequency array is ungrouped data. To group the data we need to make a 'frequency distribution'. A frequency distribution classifies the data into groups. For example, it tells us how many students have secured marks between 40 and 45.

Before constructing frequency distribution, it is necessary to learn the following important concepts (see tables 6.4 and 6.5) :

1. **Class :** Class is a group of magnitudes having two ends called class limits. For example, 20-25, 25-30 etc. or 20-24, 25-29 etc. as the case may be, each represents a class.
2. **Class Limits :** Every class has two boundaries or limits called lower limit (L_1) and upper limit (L_2). For example in the class (20-30) $L_1 = 20$ and $L_2 = 30$.
3. **Class Interval :** The difference between two limits of a class is called class interval. It is equal to upper limit minus lower limit. It is also called class width. Class interval = $L_2 - L_1$. For 30 – 20 =10.
4. **Class Frequency :** Total number of items falling in a class that is having the value within L_1 and L_2 is class frequency. For example in table 6.4 class frequency in class (40-45) is 10. Similarly in class (50-55) the frequency is 4.
5. **Mid-Point/Mid-Value(M.V.) :** The mid-value of the class interval of a class also called as mid-point is obtained by dividing the sum of lower limit and upper limit of the class by 2. It is the average value of two limits of a class. It falls just in the middle of a class is

$$\text{M.V.} = \frac{L_1 + L_2}{2}$$

For example, the mid-value of class (20-30) is $\frac{20+30}{2} = 25$

Construction of Frequency Distribution

Frequency distributions can be constructed in many ways. We will explain here the construction of the following types:

(a) Exclusive series

(b) Inclusive series

(c) Open end classes

(d) Cumulative frequency

While constructing a frequency distribution same steps are to be taken which we have followed in the frequency array. The only difference is that we record classes like (20-25), (25-30), (30-35)….(55-60) etc., in first column in place of absolute items like 20, 25,..56,58 etc.

(a) Exclusive series: In this type one of the class limits (generally upper limit L_2) is excluded while making a tally sheet. Any item having the value equal to the upper limit of a class is counted in the next class. For example, in a class of (20-25) all items having the value of 20 and more but less than 25 will be counted in this class.

Item having the value of 25 will be counted in next class of (25-30) as is clear from the following example, Using the same data as given in making a frequency array and taking class interval of 5, a frequency distribution of exclusive type will be as under:

Table 6.4: Construction of Frequency Distribution – "Exclusive Type"

Class	Tally Sheet (Tallies)	Frequency (f)
20-25	/	1
25-30	///	3
30-35	~~////~~	5
35-40	~~////~~ //	7
40-45	~~////~~ ~~////~~	10
45-50	~~////~~ ///	8
50-55	////	4
55-60	//	2
		Total Frequency = 40

(b) Inclusive Series : In this type the lower limit of next class is increased by one over the upper limit of previous class. Both the items having value equal to lower and upper limit of a class are counted or included in the same class. That is why such a frequency distribution is called inclusive type. For example in the class (20-24) both 20 and 24 will be included in the same class. Similarly in the class (40-44) both 40 and 44 will be included. The following table has been formed on the basis of same data as taken in the exclusive type.

Table 6.5: Construction of Frequency Distribution – "Inclusive Type"

Class	Tally Sheet (Tallies)	Frequency (f)
20-24	/	1
25-29	///	3
30-34	~~////~~	5
35-39	~~////~~ //	7
40-44	~~////~~ ~~////~~	10
45-49	~~////~~ ///	8
50-54	~~////~~	4
55-59	//	2
		Total Frequency = 40

(c) Open-end Classes : Open-end frequency distribution is one which has at least one of its ends open. You will observe that either lower limit of first class or upper limit of last class or both are not given in such series. In table 6.6 the first class and the last class i.e. below 25 and 55 and above are open-end classes.

Table 6.6: Open-end Classes Frequency Distribution

Class	Tally Sheet	Frequency (f)
Below-25	/	1
25-30	///	3
30-35	~~////~~	5
35-40	~~////~~ //	7
40-45	~~////~~ ~~////~~	10
45-50	~~////~~ ///	8
50-55	////	4
55 and above	//	2
		Total Frequency = 40

(d) Unequal Classes : In case of unequal classes frequency distribution, the width of different classes (i.e. L_2-L_1) need not be the same. In table 6.7, the class (30 – 40 has width 10 while the class (40-55) has width 15.

Table 6.7: Unequal Classes Frequency Distribution

Class	Tally Sheet	Frequency (f)
20-25	/	1
25-30	///	3
30-40	~~////~~ ~~////~~ //	12
40-55	~~////~~ ~~////~~ ~~////~~ ~~////~~ //	22
55-60	//	2
		Total Frequency = 40

(e) Cumulative Frequency : A 'Cumulative Frequency Distribution' is formed by taking successive totals of given frequencies. This can be done in two ways:

(i) From above, such as 1,4 (i.e. 1+3), 9(i.e. 4+5), 16 (i.e. 9+7), and so on.

Such a distribution is called 'Less-than' culmulative frequency distribution. It shows the total numbers of observations (frequencies) having less than a particular value of the variable (here marks). For example, there are 4 (i.e. 1+3) students who got marks less than 30; 9 (i.e. 4+5) students who got marks less than 35 and so on. Table 6.8 gives the less-than cumulative frequency distribution.

Table 6.8: 'Less-than' Cumulative Frequency Distribution

Marks	Cumulative Frequency (cf)
Less than 25	1
Less than 30	4 (1+3)
Less than 35	9 (4+5)
Less than 40	16 (9+7)
Less than 45	26 (16+10)
Less than 50	34 (26+8)
Less than 55	38 (34+4)
Less than 60	40 (38+2)

(ii) From below, such as 2,6 (i.e. 2 + 4), 14 (i.e. 6+8), 24 (i.e. 14 + 10) and so on. Such a distribution is called 'More-than' cumulative frequency distribution. It shows the total number of observations (frequencies) having more than a particular value of the variable (here marks). For example there are 6 (i.e. 2 + 4) students who got marks more than 50, 14 (i.e. 2 + 4 + 8) students who got marks more than 45 etc. See table 6.9.

Table 6.9: 'More-than' Cumulative Frequency Distribution

Marks	Cumulative Frequency (cf)
More than 20	40
More than 25	39 (40-1)
More than 30	36 (39-3)
More than35	31 (36-5)
More than 40	24 (31-7)
More than 45	14 (24-10)
More than 50	6 (14-8)
More than 55	2 (6-4)

INTEXT QUESTIONS 6.3

Fill in the blanks with appropriate word from the brackets.

(a) Frequency distribution ..... data into groups.
(classifies, does not classify)

(b) The difference between two limits of a class is called .....
(Class limit, class interval).

(c) In the exclusive type frequency distribution an item having value equal to the upper limit is counted in the ..... class. (same, next)

(d) In the inclusive type frequency distribution an item having value equal to the upper limit is counted in the ..... class.

(e) Preparing a frequency distribution by taking 'successive totals' of frequencies is called ..... frequency distribution. (open-ended, cumulative)

ACTIVITY

1. Visit children in your neighbourhood and record the age of at least 30 of them and then construct a frequency distribution of both exclusive as well as inclusive types.
2. From daily newspapers, record maximum temperature of your city for 30 days. Prepare at frequency distribution of both exclusive as well as inclusive types with a class interval of 1.5 degrees Celsius and with at least 5 classes.

WHAT YOU HAVE LEARNT

- For any statistical enquiry, data can be collected in two ways:

  (a) either by the investigator himself. This is called primary data.

  (b) or he can obtain it from other sources i.e. data already collected by others. This is called secondary data.
- In India there are several sources of getting secondary data. Some of these are: Central Statistical Organisation (CSO), National Sample Survey Organsation, (NSSO), Reserve Bank of India (RBI), etc.
- Collected data are normally in a disorderly form. Therefore, they have to be arranged in some orderly form or sequence. This is called arrangement of data.
- The various ways of arrangement of data are: a simple array, a frequency array

and frequency distribution. Arrays can be (i) simple array or (ii) frequency array.

- When simple frequencies are successively totaled, we get what is called cumulative frequency distribution.
- To get frequency distribution we have to make use of tally sheet.
- Formation of frequency distribution requires important decisions regarding number of classes, class limits and class width etc.
- A class is a group of magnitudes having two ends called class limits (L_1 and L_2), L_1 being lower limit and L_2 the upper limit.
- Total number of cases falling in a particular class is called class frequency.
- We can form the following types of frequency distributions:
  - (a) exclusive type where the upper limit of the class is excluded and put in the next class.
  - (b) inclusive type where the upper limit of the class is included in the same class.
  - (c) Open-end like (below 25) and (55 and above).
  - (d) Unequal classes where class width or class interval of different classes is different like (20 – 25), (25-30), (30-40)….
  - (e) Cumulative 'Less-than' and 'More-than' where simple frequencies are successively totaled from above and from below respectively.

Cumulative: means successive totaling. That is, something increasing in quantity by one addition after another.

Condensation: putting huge quantity of data in some useful, short or brief form without losing its utility.

Respondent: is a person who responds or answers to some questions raised. When an investigator approaches a person with a questionnaire, the person who answers these questions is called respondent.

Sequence: in ordinary language means connected line of events or ideas. In statistics it means a series formed on some such principle e.g. sequence of numbers from, say 2, with a difference of say, 5 That is 2, 7, 12, 17, 22 etc. These numbers are in ascending order of sequences. If we put them in the form (reverse sequence) …….. 22, 17, 12, 7, 2, these are called in descending order of sequence.

Tally Sheet: is a statement where occurrence of each value of a series is recorded by making one bar. (/)

Data: means statistical information on population, employment, prices, exports, imports etc. that has been collected, analysed and published by government departments, commercial and industrial associations, and other research agencies.

TERMINAL EXERCISE

1. Distinguish between primary and secondary data. Describe the methods for collecting primary data.
2. What is secondary data? Name some of its sources in India.
3. Distribution between simple array and frequency array with examples.
4. On the basis of the following data about the wages of 20 workers in a factory, prepare a frequency array; 450, 580,600, 480, 540, 620, 400, 475, 500, 480, 620, 480, 570, 600, 650, 410, 550, 600, 650, 450.
5. Explain the concept of 'frequency distribution'. How is it different from 'frequency array.?
6. On the basis of data in question 4, prepare a frequency distribution by exclusive method.
7. Distinguish between 'exclusive method' and 'inclusive method' of frequency distribution with examples.
8. Write short notes on:
   (a) Open-end frequency distribution.
   (b) Frequency distribution with unequal classes.
   (c) Cumulative frequency distribution.

ANSWERS TO INTEXT QUESTIONS

6.1

1. (a) Primary (b) Investigator (c) National income
2. (a) False (b) False (c) True

6.2

(a) either ascending or descending order (b) small
(c) frequency (d) does not give

6.3

(a) classifies (b) class interval
(c) next (d) same
(e) cumulative.

Terminal Exercise

1. Read section 6.1(a) and (b)
2. Read section 6.1 (a) and (c)
3. Read section 6.2(a)

(i) Arrange the data in ascending order:

400	480	550	600
410	480	570	620
450	480	580	620
450	500	600	650
475	540	600	650

(ii) Prepare a tally sheet.

Income (₹.)	Tallies	Frequency (f)
400	/	1
410	/	1
450	//	2
475	/	1
480	///	3
500	/	1
540	/	1
550	/	1
570	/	1
580	/	1
600	///	3
620	//	2
650	//	2
		Total Frequency = 20

5. Read section 6.2 and 6.3

6. First two steps have already been explained in answer to question 4. The third step is as follows.

Income groups (Rs.)	Frequency (f)
400-450	2
450-500	6
500-550	2
550-600	3
600-650	5
650-700	2
	Total Frequency = 20

7. Read section 6.3 (a) and (b)

8. (a) Read section 6.3 (c)

   (b) Read section 6.3 (d)

   (c) Read section 6.3 (e)

Notes

7

PRESENTATION OF DATA

In the previous lesson, you have learnt about the methods of organizing and condensing data in the form of arrays and frequency distributions. It is the first step towards analysis of data. Another step in this direction is presentation of data to highlight and compare significant statistical facts. Statistical data can be systematically organized and presented in the form of tables, graphs and charts. There are various types of graphs. In this lesson, you will learn about table, bar charts, pie diagram (or chart) and time series line graph.

OBJECTIVES

After completing this lesson, you will be able to:

- explain the meaning and purpose of a table;
- distinguish between reference table and special purpose table;
- draw the format of a table;
- explain the meaning and construction of simple and multiple bar charts;
- explain the need and construction of component bar charts;
- explain the meaning of pie chart and steps in its construction;
- explain the meaning of a time series graph and steps in its construction; and
- construct histogram, frequency polygon and cummutative frequency curve (OGIVE).

7.1 TABLE

(a) Meaning

A table is a systematic arrangement of related statistical data in columns and rows with some predetermined aim or purpose. Can you arrange the following information in tabular form?

"There are 50 Science, 50 Commerce and 50 Arts students in a college. The number of students from poor families is same for each course and their total is 30. Whereas science and commerce courses are equally popular in rich families, yet the number of rich arts students is twice as much. In all 40 students are from the rich families studying in the college. The majority of students are from middle class families and their number is 80."

Let us arrange this information in tabular form. There are 150 students in all. A table leaves a more lasting impression on human mind than statements saying the same thing. As they say, a picture is worth 1000 words.

Table 7.1: Distribution of students according to course and economic status

	Science	Arts	Commerce	Total
Rich	10	20	10	40
Middle Class	30	20	30	80
Poor	10	10	10	30
Total	50	50	50	150

(b) Purpose

The purpose of a table is to simplify presentation of related data and make comparisons easy. The reader can easily locate the desired information. For example, the purpose of table 7.2 might be to show the imports and exports of country 'A' vis-à-vis other countries B, C, D and E.

Table 7.2: Imports and Exports of Country 'A' during 2002-05 (₹. Crores)

	Country	Imports	Exports
1	B	70	73
2	C	72	80
3	D	74	85
4	E	85	80

From the table 7.2 on exports and imports, we can easily locate the country which has highest exports. The data given in rows is read from left to right. For example, row 1 shows that country A imports 70 from B and exports 73 to B. The data given in column B read from above to downwards. For example, column 2 shows that country A imports 70, 72, 74, 85 respectively from countries B,C,D and E.

(c) Types of Tables

Basically we have two types of tables (i) Reference or general purpose tables or (ii) special purpose or text tables. Let us discuss them one by one.

(i) **Reference or general purpose tables:** These tables are in a way a store of information with an aim of presenting detailed statistical data. From these tables we can derive smaller tables. Generally, statistical tables presented by Government of India and its various statistical agencies and departments are reference or general purpose tables.

(ii) **Special purpose or test tables:** These tables are smaller and can be obtained from reference tables. They aim to analyse a particular aspect so that we are able to bring out a specific point or answer a specific question.

(d) Parts of Table

Parts (or elements) of a table vary from table to table depending upon the nature of data and purpose of a table. However, some points are common to all (see format of table 7.3). They are:

Table 7.3: (..... Title .....) (in ₹. Crores)

Stub Head	Column Head 1		Column Head 2	
	Sub Column head	Sub column head	Sub column head	Sub column head
Stub Entries	Main Body of the Table (field)			

Footnote (.....)

Source of data (.....)

1. **Table Numbers:** If more than one table has been used or presented at one place, it is always better to give them numbers. It makes further reference to them easy. This number is always indicated in the top for example Table 7-1, Table 7-2 etc.

2. **Title:** Title is to the table what heading is to an essay. It appears at the top of a table and gives idea about what is contained in the main body of the table. The title should be brief and to the point. It is better if the title is presented in bold letters or capital letters. What is the title of Table 7-2?

3. **Head note (or prefatory note):** It is written below the title. It clarifies the contents of the table and unit of measurements like "in rupees crores" or "in lakh tons" or "in thousand bales of cotton" etc. It must be written in brackets on right side (top) of the table immediately below the title. For example, in table 7.2 the unit of measurement is rupees crores.
4. **Stub:** The stub consists of stub head and stub entries. Whereas stub describes the stub entries down below it, each stub entry labels a given data placed in its row. Both stub head and stub entries appear on the left hand column of the table. Further, stub entries describe the column heads.
5. **Main Body or Field:** It is the most important part of the table and contains the numerical information about which a hint is given in title. For example, if the title is "Exports and Imports of Country A during 1995-96, it clearly shows that the body of the table contains statistical/numerical information on value of exports and imports of country A with different countries.
6. **Footnote:** It is a qualifying statement placed at the bottom of a table. Its purpose is to explain omission or limitations of the data presented in main body of the table. For example, if the data for a year is not available then it is mentioned at the bottom of the table.
7. **Source of Data:** Last but not the least, it is essential to mention the source of data presented in the table. It helps the reader to check the original source of data himself and get more of it on the subject. This also makes the data presented in the table more reliable. It should mention information like title, edition, page number and source of publication etc.

INTEXT QUESTION 7.1

1. State whether the following statements are true or false:
   (a) Satisfactory collection of data must be followed by its good presentation.
   (b) Tabulation is the only way of presenting data.
   (c) Tables help in intelligent use of statistical data.
   (d) The title of a table should be brief and to the point.
2. Fill in the blanks using suitable word given in the bracket.
   (a) A ..... is a systematic arrangement of statistical data in columns and rows. (table, graph)
   (b) Head note is written below the ..... of the table. (title, footnote)
   (c) The ..... consists of stub head and stub entries. (stub, note)
   (d) A foot-note is placed at the ..... of a table. (top, main body, bottom)

7.2 BAR CHARTS OR DIAGRAMS

Meaning

A bar can be defined as a thick 'line', often made thicker to draw attention of the reader. The height of this bar shows the quantity of the variable we want to present. It is also called one dimensional diagram because only height of the bar is important and its base or width is not taken into account. To make them look more beautiful, bars are either coloured or shaded in different ways.

Types of bar charts:

There are two types of bar charts (a) simple and (b) components.

(a) Simple bar charts

Simple bar charts can be (i) Single bar charts, and (ii) Multiple bar charts.

(i) **Single bar charts:** We can either have vertical bars (figure 7.1) or horizontal bars (figure 7.2). Normally vertical bars are often used. Let us now explain how a bar diagram can be prepared from given data in table 7.4.

Table 7.4: Number of cars registered in three States

States	No. of Cars
A	8,000
B	10,000
C	4,000

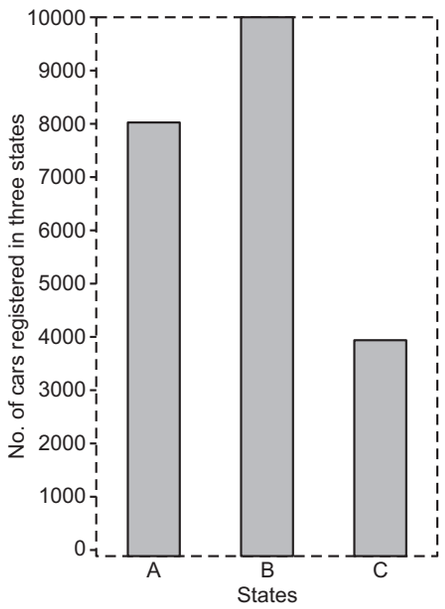


Fig. 7.1: Cars registered in states

In the case of vertical bars. States are represented on X axis and number of cars on the Y axis. As per the data given in table 7.4 each bar (rectangle with same base) is raised accordingly to the value of the variable (here the number of cars registered). For example, rectangle representing State A is raised upto 8,000, for State B upto 10,000 and for State C upto 4,000 (see Fig. 7.1).

In case we prefer to use horizontal bars, we represent States on Y-axis. Here the bars (rectangles) are drawn horizontally upto 8,000, 10,000 and 4,000 cars respectively for the three States A, B and C. (see figure 7.2).

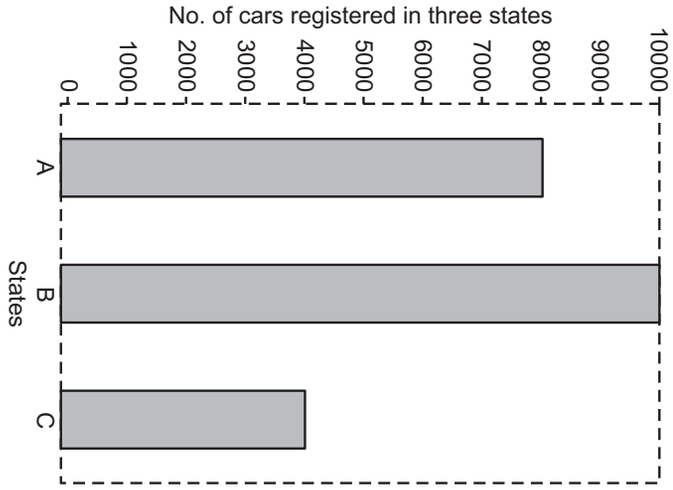


Fig. 7.2: Cars registered in states

(ii) Multiple bar charts: Sometimes it is desired to represent more than one interrelated series of data on a bar diagram. In such cases a simple bar diagram is not suitable. We have to use what is known as multiple bar diagram. Here the number of bars for each year of region or zone is equal to the number of variables (data) to be represented. For example, imports and exports will be represented by two bars; selling price, cost price and profits by three bars and so on. Normally we do not take more than three bars because it becomes complicated. The method of drawing bars is same as explained for simple bar diagrams. Two examples of multiple bar diagrams are presented below (figure-7.3 based on table 7.5 and figure 7.4 based on Table 7.6).

Table 7.5: Imports and Exports of Country 'X' during 2009 to 2013 (₹. Crores)

Year	Imports	Exports
2009-10	2955	2523
2010-11	4519	3329
2011-12	5265	4049
2012-13	5265	5143

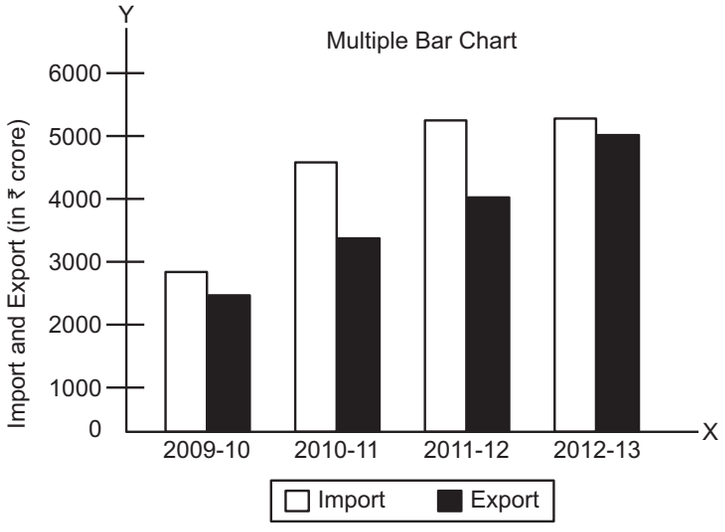


Fig. 7.3: Imports and Exports of country A during 2009-13 (in rupees Crores)

Table 7.6: Result of Class XII during 2010-2012

Year	First Division	Second Division	Third Division
2010	50	150	50
2011	60	140	70
2012	50	250	60

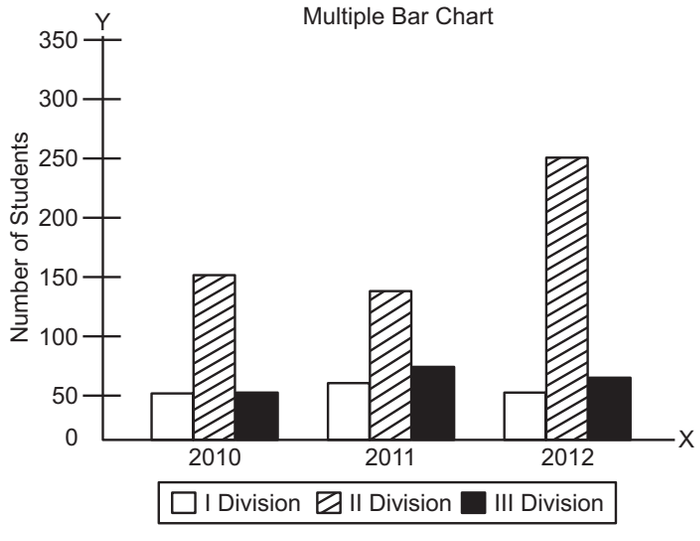


Fig. 7.4: Result of class XII during 2010-2012

(b) Component Bar Chart

A simple bar diagram explained above is used to present only one variable. But when a breakdown of total or a series of totals is to be represented, we have to use what is called sub-divided or component bar diagrams. Here we use sub-divided or component bar diagram as shown in Fig. 7.5. It is based on imaginary (or hypothetical) data shown in table 7.7.

Table 7.7: No. of students appearing in examination

Stream	University A	University B	University C
Art	8,000	6,000	3,000
Science	4,000	2,000	1,000
Commerce	7,000	5,000	4,000
Law	1,000	2,000	2,000
Total	20,000	15,000	10,000

Number of Students appearing in Examinations in Various Universities

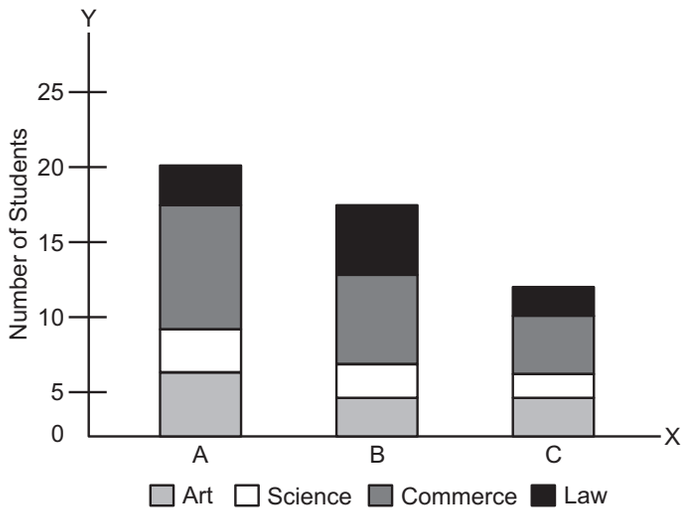


Fig. 7.5: Steps in the construction of a component bar diagram

Step 1. The order of various components in different bars should be same so as to facilitate comparison.

Step 2. The number of components in a bar, in no case should exceed 10.

Step 3. Index or key showing various components must be shown through different shades or colours

Notes

7.3 PIE DIAGRAM

Meaning

It is also known as angular diagram. Pie diagrams are more popularly used for presenting percentage breakdown of data. For example, students of a particular college may be put in three categories-Science students, Commerce students and Arts students. Or exports of India may be classified as to USA. Europe, Middle-East countries, Africa etc. The pie diagram can be effectively used to show these categories or breakdowns. A pie diagram therefore, is a circle subdivided into component sectors to present the proportion of different constituent parts to the total. As such a pie diagram is shown in percentage terms.

Steps in the construction of pie diagram

Step 1. Find the value of each category or component or group as percentage of total of all categories or components or groups.

Step 2. Calculate degree of the angle formed by each category or component or group by the formula given below.

Degree for a particular category/component/group

$$= \frac{\text{Value of the group}}{\text{Total of all groups}} \times 360°$$

Step 3. Take a circle of a suitable size and draw radius.

Step 4. Now draw angles calculated in step 2 with the help of a protractor.

Step 5. Shade or colour different segments suitably or make the distinctions between different categories or components or groups.

Step 6. For each category or component or group put the percentage in the pie diagram as shown in figure 7.6.

Let us now take an imaginary example to illustrate the construction of a pie-diagram.

Example: From the monthly budget of an industrial worker of Mumbai Industrial Area, it was found that the family spent ₹. 360 on food, ₹. 108 on clothing, ₹. 90 on housing, ₹. 24 on comforts, ₹. 12 on education and entertainment and ₹. 6 on miscellaneous items. Construct a pie-diagram.

Solution: We arrange the data in tabular form given below and complete all the steps mentioned above.

Table 7.8: Monthly Family Budget of an Industrial Worker of Bombay

Items	Expenditure	Percentage	Degree = $\frac{\text{Value of item}}{\text{Total value}} \times 360°$
Food	360	$\frac{360}{600} \times 100 = 60$	$\frac{60}{100} \times 360° = 216.0°$
Clothing	108	$\frac{108}{600} \times 100 = 18$	$\frac{108}{100} \times 360° = 64.8°$
Housing	60	$\frac{90}{600} \times 100 = 15$	$\frac{15}{100} \times 360° = 54.0°$
Comforts	24	$\frac{24}{600} \times 100 = 4$	$\frac{4}{100} \times 360° = 14.4°$
Education and Entertainment	12	$\frac{12}{600} \times 100 = 2$	$\frac{2}{100} \times 360° = 7.2°$
Misc.	6	$\frac{6}{600} \times 100 = 1$	$\frac{1}{100} \times 360° = 3.6°$
Total	**600**	**100**	**360°**

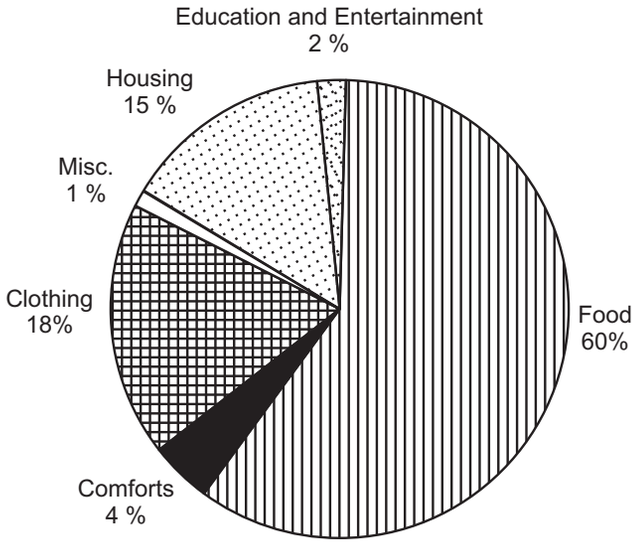


Fig. 7.6: Monthly Budget of Industrial Worker in Mumbai

INTEXT QUESTIONS 7.2

1. State whether the following statements are true or false:

   (a) The width of a one-dimensioanl bar diagram is important.

   (b) In bar diagram, height of bars shows the value of the variable.

   (c) We an have vertical as well as horizontal bars to present some data having one variable.

   (d) When a break down of data is to be represented we use multiple bar diagram.

2. Fill in the blanks with suitable word out of those given in the brackets:

   (a) A pie chart is also called ..... diagram.

   (a bar, an angular, a multiple bar)

   (b) $\frac{\text{Value of the group}}{\text{Total of all groups}} \times 360° = ...$

   (area, radius, degree for a groups).

7.4 TIME SERIES LINE GRAPH

Statistical data can also be presented in the form of line graphs. A line graph records the relationship between two variables. If one of the two variables is time in days, weeks, months or years we get a time series line graph. For example, let us draw a line graph on the basis of the following data on production of coal in country 'X' from 2009-10 to 2013-14.

Table 7.9: Production of Coal (Million Tons)

Year	Production (Million Tons)
2009-10	77.22
2010-11	78.17
2011-12	88.42
2012-13	99.80
2013-14	103.50

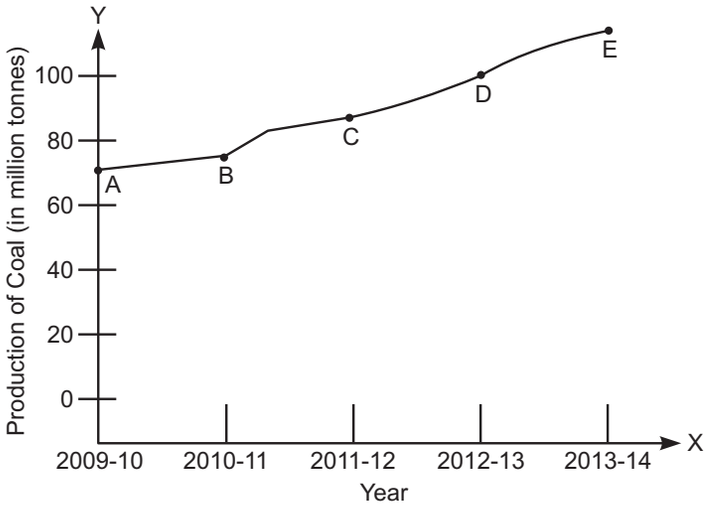


Fig. 7.7: Production of coal in country X 2009-14 (in Million Tons)

The above graph is a time series line graph. Time is represented on the X axis and production on the Y axis. Time and production are two variables in this graph. It is production which changes with time. In other words as time passes production is affected and it increases or decreases or may remain constant. Since production changes with time, it is said to be dependent on time. Production is, therefore, treated as a dependent variable. Time is not influenced by production and therefore taken as an independent variable.

Point A on the line graph (also called curve) shows that production of crude oil in country 'X' in the year 2009-10 was 77.22 million tones. Similarly points B, C and D show production levels in the subsequent years. The upward rising curve from left to right indicates that production of coal oil in Country 'X' is constantly rising since 2009-10.

It is possible to show two or more comparable dependent variables on a time series line graph. In that case each dependent variable will be recorded on a separate curve. For example, take the following data on exports and import of country 'X'.

Table 7.10: Exports and Imports of Country 'X'

Year	Imports (in ₹ 100 crores)	Exports (in ₹ 100 crores)
2009-10	15	35
2010-11	85	100
2011-12	90	70
2012-13	130	120
2013-14	170	180

The time series line graph prepared on the basis of above data is given below (see figure7.8)

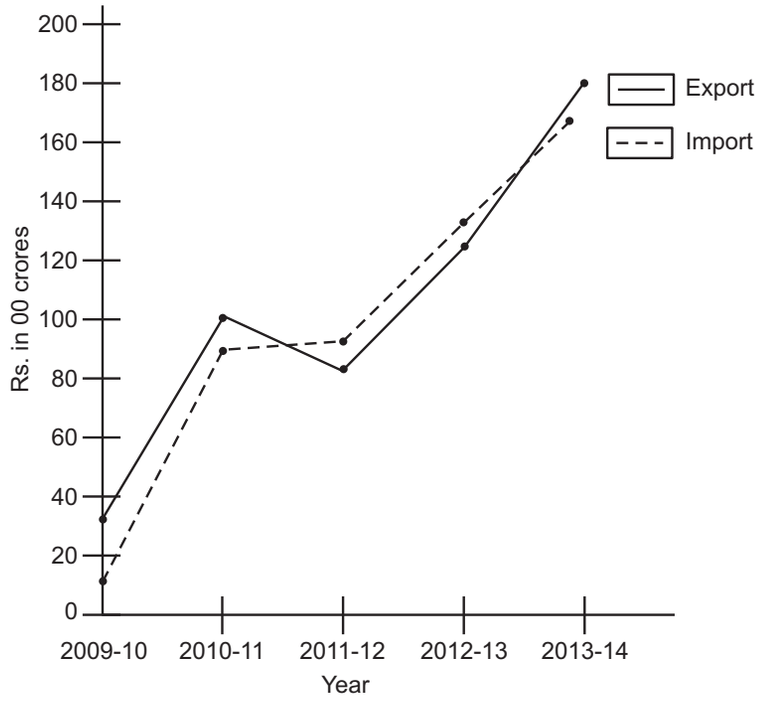


Fig. 7.8: Exports and Imports of Country X in 2009-14 (in rupees' 00 crores)

In the above graph imports are shown in broken line and exports otherwise. Such a presentation is very useful to make comparison between two dependent variables.

INTEXT QUESTIONS 7.3

Fill in the blanks:

(a) A ..... graph shows the relationship between two variables.

(b) If one of the variable on line graph is ..... it is called time series line graph.

(c) In a time series line graph ..... is an independent variable.

(d) In a time series line graph ..... variable is represented on the Y-axis.

7.5 HISTOGRAM

Histogram is a joining rectangular diagram of a continuous series in which each rectangle represents the class interval with frequency. It is a two dimensional diagram and also called a frequency histogram.

(i) Histogram of equal class intervals:

Example: Presents the following data in a histogram:

Marks	Frequency
0-10	2
10-20	5
20-30	8
30-40	11
40-50	10
50-60	9
60-70	4
70-80	1

Method of Construction of Histogram

(i) Take marks on x-axis.

(ii) Take frequencies on y-axis.

(iii) Get rectangle joining each other representing each class with frequency.

(iv) Label both the axis.

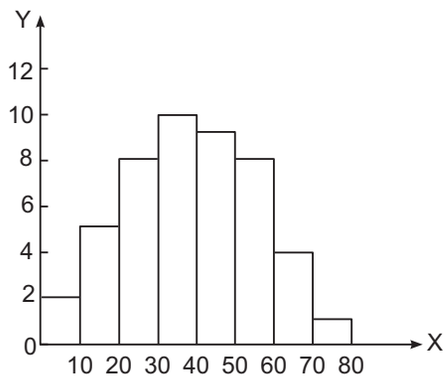


Fig. 7.9: Histogram of equal class intervals.

(ii) Histogram of unequal class intervals

Example: Represent the following data by mean of histogram:

Marks	No. of students(F)
10-15	6
15-20	19
20-25	28
25-30	15
30-40	12
40-60	12
60-80	8

Method of Construction of Histogram

(i) Since the last intervals are unequal, frequencies must be adjusted.

(ii) Take the class which has the lowest class interval.

(iii) Do not adjust the frequencies of the lowest class.

(iv) Frequencies of other classes are adjusted with this lowest class intervals.

(v) Adjusted frequencies will decide the heights of each rectangle of histogram but widths will be according to class limits.

(vi) The frequencies of minimum class intervals on which the frequencies of other classes are adjusted will not be changed.

(vii) Both axis should be clearly labelled.

The adjusted frequencies are:-

Marks	Frequency	Adjusted	Adjusted Frequency
10-15	6	–	6
15-20	19	–	19
20-25	28	–	28
25-30	15	–	15
30-40	12	$\frac{5\times12}{10}$	6
40-60	12	$\frac{5\times12}{20}$	3
60-80	8	$\frac{5\times8}{20}$	2

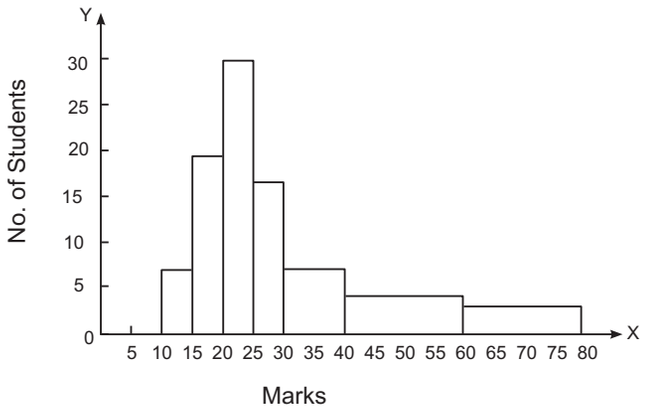


Fig. 7.10: Histogram of unequal class intervals

7.6 FREQUENCY POLYGON

Polygon is a diagrammatic presentation of data which is constructed by joining the midpoints of the tops of rectangles in a diagram. However, a polygon can be drawn even without constructing a histogram.

Example: Construct a frequency polygon from the data given below

Marks	0-10	10-20	20-30	30-40	40-50	50-60	60-70
Students	5	10	15	20	12	8	5

Method:

(i) Draw a suitable histogram keeping in view all the basic principles.

(ii) Get the mid-points of the upper horizontal side of each rectangle.

(iii) join these mid-points of the adjacent rectangle of the histogram by straight lines.

(iv) Both axes should be clearly labelled.

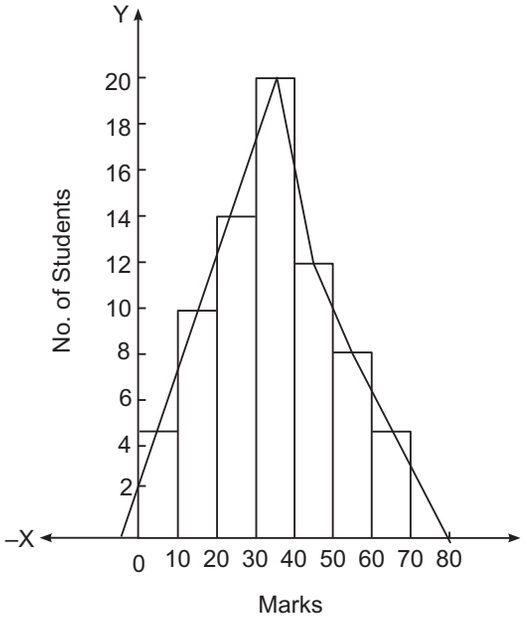


Fig. 7.11: Frequency polygon

7.7 CUMULATIVE FREQUENCY CURVE (OGIVE)

Cumulative frequency curve or ogive is the curve which is constructed by plotting cumulative frequency data on the graph paper in the form of a smooth curve.

A cumulative frequency curve or ogive may be constructed in two ways

(a) Less than, method

(b) More than method

Example: Present the following data in the form of less than ogive and more than ogive

Marks	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40
No. of students	4	6	10	25	22	18	5	

Method

(i) Get the cumulative frequencies of the given frequencies either by 'less than' method or by 'more than' method;

(ii) Take 'marks' (variable under study on x-axis.

(iii) Take calculated cumulative frequencies on y-axis.

(iv) Plot the various points and join them to get a curve i.e. ogive.

(v) Both the axes should be clearly labelled.

Cumulative frequency Distributive

Marks	Cumulative Frequencies	Marks	Cumulative Frequencies
less than 5	4	More than 0	100
less than 10	4 + 6 = 10	More than 5	100 – 4 = 96
less than 15	10 + 10 = 20	More than 10	96 – 6 = 90
less than 20	20 + 10 = 30	More than 15	90 – 10 = 80
less than 25	30 + 25 = 55	More than 20	80 – 10 = 70
less than 30	55 + 22 = 77	More than 25	70 – 25 = 45
less than 35	77 + 18 = 95	More than 30	45 – 22 = 23
less than 40	95 + 5 = 100	More than 35	23 – 18 = 5
		More than 40	5 – 5 = 0

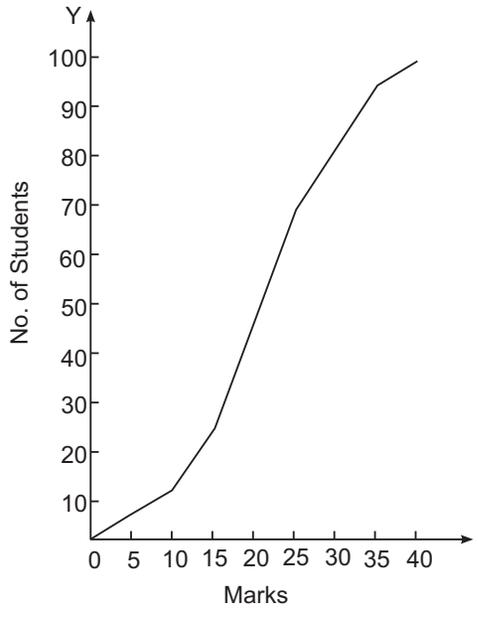


Fig. 7.12: 'Less than' ogive

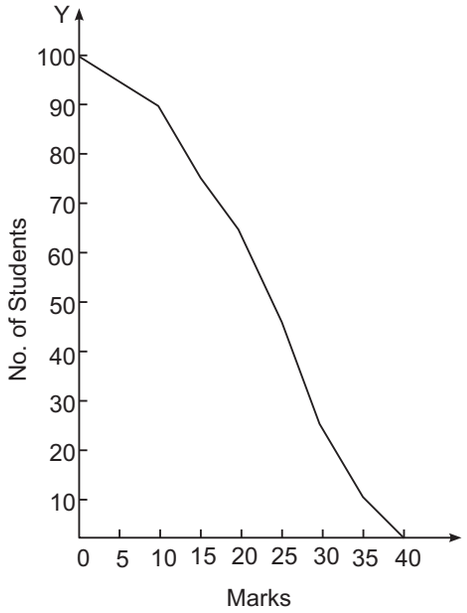


Fig. 7.13: 'More than' ogive

WHAT YOU HAVE LEARNT

- After data have been collected, they must now be arranged and presented in some useful form.
- A good presentation highlights the data and brings out important points for necessary comparison.
- Tables, frequency arrays, frequency distribution, time series line graphs etc., are some important ways in which data are presented.
- A table is a systematic presentation of data in rows and columns
- Each table has some essential constituent parts like table number, title, head note, caption, stubs, main body, foot note and source of information.
- A graph is also an important way of presenting data-such as time series line graphs, bar charts, pie diagram etc.
- A bar diagram is defined as a thick line made thicker to draw attention of the viewer.
- Its height is important as it shows the value of the variable.
    - A bar diagram can be drawn either vertically or horizontally.
    - When a breakdown of a total or a series of totals is to be shown, we use what is known as sub-divided or component bar diagram.
    - A pie diagram is also an important and effective way of presenting data. It is a circle sub-divided into components to present the proportion of different constituent parts of the total.

- When an economic variable is presented along with time, it is called a time series line graph.

TERMINAL EXERCISE

1. What is a statistical table? List its various parts.
2. What is the purpose of preparing a table? In this context distinguish between reference table and text table.
3. What is a bar chart? Explain briefly its various types.
4. What is the difference between simple bar diagram, sub-divided or component bar diagram and multiple bar diagram?
5. Explain the meaning and uses of a pie diagram. Prepare a pie diagram of family expenditure from the following data:

S.No.	Items	Expenditure (₹.)
1.	Food	480
2.	Clothing	300
3.	Education and Entertainment	330
4.	Rent	450
5.	Miscellaneous	240
	Total Expenditure	1800

6. Explain the meaning of time series line graph with the help of an example.
7. Draw a time series line graph on the basis of following data:

Annual Profits of A Firm

Year	Profit (₹. In thousand)
2009	60
2010	72
2011	75
2012	65
2013	80
2014	95

8. Make a blank table (format) showing the distribution of students of 12th class according to:

   (a) Subject group i.e. Science, Arts and Commerce

   (b) Sex i.e. boys and girls.

9. The following table gives selling price and cost price of a good 'X' for five years.

Year	2009	2010	2011	2012	2013
Selling Prices 'X'	105	110	120	90	160
Cost Price 'X'	100	80	120	120	140

   Plot the above information on a graph paper in the form of line graph. What type of graph do you get?

10. Draw histogram, frequencies polygon, 'less than' ogive and 'more than' ogive from the data given below:

Marks	0-10	10-20	20-30	30-40	40-50
No. of students	3	10	14	10	3

ANSWERS TO INTEXT QUESTIONS

7.1

1. (a) True (b) False (c) True (d) True
   (a) table (b) title (c) stub (d) bottom

7.2

1. (a) False (b) True (c) True (d) False
2. (a) an angular (b) degree for a component

7.3

(a) line (b) time (c) time (d) dependent

Notes

Guidelines to Activities

1. **Hint:**

Subject group	Number of Students		Total
	Boys	Girls	
Science			
Arts			
Commerce			
Total			

(a) Fill up yourself, the title, footnote, etc. i.e. parts of a table.

(b) Fill up the main body of the table with imaginary figures.

2. (a) Measure year of X axis and selling price (S.P.) as well as cost price (C.P.) on Y axis to get a time series line graph.

MODULE - IV
STATISTICAL TOOLS

8. Measures of Central Tendency
9. Measures of Dispersion
10. Correlation Analysis
11. Index Numbers

8

MEASURES OF CENTRAL TENDENCY

In the previous lesson, we have studied how to collect the raw data, its classification and tabulation in a useful form. Yet, this is not sufficient, for practical purposes; there is a need for further condensation of the data, particularly when we want to compare two or more different distributions data set. We may reduce the entire distribution to one number which represents the distribution using the measures of central tendency.

OBJECTIVES

After completing this lesson, you will be able to:

- explain the concept of measures of central tendency or averages;
- calculate arithmetic mean, combined arithmetic mean and weighted arithmetic mean;
- calculate median and quartiles;
- calculate mode;
- compare the various measures of central tendency; and
- apply these measures for solving various business problems.

8.1 MEANING OF CENTRAL TENDENCY

The measure of central tendency is defined as the statistical measure that identifies a single value as the representative of an entire distribution. It aims to provide an accurate description of the entire data. It is the single value that is most typical/ representative of the data. Since such typical values tend to lie centrally within a set of observations when arranged according to magnitudes, averages are called measures of central tendency. In other words, the measure of central tendency

summarizes the data in a single value in such a way that this single value can represent the entire data. The word average is commonly used in day-to-day conversations. For example, we may talk of average income of an Indian, average rainfall, average production, average price etc.

8.2 TYPES OF AVERAGES (OR) MEASURES OF CENTRAL TENDENCY

The following are the important types of averages:

- Arithmetic mean.
  - Simple arithmetic mean.
  - Weighted arithmetic mean.
- Median
- Quartiles.
- Mode.

The first one is called **'mathematical average'** where as other three are called **'measures of location'** or **'measures of position'** or **'positional averages'.**

8.2.1 Arithmetic Mean:

Arithmetic mean is the most commonly used measure of central tendency. Arithmetic mean is computed by adding all the values in the data set divided by the number of observations in it.

8.2.1.1 Computation of Arithmetic Mean in case of Individual Series

The arithmetic mean in case of individual series can be computed using following methods:

- **Direct Method**
- **Assumed Mean Method**
- **Direct Method**:

If there are N observations as $X_1, X_2 X_3 ... X_N$ then the Arithmetic Mean (usually denoted by $\bar{X}$, which is read as X bar) in case of individual series using direct method is given by:

$$\bar{X} = \frac{X_1+X_2+X_3+.... X_N}{N}$$

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

Where, ΣX = sum of all N number of observations and N = total number of observations.

Example 1: Calculate Arithmetic Mean from the data showing the marks obtained by 7 students of class XIth in certain examination 5,11,16,17,19,24,30.

The Arithmetic Mean of marks is given by:

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

$$= \frac{5+11+16+17+19+24+30}{7}$$

$$= \frac{122}{7} = 17.43 \text{ marks}$$

The average marks are 17.43.

- **Assumed Mean Method:**

Assumed mean method also called shortcut method is useful if the number of observations in the data is large and/or figures are in fraction. It helps to simplify the calculations. In this method a particular value is assumed as arithmetic mean on the basis of some logic or experience. The deviation from the said assumed mean from each of the observation is computed. The summation of these deviations is taken and then it is divided by the number of observations in the data. The actual arithmetic mean is calculated using the following formula:

$$\bar{X} = A + \frac{\Sigma d}{N}$$

Where $\bar{X}$ = Arithemetic mean, A = Assumed mean, $\Sigma d = \Sigma(X - A)$

Σd = sum of deviations, N = Number of Individual observations

Note: Any value whether existing in the data or not can be taken as the assumed mean but the final answer would be the same.

Example 2: Data of exports of a certain firms for the year 2013-2014 are mentioned in the following table:

Firms	1	2	3	4	5	6	7	8	9
Value of Exports (₹ Cr)	10	20	30	40	50	60	70	80	90

Compute average value of exports for these firms using Assumed Mean Method.

Solution:

Table 8.1: Computation of Arithmetic Mean by Assumed Mean Method

Firms	Exports(X) (in ₹Cr)	Deviation from assumed mean (A=60); d=(X-60)
1	10	-50
2	20	-40
3	30	-30
4	40	-20
5	50	-10
6	60	0
7	70	10
8	80	20
9	90	30
N = 9	ΣX = 450	Σd = –90

$$\bar{X} = A + \frac{\Sigma d}{N} = 60 + \frac{(-90)}{9} = \text{ Rupees 50 crores}$$

INTEXT QUESTIONS 8.1

1. A researcher has collected the following sample individual data.

   5 12 6 8 5 6 7 5 12 4

   The mean of the data is

   (a) 5 (b) 6 (c) 7 (d) 8

2. Find the mean of the set of numbers below:

   3, 4, –1, 22, 14, 0, 9, 18, 7, 0, 1

8.2.1.2 Computation of Arithmetic Mean for Grouped data

- **Discrete Series:**

In case of discrete series where the variable X takes the values $X_1, X_2 \ldots X_N$ with respective frequencies $f_1, f_2 \ldots f_N$ the arithmetic mean can be calculated by applying:

(i) Direct Method

(ii) Assumed Mean Method.

(iii) Step Deviation Method

(i) Direct Method: According to this method the arithmetic mean is given by:

$$\bar{X} = \frac{f_1X_1 + f_2X_2 + ...f_NX_N}{f_1 + f_2 + ...f_N} = \frac{\sum fX}{\sum f}$$

where Σf = total frequency

Example 3: The following data gives the weekly wages (in ₹) **of 20 workers in a factory:**

Weekly Earnings (in ₹)	100	140	170	200	250
No. of workers	5	2	6	4	3

Calculate the average weekly earnings of the workers.

Solution:

Table 8.2: Computation of Arithmetic Mean

Weekly Wages(X)	No. of workers(f)	fX	(A=170); d=X-170	fd
100	5	500	-70	-350
140	2	280	-30	-60
170	6	1020	0	0
200	4	800	30	120
250	3	750	80	240
	$\Sigma f=20$	$\Sigma fX=3350$		$\Sigma fd=-50$

Arithmetic mean using direct method, the average weekly wages are:

$$\frac{\sum fX}{\sum f} = \frac{3350}{20} = \text{Rs } 167.50$$

(ii) Assumed Mean Method: Since in the discrete series frequency (f) of each item is given, we multiply each deviation (d) from the assumed mean (A) with the respective frequency (f) to get fd. According to this method, arithmetic mean is given by:

$$\bar{X} = A + \frac{\sum fd}{N}$$

where A = assumed mean, d = X – A and N = Σf

Arithmetic mean using Assumed Mean Method, the average weekly earnings are:

$$\bar{X} = A + \frac{\sum fd}{N} = 170 + \frac{-50}{20} = \text{Rs.}167.50$$

(iii) Step Deviation Method: In this case the deviations taken from assumed mean are divided by the common factor 'c' which simplifies the calculation.

Here we estimate $d' = \frac{d}{c} = \frac{X - A}{c}$ in order to reduce the size of numerical figures for easier calculation. The arithmetic mean is given by:

$$\bar{X} = A + \frac{\sum fd'}{\sum f} \times c$$

Example 4: From the following data of the marks obtained by 60 students of a class.

Marks	20	30	40	50	60	70
No of students	8	12	20	10	6	4

Calculate the arithmetic mean by

(i) Direct Method

(ii) Assumed Mean Method

(iii) Step-Deviation Method

Solution:

Table 8.3: Calculation of Arithmetic mean

Marks (X)	**No. of students(f)**	**fX**	**d = (X – 40)**	**d′ = d/10**	**fd**	**fd′**
20	8	160	–20	–2	–160	–16
30	12	360	–10	–1	–120	–12
40	20	800	0	0	0	0
50	10	500	10	1	100	10
60	6	360	20	2	120	12
70	4	280	30	3	120	12
	Σf = 60	**ΣfX = 2,460**			**Σfd = 60**	**Σfd′ = 6**

(i) Direct method:

$$\bar{X} = \frac{\Sigma fX}{\Sigma f} = \frac{2460}{60} = 41$$

Hence the average marks = 41.

(ii) Assumed Mean Method:

$$\bar{X} = A + \frac{\Sigma fd}{N} = 40 + \frac{60}{60} = 40 + 1 = 41$$

Hence the average marks = 41.

(iii) Step-Deviation Method

$$\bar{X} = A + \frac{\Sigma fd'}{\Sigma f} \times c = 40 + \frac{6}{60} \times 10 = 41$$

Hence the average marks = 41.

Example 5: From the following data, find the missing item if the Mean wage is **₹ 115.86**

Wages in (₹):	110	112	113	117	?	125	128	130
No. of workers :	25	17	13	15	14	8	6	2

Solution: Let x be the missing item.

Table 8.4: Calculation of missing Item

Wages in ₹ (X_i)	**Number of workers f_i**	**f_iX_i**
110	25	2750
112	17	1904
113	13	1469
117	15	1755
x	14	14x
125	8	1000
128	6	768
130	2	260
Total	$\Sigma f_i = 100$	$\Sigma f_iX_i = 9906 + 14x$

Now the arithmetic mean $(\bar{X}) = \frac{\Sigma f_i X_i}{\Sigma f_i}$

Therefore, $115.86 = \frac{9906 + 14x}{100}$

or $115.86 \times 100 = 9906 + 14x$

$11586 = 9906 + 14x$

$11586 - 9906 = 14x$

$1680 = 14x$

or $x = \frac{1680}{14}$

$x = 120$

Therefore the missing item is ₹ 120

INTEXT QUESTIONS 8.2

1. Find the mean of the set of ages in the table below:

Age (years)	Frequency
10	0
11	8
12	3
13	2
14	7

2. Find the mean average weekly earnings for the data given in example 3, by using step deviation method.

8.2.1.3 Computation of Arithmetic Mean in case of Continuous series

In case of continuous series, class intervals and frequencies are given. In this case the mid-points of various class intervals are taken for calculating arithmetic mean. It may be noted that class intervals may be exclusive or inclusive or of unequal size. In case of continuous series also the computation of arithmetic mean is done by applying:

(i) Direct Method;

(ii) Assumed Mean Method;

(iii) Step Deviation Method.

(i) Direct Method: The steps involved in the calculation of arithmetic mean are as follows:

1. Calculate the mid-point of each class and denote these mid-points as m as follows:

$$\text{Mid-point } (m) = \frac{\text{Lower Limit} + \text{Upper Limit}}{2}$$

2. Multiply the mid-point with respective frequency and denote these product as fm

3. The arithmetic mean is obtained as follows:

$$\bar{X} = \frac{\Sigma fm}{\Sigma f}$$

(ii) Assumed Mean Method: Under this method the formula for calculating mean is

$$\bar{X} = A + \frac{\Sigma fd}{\Sigma f}$$

Where A = assumed mean d = m – A

f = frequency of n number of observation.

(iii) Step Deviation Method: To make the calculations simpler, we first find a common figure by which all the values of d can be divided. It will reduce the values of d and make further calculations easier. This common factor by which values of d are divided is termed as c i.e. $\left(\frac{d}{c} = d'\right)$. At a later stage the value of d′ is again multiplied by this common factor so that the final result of arithmetic mean is not affected. The steps involved are as follows:

Step 1: Obtain

$$d' = \frac{m - A}{c}$$

where m = mid-point, A = Assumed mean

c = common factor which is the difference between upper limit and lower limit of a class

Step 2: Apply the following formula to calculate arithmetic mean:

$$\bar{X} = A + \frac{\Sigma fd'}{\Sigma f} \times c$$

Example 6: Calculate average Land- size of the farmers of a village from the following data using (a) Direct method (b) Step deviation method.

Size of Land (in hectares)	0-10	10-20	20-30	30-40	40-50	50-60
No. of Farmers	42	44	58	35	26	15

Solution:

Table 8.5: Computation of Land Size for Exclusive Class Interval

Land Size (in hectares)	No. of Farmers(f)	Mid Points (m)	fm	$d' = \frac{m-35}{10}$	fd′
0-10	42	5	210	–3	–126
10-20	44	15	660	–2	–88
20-30	58	25	1450	–1	–58
30-40	35	35	1225	0	0
40-50	26	45	1170	1	26
50-60	15	55	825	2	30
	Σf = 220		**Σfm=5540**		**Σfd′=-216**

Applying Direct Method:

$$\bar{X} = \frac{\Sigma fm}{\Sigma f} = \frac{5540}{220} = 25.2 \text{ hectares}$$

Applying the Step Deviation Method:

$$\bar{X} = A + \frac{\Sigma fd'}{\Sigma f} \times c = 35 + \left(\frac{-216}{220}\right) \times 10 = 25.2 \text{ hectares}$$

INTEXT QUESTIONS 8.3

1. The following distribution gives the pattern of overtime work per month done by 180 employees of a company. Calculate the arithmetic mean.

Overtime (in hrs)	0-10	10-30	30-40	40-50	50-60
No. of Employees	10	60	50	40	20

Solution: Since the class intervals are unequal, the frequencies have to be adjusted to make the class interval equal on the assumption that these are equally distributed throughout the class.

$$\bar{X} = A + \frac{\Sigma fd'}{\Sigma f} \times c = 45 + \left(\frac{-220}{180}\right) \times 10 = 32.778 \text{ hours}$$

2. A company is planning to improve plant safety. For this accident data for the last 180 weeks were compiled. These data are grouped into the frequency distribution as shown below:

No. of accidents	1-10	11-20	21-30	31-40	41-50	51-60
No. of Weeks	10	20	30	50	40	30

Calculate the arithmetic mean of the number of accident per day.

Solution: In this case the inclusive series are converted into exclusive series by deducting half the difference between upper limit of a class and lower limit of next class from the lower limit of class and adding the same to upper limit of class.

$$\bar{X} = A + \frac{\Sigma fd'}{\Sigma f} \times c = 45.5 + \left(\frac{-180}{180}\right) \times 10 = 35.5 \text{ accident per week}$$

8.2.3 Properties of Arithmetic Mean

1. The sum of the deviations, of all the values of X, from their arithmetic mean, is zero.
2. The product of the arithmetic mean and the number of items gives the total of all items.
3. The sum of the squares of the deviations of the items taken from arithmetic mean is minimum.
4. If a constant is added or subtracted to all the variables, mean increases or decreases by that constant.
5. If all the variables are multiplied or divided by a constant, mean also gets multiplied or divided by the constant.

INTEXT QUESTIONS 8.4

Choose the correct answer:

1. The sum of deviations of the individual data elements from their mean is:
   (a) always greater than zero
   (b) always less than zero
   (c) sometimes greater than and sometimes less than zero, depending on the data elements
   (d) always equal to zero
2. In a group of 12 scores, the largest score is increased by 36 points. What effect will this have on the mean of the scores?
   (a) It will be increased by 12 points
   (b) It will remain unchanged
   (c) It will be increased by 3 points
   (d) It will increase by 36 points
   (e) There is no way of knowing exactly how many points the mean will be increased.

8.2.4 Combined Mean

If a series of N observations consists of two components having N_1 and N_2 observations ($N_1+N_2=N$), and means $\bar{X}_1$ and $\bar{X}_2$ respectively then the Combined mean $\bar{X}$ of N observations is given by

$$\text{Combined mean } \bar{X} = \frac{N_1\bar{X}_1 + N_2\bar{X}_2}{N_1 + N_2}$$

Example 7: The average marks of three batches of students having 70, 50 and 30 students respectively are 50, 55 and 45. Find the average marks of all the 150 students, taken together.

Solution: Let X be the average marks of all 150 students taken together.

Average. marks	$\bar{X}_1 = 50$;	$\bar{X}_2 = 55$;	$\bar{X}_3 = 45$
No. of students	$N_1 = 70$;	$N_2 = 50$;	$N_3 = 30$

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

$$= \frac{70\times50+50\times55+30\times45}{70+50+30} = \frac{7600}{150}$$

$$\bar{X}_{123} = 50.67 \text{ marks}$$

INTEXT QUESTIONS 8.5

1. The mean of a certain number of observations is 40. If two or more items with values 50 and 64 are added to this data, the mean rises to 42. Find the number of items in the original data.

2. Eight coins were tossed together and the number of times they fell on the side of heads was observed. The activity was performed 256 times and the frequency obtained for different values of x, (the number of times it fell on heads) is shown in the following table. Calculate then mean by: i) Direct method ii) Short-cut method

X:	0	1	2	3	4	5	6	7	8
f:	1	9	26	59	72	52	29	7	1

3. Calculate the average age of employees working in a company from the following data:

Age (years) below:	25	30	35	40	45	50	55	60
No. of employees:	8	23	51	81	103	113	117	120

8.2.5 Weighted Arithmetic Mean:

In calculating simple arithmetic mean, it is assumed that all the items in the series carry equal importance. But in practice, there are many cases where relative importance should be given to different items. When the mean is computed by giving each data value a weight that reflects its importance, it is referred to as a weighted mean. When data values vary in importance, the analyst must choose the weight that best reflects the importance of each value. If $w_1, w_2, w_3, \ldots w_N$ are weights of N observations in a series $X_1, X_2, X_3, \ldots X_N$ then the weighted mean is calculated as

$$\bar{X}_w = \frac{\Sigma wX}{\Sigma w}$$

Note: If the weights of all the observations are equal i.e. $w_1 = w_2 = w_3, \ldots w_N = w$ Then the weighted A.M is equal to simple A.M i.e. $\bar{X}_w = \bar{X}$.

Example 8: An examination was held to decide the award of scholarship. The weights of various subjects were different. The marks obtained by 3 candidates (out of 100) in each subject are given below:

Subject	Weight	Students		
		A	B	C
Mathematics	40	60	57	62
History	30	62	61	67
Chemistry	20	55	53	60
English	10	67	77	49

Calculate the weighted A.M. to award the scholarship.

Solution:

Table 8.6: Calculation of the weighted arithmetic mean

Subject	Weight	Students					
		A		B		C	
		Marks (X_A)	$X_A w_i$	Marks (X_B)	$X_B w_i$	Marks (X_C)	$X_C w_i$
Mathematics	40	60	2400	57	2280	62	2480
History	30	62	1860	61	1830	67	2010
Chemistry	20	55	1100	53	1060	60	1200
English	10	67	670	77	770	49	490
Total	**100**	**244**	**6030**	**248**	**5940**	**238**	**6180**

Applying the formula for weighted mean, we get

$$\bar{X}_{wA} = \frac{6030}{100} = 60.3 \text{ marks}; \quad \bar{X}_A = \frac{244}{4} = 61 \text{ marks.}$$

$$\bar{X}_{wB} = \frac{5940}{100} = 59.4 \text{ marks}; \quad \bar{X}_B = \frac{248}{4} = 62 \text{ marks.}$$

$$\bar{X}_{wC} = \frac{6180}{100} = 61.8 \text{ marks}; \quad \bar{X}_C = \frac{238}{4} = 59.5 \text{ marks.}$$

From the above calculation, it may be noted that student B should get the scholarship as per simple A.M. values, but according to weighted A.M., student C should get the scholarship because all the subjects of examination are not of equal importance.

INTEXT QUESTIONS 8.6

1. A big mall wants to know the weighted mean of the sales price of 2,000 units of one product that had its final price adjusted according to the first ten days of sales. The table below summarizes the relation between final price and number of sold units.

Price per unit	No. of sold units	Price per unit	No.of sold units
₹ 24.20	354	₹ 24.14	288
₹ 24.10	258	₹ 24.06	240
₹ 24.00	209	₹ 23.95	186
₹ 23.90	133	₹ 23.84	121
₹ 23.82	110	₹ 23.75	101

Compute both the average price and the weighted average sales price of this product

An Evaluation of Arithmatic Mean

Arithmetic mean is easy to calculate**.** All values in the series are used in the calculation of mean, so it can be regarded as more representative of the entire data set. However, mean is affected by extreme items i.e. very high or a very low value in the data set. Thus the mean may be rather lower or higher than most of the values in the data set and so become unrepresentative of the entire data. Mean cannot be calculated in the open-ended frequency distribution.

8.3 MEDIAN

Median is the positional value that divides the series into two equal parts in such a way that half of the items lie above this value and the remaining half lie below this value. In Connor's words - "The median is that value of the variable which divides the group into two equal parts, one part comprising all values greater and the other all values lesser than the median." Median is called a positional average because it is based on the position of a given observation in a series arranged in an ascending or descending order and position of the median is such that equal number of items lie on either side of it. Median is denoted by Med. or M_d.

8.3.1 Computation of Median in case of Individual Series

The steps involved in the calculation of median are as follows:

Step 1: Arrange the data in ascending or descending order.

Step 2: Ascertain $\frac{N+1}{2}$th item. This will give the position of the median i.e. item/items at which the median lies.

It may be noted that the formula $\frac{N+1}{2}$th item gives the position of the median in an ordered series, not the median itself. Median is the size of $\frac{N+1}{2}$th item.

Example 9: The following data relates to the no. of patients examined per hour in the hospital:

No. of Patients Examined	10	12	15	20	13	24	17	18

Calculate the median.

Solution:

Arranging the size of item in ascending order:

No. of Patients Examined	10	12	13	15	17	18	20	24

$$\text{Median} = \text{size of } \left(\frac{N+1}{2}\right)\text{th item} = \left(\frac{8+1}{2}\right)\text{th item}$$

$$= \text{size of } 4.5\text{th item}$$

$$\text{We get Median} = \frac{15+17}{2} = 16$$

Thus the median no. of patients examined per hour is 16.

Example 10: The following figures represent the number of books in Statistics issued at the counter of a library on 11 different days. 96, 180, 98, 75, 270, 80, 102, 100, 94, 75 and 200. Calculate the median.

Solution: Arrange the data in the ascending order as 75, 75, 80, 94, 96, 98, 100, 102,180, 200, 270.

Now the total number of items 'N'= 11

$$\text{Therefore, the median} = \text{size of } \left(\frac{N+1}{2}\right)\text{th item}$$

$$= \text{size of } \left(\frac{11+1}{2}\right) \text{th item}$$

$$= \text{size of } 6^{th} \text{ item}$$

$$= 98 \text{ books per day}$$

INTEXT QUESTION S 8.7

1. If a data set has an even number of observations, the median
   (a) cannot be determined
   (b) is the average value of the two middle items
   (c) must be equal to the mean
   (d) is the average value of the two middle items when all items are arranged in ascending order

2. A distribution of 6 scores has a median of 21. If the highest score increases 3 points, the median will become:
   (a) 21
   (b) 21.5
   (c) 24
   (d) Cannot be determined without additional information.
   (e) none of these

8.3.2 Computation of Median in case of Discrete Series:

In case of discrete series the position of median i.e. $\frac{N+1}{2}$ th item can be located through cumulative frequency. The steps involved in the calculation of median are as follows:

Step 1: Arrange the data in ascending or descending order of magnitude.

Step 2: find out the cumulative frequency (c.f.)

Step 3: Median = size of $\frac{N+1}{2}$ th item

Step 4: Now look at the cumulative frequency column and find that total which is either equal to $\frac{N+1}{2}$ or next higher to that and determine the value of the variable corresponding to it. That gives the value of median.

Example 11: Calculate Median from the following data:

Marks	45	55	25	35	5	15
No of Students	40	30	30	50	10	20

Solution:

Table 8.7: Calculation of Median Marks

Marks in an Ascending order	No. of students	Cumulative frequencies
5	10	10
15	20	30
25	30	60
35	50	110
45	40	150
55	30	180

Median = size of $\frac{N+1}{2}$ th item = $\frac{180+1}{2}$ item = 90.5th item

Cumulative frequency which includes 90.5^{th} item =110

Median = size of item corresponding to 110 = 35marks.

8.3.3 Computation of Median in case of Continuous Series

The steps involved in the calculation of median are as follows:

Step 1: Calculate Cumulative Frequencies.

Step 2: Ascertain $\left[\frac{N}{2}\right]$ th item.

Step 3: Find out the cumulative frequency which includes $\left[\frac{N}{2}\right]$ th item and corresponding class frequency. The corresponding class of this cumulative frequency is called the median class.

Step 4: Calculate Median as Follows:

$$\text{median} = l_1 + \frac{\frac{N}{2} - \text{c.f.}}{\text{f}} \times i$$

where l_1 = Lower limit of the median class

c.f. = cumulative frequency of the preceeding class

f = frequency of the median class

i = class interval of median class

Example 12: Calculate the median of weekly expenditure from the following data:

Weekly Expenditure (in ₹)	0-10	10-20	20-30	30-40	40-50
No. of families	14	23	27	21	15

Solution:

Table 8.8: Calculation of Median Weekly Expenditure (in ₹)

Weekly Expenditure (in ₹)	No. of families (f)	Cumulative frequency (c.f)
0-10	14	14
10-20	23	37
20-30	27	64
30-40	21	85
40-50	15	100

Ascertain $\left[\frac{N}{2}\right]$th item $= \left[\frac{100}{2}\right]$th item = 50th item lies in class interval as 20-30.

Thus the Median Class is 20-30.

Now applying formula of median

$$\text{Median} = l_1 + \frac{\frac{N}{2} - \text{c.f}}{\text{f}} \times \text{i}$$

here l_1 = 20, c.f. = 37, f = 27, i = 10

$$\text{Median} = 20 + \frac{50-37}{27} \times 10$$

= ₹ 24.815

Note that while calculating the median of a series, it must be put in the 'exclusive class-interval' form. If the original series is in inclusive type, first convert it into the exclusive type and then find its median.

INTEXT QUESTIONS 8.8

1. Calculate the median age of the persons from the following data.

Age (years) :	20-25	25-30	30-35	35-40	40-45
No. of person :	70	80	180	150	20

2. Calculate the median marks of the students:

Marks :	40-50	30-40	20-30	10-20	0-10
No. of students :	10	12	40	30	8

8.3.4 Important Mathematical property of median

The sum of the deviations of the items from median, ignoring signs is the least.

$$\Sigma|X - Md| \text{ is least.}$$

An Evaluation of Median

Since Median is the middle term it is not affected by extreme values and can also be calculated in the open ended frequency distribution. It is not based on all the values of the data set.

8.4 QUARTILES

Quartile is that value which divides the total distribution into four equal parts. So there are three quartiles, *i.e.* Q_1, Q_2 and Q_3 which are termed as first quartile, second quartile and third quartile or lower quartile, middle quartile and upper quartile respectively. Q_1 (quartile one) covers the first 25% items of the series. Q_1 divides the series in such a way that 25% of the observations have the value less than Q_1 and 75% have the value more than Q_1. Q_2 (quartile two) is the median or middle value of the series and Q_3 (quartile three) covers 75% items of the series. Q_3 divides the series in such a way that 75% of the observations have the value less than Q_3 and 25% have the value more than Q_3.

- **Calculation of Quartiles:**

The calculation of quartiles is done exactly in the same manner as it is in case of the calculation of median.

8.4.1 In case of Individual and Discrete Series

$$Q_k = \text{Size of } \frac{k(N+1)}{4} \text{ th item of the series}$$

8.4.2 In case of Continuous Series

$$Q_k = \text{Size of } k\left(\frac{N}{4}\right) \text{ th item of the series},$$

Q_k is calculated as follows:

$$Q_k = l_1 + \frac{k\left(\frac{N}{4}\right) - cf}{f} \times i$$

Where, l_1 = Lower limit of quartile class

l_2 = upper limit of quartile class

c = Cumulative frequency preceding the quartile class

f = Frequency of kth quartile class.

Example 13: Find the Q_1 and Q_3 of the following:

(a) 4, 5, 6, 7, 8, 9, 12, 13, 15, 10, 20

(b) 100, 500, 1000, 800, 600, 400, 7000 and 1200

Solution:

(a) Values of the variable are in ascending order:

i.e. 4, 5, 6, 7, 8, 9, 10, 12, 13, 15, 20, So N = 11 (No. of Values)

$$Q_1 = \text{Size of } \frac{(N+1)}{4} \text{ th item of the series}$$

$$= \left(\frac{11+1}{4}\right) = \text{size of } 3^{rd} \text{ item.} = \text{size of 3rd item} = 6$$

$$Q_3 = \text{Size of } \frac{3(N+1)}{4} \text{ th item of the series}$$

$$= 3\left(\frac{11+1}{4}\right) = \text{size of } 9^{th} \text{ item.} = \text{size of 9th item} = 13$$

$\therefore$ Required Q_1 and Q_3 are 6 and 13 respectively,

(b) The values of the variable in ascending order are:

100, 400, 500, 600, 700, 800, 1000, 1200, N = 8

$$Q_1 = \text{Size of } \frac{(N+1)}{4} \text{ th item of the series}$$

$$= \text{Size of } \frac{(8+1)}{4} \text{ th item of the series}$$

= size of 2.25th item

= size of {Second item + 0.25(Third item - Second item)}

= 400 + 0.25 (500 - 400) = 400 + 25 = 425

$$Q_3 = \text{Size of } \frac{3(N+1)}{4} \text{ th item of the series}$$

$$= \text{Size of } \frac{3(8+1)}{4} \text{ th item of the series}$$

= size of 6.75th item

= size of [6th item + 0.75(7th item - 6th item)]

= 800 + 0.75 (1000 - 800)

= 800 + 150 = 950

Required Q_1 and Q_3 are 425 and 950 respectively.

Example 14: Find the median and Q_1 from the following data.

Marks :	0-10	10-30	30-50	50-80	80-90	90-100
No of Students :	4	12	20	8	4	2

Solution: To locate median class firstly we have to calculate cumulative frequencies.

Table 8.9: Calculation of Median and Quartile Marks

Marks	0-10	10-30	30-50	50-80	80-90	90-100
No of Students	4	12	20	8	4	2
Cumulative frequency	4	16	36	44	48	50

Calculation of Median is shown as under:

Here N = 50, so N/2 = 25, hence median class is 30-50

$$\text{Median} = l_1 + \frac{\frac{N}{2} - c.f}{f} \times i$$

$$\text{Median} = 30 + \frac{25-16}{20} \times 20 = 39 \text{ marks}$$

Calculation of Q_1 :

Here N = 50 so N/4 = 12.5, hence Quartile class (Q_1) is 10-30

$$Q_1 = l_1 + \frac{N/4 - cf}{f} \times i$$

$$Q_1 = 10 + \frac{12.5-4}{12} \times 20 = 24.16 \text{ marks}$$

8.5 MODE

Mode (M_0) is the value around which maximum concentration of items occurs. For example, a manufacturer would like to know the size of shoes that has maximum demand or style of the shirt that is more frequently demanded. Here, *Mode* is the most appropriate measure. Mode is the value which is repeated the highest number of times in the series. It is the size of that item which possesses the maximum frequency.

8.5.1 Computation of Mode in case of Ungrouped Data/ Individual series

The mode of this series can be obtained by mere inspection. The number which occurs most often is the mode.

Note that if in any series, two or more numbers have the maximum frequency, then the mode will be difficult to calculate. Such series are called as Bi-modal, Tri-modal or Multi-modal series.

Example 15: Find the mode of 15, 21, 26, 25, 21, 23, 28, 21

Solution: The mode is 21 since it occurs three times and the other values occur only once.

INTEXT QUESTIONS 8.9

1. The most frequently occurring value of a data set is called:

   (a) range (b) mode (c) mean (d) median

2. Find the mode of 12, 15, 18, 26, 15, 9, 12, 27

3. The measure of location which is the most likely to be influenced by extreme values in the data set is the:

   (a) median (b) mode (c) mean (d) Quartile

4. A researcher has collected the following sample individual data

5	12	6	8	5	6	7	5	12	4

   The Median is:

   (a) 5 (b) 6 (c) 7 (d) 8

   And the Mode is:

   (a) 5 (b) 6 (c) 7 (d) 8

5. Which of the following can have more than one value?

   (a) Median; (b) Quartile; (c) mode and (d) mean

8.5.2 Computation of mode in case of discrete series

The mode in case of discrete series is calculated by applying the following methods:

(a) Simple inspection method:

By simple inspection, the modal value is the value of the variable against which the frequency is the largest.

Example 16: Find the modal age of boys studying in XII class from the following data.

Age : (in yrs)	5	7	10	12	15	18
No. of Boys :	4	6	9	7	5	3

Solution:

From the above data we can clearly see that modal age is 10 yrs because 10 has occurred maximum number of times i.e. 9.

b) Grouping and Analysis Table method: This method is generally used when the difference between the maximum frequency and the frequency preceding it or succeeding it is very small.

Process of Computation:

In order to find mode, a grouping table and an analysis table are to be prepared in the following manner:

Grouping Table:

A grouping table consists of 6 columns.

1. Arrange the values in ascending order and write down their corresponding frequencies in the column-1.
2. In column-2 the frequencies are grouped into two's and added.
3. In column-3 the frequencies are grouped into two's, leaving the first frequency and added.
4. In column-4 the frequencies are grouped into three's, and added.
5. In column-5 the frequencies are grouped into three's, leaving the first frequency and added.
6. In column-6 the frequencies are grouped into three's, leaving the first and second frequencies and added.
7. Now in each these columns mark the highest total with a circle.

Analysis Table:

After preparing a grouping table, prepare an analysis table. While preparing this table take the column numbers as rows and the values of the variable as columns. Now for each column number see the highest total in the grouping table (Which is marked with a circle) and mark the corresponding values of the variable to which the frequencies are related by using bars in the relevant boxes. Now the value of the variable (class) which gets highest number of bars is the modal value (modal class).

Applying grouping and Analysis Table Method to the given example for calculating the value of mode for discrete series.

Table 8.10: Grouping Table

Age	Frequency					
	Col I	Col II	Col III	Col IV	Col V	Col VI
5	4	10		**19**		
7	6		**15**		**22**	
10	**9**	**16**				**21**
12	7		12	15		
15	5	8				
18	3					

Analysis Table

Column	5	7	10	12	15	18
Col I			1			
Col II			1	1		
Col III		1	1			
Col IV	1	1	1			
Col V		1	1	1		
Col VI			1	1	1	
Total	1	3	**6**	3	1	0

Thus the Modal age of Boys is 10 years.

8.5.3 Computation of Mode in case of Continuous series

In case of continuous series, for calculating mode, first of all ensure that the given continuous series is the exclusive series with equal class intervals. In order to find out the mode we need one step more than those used for discrete series. As explained in the discrete series, modal class is determined by inspection or by preparing grouping and analysis tables. The steps involved are:

1. Determine the modal class which as the maximum frequency.
2. Value of the mode can be calculated by the formula :

$$\text{Mode} = l_1 + \frac{f_1 - f_0}{2f_1 - f_0 - f_2} \times i$$

l_1 = lower limit of the modal class

f_1 = frequency of the modal class

f_0 = frequency of the preceeding the modal class

f_2 = frequency of the succeeding the modal class

i = class interval of the modal class

Note: 1.It may be noted that in case of continuous series, class intervals should be equal and series should be exclusive to calculate the mode. If the given series is inclusive and has unequal class interval then the same has to be converted into exclusive series and series with equal class interval.

2. If mid points are given, class intervals are to be obtained.

Example 17: From the following data calculate mode:

Age (in years) :	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60
No. of Persons :	50	70	80	150	180	120	70	50

Solution:

Table 8.11: Computation of mode

Grouping Table:

Age	Frequency					
	(1)	(2)	(3)	(4)	(5)	(6)
20-25	50	120		200		
25-30	70		150		300	
30-35	80	230				**410**
35-40	150		**330**	**450**		
40-45	**180**	**300**			**370**	
45-50	120		190			240
50-55	70	120				
55-60	50					

Analysis Table

Column	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60
1					1			
2					1	1		
3				1	1			
4				1	1	1		
5					1	1	1	
6			1	1	1			
Total	0	0	1	3	6	3	1	0

The modal class is 40-45. Mode is given by:

$$\text{Mode} = l_1 + \frac{f_1 - f_0}{2f_1 - f_0 - f_2} \times i$$

Here L = 40, f_1 = 180, f_0 = 150, f_2 = 120, i = 5

$$\text{Mode} = 40 + \frac{180 - 150}{(2 \times 180) - 150 - 120} \times 5 = 40 + \left[\frac{30}{90}\right] \times 5 = 41.67 \text{ years.}$$

Example 18: Calculate the modal wages from the following data:

Daily wages (in ₹):	20-25	25-30	30-35	35-40	40-45	45-50
No. of workers:	1	3	8	12	7	5

Solution: Here the maximum frequency is 12 by inspection method, corresponding to the class interval (35 - 40) which is the modal class.

$$\text{Mode} = l_1 + \frac{f_1 - f_0}{2f_1 - f_0 - f_2} \times i$$

Here L = 35, f_1 = 12, f_0 = 8, f_2 = 7, i = 5

$$\text{Mode} = 35 + \frac{12-8}{(2\times12)-8-7} \times 5 = 35 + \left[\frac{4}{9}\right] \times 5 = 37.22 \text{ (in rup}$$

Modal wages is ₹ 37.22

An Evaluation of Mode

Mode is not affected by extreme values and can be calculated in the open ended frequency distribution.

Example 19: The following table shows the daily wages of a random sample of construction workers. Calculate its mean, median and mode.

Daily Wages (₹)	Number of Workers
200 - 399	5
400 - 599	15
600 - 799	25
800 - 999	30
1000 - 1199	18
1200 - 1399	7
Total	100

Solution:

Table 8.12: Calculation of Mean

Daily Wages (₹)	Number of Workers (f)	Class Mark m	fm
200 - 399	5	299.5	1,497.5
400 - 599	15	499.5	7,492.5
600 - 799	25	699.5	17,489.5
800 - 999	30	899.5	26,985.0
1000 - 1199	18	1,099.5	19,791.0
1200 - 1399	7	1,299.5	9,096.5
Total	100		82,352.0

$$\textbf{Mean } (\bar{X}) = \frac{\Sigma fm}{\Sigma f} = \frac{82,352.0}{100} = 823.52 \text{ (in rupees)}$$

Thus Mean Wages are ₹ 823.52

In order to calculate the mode and median the given series has to be converted from inclusive series into exclusive series.

Table 8.13: Calculation of Median

Daily Wages (₹)	Number of Workers(f)	Cumulative Frequency
199.5 – 399.5	5	5
399.5 – 599.5	15	20
599.5 – 799.5	25	45
799.5 – 999.5	30	75
999.5 – 1199.5	18	93
1199.5 – 1399.5	7	100
Total	100	

$$\text{Median} = l_1 + \frac{\frac{N}{2} - c.f}{f} \times i$$

Here N = 100 so N/2 = 50, hence median class is 799.5 – 999.5

$$\text{Median} = 799.5 + \frac{50-45}{30} \times 200 = 832.83 \text{ (in Rupees)}$$

So the median daily wage is ₹ 832.8

Table 8.14: Computation of Mode

Grouping Table

Daily Wages (₹)	Frequency					
	(1)	(2)	(3)	(4)	(5)	(6)
199.5-399.5	5	20		45		
399.5-599.5	15		40		**70**	
599.5-799.5	25	**55**				**73**
799.5-999.5	**30**		**48**	**55**		
999.5-1199.5	18	25				
1199.5-1399.5	7					

Analysis Table

Col.	199.5- 399.5	399.5- 599.5	599.5-799.5	799.5-999.5	999.5-1199.5	1199.5-1399.5
1				1		
2			1	1		
3				1	1	
4				1	1	1
5		1	1	1		
6			1	1	1	
Total	0	1	3	6	3	1

The modal class is 799.5 – 999.5. Mode is given by:

$$\text{Mode} = l_1 + \frac{f_1 - f_0}{2f_1 - f_0 - f_2} \times i$$

Here $l_1 = 799.5$, $f_1 = 30$, $f_0 = 25$, $f_2 = 18$, $i = 200$

$$\text{Mode} = 799.5 + \frac{30-25}{(2\times30)-25-18} \times 200$$

$$= 799.5 + \left[\frac{5}{17}\right] \times 200 = 858.32 \text{ (in Rupees).}$$

Thus the modal wage is ₹858.32

WHAT YOU HAVE LEARNT

- The measure of central tendency identifies the single value that is most typical/ representative of the entire data-set.
- The following are the important measures of central tendency:
  - Arithmetic mean.
    - Simple arithmetic mean.
    - Weighted arithmetic mean.
  - Median
  - Quartiles.
  - Mode.

- The arithmetic mean in case of individual series can be computed using
  - **Direct Method**

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

  - **Assumed Mean Method**

$$\bar{X} = A + \frac{\Sigma d}{N}$$

where $\bar{X}$ = Arithemetic mean, A = Assumed mean

Σd = sum of deviations, N = Number of Individual observations

- Arithmetic Mean in case of discrete series is given by:
  - **Direct Method**

$$\bar{X} = \frac{\Sigma fX}{\Sigma f}$$

where Σf = total frequency

  - **Assumed Mean Method**

$$\bar{X} = A + \frac{\Sigma fd}{N}$$

where A = assumed mean, d = X – A and N = Σf

  - **Step Deviation Method**

$$\bar{X} = A + \frac{\Sigma fd'}{\Sigma f} \times c$$

- Arithmetic Mean in case of continuous series is given by:
  - **Direct Method**

$$\bar{X} = \frac{\Sigma fm}{\Sigma f}$$

where $\text{Mid-point (m)} = \frac{\text{Lower Limit} + \text{Upper Limit}}{2}$

  - **Assumed Mean Method**

$$\bar{X} = A + \frac{\Sigma fd}{\Sigma f}$$

where A = assumed mean d = m – A

f = frequency of n number of observation.

- **Step Deviation Method**

$$\bar{X} = A + \frac{\Sigma fd'}{\Sigma f} \times c$$

where $d' = \frac{m - A}{c}$

m = mid-point, A = Assumed mean

c = common factor which is the difference between upper limit and lower limit of a class

- The combined mean of two series is given by

Combined mean $\bar{X} = \frac{N_1\bar{X}_1 + N_2\bar{X}_2}{N_1 + N_2}$

where N_1 and N_2 are no. of items in the two series and $\bar{X}_1$ and $\bar{X}_2$ are the means of two series.

- The weighted arithmetic mean is given by:

$$\frac{\Sigma wX}{\Sigma w}$$

where $w_i = w_1, w_2, w_3, \ldots w_N$ are weights of N observations in a series and $x_i = x_1, x_2, x_3, \ldots x_N$ are N observations in the series.

- Median is the positional value that divides the series into two equal parts in such a way that half of the items lie above this value and the remaining half lie below this value.
- In individual and discrete series, the formula to calculate median is :

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

- If the number of observations is even then median is given by

$$\text{Median} = \left[\frac{\text{size of } \left(\frac{N}{2}\right)^{th} + \text{size of } \left(\frac{N}{2}+1\right)^{th}}{2}\right]$$

- Median in case of cumulative series is given by:

  Median = size of $\left(\frac{N}{2}\right)$ th item

$$\text{Median} = l_1 + \frac{\frac{N}{2} - c.f}{f} \times i$$

  where l_1 = Lower limit of the median class

  c.f. = cummulative frequency of the preceeding class

  f = frequency of the median class

  i = class interval of median class

- Quartile is the value which divides the total distribution into four equal parts. There are three quartiles, i.e. Q_1, Q_2 and Q_3 which are termed as first quartile, second quartile and third quartile or lower quartile, middle quartile and upper quartile respectively.

- In case of Individual and Discrete Series, the quartiles are computed by:

$$Q_k = \text{Size of } \frac{k(N+1)}{4} \text{ th item of the series}$$

- In case of Continuous Series the quartiles are computed by:

$$Q = l_1 + \frac{k\left(\frac{N}{4}\right) - cf}{f} \times i$$

  where l_1 = Lower limit of ith quartile class

  l_2 = upper limit of ith quartile class

  c = Cumulative frequency preceding the ith quartile class

  f = Frequency of kth quartile class.

- Mode is the value around which maximum concentration of items occurs.

- Mode in case of ungrouped or Individual series is the number which occurs most often in data.

- The mode in case of grouped data (discrete series and continuous series) is the value of the variable against which the frequency is the largest.

TERMINAL EXERCISE

Mean

1. An average daily wages of all 90 workers in a factory is ₹. 60. An average daily wages of non-technical workers is ₹. 45. Calculate an average daily wages of technical workers if one-third workers are technical.

2. For the two frequency distribution given below, the mean calculated from the first was 25.4 and that from the second was 32.5. Find the values of x and y.

Class Interval	Distribution I	Distribution II
10-20	20	4
20-30	15	8
30-40	10	4
40-50	x	2x
50-60	y	y

3. The mean of 99 items is 55. The value of 100th item is 99 more than the mean of 100 items. What is the value of 100th item

Median

4. The length of time taken by each of 18 workers to complete a specific job was observed to be the following:

Time(in min)	5-9	10-14	15-19	20-24	25-29
No. of workers	3	8	4	2	1

Calculate the median time and Q_1 and Q_3

5. Calculate the median from the following data:

Mid values	115	125	135	145	155	165	175	185	195
frequency	6	25	48	72	116	60	38	22	3

6. If the quartiles for the following distribution are Q_1= 23.125 and Q_3=43.5, find the median:

Daily Wages	0-10	10-20	20-30	30-40	40-50	50-60
No. of workers	5	-	20	30	-	10

7. The mean and median of a group of 25 observations are 143,144, and 147 respectively. A set of 6 observations is added to this data with values 132, 125, 130, 160, 165 and 157. Find mean and median for the combined group of 31 observations.

Mode

8. Locate mode in the data:

   7, 12, 8, 5, 9, 6, 10, 9, 4, 9, 9

9. Determine the modal value in the following series:

Value	10	12	14	16	18	20	22	24	26	28	30	32
frequency	7	15	21	38	34	34	11	19	10	38	5	2

10. The median and mode of the following wage distribution are known to be ₹. 33.5 and ₹. 34 respectively. Three frequency values from the table are however missing. Find the missing values.

Wages in ₹	Frequencies
0-10	10
10-20	10
20-30	?
30-40	?
40-50	?
50-60	6
60-70	4
	230

11. The details of monthly salary of various categories of employees working in a university are given below. From these details , calculate mode of monthly salary.

Category	Monthly Salary (₹)	No. of employees
Principal	10,00,000	1
Vice Principal	2,50,000	1
Senior	75,000	5
Professor Professor	30,000	8
Associate Professor	20,000	13
Assistant Professor	18,000	9

12. The distribution of age of patients turned out in a hospital on a particular day was as under:

Age (in years)	No. of patients
More than 10	148
More than 20	124
More than 30	109
More than 40	71
More than 50	30
More than 60	16
More than 70 and upto 80	1

Find the median age and modal age of the patients.

ANSWERS TO INTEXT QUESTIONS

8.1

1. (c) 2. 7

8.2

1. 12.4 years 2. 41

8.4

1. (d) 2. (c)

8.5

1. 15 2. 3.97 3. 36.83 years

8.6

1. Average price ₹23.98

   Weighted mean for sales in the first ten days ₹24.03

8.7

1. (d)
2. (a) Median will remain the same

8.8

1. 32.78 years
2. 23 marks

8.9

1. (b)
2. The modes are 12 and 15 since both occur twice
3. (c)
4. (b)
5. (c)

Notes

9

MEASURES OF DISPERSION

The previous lesson provides the measure of central tendency that sum up or describe the data into a single representative value. The measures of central tendency may not be adequate to describe data unless we know the manner in which the individual items scatter around it. In other words, a further description of a series on the scatter or variability known as **dispersion** is necessary, if we are to gauge how representative the average is.

Let us take the following three sets.

Students	Group X	Group Y	Group Z
1	50	45	05
2	50	50	45
3	50	55	100
mean $\bar{X}$	50	50	50

Thus, the three groups have same mean i.e. 50. In fact the median of group X and Y are also equal. Now if one would say that the students from the three groups are of equal capabilities, it is totally a wrong conclusion. Close examination reveals that in group X students have equal marks as the mean, students from group Y are very close to the mean but in the third group Z, the marks are widely scattered. It is thus clear that the measures of the central tendency is alone not sufficient to describe the data. The measure of dispersion helps us to know the degree of variability in the data and provide a better understanding of the data.

OBJECTIVES

After completing this lesson, you will be able to:

- know the meaning and need of measures of dispersion;

- distinguish between absolute and the relative measures of dispersion;
- apply the various measures of dispersion; and
- calculate and compare the different measures of dispersion.

9.1 MEANING OF DISPERSION

Dispersion is the extent to which values in a distribution differ from the average of the distribution.

In measuring dispersion, it is imperative to know the amount of variation (absolute measure) and the degree of variation (relative measure). In the former case we consider the range, Quartile Deviation, standard deviation etc. In the latter case we consider the coefficient of range, coefficient quartile deviation, the coefficient of variation etc.

9.1.1 Absolute and Relative Measures of Dispersion

The dispersion of a series may be measured either absolutely or relatively. If the dispersion is expressed in terms of the original units of the series, it is called absolute measure of dispersion. The disadvantage of absolute measure of dispersion is that it is not suitable for comparative study of the characteristics of two or more series.

For example if the data is expressed in kilograms then the absolute variation will also be expressed in kilograms but if the same data is expressed in grams then the variation will appear 1000 times more. So for comparison point of view it is necessary to calculate the relative measures of dispersion which are expressed as percentage form (i.e. unitless number). These types of expressions are called coefficients of dispersion. Each absolute measure of dispersion has a relative measure of dispersion.

9.2 MEASURES AND METHODS OF COMPUTING DISPERSION

The following are the important measures of dispersion:

1. Range
2. Quartile deviation or Semi-Inter quartile range.
3. Mean deviation
4. Standard deviation
5. Lorenz Curve

Range and Quartile Deviation measure the dispersion by calculating the spread within which the values lie. Mean Deviation and Standard Deviation calculate the extent to which the values differ from the average.

9.2.1 Range

Range (R) is the difference between the largest (L) and the smallest value (S) in a distribution. Thus

$$\text{Range (R)} = L - S$$

Coefficient of Range: It is a relative measure of the range. It is used in the comparative study of the dispersion

$$\text{co-efficient of Range} = \frac{L-S}{L+S}$$

In case of continuous series Range is just the difference between the upper limit of the highest class and the lower limit of the lowest class.

Range: Evaluation

Range is very simple to understand and easy to calculate. However, it is not based on all the observations of the distribution and is unduly affected by the extreme values. Any change in the data not related to minimum and maximum values will not affect range. It cannot be calculated for open-ended frequency distribution.

Example 1: The amount spent (in ₹) by the group of 10 students in the school canteen is as follows:

110, 117, 129, 197, 190, 100, 100, 178, 255, 790.

Find the range and the co-efficient of the range.

Solution: R = L - S = 790 - 100 = ₹ 690

$$\text{Co-efficient of Range} = \frac{L-S}{L+S} = \frac{790-100}{790+100} = \frac{690}{890} = 0.78$$

Example 2: Find the range and it's co-efficient from the following data.

Size	10-20	20-30	30-40	40-50	50-100
Frequency	2	3	5	4	2

Solution: R = L – S = 100 – 10 = 90

$$\text{Co-efficient of range} = \frac{L-S}{L+S} = \frac{100-10}{100+10} = \frac{90}{110} = 0.82$$

INTEXT QUESTIONS 9.1

1. The difference between the largest and the smallest data values is the

   (a) variance (b) inter-quartile range

   (c) range (d) coefficient of variation

2. A researcher has collected the following sample data. The mean of the sample is 5.

   3 5 12 3 2

   The range is

   (a) 1 (b) 2 (c) 10 (d) 12

9.2.2 Quartile Deviation

It is based on the lower quartile Q_1 and the upper quartile Q_3. The difference $Q_3 - Q_1$ is called the inter-quartile range. The difference $Q_3 - Q_1$ divided by 2 is called semi-inter-quartile range or the quartile deviation.

$$\text{Thus Quartile Deviation (Q.D)} = \frac{Q_3 - Q_1}{2}$$

9.2.2.1 Coefficient of Quartile Deviation

A relative measure of dispersion based on the quartile deviation is called the coefficient of quartile deviation. It is defined as

$$\text{Coefficient of Quartile Deviation} = \frac{\frac{Q_3 - Q_1}{2}}{\frac{Q_3 + Q_1}{2}} = \frac{Q_3 - Q_1}{Q_3 + Q_1}$$

It is pure number free of any units of measurement. It can be used for comparing the dispersion in two or more than two sets of data.

9.2.2.2 Computation of Quartile Deviation of Ungrouped Data

Example 3: Find out the quartile deviation of daily wages (in ₹) of 7 persons is given below:120,70,150,100,190,170,250

Solution:

Arranging the data in an ascending order we get

70, 100, 120, 150, 170, 190, 250

Here n = 7,

$$Q_1 = \text{Size of } \frac{(N+1)}{4} \text{th item}$$

$$= \text{Size of } \frac{(7+1)}{4} \text{th item} = 2^{nd} \text{item} = 100 \text{ rupees}$$

$$Q_3 = \text{Size of } \frac{3(N+1)}{4} \text{th item}$$

$$= \text{Size of } \frac{3(7+1)}{4} \text{th item} = 6^{th} \text{item} = 190 \text{ rupees}$$

$$\text{Q.D.} = \frac{Q_3 - Q_1}{2} = \frac{190-100}{2} = 45 \text{ rupees}$$

INTEXT QUESTION 9.2

1. If the first quartile is 104 and quartile deviation is 18. Find the third quartile.

Example 4: The wheat production (in Kg) of 20 acres is given as: 1120, 1240, 1320, 1040, 1080, 1200, 1440, 1360, 1680, 1730, 1785, 1342, 1960, 1880, 1755, 1720, 1600, 1470, 1750, and 1885. Find the quartile deviation and coefficient of quartile deviation.

Solution:

After arranging the observations in ascending order, we get 1040, 1080, 1120, 1200, 1240, 1320, 1342, 1360, 1440, 1470, 1600, 1680, 1720, 1730, 1750, 1755, 1785, 1880, 1885, 1960.

$$Q_1 = \text{value of } \left(\frac{N+1}{4}\right) \text{th item}$$

$$= \text{Value of } \left(\frac{20+1}{4}\right) \text{th item}$$

= Value of (5.25)th item

= 5th item + 0.25(6th item – 5th item)

= 1240 + 0.25(1320 – 1240)

Q_1 = 1240 + 20 = 1260

Q_1 = 1240 + 20 = 1260 kg

$$Q_3 = \text{Value of } \frac{3(N+1)}{4} \text{ th item}$$

$$= \text{Value of } \frac{3(20+1)}{4} \text{ th item}$$

= Value of (15.75)th item

= 15th item + 0.75(16th item – 15th item)

= 1750 + 0.75 (1755 – 1750)

Q_3 = 1750+3.75 = 1753.75 kg

Quartile Deviation (Q.D)

$$= \frac{Q_3 - Q_1}{2} = \frac{1753.75 - 1260}{2} = \frac{492.75}{2} = 246.875$$

$$\text{Q.D.} = \frac{Q_3 - Q_1}{2} = \frac{1753.75 - 1260}{2}$$

$$= \frac{492.75}{2} = 246.875\text{kg.}$$

Coefficient of Quartile Deviation

$$= \frac{Q_3 - Q_1}{Q_3 + Q_1} = \frac{1753.75 - 1260}{1753.75 + 1260} = 0.164$$

Computation of Q.D. for a frequency distribution

9.2.2.2 Computation in case of Discrete Series:

Example 5: The Tax authority collected the following amount of tax from different firms in a particular market.

Amount of Taxes (in 000 ₹)	10	11	12	13	14
No. of Firms	3	12	18	12	3

Calculate the quartile deviation and the coefficient of quartile deviation.

Solution:

Table 9.1: Calculation of Quartile deviation

Amount of Taxes (in '000 ₹)	No. of Firms (f)	Cummulative Frequency (C.F.)
10	3	3
11	12	15
12	18	33
13	12	45
14	3	48
	Σf = 48	

Here N = 48,

$$Q_1 = \text{Size of } \frac{(N+1)}{4} \text{th item}$$

$$= \text{Size of } \frac{(48+1)}{4} \text{th item}$$

$$= \text{Size of } 12.25^{th} \text{ item} = 11 \text{ (in '000 rupees)}$$

$$Q_3 = \text{Size of } \frac{3(N+1)}{4} \text{th item}$$

$$= \text{Size of } \frac{3(48+1)}{4} \text{th item}$$

$$= \text{Size of } 36.75^{th} \text{ item} = 13 \text{(in '000 rupees)}$$

$$\text{Q.D.} = \frac{Q_3 - Q_1}{2} = \frac{13-11}{2} = 1 \text{ (in '000 rupees)}$$

$$\text{Coeff of Q.D.} = \frac{Q_3 - Q_1}{Q_3 + Q_1} = \frac{13-11}{13+11} = 0.083$$

9.2.2.3 Computation of Q.D. for a Continuous Series

Example 6: Calculate quartile deviation and coefficient of quartile deviation from the following distribution:

Weekly Wages(in '000 ₹)	5-7	8-10	11-13	14-16	17-19
No. of Workers	14	24	38	20	04

Solution:

Table 9.2: Calculation of Quartile deviation and coefficient of quartile deviation

Weekly Wages (in '000 ₹)	No. of Workers (f)	Cummulative Frequency (C.F.)
4.5-7.5	14	14
7.5-10.5	24	38
10.5-13.5	38	76
13.5-16.5	20	96
16.5-19.5	4	100
	Σf = 100	

$$Q_1 = l_1 + \frac{l_2 - l_1}{f}\left(\frac{N}{4} - cf\right)$$

$\frac{N}{4} = 25$. Q_1 lies in the class of 7.5-10.5

$$Q_1 = l_1 + \frac{l_2 - l_1}{f}\left(\frac{N}{4} - cf\right) = 7.5 + \frac{25-14}{24} \times 3 = 8.875 \text{ (in ₹000)}$$

$$Q_3 = l_1 + \frac{l_2 - l_1}{f}\left(\frac{3N}{4} - cf\right) = 10.5 + \frac{75-38}{38} \times 3 = 13.42 \text{ (in ₹000)}$$

$$\text{Q.D.} = \frac{Q_3 - Q_1}{2} = \frac{13.42 - 8.875}{2} = 2.273 \text{ (in ₹000)}$$

$$\text{Coeff. of Q.D.} = \frac{Q_3 - Q_1}{Q_3 + Q_1} = \frac{13.42 - 8.875}{13.42 + 8.875} = 0.21$$

Quartile Deviation: An Evaluation

Since Quartile deviation is based only on Q_1 and Q_3, it means this measure is based on middle 50% of the data of the series. Thus unlike range, Quartile deviation is not affected' by extreme items as it ignores 25% of the data from the beginning of the dataset and 25% of the data from the end (data arranged in ascending order). It can be calculated in case of open-ended distribution. However, it is not based on all the observations in the data.

INTEXT QUESTIONS 9.3

1. Which of the following is a measure of dispersion?
   (a) percentiles
   (b) quartiles
   (c) inter-quartile range
   (d) all of the above are measures of dispersion
2. The inter-quartile range is
   (a) the 50th percentile
   (b) another name for the standard deviation
   (c) the difference between the largest and smallest values
   (d) the difference between the third quartile and the first quartile
3. Which of the following limitation of the range is overcome by the inter-quartile range?
   (a) the sum of the range variances is zero
   (b) the range is difficult to compute
   (c) the range is influenced too much by extreme values
   (d) the range is negative
4. A researcher has collected the following sample data. The mean of the sample is 5.

   3 5 12 3 2

   The inter-quartile range is:

   (a) 1 (b) 2 (c) 10 (d) 12

9.2.3 Mean Deviation

Mean deviation (MD) of a series is the arithmetic average of the deviation of various items from a measure of central tendency (mean, median and mode)

Mean deviation is based on the items of the distribution and is calculated as an average, on the basis of deviation obtained from either mean, median or mode but generally from the median.

First we compute deviations of all the items from either mean or median ignoring plus (+) and (–) signs. They are called absolute values of deviations where the two parallel bars (ii) indicate that the absolute value is taken. This is also called modulas value. Then the aggregate of these deviations are divided by the number of observations this is called mean deviation.

9.2.3.1 Calculation of mean deviation

(i) Arrange the data in ascending order (for calculating of median)

(ii) Calculate median/mean/mode

(iii) Take deviations of items from median/mean ignoring ± signs and denote the column as |D|

(iv) Calculate the sum of these deviation in case of discrete and continuous series |D| is multiplied by respective frequency of the item to get Σf |D|

(v) Divide the total obtained by number of items to get mean deviation

$$\text{M.D.} = \frac{\Sigma f\,|D|}{N}$$

(vi) apply the formula to get coefficient of mean deviation

$$\text{Coefficient of M.D.} = \frac{\text{M.D}}{\text{Median / Mean / Mode}}$$

Example 6: Calculate mean deviaiton and coefficient of mean deviation from both mean and median for the following data on the monthly income (in ₹) of households

Income (₹)	8520	6350	7920	8360	7500

Table 9.3: Calculation of mean deviaiton from median

Monthly Income (₹)	Deviation from mean (7730) ignoring ± signs |D|	Deviations from median (7920) ignoring ± signs |D|
6350	1380	1570
7500	230	420
7920	190	0
8360	630	440
8520	790	600
$\Sigma X = 38650$	$\Sigma\|D\| = 3220$	$\Sigma\|D\| = 3030$

$$\text{Mean} = \frac{\Sigma X}{N}$$

$$= \frac{38650}{5} = 7730$$

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

$$= \frac{3220}{5} = \text{Rs } 644$$

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

$$= \frac{644}{7730} = 0.083$$

$$\text{and Median} = \text{Size of } \left(\frac{N+1}{2}\right)^{th} \text{ item}$$

$$= \text{Size of } \left(\frac{5+1}{2}\right)^{th} \text{ item}$$

$$= \text{Size of 3rd item}$$

$$= ₹\ 7920$$

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

$$= \frac{3030}{5} = \text{Rs } 606$$

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

$$= \frac{606}{7920} = 0.076$$

9.2.3.2 Calculation of mean deviaiton in discrete series

Example 7: Calculate (a) median (b) mean deviation and (c) Coefficient of mean deviation

Size of item (X)	6	12	18	24	30	36	42
Frequency (f)	4	7	9	18	15	10	5

Solution.

Table 9.4: Calculation of mean deviaiton from Median

X	f	cf	|D|	f|D|
6	4	4	18	72
12	7	11	12	84
18	9	20	6	54
24	18	38	0	0
30	15	53	6	90
36	10	63	12	120
42	5	68	18	90
	$\Sigma f = 68$		$\Sigma\|D\| = 72$	$\Sigma f\|D\| = 510$

$$\text{Median} = \text{Size of } \left(\frac{N+1}{2}\right)^{th} \text{ item}$$

$$= \text{Size of } \left(\frac{68+1}{2}\right)^{th} \text{ item}$$

$$= 34.5\text{th item}$$

$$\text{M.D.} = \frac{\Sigma f\,|D|}{N} = \frac{510}{68} = 7.5$$

$$\text{Coefficient of M.D.} = \frac{\text{M.D.}}{\text{Median}} = \frac{7.5}{24} = 0.312$$

Calculation of mean deviaiton in continuous series

Example 8: Calculate (i) mean, (ii) mean deviation from mean and (iii) co-efficient of mean deviation.

Marks	0-10	10-20	20-30	30-40	40-50
No. of students	5	8	15	16	6

Solution: Calculation of mean deviation from mean

Table 9.5: Calculation of mean deviaiton from Mean

Marks X	No of students f	Mid-point m	$\frac{m-25}{10}$	fd′	|D| = m – 27	f|D|
0-10	5	5	–2	–10	22	110
10-20	8	15	–1	–8	12	96
20-30	15	25	0	0	2	30
30-40	16	35	+1	+16	8	128
40-50	6	45	+2	+12	18	108
	Σf = 50			Σfd′ = 10		Σf|D|= 472

$$\bar{X} = A + \frac{\Sigma fd'}{N} \times c$$

$$= 25 + \frac{10}{50} \times 10 = 27 \text{ Marks}$$

$$\text{M.D.} = \frac{\Sigma f\,|D|}{N} = \frac{472}{50} = 9.44 \text{ Marks}$$

$$\text{Coefficient of M.D.} = \frac{\text{M.D.}}{\text{Mean}} = \frac{9.44}{27} = 0.349$$

Mean deviaiton: An evaluation

Mean deviation ignores the ± signs of the deviation which is mathematically unsound and illogical. Therefore, this method is non-algebraic. Moreover, it can not be computed for distribution for open end classes.

INTEXT QUESTIONS 9.4

(i) Calculated mean deviation and co-efficient of mean deviation from median

No of tomatoes per plant	0	1	2	3	4	5	6	7	8	9	10
No of plants	2	5	7	11	18	24	12	8	6	4	3

(ii) Calculate mean deviation from mean

Class:	3-4	4-5	5-6	6-7	7-8	8-9	9-10
Frequency	3	7	22	60	85	32	8

9.2.4 Standard Deviation (S. D.)

Standard deviation is the most important and commonly used measure of dispersion. It measures the absolute dispersion or variability of a distribution. Standard deviation is the positive square root of the mean of the squared deviations of observations from their mean. It is denoted by S.D. or σ_x.

9.2.4.1 Computation of Standard deviation in case of Individual Series

The following four methods are used to calculate the standard deviation:

1. Actual Mean Method

Let X variable takes on N values i.e. $X_1, X_2, \ldots X_N$. The standard deviation of these N observations using actual mean method can be computed as follows:

1. Obtain the arithmetic mean $(\bar{X})$ of the given data.
2. Obtain the deviation of each ith observation from $\bar{X}$ i.e. $(X_i - \bar{X})$. (Note that $\Sigma(X_i - \bar{X}) = 0$)
3. Square each deviation i.e. $(X_i - \bar{X})^2$
4. Obtain the sum in step 3 i.e. $\sum_{i=1}^{N}(X_i - \bar{X})^2$
5. Obtain the square root of the mean of these squared deviations as follows:

$$\text{Standard deviation } (\sigma_x) = \sqrt{\frac{\Sigma(X-\bar{X})^2}{N}}$$

N = Total No. of observation

2. Assumed Mean Method

This method is applied to calculate the standard deviation when the mean of the data is in fraction. In that case it is difficult and tedious to find the deviation of all observations from the actual mean by the above method. Thus the deviations (d) are taken from the Assumed mean (A) and standard deviation is estimated by using the following formula:

$$\text{Standard Deviation } (\sigma_x) = \sqrt{\frac{\Sigma d^2}{N} - \left(\frac{\Sigma d}{N}\right)^2}$$

where d = (X – A) i.e. deviation taken from the assumed mean (A)

3. Direct Method

The relevance of this method is particularly useful when the items are very small. To obtain standard deviations, we apply the following formula:

$$\text{Standard Deviation } (\sigma_x) = \sqrt{\frac{\sum X^2}{N} - (\bar{X})^2}$$

where $\bar{X}$ = arithemetic mean

(**Note:** The direct method basically implies taking deviations from zero)

4. Step Deviation Method

In this method we divide the deviations by a common class interval (c) and use the following formula for computing standard deviation:

$$\text{Standard Deviation } (\sigma_x) = \sqrt{\frac{\sum d'^2}{N} - \left(\frac{\sum d'}{N}\right)^2} \times c$$

where $d' = \left(\frac{X - A}{c}\right)$ i.e. deviation taken from the assumed mean and divide by class interval (c)

Example 9: The wholesale price of a commodity for 6 days in a month of February 2014 is as follows:

Days	1	2	3	4	5	6
Commodity Price(₹ Per Quintal)	5	15	25	35	45	55

Compute the standard deviation using:

(i) Actual Mean Method

(ii) Assumed Mean Method

(iii) Direct Method and

(iv) Step-Deviation Method

Solution:

Table 9.6: Calculation of standard deviation

Days	Price (₹ Per Quintal)	$(X-\bar{X})$ $= (X-30)$	$(X-\bar{X})^2$ $= (X-30)^2$	$d =$ $(X-40)$	$d^2 =$ $= (X-40)^2$	X^2	$d' = \frac{X-40}{5}$	d'^2
1	5	-25	625	–35	1225	25	–7	49
2	15	-15	225	–25	625	225	–5	25
3	25	-5	25	–15	225	625	–3	9
4	35	5	25	–5	25	1225	–1	1
5	45	15	225	5	25	2025	1	1
6	55	25	625	15	225	3025	3	9
		$\sum(X-\bar{X})$ $= 0$	$\sum(X-\bar{X})^2$ $= 1750$	$\sum d$ $= -60$	$\sum d^2$ $= 2350$	$\sum X^2$ $= 7150$	$\sum d'$ $= -12$	$\sum d'^2$ $= 94$

Applying Actual Mean Method

$$\bar{X} = \frac{\sum X}{N} = \frac{180}{6} = 30 \text{ (in Rupees)}$$

$$\text{Standard deviation } (\sigma_x) = \sqrt{\frac{\sum(X-\bar{X})^2}{N}} = \sqrt{\frac{1750}{6}} = 17.078 \text{ (in rupees)}$$

Applying Assumed Mean Method:

Here $\bar{X} = A + \frac{\sum d}{N} = 40 + \frac{-60}{6} = 30$

$$\text{Standard Deviation } (\sigma_x) = \sqrt{\frac{\sum d^2}{N} - \left(\frac{\sum d}{N}\right)^2}$$

$$\sum d^2 = 2350, \ \sum d = -60, N = 6$$

$$\therefore \quad (\sigma_X) = \sqrt{\frac{2350}{6} - \left(\frac{-60}{6}\right)^2} = \text{Rs.}17.078$$

Applying Direct Method

$$\text{Standard Deviation } (\sigma_x) = \sqrt{\frac{\sum X^2}{N} - (\bar{X})^2}$$

where $\bar{X} = 30,\ \sum X^2 = 7150,\ N = 6$

$$\therefore \qquad (\sigma_X) = \sqrt{\frac{7150}{6} - (30)^2} = \text{Rs.}17.078$$

Applying Step Deviation Method

$$\text{Standard Deviation } (\sigma_x) = \sqrt{\frac{\sum d'^2}{N} - \left(\frac{\sum d'}{N}\right)^2} \times c$$

where $c = 5, \sum d'^2 = 94, N = 6, \sum d' = -12$

$$\therefore \qquad (\sigma_X) = \sqrt{\frac{94}{6} - \left(\frac{-12}{6}\right)^2} \times 5 = \text{Rs.}17.078$$

Note: The sum of deviations taken from mean is Zero. But the sum of deviations from a value other than actual mean is not equal to zero

9.2.4.2 Computation of Standard Deviation in case of Continuous Series

In continuous series, the class-interval and frequencies are given. The following methods are used to compute standard deviation in this case:

1. Actual Mean Method

In this method the following steps are involved:

- Calculate the mean of the distribution.
- Estimate deviations of mid-values from the actual mean i.e. $x = m - \bar{X}$.
- Multiply the deviations with their corresponding frequencies to get 'fx'. [Note that $\Sigma fx = 0$].
- Calculate fx^2 values by multiplying 'fx' values with 'x' values and sum up these to get $\sum fx^2$.
- Apply the following formula to obtain standard deviation:

$$\text{Standard deviation } (\sigma_x) = \sqrt{\frac{\sum fx^2}{\sum f}}$$

where $x = (m - \bar{X})$ i.e. deviation taken from the arithemetic mean $(\bar{X})$

2. Assumed Mean Method

The steps involved in the calculation of standard deviation are as follows:

- Calculate mid-points (i.e. m) of classes.
- Estimate the deviations of mid-points from the assumed mean (A) i.e. d = m – A.
- Multiply values of 'd' with corresponding frequencies to get 'fd' values (note that the total of this column is not zero since deviations have been taken from assumed mean).
- Apply the following formula to calculate standard deviation:

$$\text{Standard deviation } (\sigma_x) = \sqrt{\frac{\sum fd^2}{\sum f} - \left(\frac{\sum fd}{\sum f}\right)^2}$$

where d = (m – A) i.e. deviation taken from the assumed mean (i.e. A)

3. Step Deviation Method

The steps involved in the calculation of standard deviation are as follows:

- Calculate class mid-points (m) and deviations (d) from an arbitrarily chosen value just like in the assumed mean method. i.e. d= m-A.
- Divide the deviations by a common factor 'C' denoted by $d' = \left(\frac{m - A}{c}\right)$.
- Multiply d′ values with corresponding f values to obtain fd′ values.
- Multiply fd′ values with d′ values to get fd'^2 values.
- Obtain $\Sigma fd'$ and $\Sigma fd'^2$ values.
- Apply the following formula.

$$\text{Standard Deviation } (\sigma_x) = \sqrt{\frac{\sum fd'^2}{\sum f} - \left(\frac{\sum fd'}{\sum f}\right)^2} \times c$$

where $d' = \left(\frac{m - A}{c}\right)$ i.e. deviation taken from the assumed mean and divide by class interval (c) (or the common factor in case the class intervals are unequal), m is the mid value of the interval.

Standard Deviation: Interesting Properties

1. The value of Standard Deviation remains same if each observation in a series is increased or decreased by a constant value i.e. Standard deviation is independent of change of origin.
2. The value of Standard Deviation changes if each of observation in a series is multiplied or divided by a constant value i.e. Standard deviation is not independent of change of scale.

Example 10: A study of 1000 companies gives the following information

Profit (in ₹ crores)	0-10	10-20	20-30	30-40	40-50	50-60
No. of Companies	10	20	30	50	40	30

Calculate the standard deviation of the profit earned.

(i) Actual Mean Method

(ii) Assumed Mean Method

(iii) Step-Deviation Method

Solution:

Table 9.7: Calculation of standard deviation

Profit (in ₹ crores)	**No. of Companies**	**m**	**fm**	**d = (m – 40)**	**$d' = \frac{m-45}{10}$**	**fd**	**fd^2**	**fd′**	**fd'^2**
0-10	10	5	50	–35	–4	–350	12250	–40	160
10-20	20	15	300	–25	–3	–500	12500	–60	180
20-30	30	25	750	–15	–2	–450	6750	–60	120
30-40	50	35	1750	–5	–1	–250	1250	–50	50
40-50	40	45	1800	5	0	200	1000	0	0
50-60	30	55	1650	15	1	450	6750	30	30
			6300	**Σd = –60**	**Σd′ = –9**	**–900**	**40500**	**–180**	**540**

Applying Actual Mean Method

$$\text{Standard deviation } (\sigma_x) = \sqrt{\frac{\sum fx^2}{\sum f}}$$

$\sum fx^2 = 36000, \sum f = 180$

$$\therefore (\sigma_X) = \sqrt{\frac{36000}{180}} = 14.142 \text{(in rupees crores)}$$

Applying Assumed Mean Method:

$$\text{Standard deviation } (\sigma_x) = \sqrt{\frac{\sum fd^2}{\sum f} - \left(\frac{\sum fd}{\sum f}\right)^2}$$

$\sum fd^2 = 40500, \sum fd = -900, \sum f = 180, d = X - 40$

$$\therefore (\sigma_X) = \sqrt{\frac{40500}{180} - \left(\frac{-900}{180}\right)^2} = 14.142 \text{(in rupees crores)}$$

Applying Step Deviation Method:

$$\text{Standard deviation } (\sigma_x) = \sqrt{\frac{\sum fd'^2}{\sum f} - \left(\frac{\sum fd'}{\sum f}\right)^2} \times c$$

$d' = \frac{m-45}{10}, \sum fd'^2 = 540, \sum fd' = -180, \sum f = 180, c = 10$

$$\therefore (\sigma_X) = \sqrt{\frac{540}{180} - \left(\frac{-180}{180}\right)^2} \times 10 = 14.142 \text{(in rupees crores)}$$

Example 11: The following table shows the daily wages of a random sample of construction workers. Calculate its mean deviation and standard deviation.

Daily Wages (₹)	Number of Workers
200 - 399	5
400 - 599	15
600 - 799	25
800 - 999	30
1000 - 1199	18
1200 - 1399	7
Total	100

Solution:

Table 9.8: Computation of mean deviation

Daily Wages (₹) X	Number of Workers (f)	Class Mark (m)	fm	$f_i \lvert m - \bar{X} \rvert = f_i \lvert m - 823.5 \rvert$
200 – 399	5	299.5	1497.50	2,620
400 – 599	15	499.5	7492.50	4,860
600 – 799	25	699.5	17487.50	3,100
800 – 999	30	899.5	26985.00	2,280
1000 – 1199	18	1,099.5	19791.00	4,968
1200 – 1399	7	1,299.5	9096.50	3,332
Total	100		82350.00	21,160

$$\text{Mean deviation} = \frac{\Sigma f_i \lvert m - \bar{X} \rvert}{\Sigma f_i} = \frac{21,160}{100} = 211.60 \text{ (₹)}$$

Table 9.9: Computation of Standard deviation

Daily Wages (₹)	Number of Workers	Class Mark (M.V.)	$f_i (m - \bar{X})^2$
200 – 399	5	299.5	1, 372,880
400 – 599	15	499.5	1,574,640
600 – 799	25	699.5	384,400
800 – 999	30	899.5	173,280
1000 – 1199	18	1,099.5	1,371,168
1200 – 1399	7	1,299.5	1,586,032
Total	100		6,462,400

$$\text{Standard deviation} = \sqrt{\frac{6462400}{100}} = 254.21 \text{ (Rupees)}$$

INTEXT QUESTION 9.5

1. Sona, Karina, Omar, Mustafa and Amie obtained marks of 6, 7, 3, 7, 2 on a standardized test respectively. Find the standard deviation of their scores.

9.2.4.3 Comparison of the variation of two series using standard deviation

The values of the standard deviations cannot be used as the basis of the comparison mainly because units of measurements of the two distributions may be different. The correct measure that should be used for comparison purposes is the **Coefficient of Variation (C.V.)** given by **Karl Pearson**:

$$C.V. = \frac{\sigma_X}{\bar{X}} \times 100$$

$$\sigma_X = \text{S.D. of variable X}, \quad \bar{X} = \text{mean of variable X}$$

Example 12: The following table shows the summary statistics for the daily wages of two types of workers.

Worker's Type	Daily Wages	
	Mean	Standard deviation
I	₹ 100	₹ 20
II	₹ 150	₹ 24

Compare these two daily wages distributions.

Solution:

Table 9.10: Calculation of coefficient of variations

In comparison	Distribution	Reason
Average magnitude	II > I	$\bar{X}_{II} = 150 > \bar{X}_I = 100$
Variation	I > II	$CV_I = \frac{20}{100} \times 100 = 20\% > CV_{II}$ $= \frac{24}{150} \times 100 = 16\%$

INTEXT QUESTIONS 9.6

1. The hourly wages of a sample of 130 system analysts are given below:

   mean = 60 range = 20

   mode = 73 variance = 324

   median = 74

   The coefficient of variation equals

   (a) 0.30% (b). 30% (c) 5.4% (d) 54%

2. The measure of dispersion that is influenced most by extreme values is:

   (a) the standard deviation

   (b) the range

   (c) the inter-quartile range

3. The descriptive measure of dispersion that is based on the concept of a deviation about the mean is

   (a) the range (b) the inter-quartile range

   (c) the absolute value of the range (d) the standard deviation

4. The numerical value of the standard deviation can never be

   (a) zero (b) negative (c) one

5. A researcher has collected the following sample data. The mean of the sample is 5.

   3 5 12 3 2

   The Standard deviation is

   a. 8.944 b. 4.062 c. 13.2 d. 16.5

   Answer: b

   And

   The Coefficient of Variation is

   a. 72.66% b. 81.24% c. 264% d. 330%

   Answer: b

9.2.5 Lorenz Curve

Lorenz curve is the graphical method of studying dispersion. Lorenz curve is the cumulative frequency curve showing the distribution of a variable such as population against any independent variable such as income or area settled. If the

distribution of the dependent variable is equal, the plot will show as a straight, 45° line. Unequal distributions will yield a curve. The gap between this curve and the 45° line is the inequality gap. The farther the curve from this 45° line, the greater is the variability present in the distribution. Lorenz curve is used to see the degree of concentration of income or health. For example, it may show top 25% of population accounts for 70% of income or bottom 25% of population has only 5% of income (see figure 9.1).

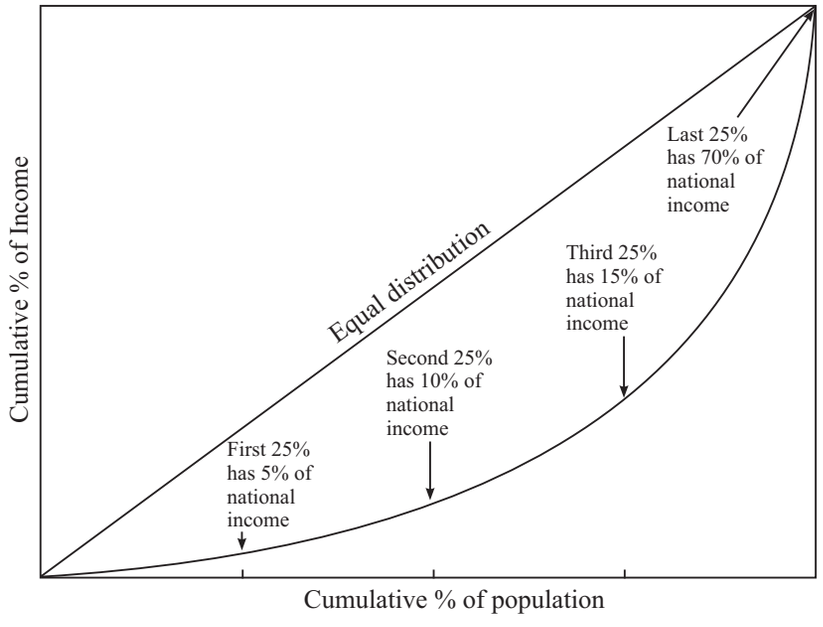


Fig. 9.1

Steps involved in drawing Lorenz Curve:

The drawing of Lorenz curve requires following steps:

1. Find cumulative totals of variables. In case of continuous variable calculate the cumulative totals of mid-points.
2. Estimate cumulative frequencies.
3. Express the cumulative mid-points and frequencies into percentages by taking each of the sum total as 100.
4. Take the cumulative percentages of the variable on Y axis and cumulative percentages of frequencies on X-axis. Each axis will have values from '0' to '100'.
5. Draw a line joining Co-ordinate (0, 0) with (100,100). This is called the line of equal distribution.
6. Plot the cumulative percentages of the variable with corresponding cumulative percentages of frequency. Join these points to get the Lorenz Curve.

WHAT YOU HAVE LEARNT

- The important measures of dispersion are:
  - i) Range
  - ii) Quartile deviation or Semi-Inter quartile range.
  - iii) Standard deviation
  - iv) Lorenz Curve
- Range (R) is the difference between the largest (L) and the smallest value (S) in a distribution i.e. Range (R) = L – S
- The Coefficient of Range is the relative measure of the range and is given by:

$$\frac{L-S}{L+S}$$

- Quartile Deviation (Q.D) is given by $\text{Q.D.} = \frac{Q_3 - Q_1}{2}$
- The Coefficient of quartile deviation is given by $\text{Coeff of Q.D.} = \frac{Q_3 - Q_1}{Q_3 + Q_1}$
- Standard deviation is the most important and commonly used measure of dispersion It is denoted by S.D. or σ_x.
- Standard deviation in case of Individual Series is given by four methods:

(i) Actual Mean Method

$$\text{Standard deviation } (\sigma_x) = \sqrt{\frac{\sum (X-\bar{X})^2}{N}}$$

N = Total No. of observation

(ii) Assumed Mean Method

$$\text{Standard deviation } (\sigma_x) = \sqrt{\frac{\sum d^2}{N} - \left(\frac{\sum d}{N}\right)^2}$$

where d = (X – A) i.e. deviation taken from the assumed mean (A)

(iii) Direct Method

$$\text{Standard deviation } (\sigma_x) = \sqrt{\frac{\sum X^2}{N} - (\bar{X})^2}$$

where $\bar{X}$ = arithemetic mean

(iv) Step Deviation Method

$$\text{Standard deviation } (\sigma_x) = \sqrt{\frac{\sum d'^2}{N} - \left(\frac{\sum d'}{N}\right)^2} \times c$$

where $d' = \left(\frac{X - A}{c}\right)$ i.e. deviation taken from the assumed mean and divide by class interval (c)

- Standard Deviation in case of Continuous Series is given by

(i) Actual Mean Method

$$\text{Standard deviation } (\sigma_x) = \sqrt{\frac{\sum fx^2}{\sum f}}$$

where $x = (m - \bar{X})$ i.e. deviation taken from the arithemetic mean $(\bar{X})$

(ii) Assumed Mean Method

$$\text{Standard deviation } (\sigma_x) = \sqrt{\frac{\sum fd^2}{\sum f} - \left(\frac{\sum fd}{\sum f}\right)^2}$$

where d = (m – A) i.e. deviation taken from the assumed mean (i.e. A)

(iii) Step Deviation Method

$$\text{Standard deviation } (\sigma_x) = \sqrt{\frac{\sum fd'^2}{\sum f} - \left(\frac{\sum fd'}{\sum f}\right)^2} \times c$$

where $d' = \left(\frac{m - A}{c}\right)$ i.e. deviation taken from the assumed mean and divide by class interval (c) (or the common factor in case the class intervals are unequal, m is the mid value of the interval.

- Standard deviation is independent of change of origin but not independent of change of scale.
- The coefficient of variation (C.V.) is the relative measure of dispersion which is used for the comparison of variability of two or more distributions. It is given by:

$$C.V. = \frac{\sigma_X}{\bar{X}} \times 100$$

σ_X = S.D. of variable X, $\bar{X}$ = mean of variable X

- Lorenz curve is the graphical method of estimating dispersion.

TERMINAL EXERCISES

Range

1. The following are the prices of shares of A B Co. Ltd. from Monday to Saturday:

Days	Price (in ₹)	Days	Price (in ₹)
Monday	200	Thursday	160
Tuesday	210	Friday	220
Wednesday	208	Saturday	250

Calculate range and its coefficient

2. Find the range of given data

108, 107, 105, 106, 107, 104, 103, 101, 104

3. Find the value of range of frequency distribution

Age in years:	14	15	16	17	18	19	20
No. of students :	1	2	2	2	6	4	0

4. Calculate the range for the distribution given below

Height in cms	150	151	152	154	159	160	165	166
No. of Boys	2	2	9	15	18	10	4	1

5. Find the range of the following data

Profit (in '000 ₹):	0-10	10-20	20-30	30-40	40-50
No. of firms	0	6	0	7	15

6. Find the range of the following distribution

Class Interval	10-20	20-30	30-40	40-50	50-60
Frequency	8	10	15	18	19

Quartile Deviation

7. Calculate the QD for a group of data,

   241, 521, 421, 250, 300, 365, 840, 958

8. From the following figures find the quartile deviation and its coefficient:

Height (cms.):	150	151	152	153	154	155	156	157	158
No. of Students:	15	20	32	35	33	22	20	12	10

9. Using quartile deviation, state which of the two variables – A and B is more variable:

A		B	
Mid-Point	Frequency	Mid-Point	Frequency
15	15	100	340
20	33	150	492
25	56	200	890
30	103	250	1420
35	40	300	620
40	32	350	360
45	10	400	187
		450	140

10. Find the quartile deviation from the following table:

Size:	4-8	8-12	12-16	16-20	20-24	24-28	28-32	32-36	36-40
Frequency:	6	10	18	30	15	12	10	6	2

11. Calculate the coefficient of quartile deviation from the following data:

Class Interval	Frequency
10–15	4
15–20	12
20–25	16
25–30	22
30–40	10
40–50	8
50–60	6
60–70	4
	8

Standard deviation

12. Determine the standard deviation of the following student test results percentages.

92% 66% 99% 75% 69% 51% 89% 75% 54% 45% 69%

13. Calculate the coefficient of variation for the following data set.

The price (in ₹), of a stock over five trading days was 52, 58, 55, 57, 59.

14. The frequency table of the monthly salaries of 20 people is shown below.

Salary (in ₹)	Frequency
3500	5
4000	8
4200	5
4300	2

(a) Calculate the mean of the salaries of the 20 people.

(b) Calculate the standard deviation of the salaries of the 20 people.

15. The following table shows the grouped data, in classes, for the heights of 50 people.

Height (in cm) – classes	Frequency
$120 \leq 130$	2
$130 \leq 140$	5
$140 \leq 150$	25
$150 \leq 160$	10
$160 \leq 170$	8

a) Calculate the mean of the salaries of the 50 people.

b) Calculate the standard deviation of the salaries of the 50 people.

16. The following is the frequency distribution for the speeds of a sample of automobiles traveling on an interstate highway.

Speed Miles per Hour	Frequency
50 – 54	2
55 – 59	4
60 – 64	5
65 – 69	10
70 – 74	9
75 – 79	5
	35

Calculate the mean, and the standard deviation of speed.

17. In 2012, the average age of workers in a company was 22 with a standard deviation of 3.96. In 2013, the average age was 24 with a standard deviation of 4.08. In which year do the ages show a more dispersed distribution? Show your complete work and support your answer.

Therefore the year 2012 shows a more dispersed distribution.

18. The following is a frequency distribution for the ages of a sample of employees at a local company.

Age (in years)	Frequency
30 – 39	2
40 – 49	3
50 – 59	7
60 – 69	5
70 – 79	1

(a) Determine the average age for the sample.

(b) Compute the standard deviation.

(c) Compute the coefficient of variation.

19. The population change between 1990 and 2000 for several small cities are shown below.

City	Population Change (number of residents)
A	3083
B	1466
C	-461
D	1113
E	-11
F	395
G	3290
H	437

For the above **sample**, determine the following measures.

(a) The mean

(c) The standard deviation

(d) The median

ANSWERS TO INTEXT QUESTIONS

9.1

1. (c)
2. (c)

9.2

1. 140

9.3

1. (c)
2. (d)
3. (c)
4. (b)

9.4

1. Median = 5, M.D. = 1.68
2. M.D. 0.915, Coefficient of M.D. = 0.336

9.5

1. 2.1 marks

9.6

1. (b)
2. (b)
3 (d)
4. (b)
5. Standard deviation (b) C.V

Notes

10

CORRELATION ANALYSIS

In previous lessons you have learnt how to summarize the mass of data and variations in the similar variable. Many a time, we come across situations which involve the study of association among two or more variables. For example we may find that there is some relationship between the two variables such as amount of rain fall and production of wheat; figures of accidents and number of motor cars in a city; money spent on advertising and sales. On the other hand, if we compare the figures of rainfall in India and the production of cars in Japan, we may find that there is no relationship between the two variables. If there is any relation between two variables i.e. when one variable changes the other also changes in the same or in the opposite direction, we say that the two variables are correlated.

OBJECTIVES

After completing this lesson, you will be able to:

- explain the meaning of the term correlation;
- explain the relationship between two variables;
- calculate the different measures of correlation; and
- analyze the degree and direction of the relationships.

10.1 MEANING OF CORRELATION

Correlation refers to the associations between variables. When an association exists between two variables, it means that the average value of one variable changes as there is a change in the value of the other variable. A correlation is the simplest type of association. When a correlation is weak, it means that the average value of one variable changes only slightly (only occasionally) in response to changes in the other variable. If there is no association, it means that there is no

change in the value of one variable in response to the changes in the other variable. In some cases, the correlation may be positive or it may be negative. A positive correlation means that as one variable increases the other variable increases, e.g. Height of a child and age of the child. Negative correlation implies as one variable increases the other variable decrease, e.g. value of a car and age of the car.

10.2 CORRELATION AND CAUSATION

The correlation between two variables measures the strength of the relationship between them but it doesn't indicate the cause and effect relationship between the variables. Correlation measures co-variation, not causation. Causation means changes in one variable affects/ causes the changes in other variable. In other words, just because two events or things occur together does not imply that one is the cause of the other. A positive "linear" correlation between two variables say X and Y implies that high values of X are associated with high values of Y, and that low values of X are associated with low values of Y. It does not imply that X causes Y. for example, a high degree of positive correlation may be obtained between the size of arms of children and their reasoning ability i.e. children with longer arms reason better than those with shorter arms, but there is no causal connection here. Children with longer arms reason better because they're older! In this example the common third factor 'age' is responsible for the high correlation between size of arms and reasoning ability. This refers to spurious correlation. Similarly a Researcher found a high degree of positive correlation between the number of temple goers and the number of burglaries committed in different towns. An explanation that more temple goers means more empty houses or attending temple makes people want to rob would be a logical fallacy. Instead the third factor population is causing this relationship. The highly populated area tends to have more temple goers and also case of burglaries. The following table 11.1 provides some interesting examples of influence of third variable on correlation between variables.

Table 10.1: Spurious Correlation and Influence of Third Variable.

Observed Spurious Correlation	Influence of Third Variable.
Positive Correlation between Amount of ice cream sold and deaths by drowning at the beach during summer.	**Summer Season:** Ice cream sales and drowning tend to be high during the warm months of the year.
Shoe size and reading performance for elementary school children.	**Age:** Older children have larger shoe sizes and read better.
Number of doctors in region and number of people dying from disease.	**Population density:** In highly dense areas, there are more doctors and more people die.

Number of police officers and number of crimes.	**Population density:** In highly dense areas, there are more police officers and more crimes.
Teachers' salaries and the price of vegetables.	**Time:** Both tend to increase over time.

Further, It is found that there is a positive and a high degree of correlation between the amount of oranges imported and road accidents i.e. as the amount of imported oranges increases, so do the traffic fatalities. However, it is fairly obvious just from logical thought that there is likely to be no causal relationship between the two. That is, the importing of oranges does not cause traffic fatalities. Conversely, if we stopped importing oranges, we would not expect the number of traffic fatalities to decline. It may be a sheer coincidence that a high degree of correlation is obtained between them.

10.3 TYPES OF CORRELATION

Correlation may be:

1. Positive and negative correlation
2. Linear and non-linear correlation

A) If two variables change in the same direction (i.e. if one increases the other also increases, or if one decreases, the other also decreases), then this is called a **positive correlation.** For example: Advertising and sales.

Some other examples of series of positive correlation are:

(i) Heights and weights;

(ii) Household income and expenditure;

(iii) Price and supply of commodities;

(iv) Amount of rainfall and yield of crops.

INTEXT QUESTIONS 10.1

1. It has been noted that there is a positive correlation between the I.Q. level and the size of women's shoes. With smaller size of shoes of women corresponds to lower intelligence level and higher size of shoes of women corresponds to higher intelligence level of women. Comment on the conclusion that economic factors cause hemlines to rise and fall.

2. A researcher has a large number of data pairs (age, height) of humans beings from birth to 70 years. He computes a correlation coefficient. Would you expect it to be positive or negative? Why?

B) **If two variables change in the opposite direction** (i.e. if one increases, the other decreases and vice versa), then the correlation is called a **negative correlation.** For example: T.V. registrations and cinema attendance.

Some other examples of series of negative correlation are:

(i) Volume and pressure of perfect gas;

(ii) Current and resistance [keeping the voltage constant]

(iii) Price and demand for goods.

INTEXT QUESTIONS 10.2

1. What sort of correlation would be expected between a company's expenditure on health and safety and the number of work related accidents.
   (a) positive
   (b) negative
   (c) none
   (d) infinite
2. When "r" is negative, one variable increases in value, …..
   (a) the other increases
   (b) the other increases at a greater rate
   (c) the other variable decreases in value
   (d) there is no change in the other variable
   (e) all of the above

10.4 LINEAR AND NON-LINEAR CORRELATION

The nature of the graph gives us the idea of the linear type of correlation between two variables. If the graph is in a straight line, the correlation is called a **"linear correlation"** and if the graph is not in a straight line, the correlation is **non-linear** or **curvi-linear.**

For example, if variable x changes by a constant quantity, say 20 then y also changes by a constant quantity, say 4. The ratio between the two always remains the same (1/5 in this case). In case of a curvi-linear correlation this ratio does not remain constant.

In general two variables x and y are said to be linearly related, if there exists a relationship of the form

$$y = a + bx$$

where 'a' and 'b' are real numbers. This is nothing but a straight line when plotted on a graph sheet with different values of x and y and for constant values of a and b. Such relations generally occur in physical sciences but are rarely encountered in economic and social sciences.

The relationship between two variables is said to be non – linear if corresponding to a unit change in one variable, the other variable does not change at a constant rate but changes at a fluctuating rate. In such cases, if the data is plotted on a graph sheet we will not get a straight line curve. For example, one may have a relation of the form

$$y = a + bx + cx^2$$

10.5 DEGREES OF CORRELATION

Through the coefficient of correlation, we can measure the degree or extent of the correlation between two variables. On the basis of the coefficient of correlation we can also determine whether the correlation is positive or negative and also its degree or extent.

1. **Perfect correlation:** If two variables change in the same direction and in the same proportion, the correlation between the two is perfect positive. According to Karl Pearson the coefficient of correlation in this case is +1. On the other hand, if the variables change in the opposite direction and in the same proportion, the correlation is perfect negative. Its coefficient of correlation is -1. In practice we rarely come across these types of correlations.
2. **Absence of correlation:** If two series of two variables exhibit no relations between them or change in one variable does not lead to a change in the other variable, then we can firmly say that there is no correlation or absurd correlation between the two variables. In such a case the coefficient of correlation is 0.
3. **Limited degrees of correlation:** If two variables are not perfectly correlated or there is a perfect absence of correlation, then we term the correlation as Limited correlation.

Thus Correlation may be positive, negative or zero but lies with the limits ± 1. i.e. the value of r is such that $-1 \leq r \leq +1$. The + and – signs are used for positive linear correlations and negative linear correlations, respectively.

- If x and y have a strong positive linear correlation, r is close to +1. An r value of exactly +1 indicates a perfect positive correlation.
- If x and y have a strong negative linear correlation, r is close to -1. An r value of exactly -1 indicates a perfect negative correlation
- If there is no linear correlation or a weak linear correlation, r is close to 0.

The following Table reveals the effect (or degree) of coefficient of correlation.

Table 10.2: Degree and Type of Correlation

Degrees	Positive	Negative
Absence of correlation →	Zero	Zero
Perfect correlation →	+ 1	–1
High degree →	+ 0.75 to + 1	– 0.75 to –1
Moderate degree →	+ 0.25 to + 0.75	– 0.25 to – 0.75
Low degree →	0 to 0.25	0 to – 0.25

Note that r is a dimensionless quantity; that is, it does not depend on the units employed

INTEXT QUESTIONS 10.3

1. The coefficient of correlation ranges between
   (a) 0 and 1
   (b) –1 and +1
   (c) minus infinity and plus infinity
   (d) 1 and 100
2. If two variables are absolutely independent of each other the correlation between them must be,
   (a) –1
   (b) 0
   (c) +1
   (d) +0.1
3. The coefficient of correlation:
   (a) can be larger than 1
   (b) cannot be larger than 1
   (c) cannot be negative

4. If height is independent of average yearly income, what is the predicted correlation between these two variables?
   (a) 1
   (b) –1
   (c) 0
   (d) Impossible to say for sure
5. A student produces a correlation of +1.3. This is
   (a) a high positive correlation
   (b) a significant correlation
   (c) an impossible correlation
   (d) only possible if N is large
6. If A scored the top mark in the apprentices test on computing and the correlation between that test and the test on English language was +1.0 what position did A get in the test on English language.
   (a) middle
   (b) bottom
   (c) top
   (d) cannot say from the information given
7. Which correlation is the strongest +0.65 or –0.70
   (a) –0.70
   (b) +0.65
   (c) depends on N
   (d) cannot say from the information given
7. The symbol for the Karl Pearson Correlation Co-efficient is
   (a) Σ (b) σ (c) α (d) r
8. For a normal good, if price increases then the quantity demanded decreases. What type of correlation co-efficient would you expect in this situation?
   (a) 0
   (b) positive
   (c) 0.9
   (d) negative
   (e) unknowable

10.6 PROPERTIES OF CORRELATION COEFFICIENT

1. The correlation coefficient 'r' lies between -1 to +1.
2. The correlation coefficient 'r' is the pure number and is independent of the units of measurement of the variables.
3. The correlation coefficient 'r' is independent of change of origin i.e. the value of r is not affected even if each of the individual value of two variables is increased or decreased by some non-zero constant.
4. The correlation coefficient 'r' is independent of change of scale i.e. the value of r is not affected even if each of the individual value of two variables is multiplied or divided by some non-zero constant.

INTEXT QUESTIONS 10.4

1. Given a set of paired data (X, Y)
   (a) If Y is independent of X, then what value of a correlation coefficient would you expect?
   (b) If Y is linearly dependent on X, then what value of a correlation coefficient would you expect?
2. State whether the following statement is true or false: "If a positive correlation exists between height and weight, a person with above average height is expected to have above average weight".

10.7 METHODS OF DETERMINING CORRELATION

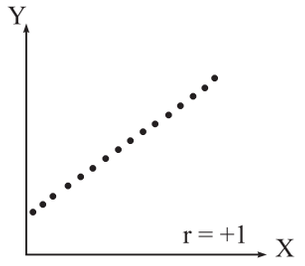
We shall consider the following most commonly used methods.

1. Scatter Plot
2. Karl Pearson's coefficient of correlation
3. Spearman's Rank-correlation coefficient.

10.7.1 Scatter Plot (Scatter diagram or dot diagram)

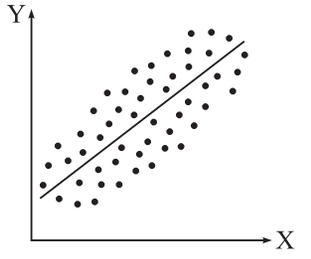
Scatter Plots (also called scatter diagrams) are used to graphically investigate the possible relationship between two variables without calculating any numerical value. In this method, the values of the two variables are plotted on a graph paper. One is taken along the horizontal (X-axis) and the other along the vertical (Y-axis). By plotting the data, we get points (dots) on the graph which are generally scattered and hence the name 'Scatter Plot'.

The manner in which these points are scattered, suggest the degree and the direction of correlation. The degree of correlation is denoted by 'r' and its direction is given by the signs positive and negative.



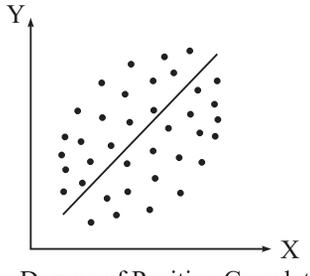
Perfect Positive Correlation

(a)



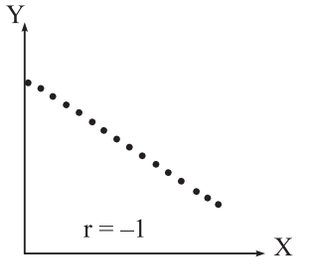
High Degree of Positive Correlation

(b)



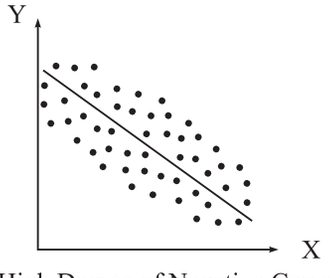
Low Degree of Positive Correlation

(c)



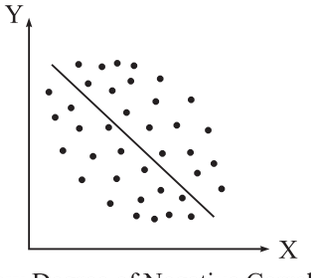
Perfect Negative Correlation

(d)



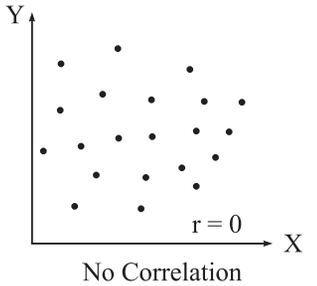
High Degree of Negative Correlation

(e)



Low Degree of Negative Correlation

(f)



No Correlation

(g)

(i) If all points lie on a rising straight line, the correlation is perfectly positive and r = +1 (see fig. a)

(ii) If all points lie on a falling straight line the correlation is perfectly negative and r = -1 (see fig. d)

(iii) If the points lie in narrow strip, rising upwards, the correlation is high degree of positive (see fig. b)

(iv) If the points lie in a narrow strip, falling downwards, the correlation is high degree of negative (see fig. e)

(v) If the points are spread widely over a broad strip, rising upwards, the correlation is low degree positive (see fig. c)

(vi) If the points are spread widely over a broad strip, falling downward, the correlation is low degree negative (see fig. f)

(vii) If the points are spread (scattered) without any specific pattern, the correlation is absent. i.e. r = 0. (see fig. g)

Though this method is simple and is a rough idea about the existence and the degree of correlation, it is not reliable. As it is not a mathematical method, it cannot measure the degree of correlation.

10.7.2 Karl Pearson's coefficient of correlation

It gives the precise numerical expression for the measure of correlation. It is denoted by 'r'. The value of 'r' gives the magnitude of correlation and its sign denotes its direction. The mathematical formula for computing r is:

$$r = \frac{\sum xy}{N\sigma_X\sigma_y} \qquad ...(1)$$

where $x = (X - \bar{X})$, $y = (Y - \bar{Y})$, σ_X = s.d. of X

σ_y = s.d. of Y

and N = number of paris of observations

Since $\sigma_X = \sqrt{\frac{\sum x^2}{N}}$ and $\sigma_y = \sqrt{\frac{\sum y^2}{N}}$

So equation 1 can be rewritten as:

$$r = \frac{\sum xy}{\sqrt{\sum x^2} \times \sqrt{\sum y^2}}$$

By using actual mean

$$r = \frac{\Sigma(X-\bar{X})\times(Y-\bar{Y})}{\sqrt{\Sigma(X-\bar{X})^2}\times\sqrt{\Sigma(Y-\bar{Y})^2}} \quad ...(2)$$

By assumed mean method

$$r = \frac{\Sigma dxdy - \frac{\Sigma dx \cdot \Sigma dy}{N}}{\sqrt{\Sigma dx^2 - \frac{(\Sigma dx)^2}{N}}\times\sqrt{\Sigma dy^2 - \frac{(\Sigma dy)^2}{N}}} \quad ...(3)$$

By direct method

$$r = \frac{N\sum XY - [\sum X][\sum Y]}{\sqrt{N\sum X^2 - (\sum X)^2}\times\sqrt{N\sum Y^2 - (\sum Y)^2}} \quad ...(4)$$

Now covariance of X and Y is defined as

$$\text{cov}(X,Y) = \frac{\Sigma(X_i-\bar{X})(Y_i-\bar{Y})}{N}$$

$$\therefore \quad r = \frac{\text{cov}(X,Y)}{\sigma_X\sigma_Y}$$

Where N is the number of pairs of data.

$$d_x = X - A_X$$
$$d_y = Y - A_Y$$

INTEXT QUESTIONS 10.5

1. Positive values of covariance indicate
   (a) a positive variance of the X values
   (b) a positive variance of the Y values
   (c) the standard deviation is positive
   (d) positive relation between two variables

Example 1: Calculate the coefficient of correlation between the expenditure on advertising and sales of the company from the following data.

Advertising Expenditure (in 000 ₹):	165	166	167	168	167	169	170	172
Sales (in Lakh ₹)	167	168	165	172	168	172	169	171

Solution: N = 8 (pairs of observations)

Table 10.3: Calculation of coefficient of correlation

Advertising Expenditure (in 000 ₹) : X_i	Sales (in Lakh ₹) Y_i	$x = X_i - \bar{X}$	$y = Y_i - \bar{Y}$	xy	x^2	y^2
165	167	–3	–2	6	9	4
166	168	–2	–1	2	4	1
167	165	–1	–4	4	1	16
167	168	–1	–1	1	1	1
168	172	0	3	0	0	9
169	172	1	3	3	1	9
170	169	2	0	0	4	0
172	171	4	2	8	16	4
$\Sigma X_i = 1344$	$\Sigma Y_i = 1352$	0	0	$\Sigma xy = 24$	$\Sigma x^2 = 36$	$\Sigma y^2 = 44$

Calculation:

$$\bar{X} = \frac{\Sigma X_i}{N} = \frac{1344}{8}$$

$$= 168 \text{ cm and } \sigma_x = \sqrt{\frac{\Sigma x^2}{N}} = \sqrt{\frac{36}{8}}$$

$$\bar{Y} = \frac{\Sigma Y_i}{N} = \frac{1352}{8}$$

$$= 169 \text{ cm and } \sigma_y = \sqrt{\frac{\Sigma y^2}{N}} = \sqrt{\frac{44}{8}}$$

Now, $$r = \frac{\Sigma xy}{N\sigma_x\sigma_y} = \frac{24}{8\sqrt{\frac{36}{8}} \times \sqrt{\frac{44}{8}}} = \frac{24}{\sqrt{36 \times 44}} = +0.6029$$

Since r is positive and 0.6. This shows that the correlation is positive and moderate (i.e. direct and reasonably good).

Example 2: From the following data compute the coefficient of correlation between X and Y.

		X	Y
No. of items	→	15	15
Arithmetic mean	→	25	18
$\Sigma(X_i - \bar{X})^2$ and $\Sigma(Y_i - \bar{Y})^2$	→	136	138
$\Sigma(X_i - \bar{X}) \cdot \Sigma(Y_i - \bar{Y})$	→	122	

Solution: Given, N = 15, $\bar{X} = 25$. $\bar{Y} = 18$

$$\Sigma(X_i - \bar{X})^2 \quad \text{i.e.} \quad \Sigma x^2 = 136$$

$$\Sigma(Y_i - \bar{Y})^2 \quad \text{i.e.} \quad \Sigma y^2 = 138$$

and $$\Sigma(X_i - \bar{X}) \cdot \Sigma(Y_i - \bar{Y}) = \Sigma xy = 122$$

Using $$r = \frac{\Sigma xy}{\sqrt{\Sigma x^2} \times \sqrt{\Sigma y^2}}$$

we get $$r = \frac{122}{\sqrt{136} \times \sqrt{138}} = \frac{122}{136.9} = 0.891$$

Example 3: If covariance between X and Y is 12.3 and the variance of x and y are 16.4 and 13.8 respectively. Find the coefficient of correlation between them.

Solution: Given: Covariance = cov (X, Y) = 12.3

Variance of X (σ_x^2) = 16.4

Variance of Y (σ_y^2) = 13.8

Now,

$$r = \frac{\text{cov}(X, Y)}{\sigma_x \sigma_y} = \frac{12.3}{\sqrt{16.4} \times \sqrt{13.8}}$$

$$= \frac{12.3}{4.05 \times 3.71} = 0.82$$

Example 4: Find the number of pair of observations from the following data.

$$r = 0.25, \Sigma(X_i - X)(Y_i - Y) = 60, \sigma_y = 4, \Sigma(X_i - \bar{X})2 = 90.$$

Solution: Given: r = 0.25

$$\Sigma\left(X_i - \bar{X}\right)\left(Y_i - \bar{Y}\right) = \Sigma xy = 60$$

$$\sigma_x = \sqrt{\frac{\Sigma x^2}{N}} = \sqrt{\frac{\Sigma\left(X_i - \bar{X}\right)^2}{N}} = \sqrt{\frac{90}{N}}$$

$$\sigma_y = 4 = \sqrt{\frac{\Sigma y^2}{N}}$$

Now, $$r = \frac{\Sigma xy}{n\sigma_x \cdot \sigma_y} = \frac{60}{N\sqrt{\frac{90}{N}} \times 4} = \frac{15}{\sqrt{90N}}$$

$\therefore$ $$0.25 = \frac{15}{\sqrt{90N}}$$

$\therefore$ $$0.25 \times \sqrt{90N} = 15$$

on squaring

$\therefore$ $$0.0625 \times 90N = 225$$

$\therefore$ $$90N = \frac{225}{0.0625}$$

$\therefore$ $$90N = 3600$$

$\therefore$ $$N = 40$$

Therefore, the number of pairs of observations = 40

10.7.2.1 Assumed Mean Method (Step Deviation)

If the values of X and Y are very big, the calculation becomes very tedious and if we change the variable X to $u = \frac{X_1 - A}{h}$ and Y to $v = \frac{Y_1 - B}{k}$ where A and B are the assumed means for variable X and Y respectively and h and k are common

factor of variable X and Y, As stated earlier the one of the property of correlation coefficient is that it is independent of change of origin and change of scale so

$$r_{xy} = r_{uv}$$

The formula for r can be simplified as

$$r_{xy} = r_{uv} = \frac{\Sigma uv - \left(\frac{(\Sigma u)(\Sigma v)}{N}\right)}{\sqrt{\Sigma u^2 - \frac{(\Sigma u)^2}{N}} \times \sqrt{\Sigma v^2 - \frac{(\Sigma v)^2}{N}}}$$

Example 5: The following data relates to the Cost and Sales of a Company for the past 10 months

Cost (in 000 ₹):	44	80	76	48	52	72	68	56	60	64
Sales(in 000 ₹):	48	75	54	60	63	69	72	51	57	66

Find the coefficient of correlation between the two.

Solution: Here A = 60, h = 4, B = 60 and k = 3

Table 10.4: Correlation coefficient between cost and sales

Cost (in 000 ₹)	**Sales (in 000 ₹)**	**$u = \frac{X_1 - A}{h}$**	**$v = \frac{Y_1 - B}{d}$**	**uv**	**u^2**	**v^2**
44	48	–4	–4	16	16	16
80	75	5	5	25	25	25
76	54	4	–2	–8	16	4
48	60	–3	0	0	9	0
52	63	–2	1	–2	4	1
72	69	3	3	9	9	9
68	72	2	4	8	4	16
56	51	–1	–3	3	1	9
60	57	0	–1	0	0	1
64	66	1	2	2	4	4
		$\Sigma u = 5$	$\Sigma v = 5$	$\Sigma uv = 53$	$\Sigma u^2 = 85$	$\Sigma v^2 = 85$

Calculation:

$$r_{xy} = r_{uv} = \frac{\Sigma uv - \left(\frac{(\Sigma u)(\Sigma v)}{N}\right)}{\sqrt{\Sigma u^2 - \frac{(\Sigma u)^2}{N}} \times \sqrt{\Sigma v^2 - \frac{(\Sigma v)^2}{N}}}$$

$$= \frac{53 - \left(\frac{(5)(5)}{10}\right)}{\sqrt{85 - \frac{(5)^2}{10}} \times \sqrt{85 - \frac{(5)^2}{10}}}$$

$$= \frac{53 - \left(\frac{(5)(5)}{10}\right)}{\sqrt{85 - \frac{(5)^2}{10}} \times \sqrt{85 - \frac{(5)^2}{10}}}$$

$$= \frac{53 - 2.5}{\sqrt{82.5} \times \sqrt{82.5}}$$

$$= \frac{50.5}{82.5} = 0.61$$

10.6.3 Spearman's Rank Correlation Coefficient

This method is based on the ranks of the items rather than on their actual values. The advantage of this method over the others in that it can be used even when the actual values of items are unknown. For example if you want to know the correlation between honesty and wisdom of the boys of your class, you can use this method by giving ranks to the boys. It can also be used to find the degree of agreements between the judgments of two examiners or two judges. The formula is:

$$R = 1 - \frac{6\Sigma D^2}{N\left(N^2 - 1\right)}$$

where R = Rank correlation coefficient

D = Difference between the ranks of two items

N = the number of observations.

Note: $-1 \le R \le 1$.

(i) When $R = +1 \Rightarrow$ Perfect positive correlation or complete agreement in the same direction

(ii) When $R = -1 \Rightarrow$ Perfect negative correlation or complete agreement in the opposite direction.

(iii) When $R = 0 \Rightarrow$ No Correlation.

Computation:

(i) Give ranks to the values of items. Generally the item with the highest value is ranked 1 and then the others are given ranks 2, 3, 4 ... according to their values in the decreasing order.

(ii) Find the difference $D = R_1 - R_2$

where R_1 = Rank of X and R_2 = Rank of Y

Note that $\Sigma D = 0$ (always)

(iii) Calculate D^2 and then find ΣD^2

(iv) Apply the formula.

Note :

In some cases, there is a tie between two or more items. For example if each item have rank say 4th then they are given $\frac{4+5}{2} = 4.5$th rank. If three items are of equal rank say 4th then they are given $\frac{4+5+6}{3} = 5$th rank each. If m be the number of items of equal ranks, the factor $\frac{1}{12}(m^3 - m)$ is added to SD^2. If there is more than one of such cases then this factor added as many times as the number of such cases, then

$$R = 1 - \frac{6\left\{\Sigma D^2 + \frac{1}{12}\left(m_1^3 - m_1\right) + \frac{1}{12}\left(m_2^3 - m_2\right) + \ldots\right\}}{N\left(N^2 - 1\right)}$$

Example 6 : Calculate ' R ' from the following data.

Student No. :	1	2	3	4	5	6	7	8	9	10
Rank in Maths :	1	3	7	5	4	6	2	10	9	8
Rank in Stats :	3	1	4	5	6	9	7	8	10	2

Solution:

Table 10.5: Calculation of rank correlation

Student No.	Rank in Maths (R_1)	Rank in Stats (R_2)	$D = (R_1 - R_2)$	D^2
1	1	3	–2	4
2	3	1	2	4
3	7	4	3	9
4	5	5	0	0
5	4	6	–2	4
6	6	9	–3	9
7	2	7	–5	25
8	10	8	2	4
9	9	10	–1	1
10	8	2	6	36
N = 10			$\Sigma D = 0$	$\Sigma D^2 = 96$

Calculation of R :

$$R = 1 - \frac{6\Sigma D^2}{N\left(N^2 - 1\right)} = 1 - \frac{6(96)}{10(100-1)} = 1 - \frac{6\times 96}{10\times 99} = 0.4181$$

Example 7: Calculate 'R' of 6 students from the following data.

Marks in Stats :	40	42	45	35	36	39
Marks in English :	46	43	44	39	40	43

Solution:

Table 10.6: Calculation of rank correlation

Marks in Stats	R_1	Marks in English	R_2	D	D^2
40	3	46	1	2	4
42	2	43	3.5	–1.5	2.25
45	1	44	2	–1	1
35	6	39	6	0	0
36	5	40	5	0	0
39	4	43	3.5	0.5	0.25
N = 6				$\Sigma D = 0$	$\Sigma D^2 = 750$

Here m = 2 since in series of marks in English of items of values 43 repeated twice.

$$R = 1 - \frac{6\left\{\Sigma D^2 + \frac{1}{12}\left(2^3 - 2\right)\right\}}{N\left(N^2 - 1\right)} = 1 - \frac{6\left\{7.5 + \frac{1}{12}(8-2)\right\}}{6(36-6)}$$

$$R = 1 - \frac{6(7.5 + 0.5)}{210} = 0.771$$

Example 8: The value of Spearman's rank correlation coefficient for a certain number of pairs of observations was found to be 2/3. The sum of the squares of difference between the corresponding rnarks was 55. Find the number of pairs.

Solution: We have

$$1 - \frac{6\Sigma D^2}{N\left(N^2 - 1\right)} \text{ but } R = \frac{2}{3} \text{ and } \Sigma D^2 = 55$$

$$\therefore \quad \frac{2}{3} = 1 - \frac{6 \times 55}{N\left(N^2 - 1\right)}$$

$$\therefore \quad -\frac{1}{3} = -\frac{6 \times 55}{N\left(N^2 - 1\right)}$$

$\therefore$ $N(N^2 - 1)\ 6 \times 55$

Now $N(N^2 - 1) = 990$

$\therefore$ $N(N^2 - 1) = 10 \times 99 = 10(100 - 1)$

$\therefore$ $N(N^2 - 1) = 10(102 - 1) \Rightarrow N = 10$

Therefore, there were 10 students.

INTEXT QUESTIONS 10.6

1. The marks awarded by two judges in a certain beauty contest are given below:

Judge I	56	75	45	71	61	64	58	80	76	61
Judge II	66	70	40	60	65	56	59	77	67	63

By Using Rank correlation method, Determine whether the two judges have common taste in the judgement of beauty?

WHAT YOU HAVE LEARNT

- Correlation measures the associations between variables. Correlation can be positive or negative and linear or non-linear. It is denoted by r.
- The value of r lies between -1 and +1 i.e. $-1 \le r \le +1$.
- The correlation coefficient 'r' is independent of change of origin and change of scale.
- The important methods of measuring correlation are (i) Scatter Plot (ii) Karl Pearson's coefficient of correlation; and (iii) Spearman's Rank-correlation coefficient;
- Scatter Plots are used to graphically investigate the possible relationship between two variables without calculating of any numerical value.
- The mathematical formula for computing *r* using Karl Pearson method is given:

$$r = \frac{\sum xy}{N\sigma_X\sigma_y} \qquad ...(1)$$

where $x = (X - \bar{X})$, $y = (Y - \bar{Y})$, σ_X = s.d. of X

σ_X = s.d. of Y and N = number of paris of observation

- Correlation (r) can also be calculated using actual figure of two variables X and Y as follows:

$$r = \frac{N\sum XY - [\sum X][\sum Y]}{\sqrt{N\sum X^2 - (\sum X)^2} \times \sqrt{N\sum Y^2 - (\sum Y)^2}}$$

- The covariance 'of two variables say X and Y is defined as:

$$\text{cov}(X, Y) = \frac{\sum (X - \bar{X})(Y - \bar{Y})}{N}$$

where N is the number of pairs of data.

If covariance is given, then $r = \frac{\text{cov}(X, Y)}{\sigma_X \sigma_Y}$

- The correlation (r) using Assumed Mean Method is given by:

$$r_{xy} = r_{uv} = \frac{\Sigma uv - \left(\frac{(\Sigma u)(\Sigma v)}{N}\right)}{\sqrt{\Sigma u^2 - \frac{(\Sigma u)^2}{N}} \times \sqrt{\Sigma v^2 - \frac{(\Sigma v)^2}{N}}}$$

where $u = \frac{X - A}{h}$ and $v = \frac{Y - B}{k}$

A and B are the assumed means for variable X and Y respectively and h and k are common factor of variable X and Y.

- The Spearman rank correlation (R) is given by:

$$R = 1 - \frac{6\Sigma D^2}{N\left(N^2 - 1\right)}$$

where R = Rank correlation coefficient

D = Difference between the ranks of two items

N = the number of observations.

TERMINAL EXERCISES

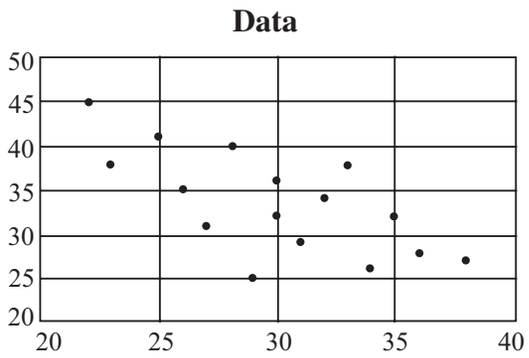
1. The data relating to variable X and Y is given below:

X	72	73	75	76	77	78	79	80	80	81	82	83	84	85	86	88
Y	45	38	41	35	31	40	25	32	36	29	34	38	26	32	28	27

(a) Sketch a scatter plot.

(b) Compute the correlation coefficient, r.

Answer 1: a.



2. Calculate and analyze the correlation coefficient between the number of study hours and the number of sleeping hours of different students.

Number of Study hours	2	4	6	8	10
Number of sleeping hours	10	9	8	7	6

3. Find the value of the correlation coefficient from the following table:

Subject	Age X	Glucose Level Y
1	43	99
2	21	65
3	25	79
4	42	75
5	57	87
6	59	81

4. The values of the same 15 students in two subjects A and B are given below; the two numbers within the brackets denoting the ranks of the same student in A and B respectively.

(1,10) (2,7) (3,2) (4,6) (5,4) (6,8) (7,3) (8,1).

(9,11) (10,15) (11,9) (12,5) (13,14) (14,12) (15,13)

Use Spearman's formula to find the rank Correlation Coefficient.

5. Calculate Karl Pearson's coefficient of correlation from the advertisement cost and sales as per the data given below:

Advertisement Cost (in'000 $)	39	65	62	90	82	75	25	98	36	78
Sales (in lakh $)	47	53	58	86	62	68	60	91	51	84

6. The following observations are given for two variables.

Y	X
5	2
8	12
18	3
20	6
22	11
30	19
10	18
7	9

(a) Compute and interpret the sample covariance for the above data.

(b) Compute and interpret the sample correlation coefficient.

7. A trainee manager wondered whether the length of time his trainees revised for an examination had any effect on the marks they scored in the examination. Before the exam, he asked a random sample of them to honestly estimate how long, to the nearest hour, they had spent revising. After the examination he investigated the relationship between the two variables.

Trainee	A	B	C	D	E	F	G	H	I	J
Revision time	4	9	10	14	4	7	12	22	1	17
Exam mark	31	58	65	73	37	44	60	91	21	84

(a) Plot the scatter diagram in order to inspect the data.

(b) Calculate the correlation coefficient.

8. Positive values of covariance indicate

(a) a positive variance of the x values

(b) a positive variance of the y values

(c) the standard deviation is positive

(d) positive relation between two variables

9. A numerical measure of linear association between two variables is the

(a) variance

(b) coefficient of variation

(c) correlation coefficient

(d) standard deviation

10. The coefficient of correlation ranges between
    (a) 0 and 1
    (b) -1 and +1
    (c) minus infinity and plus infinity
    (d) 1 and 100
11. The coefficient of correlation:
    (a) can be larger than 1
    (b) cannot be larger than 1
    (c) cannot be negative
12. If height is independent of average yearly income, what is the predicted correlation between these two variables?
    (a) 1
    (b) –1
    (c) 0
    (d) Impossible to say for sure
13. A student produces a correlation of +1.3. This is
    (a) a high positive correlation
    (b) a significant correlation
    (c) an impossible correlation
    (d) only possible if N is large
14. What sort of correlation would be expected between a company's expenditure on health and safety and the number of work related accidents..
    (a) positive
    (b) negative
    (c) none
15. If A scored the top mark in the apprentices test on computing and the correlation between that test and the test on English language was +1.0 what position did A get in the test on English language.
    (a) middle
    (b) bottom
    (c) top
    (d) cannot say from the information given

16. Which correlation is the strongest +0.65 or -0.70
    (a) –0.70
    (b) +0.65
    (c) depends on N
    (d) cannot say from the information given
17. The symbol for the Karl Pearson Correlation Co-efficient is –
    (a) Σ
    (b) σ
    (c) α
    (d) r
18. When "r" is negative, one variable increases in value, …..
    (a) the other increases
    (b) the other increases at a greater rate
    (c) the other variable decreases in value
    (d) there is no change in the other variable
    (e) all of the above
19. If two variables are absolutely independent of each other the correlation between them must be,
    (a) –1
    (b) 0
    (c) +1
    (d) +0.1
20. For a normal good, if price increases then the quantity demanded decreases. What type of correlation co-efficient would you expect in this situation?
    (a) 0
    (b) positive
    (c) 0.9
    (d) negative
    (e) unknowable

ANSWERS TO INTEXT QUESTIONS

10.1

1. A positive correlation does exst; however correlation does not imply causation
2. Positive, since in general, people grow in height increasing with age

10.2

1. (b)
2. (c)

10.3

1. (b)	2. (b)	3. (b)	4. (c)	5. (c)
6. (c)	7. (a)	8. (d)	9. (d)	

10.4

1. (a) $r = 0$
2. (b) $r = 1$ or $r = -1$ these two are same as $|r| = -1$

10.5

1. (d)

10.6

1. +0.67 this indicates a strong positive relationship between the ranks given by two judges i.e. the judges have high degree of common approach towards judgement of beauty.

Notes

11

INDEX NUMBERS

Of the important statistical devices and techniques, Index Numbers have today become one of the most widely used for judging the pulse of economy, although in the beginning they were originally constructed to gauge the effect of changes in prices. Today we use index numbers for cost of living, industrial production, agricultural production, imports and exports, etc. Index numbers are the indicators which measure percentage changes in a variable (or a group of variables) over a specified time.

OBJECTIVES

After completing this lesson, you will be able to:

- describe the term index and appreciate its uses;
- differentiate between a weighted and unweighted index;
- construct and interpret a Laspeyer's price index;
- construct and interpret a Paasche's price index;
- construct and interpret a value index;
- explain how the Consumer Price Index is constructed and interpreted;
- explain how industrial production index is constructed; and
- understand its limitations.

11.1 MEANING OF INDEX NUMBER

"An index number is a statistical measure, designed to measure changes in a variable, or a group of related variables".

"Index number is a single ratio (or a percentage) which measures the combined change of several variables between two different times, places or situations".

INDEX NUMBER expresses the relative change in price, quantity, or value compared to a base period. An index number is used to measure changes in prices paid for raw materials; numbers of employees and customers, annual income and profits, etc.

If the index number is used to measure the relative change in just one variable, such as hourly wages in manufacturing, it is referred to as a simple index. An index number can also be used to measure changes in the value of the group of variables such as prices of specified list of commodities, volume of production in different sectors of an industry, production of various agricultural crops, cost of living etc, it is referred to as composite index. Index number measures average change in a group of related variables over two different situations such as prices of specified list of commodities, volume of production in different sectors of an industry, production of various agricultural crops, cost of living etc. Index number does not indicate that the change is uniform for all commodities or group of related variables used to calculate it. It may be noted that in case of, say, Price Index, price of of some of the items may be rising, while it is falling in other items. Price index will only indicate the average change in the price of group of related commodities.

Conventionally, index numbers are expressed in terms of percentage. Of the two periods, the period with which the comparison is to be made, is known as the base period. The value in the base period is given the index number 100. Suppose the change in price in the year 2013 is measured in comparison to the year 2000, then 2000 become the base year and 2013 becomes the current year. For Example By saying that the price index for the year 2013 is 125, taking base year as 2000, it means that there is an increase of 25% in the general price as compared to the corresponding figure for the year 2000. Price index numbers measure and permit comparison of the prices of certain goods. Quantity index numbers measure the changes in the physical volume of production, construction or employment.

11.2 CHARACTERISTICS OF INDEX NUMBERS

Following are some of the important characteristics of index numbers:

- Index numbers are a special type of average that provides a measurement of relative changes in the level of a certain phenomenon from time to time. It is a special type of average because it can be used to compare two or more series which are composed of different types of items or even expressed in different types of units.
- Index numbers are expressed in terms of percentages to show the extent of relative change.
- Index numbers measure relative changes. They measure the relative change in the value of a variable or a group of related variables over a period of time or between places.

- Index numbers can also measure changes which are not directly measurable. For Example the cost of living, the price level or the business activity in a country are not directly measurable but it is possible to study relative changes in these activities by measuring the changes in the values of variables/factors which affect these activities.

11.3 USES OF INDEX NUMBERS

Index numbers are indispensable tools of economics and business analysis. Following are the main uses of index numbers.

(i) Index numbers are economic barometers. Index numbers measure the level of business and economic activities and are therefore helpful in gauging the economic status of the country. Index number is a special type of averages which helps to measure the economic fluctuations on price level, money market, economic cycle like inflation, deflation etc.

(ii) Index numbers helps in formulating suitable economic policies and planning etc. Many of the economic and business policies are guided by index numbers. For example, while deciding the increase of DA of the employees; the employers have to depend primarily on the cost of living index. If salaries or wages are not increased according to the cost of living it leads to strikes, lock outs etc. The index numbers provide some guide lines that one can use in making decisions.

(iii) Index numbers are used in studying trends and tendencies. Since index numbers are most widely used for measuring changes over a period of time, the time series so formed enable us to study the general trend of the phenomenon under study.

(iv) Index numbers are useful in forecasting future economic activity. Index numbers are used not only in studying the past and present workings of our economy but also important in forecasting future economic activity.

(v) Index numbers measure the purchasing power of money. The cost of living index numbers determine whether the real wages are rising or falling or remain constant. The real wages can be obtained by dividing the money wages by the corresponding price index and multiplied by 100. Real wages helps us in determining the purchasing power of money.

11.4 CONSTRUCTION OF AN INDEX NUMBER:

The various methods of construction of Index numbers are explained through price index numbers. The methods of construction of price index numbers can be classified into broad categories as shown below:

Table 11.1: Price Indices

Un-weighted Index		Weighted Index	
Simple Aggregative Method	Simple Average of Price Relatives Method	Weighted Aggregative Method	Weighted Average of Price Relatives Method

11.4.1 Un-weighted Index

In the un-weighted index number the weights are not assigned to the various items used for the calculation of index number. Two unweighted price index number are given below:

(i) Simple Aggregate Method

This method is based on the assumption that various items and their prices are quoted in same units. Equal importance is given to all the items. The formula for a simple aggregative price index is given as follows:

$$P_{01} = \frac{\Sigma P_1}{\Sigma P_0} \times 100$$

where ΣP_1 is the total of current year's prices for the various items.

ΣP_0 is the total of base year's prices for the various items.

Example 1: From the following data compute price index number for the year 2014 taking 2013 as the base year using simple aggregative method:

Commodity	Prices in the year 2013	Prices in the year 2014
A	1	5
B	2	4
C	3	3
D	4	2

Solution:

Table 11.2: Computation of price Indian number using Aggregative Method

Commodity	Prices in the year 2013 P_0	Prices in the year 2014 P_1
A	1	5
B	2	4
C	3	3
D	4	2
	$\Sigma P_0 = 10$	$\Sigma P_1 = 14$

The price index number is given by:

$$P_{01} = \frac{\Sigma P_1}{\Sigma P_0} \times 100 = \frac{14}{10} \times 100 = 140$$

From this price index of 140, it can be concluded that the aggregate of the prices of the given group of commodities has increased by 40% over the period from 2013 to 2014.

This price index number calculated by using simple aggregative method has limited use. The reasons are as follows:

(a) This method doesn't take into account the relative importance of various commodities used in the calculation of index number since equal importance is given to all the items.

(b) The different items are required to be expressed in the same unit. In practice, however, the different items may be expressed in different units.

(c) The index number obtained by this method is not reliable as it is affected by the unit in which prices of several commodities are quoted.

(ii) Simple Average of Price Relatives Method

This method is an improvement over the previous method as it is not affected by the unit in which the prices of various commodities are quoted. The price relatives are pure number and therefore are independent of original units in which these are quoted. The price index number using price relatives is defined as follows:

$$P_{01} = \frac{\Sigma \frac{P_1}{P_0} \times 100}{N}$$

where P_1 and P_0 indicate the price of the ith commodity in the current period and base period respectively. The ratio $(P_1/P_0) \times 100$ is also referred to as price relative of the commodity and n stands for the number of commodities.

Using the data of Example 1 the index number using price relative method can be calculated as follows:

Table 11.3: Calculation of Index number using Simple Price Relative Method

Commodity	Prices in the year 2013 P_0	Prices in the year 2014 P_1	Price Relatives $\frac{P_1}{P_0} \times 100$
A	1	5	500
B	2	4	200
C	3	3	100
D	4	2	50
	$\Sigma P_0 = 10$	$\Sigma P_1 = 14$	$\Sigma \frac{P_1}{P_0} \times 100 = 850$

$$P_{01} = \frac{\Sigma \frac{P_1}{P_0} \times 100}{N} = \frac{850}{4} = 212.5$$

Thus the price in the year 2014 are112.5% higher in 2013.

The index number based on simple average of price relatives is not influenced by the units in which the prices of the commodities are quoted.

However, this method like simple aggregative method gives equal importance to all the items and thus neglects their relative importance in the group.

11.4.2 Weighted Index Number

In weighted index number rational weights are assigned to all the items or commodities. Such weights indicate the relative importance of the items included in the calculation of the index. In most cases quantity of usage is the best measure of importance.

(i) Weighted Aggregative Price Indices

In weighted aggregative price indices, the weights are assigned to each item in the basket in various ways and the weighted aggregates are also used in different ways

to calculate an index. In most cases quantity of usage is used to calculate price index number. Laspeyre's price index and Paasche's price index are the two most important methods of calculating weighted price indices. Laspeyre's price index number is the weighted aggregative price index number which uses base year's quantity as the weights. It is given by:

$$P_{01} = \frac{\Sigma P_1 q_0}{\Sigma P_0 q_0} \times 100$$

In general, Laspeyre's index number answers the question, it provides an explanation to the question that if the expenditure on base period basket of commodities was ₹100, how much should be the expenditure in the current period on the same basket of commodities?

Example 2: From the following data compute Laspeyre's index number for the current year:

Items	Base Year		Current Year	
	Prices (in ₹)	Quantity (in kg.)	Prices (in ₹)	Quantity (in kg.)
A	1	6	5	8
B	2	7	4	7
C	3	8	3	6
D	4	9	2	5

Solution:

Table 11.4: Computation of Laspeyre's Index Number

Items	Base Year		Current Year			
	Price (P_0)	Quantity (q_0)	Price (P_1)	Quantity (q_1)	P_1q_0	P_0q_0
A	1	6	5	8	30	6
B	2	7	4	7	28	14
C	3	8	3	6	24	24
D	4	9	2	5	18	36
					$\Sigma P_1q_0 = 100$	$\Sigma P_0q_0 = 80$

Laspeyre's Price index number is given by:

$$P_{01} = \frac{\sum P_1 q_0}{\sum P_0 q_0} \times 100 = \frac{100}{80} \times 100 = 125$$

As can be seen here that the value of base period quantities has risen by 25 per cent due to price rise. It means that the price is said to have risen by 25 percent.

Paasche's price index number is the weighted aggregative price index number which uses current year's quantity as the weights. It is given by:

$$P_{01} = \frac{\sum P_1 q_1}{\sum P_0 q_1} \times 100$$

In general, Paasche's index number answers the question, if the current period basket of commodities was consumed in the base period and if we were spending ₹100 on it, how much should be the expenditure in the current period on the same basket of commodities.

In the above example 2 Paasche's price index number can be calculated as follows:

Table 11.5: Computation of Paasche's Price Index Number

Items	Base Year		Current Year			
	Price (P_0)	Quantity (q_0)	Price (P_1)	Quantity (q_1)	P_1q_1	P_0q_1
A	1	6	5	8	40	8
B	2	7	4	7	28	14
C	3	8	3	6	18	18
D	4	9	2	5	10	20
					$\Sigma P_1q_1 = 96$	$\Sigma P_0q_1 = 60$

paasche's price index number is given by:

$$P_{01} = \frac{\sum P_1 q_1}{\sum P_0 q_1} \times 100 = \frac{96}{60} \times 100 = 160$$

Paasche's price index of 160 means the price rise of 60 percent using current year quantities as weights.

INTEXT QUESTION 11.1

1. The paasche index number is based on:
   (a) Base Year Quantity
   (b) Current Year Quantity
   (c) Average of Base and Current Year Quantity
   (c) none of the above
2. What is an index number?
3. Write one use of index numbers.
4. State any two characteristics of index numbers.

(ii) Weighted Price Relative Method

Under this method price index is constructed on the basis of price relatives and not on the basis of absolute prices. The price index is obtained by taking the average of all weighted price relatives. It is given by

$$P_{01}(\text{weighted arithemetic mean}) = \frac{\sum W\left(\frac{p_1}{p_0}\times 100\right)}{\sum W}$$

Where W = weights

In a weighted price relative index, weights may be determined by the proportion or percentage of expenditure on them in total expenditure during the base or current period. In general, the base period weight is preferred to the current period weight. It is because calculating the weight every year is inconvenient.

Example 3: From the following data compute an index number by using weighted average of price relative method:

Items	Base Year		Current
	Price (P_0)	Quantity (q_0)	Year Price (P_1)
A	1	6	5
B	2	7	4
C	3	8	3
D	4	9	2

Solution:

Calculation of price index number by weighted average of price relatives method using arithmetic mean:

Table 11.6: Calculation of price Index Number

Items	Base Year		Current Year		$W = P_0q_0$	$W\left(\frac{p_1}{p_0}\times 100\right)$
	Price (P_0)	Quantity (q_0)	Price (P_1)	Relatives $=\frac{P_1}{P_0}\times 100$		
A	1	6	5	500	6	3000
B	2	7	4	200	14	2800
C	3	8	3	100	24	2400
D	4	9	2	50	36	1800
					$\Sigma W=80$	$\Sigma W\left(\frac{p_1}{p_0}\times 100\right) = 1000$

$$P_{01}\text{(weighted arithemetic mean)} = \frac{\Sigma W\left(\frac{p_1}{p_0}\times 100\right)}{\Sigma W} = \frac{10000}{80} = 125$$

The weighted price index is 125. The price index has risen by 25 percent.

It may be noted that the values of the unweighted price index and the weighted price index differ.

INTEXT QUESTIONS 11.2

1. From the following data compute an index number by using weighted average of price relative method:

Commodities	Base Year Prices (in ₹)	Current Year Prices (in ₹)	Weights (W)
A	100	90	30
B	20	20	15
C	7	60	20
D	20	15	10
E	40	55	25

11.5 SOME OTHER IMPORTANT INDEX NUMBERS

11.5.1 Consumer price index

A consumer price index (CPI) measures changes in the price level of a basket of consumer goods and services purchased by households. CPI measures changes in the price level for the specified consumers in the particular region. CPI can be calculated for industrial workers, urban labours, Agricultural workers etc. Suppose the CPI for agricultural workers with base year of 2000 is 560 in the April 2012.It means that if the agricultural worker was spending 100 in 2000 for a typical basket of commodities, he needs ₹ 560 in April 2012 to be able to buy an identical basket of commodities. It is not necessary that he/she buys the

basket. CPI only indicates the capability to buy it. It may be noted that there cannot be one CPI for any class or group of the whole country as the retail prices in different places differ. Similarly, we cannot have a cost of living index number for the whole population of a particular town because there exists different group of persons in the town purchasing different baskets of commodities.

CPI is given by :

$$\text{Cost of Living Index} = \frac{\sum WP}{\sum W}$$

where $P = \frac{P_1}{P_0} \times 100$ and W are the weights

Example 4: Construct the consumer price index number for the year 2012 on the basis of 2010 from the following data:

Commodities	Rice	Wheat	Pulses	Butter	Oil
Weights	40	20	15	20	5
Price (per unit in ₹) 2010	16	40	0.50	5.12	2
Price (per unit in ₹) 2012	20	60	0.5	6.25	1.5

Solution:

Table 11.7: Constructing Consumer Price Index Number

Commo-dities	Weights (W)	Price (per unit in ₹) 2010	Price (per unit in ₹) 2012	$P = \frac{P_1}{P_0} \times 100$	WP
Rice	40	16	20	125	5000
Wheat	20	40	60	150	3000
Pulses	15	0.50	0.5	100	1500
Butter	20	5.12	6.25	122	2440
Oil	5	2	1.5	75	375
	$\Sigma W = 100$				$\Sigma WP = 12315$

$$\text{Cost of Living Index for 2012} = \frac{\sum WP}{\sum W} = \frac{12315}{100} 123.15$$

INTEXT QUESTIONS 11.3

1. Suppose a person was earning 1500 per month in 2005, what should be his salary in 2010, if the cost of living index number in 2010 with base year 2005 is 170.30?

11.5.2 Wholesale Price Index Number

The Wholesale Price Index or WPI is the price of a representative basket of wholesale goods. The wholesale price index number indicates the change in the general price level. Unlike the CPI, it does not have any reference consumer category. WPI with 2011 as base is 156 in March, 2014 means that the general price level has risen by 56 percent during this period.

11.5.3 Industrial production index

The industrial production index indicates the change in the level of industrial production in the given period comprising many industries. It is a weighted average of quantity relatives. The formula for the index is given by:

$$\text{Industrial Production Index } (IIP_{01}) = \frac{\sum q_1 \times W}{\sum W}$$

11.6 ISSUES IN THE CONSTRUCTION OF INDEX NUMBERS

There are certain issues that should be kept in mind for the construction of index number which are explained as follows:

Purpose of Index Numbers

An index number, which is designed keeping, specific objective in mind, is a very powerful tool. For example, an index whose purpose is to measure consumer price index, should not include wholesale rates of items and the index number meant for slum-colonies should not consider luxury items like A.C., Cars refrigerators, etc.

Selection of Items

After the objective of construction of index numbers is defined, only those items which are related to and are relevant with the purpose should be included.

Choice of Average

As index numbers are themselves specialized averages, it has to be decided first as to which average should be used for their construction. The arithmetic mean, being easy to use and calculate, is preferred over other averages (median, mode or geometric mean). In this lesson, we will be using only arithmetic mean for construction of index numbers.

Assignment of weights

Proper importance has to be given to the items used for construction of index numbers. It is universally agreed that wheat is the most important cereal as against other cereals, and hence should be given due importance.

Choice of Base year

The index number for a particular future year is compared against a year in the near past, which is called base year. It may be kept in mind that the base year should be a normal year and economically stable year.

11.7 CONCLUSION

An index number is a statistical measure, designed to measure relative changes in a variable(s) with time/geographical location/other criteria. Index Numbers can be calculated for price, quantity, volume etc.The index numbers need to be interpreted carefully as there are several methods of calculating the index number. The items

to be included and the choice of the base period are important for the calculations. The index numbers are indispensable in economic policy making.

WHAT YOU HAVE LEARNT

- An index number is a statistical measure, designed to meaasure changes in a variable or a group of related variables.
- Conventionally, index numbers are expressed in terms percentage.
- Main characteristics of index numbers are :
  - (i) Index numbers are a special type of average that provide a measurement of relative changes in the level of certain phenomenon from time to time
  - (ii) Index numbers are expressed in terms fo percentages to show the extent of relative change
  - (iii) They measure relative changes.
  - (iv) They can also measure changes which are not directly measureable.
- Index numbers are economic barometers. They help in formulating economic policies and planning etc. They are used in studying trends adn tendencies. Index numbers are useful in forecasting future economic activity. They measure the purchasing power of money.
- The formula to obtain index number by simple average of price relatives method is:

$$P_{01} = \frac{\Sigma P_1}{\Sigma P_0} \times 100$$

- The formula to obtain index number by simple average of price relatives method is:

$$P_{01} = \frac{\Sigma \frac{P_1}{P_0} \times 100}{N}$$

- The formula to get Laspeyre's price index is $P_{01} = \frac{\Sigma p_1 q_0}{\Sigma p_0 q_0} \times 100$
- Formula to get Paasche's index number is:

$$P_{01} = \frac{\Sigma p_1 q_1}{\Sigma p_0 q_1} \times 100$$

- Formula to get index number by weighted price relative method is:

$$P_{01} = \frac{\Sigma W\left(\frac{p_1}{p_0} \times 100\right)}{\Sigma W}$$

- Consumer price index (cost of living index = $\frac{\Sigma WP}{\Sigma W}$

TERMINAL EXERCISES

1. Use the following to answer questions a-d:

   A company buys four products with the following characteristics:

	Number of units bought		Price paid per unit (£)	
Items	**Year 1**	**Year 2**	**Year 1**	**Year 2**
A	20	24	10	11
B	55	51	23	25
C	63	84	17	17
D	28	34	19	20

   (a) Find the simple price indexes for the products for year 2 using year 1 as the base year:

   (b) Find the simple aggregate index for year 2 using year 1 as the base year:

   (c) Find the base-weighted aggregate index, the Laspeyres index, for year 2 using year 1 as the base year.

   (d) Find the current period-weighted aggregate index, the Paasche index, for year 2 using year 1 as the base year.

2. During a certain year, Cost of Living Index Number goes up from 110 to 200 and the salary of worker is also raised from 3250 to 5000. Does the worker really gain?

3. The price relatives and weights of the set of commodities are given in the following table:

Commodities	A	B	C	D
Price Relatives	125	120	127	119
Weights	W1	2 W1	W2	W2+3

If the sum of weights is 40 and the index number for the set is 122, find the numerical value of W1 and W2.

ANSWERS TO INTEXT QUESTIONS

11.1

1. (b)
2. Read section 11.2
3. Read section 11.3
4. Read section 11.2

11.2

1. 101.017

11.3

1. ₹ 2554.5

Complete and Post the feedback form today

Final fold and seal

Feed back on Lessons

Lesson No.	Lesson Name	Content			Language		Illustrations		What You Have Learnt	
		Difficult	Interesting	Confusing	Simple	Complex	Useful	Not useful	Very helpful	Not helpful
1.										
2.										
3.										
4.										
5.										
6.										
7.										
8.										
9.										
10.										
11.										

Fourth fold

Third fold

Dear Learners,

You must have enjoyed going through your course books. It was our endeavor to make the study material relevant, interactive and interesting. Production of material is a two way process. Your feedback would help us improve the study material. Do take a few minutes of your time and fill-up the feedback form so that an interesting and useful study material can be made.

Thank you
Coordinator
(Economics)

Feed back on Questions

Lesson No.	Lesson Name	Intext Questions		Terminal Questions		
		Useful	Not useful	Easy	Diff.	V. diff.
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						

Second Fold

Yours suggestion

_____

_____

_____

_____

Did you consult any other book to study Economics? Yes/No

If Yes, give reason for consulting it

_____

_____

Name : _____

Enrolment No: _____

Address : _____

_____

Subject : _____

Book No: _____

Assistant Director (Acad.)
National Institute of Open Schooling
A-24-25, Institutional Area
Sector-62, NOIDA (U.P.)

Postage Stamp

No Enclosures allowed