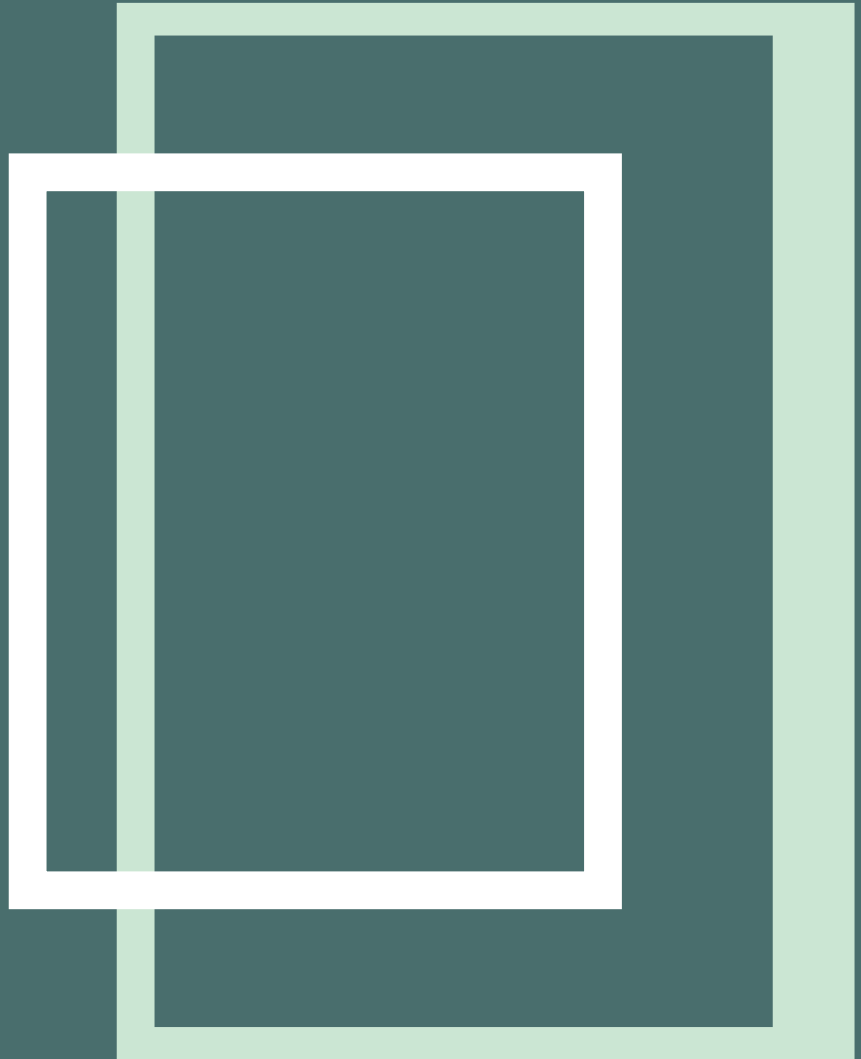# ENGINEERING ECONOMIC ANALYSIS

SHOBHA APTE

Engineering Economic Analysis

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Shobha Apte

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DEMAND, SUPPLY AND PRODUCTION

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1.1 Engineering Economics - Nature and scope

Economics

Economics is the art of production and consumption of goods, and transfer of wealth to produce and obtain those goods. Economics defines how people interact within the markets to get what they need or accomplish certain goals. Since economics is a driving force of human interaction, studying it often reveals why people and governments behave in particular ways.

The following are the economic goals:

• Price stability

• A high level of employment

• An equitable distribution of income

• Efficiency

• Growth

Some of the above goals are interdependent. The economic goals are not always complementary. in many of the cases, they are in conflict. For example, any move to have a significant reduction in unemployment will lead to increase in inflation.

Engineering Economics

Engineering economics deals with the methods that enable us to take economic decisions towards minimizing costs or maximizing benefits of the business organizations.

Efficient functioning of any business organization would enable it to provide the goods or services at a lower price. In the process of managing organizations, the managers at different levels should take appropriate economic decisions which will help in minimizing the investment, operating and maintenance expenditures besides increasing the revenue, savings and other related gains of the organization.

There are two main types of economics. They are as follows:

1. Microeconomics

2. Macroeconomics

The nature and scope of economics are related to the study of wealth or human behaviour of the scarce resources.

• Wealth and Welfare Connotations:

Wealth and welfare connotations are segregated into the classical view of Adam Smith and Neo classical view of Marshall.

• The Classical view and Contemporaries:

The Classical Economist Adam Smith defines Economics as the science of Wealth. He defines Economics as, "nature and cause of wealth of nations" whereby it "proposes to enrich the people and sovereign".

The classical view is misleading and has serious defects. This view of conception of economics laid exclusive stress on the material wealth. Material wealth is the object of desires of man. Wealth was considered to be the stop in itself.

By stressing on the word "Material Wealth", Economist Adam Smith narrowed the scope of Economics by excluding all the material activities which are related to the production of non-material goods and services such as Engineers, Accountants etc.

• Neo-Classical View and Contemporaries:

Alfred Marshall led neo-classical school which placed all the economists in a reputable position among social science. He emphasized on a man's welfare. Wealth was observed as the basis of human welfare, not stop in itself but a means to a stop.

According to Marshall, "Political Economy or Economics is a study of mankind in the ordinary business of life". It inspects that part of individual and social accomplishment which is most intimately associated with the achievement and the use of the material conditions of well being. It is on the one side, a study of riches and on the other are more significant side, a part of study of a man.

The contemporaries are it excludes the activities of socially disagreeable and non-standard persons like misers, thieves, etc, non-economic activities and activities having dishonorable ends.

• **Growth Oriented Definition:**

Modern Age is the age of economic development. Its key purpose is to enhance the social wellbeing and progress the standard of living of the people by getting rid of redundancy, poverty, disparity of income and wealth, malnutrition etc. of the realm. Hence, the financial development is the essential point of all the economic policies.

• **Scarcity**

According to Robbins, "Economics is the science which studies human behaviour as a relationship between ends and scarce means which have alternative uses". It was Lord Robbins who exposed the rational discrepancy and insufficiencies of other economists' definitions.

Scope of economics

The continuous growth in the subject matter of economics has led to divergent views about the scope of economics. It includes the Subject matter of Economics, Economics is a science or an Art, or is it a Positive or Normative science.

• **Subject Matter of Economics**

The subject matter of Economics is the study of grounds of material interests or as the science of wealth. The men, who are Subject matter of Economics, are sensible beings and take action under the active social, legal and institutional group. It eliminates the manners of socially objectionable, performance and uncharacteristic persons like misers, thieves, etc.

It consists of the study of exertion of consumption, exchange and distribution of wealth, production as well as the fortitude of the values of goods and services, the amount of employment and the determinants of fiscal development. Further, it comprises the study of grounds of unemployment, poverty, inflation, etc. and the actions for their elimination.

• **Economics as an Art**

The practical application of scientific techniques is the Art of Economics. Some of the economists consider Economics as a science and art while few others consider it as science and applied science. It is considered as newest of science and oldest of arts and the queen of all the social sciences.

• Economics as a Science

Economics is a science since its laws have widespread soundness such as the law of diminishing returns, the law of diminishing marginal utility, the law of demand etc. It is known as a science since its self-remedial nature. It goes on amendments in the dawn of new specifics based on the interpretations. Hence, the Economics is a science like any other science which has its own generalizations, theories or laws of economics which traces out a casual relationship between two or more phenomena.

• Economics as a Positive Science

As per the 19th century experts, Economics is a positive science. Since it explains what has actually happened but not what is ought to happen. According to J.N.Keynes, the Positive science is defined as "A body of systematized knowledge concerning what ought to be and concerned with the ideal as distinguished from the actual".

• Normative Economics

With contrast to the Positive Science, Normative Science deals with "what is ought to happen" cases. That is predictions of future economic development with regards to the present conditions. The postulations on which economic laws, theories or principles are based relate to man and his problems. If we attempt to test and forecast fiscal actions on their basis the subjectivity elements always penetrates. Therefore, the laws of economics are at best propensities.

Managerial Economics:

The definition of managerial economics is explained by many persons are as follows:

Mansfield states that "the managerial economics is concerned with application of economic concepts and economic analysis to the problems of formulating rational managerial decision".

McNair and Meriam states that the "Business Economics consists of the use of economic modes of thought to analyze business situations".

Spencer and Seegelman states that the "Business Economics is the integration of economic theory with business practice for the purpose of facilitating the decision making and forward planning by management".

Haynes, Mote and Paul states that the "Managerial Economics is the economics applied in decision making. It is a special branch of economics bridging the gap between abstract theory and managerial practice".
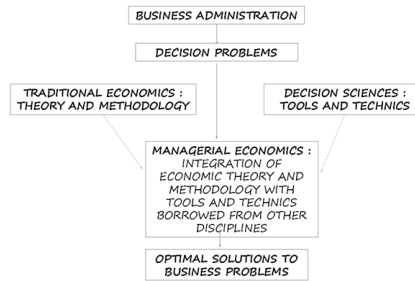
Managerial Economics

Managerial decision areas include:

• Assessment of investable funds

• Choice of product

• Selecting business area

• Sales promotion

• Determining optimum output

• Determining price of product

• Determining input-combination and technology

• Risk analysis

• Production analysis

• Pricing analysis

• Capital budgeting - Investment theory which is used to examine a firm's capital purchasing decision.

Characteristics of Managerial Economics

Managerial Economics is a discipline that deals with the application of economic theories in business management. The characteristics of managerial economics are as follows:

1. It involves application of economic principles to the problems of the firm.

2. It is microeconomic in character.

3. Though microeconomic in character, it has nothing to do with an individual's economic problems.

4. The scope is narrow, i.e., it deals with mainly project theory.

5. Management economics modifies and enlarges the economic theory to suit specific conditions.

Nature of Managerial Economics:

• In a business organization, two main primary function of management executive is decision making and forward planning. These functions go hand in hand with each other. A process of selecting one action from two or more alternative courses of action is known as decision making. Establishing plans for the future to carry out the decision is known as forward planning.

• The problem of choice arises since the resources at the disposal of a business unit like land, labour, capital and managerial capacity are limited. Hence, the firm has to make the most profitable use of these resources.

• The decision making function is carried by a business executive where he takes the decision that will ensure the most efficient means of attaining a desired objective say profit maximization. When this decision is taken then about the particular capital, output pricing, raw-materials and power etc. can be prepared. Thus, the forward planning and decision-making takes place at same time.

• Due to the uncertainty which surrounds business decision-making, the task made difficult for a business executive to complete. Since, nobody can predict the future course of business conditions, only best possible plans will be prepared by him for the future depending on past experience and future outlook and yet, he has to go on revising his plans in the light of new experience to minimize the failure. Thus, the managers are engaged in a continuous process of decision-making through an uncertain future and the overall problem confronting them is one of adjusting to uncertainty.

• By fulfilling the function of decision-making in an uncertainty framework, the economic theory can be pressed into service with a considerable advantage as it deals with a number of concepts and the principles which can be used to solve or at least throw some light upon the problems of business management.

For example, cost, profit, pricing, national income, production, demand, competition, business cycles etc. The subject-matter of Managerial Economics constitutes in the way the economic analysis can be used towards solving the business problems.

• Hence, the Managerial Economics is both a science and an art.

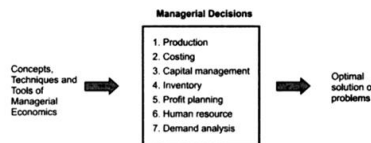**Scope of Managerial Economics:**

Since it is developing science, the scope of managerial economics is not yet clearly laid out.

1. Cost and Production Analysis

2. Capital Management.

3. Profit Management.

4. Pricing Decisions, Policies and Practices.

5. Demand Analysis and Forecasting.

The above divisions of business economics will constitute its subject matter. Recently, the usage of Operation Research methods like Linear programming, inventory models, Games theory, queuing up theory etc., have increased by the managerial economists. Hence, it has also come to be regarded as part of Managerial Economics.

Scope of managerial economics

• Cost and production analysis

Every firm's profitability depends much on its cost of production. The cost estimation with a range of output which identify the factors that causes variations in the cost estimates and choose the cost-minimizing output level and also taking into consideration the degree of uncertainty in production and the cost calculations will be prepared by a wise manager.

The production processes are under the charge of engineers. Thus, the business manager is supposed to carry out the production function analysis to avoid the wastages of materials and time. The sound pricing practices depends much on the cost control.

• Capital management

A firm's problems that are relate to the capital investments are perhaps the most complex and troublesome. The capital management implies planning and control of capital expenditure since it involves a large sum and also the problems in disposing the capital assets off are very complex that they require considerable time and labour.

• Profit management

Generally, all business firms will be organized for the earning profit and in the long period, it is the profit that provides the chief measure of success of a firm. The economics tells us that profits are the reward for the uncertainty bearing and risk taking.

Business manager who is successful is the one who can form more or less correct estimates of the costs and revenues likely to accrue to the firm at different levels of output. Therefore, the more successful a manager is in reducing uncertainty, the higher are the profits earned by him. Hence, the profit-planning and profit measurement will constitute the most challenging area of Managerial Economics.

• Pricing decisions, policies and practices

In managerial economics, pricing plays an important role. In fact, price is the genesis of the revenue of a firm. The success of a business firm largely depends on the correctness of the price decisions taken by it.

• Demand Analysis and Forecasting

A business firm is an economic organization that is engaged in transforming the productive resources into goods which are to be sold in the market. The major part of the managerial decision making will depend on accurate estimates of the demand.

The forecast of future sales serves as a guide to management for preparing the production schedules and employing resources. This will help the management to maintain or strengthen its market position and profit base. The demand analysis also identifies a number of other factors influencing the demand for the product. Hence, demand analysis and forecasting occupies a strategic place in Managerial Economics.

1.1.1 Basic problems of an economy

The following points highlight the five basic problems of an economy. The problems are: 1. What to Produce and in What Quantities? 2. How to Produce these Goods? 3. For whom is the Goods Produced? 4. How Efficiently are the Resources being Utilized? 5. Is the Economy Growing?.

Problem # 1: What to Produce and in What Quantities?

The first central problem of an economy is to decide what goods and services are to be produced and in what quantities. This involves allocation of scarce resources in relation to the composition of total output in the economy. Since the resources are scarce, society has to decide about the goods to be produced: wheat, cloth, television, roads, power, buildings and so on.
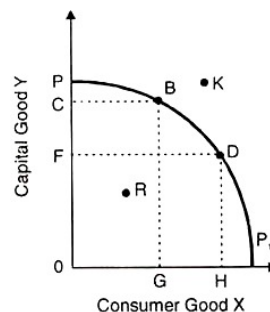
(a)

Once the nature of goods to be produced is decided, then their quantities are to be decided. How many tonnes of wheat, how many million kws of power, how many televisions, how many buildings,

etc. Since the resources of the economy are scarce, the problem of the nature of goods and their quantities has to be decided on the basis of priorities or preferences of the society.

If the society gives priority to the production of more consumer goods now, it will have less in the future. A higher priority on capital goods implies less consumer goods now and more in the future. But since the resources are scarce, if some goods are produced in larger quantities, some other goods will have to be produced in smaller quantities.

This problem can also be explained with the help of production possibility curve as shown in figure (a).

Suppose the economy produces capital goods and consumer goods. In deciding the total output of the economy, the society has to choose the combination of capital goods and consumer goods which is in keeping with its resources.

It cannot choose the combination R which is inside the production possibility curve PP1 because it reflects economic inefficiency of the system in the form of unemployment of resources. Nor can it choose the combination R which is outside the current production possibilities of the society. The society lacks in the resources to produce this combination of capital goods and consumer goods.

It will, therefore, have to choose among the combinations B, E or D which give the highest level of satisfaction. If the society decides to have more capital goods, it will choose the combination B and if it wants more consumer goods, it will choose the combination D.

Problem # 2: How to Produce these Goods?

The next basic problem of an economy is to decide about the techniques or methods to be used in order to produce the required goods. This problem is primarily dependent upon the availability of resources within the economy.

If land is available in abundance, it may have extensive cultivation. If land is scarce, intensive methods of cultivation may be used. If labour is in abundance, it may use labour-intensive techniques; while in the case of labour shortage, the capital-intensive techniques may be used.

The technique to be used also depends upon the type and quantity of goods to be produced. For producing the capital goods and large outputs, complicated and expensive machines and techniques are required. On the other hand, simple consumer goods and small outputs require small and less expensive machines and comparatively simple techniques.

Further, it has to be decided what all the goods and services are to be produced in the public sector and what all goods and services in the private sector. But in choosing between different methods of production, those methods should be adopted which bring about an efficient allocation of resources and increase the overall productivity in the economy.

Suppose the economy is producing certain quantities of consumer and capital goods at point A on PP curve in figure (b) adopting new techniques of production, given the supplies of factors, the productive efficiency of the economy increases. As a result, the PP_0 curve shifts outwards to P_1P_1.

It leads to the production of more quantities of consumer and capital goods from point A on PP_0 curve to point C of PP will be the new production possibility curve and the economy will move from point A to B where more of both the goods are produced.
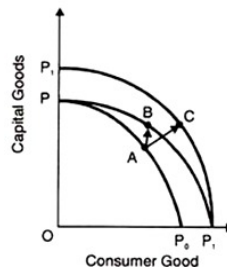
(b)

Problem # 3: For whom is the Goods Produced?

The third basic problem to be decided is the allocation of goods among the members of the society. The allocation of basic consumer goods or necessities and luxuries comforts and among the household takes place on the basis of among the distribution of national income.

Whoever possesses the means to buy the goods may have then. A rich person may have a large share of the luxuries goods and a poor person may have more quantities of the basic consumer goods he needs. This problem is illustrated in figure (c) where the production possibility curve PP shows the combinations of luxuries and necessaries.

At point B on the PP curve, the economy is producing more of luxuries OC for the rich and less of necessaries OC for the poor whereas at point D more of necessaries OH are being produced for the poor and less of luxuries OF for the rich.
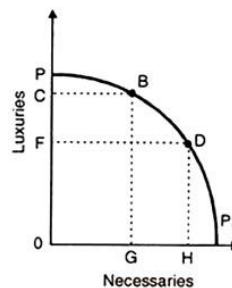
(c)

Problem # 4: How Efficiently are the Resources being Utilized?

This is one of the important basic problems of an economy because having made the three earlier decisions, the society has to see whether the resources it owns are being utilized fully or not. In case the resources of the economy are lying idle, it has to find out the ways and means to utilize them fully.

If the idleness of resources, say land, manpower or capital, is due to their male allocation, the society will have to adopt such monetary, fiscal or physical measures whereby this is corrected. This is illustrated in figure (d) where the production possibility curve PP reflects idle resources within the economy at point A, while the production possibility curve P_1P_1 reflects the full utilization of the resources at point B or C.

It is for the society to decide whether to produce more capital goods at point B or more consumer goods at point C or both at point D at the level of full employment. In an economy where the available resources are being fully utilized, it is characterized by technical efficiency or full employment.

To maintain it at this level, the economy must always be increasing the output of some goods and services.
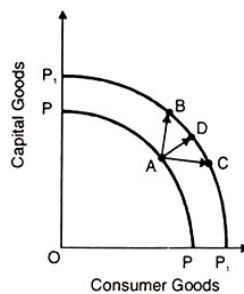

(d)

Problem # 5: Is the Economy Growing?

The last and the most important problem is to find out whether the economy is growing through time or is it stagnant. If the economy is stagnant at any point inside the production possibility curve, says in figure (e), it has to be moved on to the production possibility curve PP whereby the economy now produces larger quantities of consumer goods and capital goods.

Economic growth takes place through a higher rate of capital formation which consists of replacing existing capital goods with new and more productive ones by adopting more efficient production techniques or through innovations.

This leads to the outward shifting of the production possibility curve from PP to P_1P_1; (in figure (e)). The economy moves, say after 5 years, from point A to B or C or D on the P_1P_1 curve. Point C represents the situation where larger quantities of both consumer and capital goods are produced in the economy. Economic growth enables the economy to have more of both the goods.
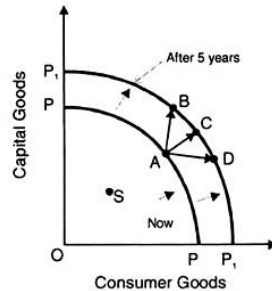
(e)

All these central problems of an economy are interrelated and interdependent. They arise from the fundamental economic problems of scarcity of means and multiplicity of ends which lead to the problem of choice or economizing of resources.

1.1.2 Micro Economics and Macro Economics

Microeconomics

Microeconomics involves on the actions of individuals and industries like the dynamics between the buyers and sellers, borrowers and lenders. The term micro has been derived from the Greek word micros, which means small.

In microeconomics, attention is concentrated on a very small part of the individual units. The microeconomics is the study of the particular firms, household, individual prices, incomes, wages, etc. Microeconomics examines the factors that influence the individual economic choices and how the choices of various decision makers are co-ordinated by markets.

Microeconomics examines how these decisions and behaviours affect the supply and demand for goods and services, which determines the prices, and how prices determine the supply and demand of goods and services.

Macroeconomics

Macroeconomics takes a much broader view by analyzing the economic activity of the whole country or the international marketplace. This term is also derived from the Greek word macros, which means large.

Macroeconomics is a branch of Economics that deals with the structure, performance and behaviour of the economy as a whole. Macroeconomists seek to understand the determinants of the aggregate trends in the economy with particular focus on national income, unemployment, inflation, investment and international trade.

In contrast, microeconomics is primarily focused on the determination of prices and the role of prices in allocating the scarce resources. It implies the study of economics aggregates or the wholes. The problems like unemployment, full employment, economic stability and economic growth

cannot be accurately investigated through examination of infinitesimally small units like producer, individual consumer, workers or firms.

The action of a single employer cannot have a perceptible impact upon the employment situation of the country. The production or investment by a single firm is unlike to generate the cyclical fluctuations. The proper analysis of such problem requires an aggregated thinking. Full employment, economic growth and instability are concerned with the entire economic system.

Unlike microeconomics studies the particular markets, macroeconomics dedicates itself into the overall behaviour and performance of an entire economy. What happens in an economy is the outcome of thousands of millions of individual decisions, and macroeconomics puts all the small pieces that are the subjects of microeconomics together to focus on the big picture, at a national or global level.

Moving from Micro to Macro

When we look at a simple supply and demand diagram for motor cars. Microeconomics is concerned with issues such as the impact of an increase in demand for cars
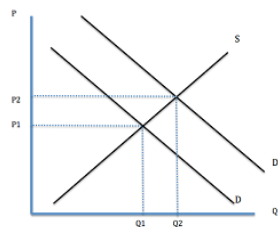
Moving from Micro to Macro

This micro economic analysis reveals that the increased demand leads to higher price and higher quantity.

Macro economic analysis

This looks at all the goods and services produced in the economy.
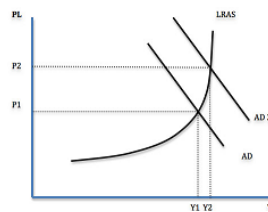
Macro economic analysis

The macro diagram is looking at Real GDP instead of quantity.

Instead of the price of a good, we are looking at the overall price level (PL) for the economy. Inflation measures the annual % change in the aggregate price level.

Macro diagrams are based on same principles as micro diagrams, looking at the Real GDP rather than Quantity and Inflation rather than Price Level (PL).

We may also consider differences between micro and macro economics.

Main differences:

• Macro economics places greater emphasis on empirical data and trying to explain it. Micro economics tends to work from theory first.

• Small segment of economy vs whole aggregate economy.

• There is little debate about the basic principles of micro-economics. Macro economics is more contentious. There are different schools of macro economics offering different explanations (e.g. Keynesian, Monetarist, Austrian, Real Business cycle,etc.,).

• Microeconomics works on the principle that markets soon create equilibrium. In macro economics, the economy may be in a state of disequilibrium for a longer period.

Differences Between Microeconomics and Macroeconomics

The main difference is that micro economics looks at small segments, and macro looks at the whole economy. But, there are few other differences.

Equilibrium – Disequilibrium

Classical economic analysis that markets return to equilibrium (S=D). If demand increases faster than supply, this causes price to rise and firms respond by increasing supply. For a long time, it was supposed that the macro economy behaved in the similar way as micro economic analysis. Before, the 1930s, there was not really a separate branch of economics known as macroeconomics.

Great Depression and Birth of Macroeconomics

In the 1930s, economies were clearly not in the equilibrium. There was a high unemployment, output was below the capacity, and there was a state of disequilibrium. Classical economics did not really have an explanation for this disequilibrium, from which a micro perspective, must not occur.

In 1936, J.M.Keynes produced his "The General Theory of Employment, Interest and Money", this examined why depression was lasting for so long. It judged why we can be in a state of disequilibrium in the macro economy.

Keynes observed that we may have a negative output gap for a prolonged time. In other words, microeconomic principles of markets clearing, did not necessarily apply to macro economics. Keynes was not the only economist to investigate this new branch of economics. For example,

Iriving Fisher examined the role of debt deflation in explaining great depression. But, Keynes theory was the most wide ranging explanation, and played a large role in creating new branch of macro-economics.

Since 1936, macroeconomics developed as a separate strand within economics. There have been competing explanations for issues such as inflation, recessions and economic growth.

1.2 Demand - Meaning of demand

Demand is said to be the aspiration for a commodity of the individual or a group, when they are able to pay for that commodity. i.e., Demand is desire with account to pay.

According to Benham's, "Demand for anything at a given price is the amount of it that will be bought per unit of time at that price".

It can also be defined as, "The different quantities of a given commodity or service when the consumers might buy in a market in a given period of time at different prices or at different incomes or at various prices of related goods".

In other words, the quantity of goods which is desired by an individual, is backed by the ability and willingness to pay.

Types of demand:

1. Derived demand and autonomous demand

When a producer derives its usage from the use of some primary product, it is termed as derived demand whereas, the autonomous demand is the demand for a product which can be independently used.

Example for derived demand is demand for tyres derived from demand for car, and an example for autonomous demand is demand for a washing machine.

2. Direct and indirect demand

It is also called as Producers' goods and consumers' goods. The demand for goods which are directly used for consumption by the ultimate consumer is termed as direct demand, whereas the demand for goods which are used by producers for producing goods and services is termed as indirect demand.

Example for direct demand is demand for T-shirts and for indirect demand is demand for cotton by a textile mill.

3. Firm and industry demand:

Firm demand is the demand for the product of a particular firm whereas the demand for the product of a particular industry is industry demand .

Example for firm demand is dove soap, and for industry demand is demand for steel in India.

4. Durable and non durable goods demand

The goods which can be used more than once, over a period of time is termed as durable goods whereas non durable goods can be used only once.

Example for durable goods is microwave oven, and for non-durable goods is band-aid.

5. Short run and long run demand

The short run demand refers to the demand with its immediate reaction to the price changes and income fluctuations, whereas the long run demand is that which will ultimately exist as a result of the changes in pricing, the promotion or product improvement after market adjustment with sufficient time.

6. Total market and market segment demand

A particular segment of the market demand is termed as segment demand, whereas, the sum of the demand for laptops by various segments in India is the total market demand.

Example for segment demand is demand for laptops by engineering students, and for total market demand is demand for laptops in India.

7. Price demand, income demand and cross demand

The demand for commodities by the consumers at alternative prices is termed as price demand. It has the ability and willingness to buy specific quantities of a good at the prevailing price in the given time period.

Income demand

The quantity demanded by the consumers at the alternative levels of income is termed as income demand. Here, the total quantity of a good or service is the goods that people are willing and able to buy at a prevailing prices in the given time period. It is the sum of individual demands.

Cross demand

The quantity demanded of commodity 'X' at a price of a related commodity 'Y' which may be a substitute or complementary to X is termed as the cross demand. This has the ability and willingness to buy a commodity or service at the prevailing price of the related commodity. That is, it substitutes the complementary products.

Example: People buy more wheat when the price of rice increases.

8. Joint demand and Composite demand

When two goods are demanded in conjunction with one another at the same time to satisfy a single want, it is termed as joint or complementary demand whereas, a composite demand is one in which a good is wanted for several different uses.

Example for joint or complementary demand is demand for petrol and two wheelers, and for composite demand is demand for iron rods for various purposes.

1.2.1 Demand function

A demand function that denotes the behavior of buyers, may be constructed for an individual or a group of buyers in a market. The market demand function is the horizontal summation of the individual demand functions. In models of firm behavior, the demand for a firm's product may be constructed.

The nature of "demand function" depends on nature of the good that is considered and the relationship being modeled. In most cases the demand relationship is based on inverse or negative relationship between price and quantity of a good purchased. The demand for purely competitive firm's output is generally depicted as horizontal (or perfectly elastic). In rare cases, under extreme conditions, a "Giffen good" will result in a positively sloped demand function. These Giffen goods rarely occur.

It is important to identify the nature of the "demand function" that is being considered.

Individual Demand Function

The behavior of a buyer is influenced by number of factors; the price of the good, incomes of the buyer, the tastes and preferences of the buyer, the prices of related goods, the period of time and a variety of other possible variables. The quantity that a buyer is willing and able to purchase is a function of these variables.

An individual demand function for a good (Good X) can be written:

P_x = The price of good X

$Q_x = f_x(P_x,$ Prelated goods, income (M), preferences, . . .)

Q_x = The quantity of good X

Income (M) = The income of the buyers

Prelated goods = The prices of compliments or substitutes

Preferences = The preferences or tastes of buyers

The demand function is a model that "explains" the change in the dependent variable "caused" by a change in each of independent variables. As all the independent variable can change at the same time it is useful to isolate effects of a change in each of independent variables. To represent the demand relationship graphically, the effects of a change in P_x on the Q_x are shown here. The other variables, are held constant. The figure shows the graphical representation of demand. As they are held constant, the demand function in the graph shows the relationship between P_x and Q_x in a given unit of time (ut).
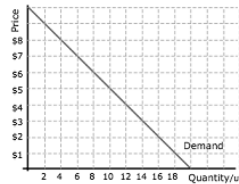
Graphical representation of demand

The demand function may be viewed from one of two perspectives. The demand is generally defined as a schedule of quantities that buyers are willing and able to purchase at a schedule of prices in a given time interval (ut),

$Q_x = f(P_x)$, given incomes, price of related goods, preferences, etc.

Demand can be even perceived as the maximum prices buyers are willing and able to pay for each unit of output.

$P_x = f(Q_x)$, given incomes, price of related goods, preferences, etc.

Remember that the demand function is commonly thought of as $Q = f(P)$ but the graph is drawn with the quantity on the X-axis and price on the Y-axis. While demand is frequently stated $Q = f(P)$, it is important to remember that the graph and calculation of total revenue (TR) and marginal revenue (MR) are calculated on the basis of a change in quantity (Q). TR = f(Q) The calculation of "elasticity" is based on change in quantity (Q) that is caused by a change in the price (P). Clarify whether the variable is independent and which is dependent in a particular concept.

Market Demand Function

When property rights are non attenuated the individual's demand functions may be summed horizontally to get the market demand function.
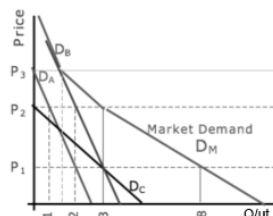
Market Demand Function

Table:

Computation of Market Demand by Horizontal Summation of Individual

Demand Functions				
Price	Ann's Demand	Bob's Demand	Cathy's Demand	Market Demand
P_1	2	3	3	8
P_2	1	0	2	3
P_3	0	0	1.5	1.5

Table and figure a market demand function is constructed from the behavior of three people (These people are the participants in a very small market). At a price of P_1, Ann will voluntarily buy 2 units of the good based on her preferences, income and the prices of related goods. Bob and Cathy buys 3 units each. Their demand functions are indicated by D_A, D_B and D_C in the figure. The total amount demanded by these three individuals at P_1 is 8 units (2+3+3). At a higher price each individual buys a smaller quantity.

The demand functions may be summed horizontally if the property rights to the good are exclusive; Ann's consumption of a unit precludes the Bob or Cathy from the consumption of that good. In the case of public goods, the consumption of the national defense by one person does not preclude others from the same good.

The behavior of a buyer was denoted by the function:

$Q_x = f_x(P_x$, Prelated goods, income (M), $_{preferences,}$ . . .).

For the market the demand function can be represented by adding the number of buyers $Q_x = f_x(P_x$, Prelated goods, income where #B represents the number of buyers. The market demand may be stated.

$Q_x = f(P_x)$, given incomes, price of related goods,

1.2.2 Law of demand and its exceptions

A microeconomic law states that all other factors being equal, as the price of a good or service increases, consumer demand for the good or service will decrease, and vice versa.

The law of demand says that, higher the price, lower the quantity demanded, because consumers' opportunity cost to acquire that good or service increases and they must make more trade offs to acquire the more expensive product.

Assumptions:

1. Tastes and preferences of the consumer remain constant.

2. No change in the income of the consumer.

3. Prices of related goods do not change.

4. Consumers do not accept any change in the price of the commodity in the near future.

Breaking Down 'Law Of Demand'

The chart below depicts the law of demand using a demand curve, which is always downward sloping. Each point on the curve (A, B, C) reflects a direct correlation between the quantity demanded (Q) and price (P). So, at point A, the quantity demanded will be Q_1 and its price will be P_1, and so on.
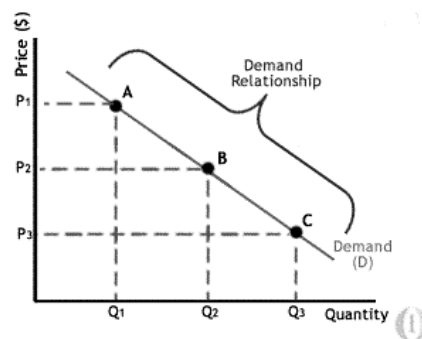
Law Of Demand

The law of demand is so intuitive that we may not even be aware of all the examples around us. When shirts go on sale, we might buy three instead of one. The quantity that we demand increases because the price has fallen.

When plane tickets become more expensive, we're less likely to travel by air and more likely to choose the less expensive options of driving or staying at home. The amount of plane tickets that we demand decreases to zero, because the cost has gone up.

The law of demand summarizes the effect that price changes have on consumer behavior. For example, a consumer will purchase more pizzas if the price of pizza falls. The opposite is true if the price of pizza increases. John might demand 10 pizzas if they cost $10 each, but only 7 pizzas if the price rises to $12, and only 4 pizzas if the price rises to $20.

The law of demand is one of the most fundamental concepts in economics. It works with the law of supply to explain how market economies allocate resources and determine the prices of goods and services.

Exceptions to Law of Demand:

As a general rule, demand curve slopes downwards, showing the inverse relationship between the price and quantity demanded. However, in certain special circumstances, the reverse may occur, i.e. a rise in price may increase the demand. These circumstances are known as 'Exceptions to the Law of Demand'.

Some of the Important Exceptions are:

1. Giffen Goods:

These are special kind of inferior goods on which the consumer spends a large pan of his income and their demand rises with an increase in price and demand falls with the decrease in price. For example, in our country, it is often seen that when price of coarse cereals like jowar and bajra falls, the consumers have a tendency to spend less on them and shift over to superior cereals like wheat and rice. This phenomenon is popularly known as 'Giffen's Paradox' was first observed by Sir Robert Gillen.

2. Status Symbol Goods or Goods of Ostentation:

The exception relates to certain prestige goods which are used as status symbols. For example, diamonds, gold, antique paintings, etc. are bought due to the prestige they confer upon the possessor. These are wanted by the rich persons for prestige and distinction. The higher the price, the higher be the demand for such goods.

3. Fear of Shortage:

If the consumers expect a shortage or scarcity of a particular commodity in the near future, then they would start buying more and more of that commodity in the current period even if their prices are rising. The consumers demand more due to fear of further rise in prices. For example, during emergencies like war, famines, etc., consumers demand goods even at higher prices due to the fear of shortage and general insecurity.

4. Ignorance:

Consumers can buy more of a commodity at a higher price when they are ignorant of the prevailing prices of commodity in market.

5. Fashion related goods:

Goods that are related to fashion does not follow the law of demand and their demand increases even with a rise in their prices. For example, if any particular type of bike is in trend, then the demand for such dress will increase even if its price is rising.

6. Necessities of Life:

Another exception occurs in the use of such commodities, that become necessities of life due to their constant use. For example, commodities such as rice, salt, wheat, medicines, etc. are purchased even if their prices increases.

7. Change in Weather:

With change in season/weather, demand for certain commodities also changes, irrespective of any change in their prices. For example, the demand for umbrellas increases in rainy season even with an increase in their prices. It should be noted that in normal conditions and considering the given assumptions, 'Law of Demand' is applicable universally.

1.2.3 Determinants of demand

Determinants of demand

The various demand determinants are:

• Income of the consumer

• Price of the product

• Prices of closely related goods

• Tastes and preference of the consumer

• Consumer's expectation of future prices and future income

• Social, economic and demographic distribution of consumers.

• Population

Determinants of Demand:

1. Price of the good:

It is an important determinant of demand since price and demand are inversely related. When it has higher price, it will have less demand and vice versa.

2. Price of related goods:

They are substitutes and complementary goods which also affect the demand. Here, the substitutes, rise in price of one commodity will lead to increase in demand for its substitute where as complementary goods, there is a fall in the price of one commodity shall lead to rise in demand for both the goods.

3. Consumer's Income:

It is directly related to demand. A change in the income of the consumer will significantly influences his demand for most commodities. When the disposable income increases, the demand will be more.

4. Taste, preference, fashions and habits:

When there is a change in taste, habits or preferences of the consumer, even his demand will change since fashions and customs in society determine many of our demands. These are very effective factors affecting demand for a commodity.

5. Population:

When the size of the population is more, the demand for goods will be more . Thus, the market demand for a commodity will substantially changes if there is change in the total population.

6. Money Circulation:

When there is more money in circulation, the demand is higher and vice versa.

7. Value of money:

It determines the demand for a commodity in the market. If there is a rise or fall in the value of money it can affect in the relative prices of different goods and their demand.

8. Weather Condition:

It determines the demand for certain goods.

9. Advertisement and Salesmanship:

When the advertisement is very attractive for a commodity, the demand will be more. Same as advertising when the salesmanship and publicity is very effective then the demand for the commodity will be more.

10. Consumer's future price expectation:

When the consumers expect that there will be a rise in prices in future, then he may buy more at the present price and so his demand increases.

11. Government policy:

If the high taxes, this will increase the price and reduce demand, whereas if there is low taxes, it will reduce the price and extend the demand.

12. Credit facilities:

By depending on the availability of credit facilities the demand for commodities can change. When there are more facilities the demand will be higher.

13. Multiplicity of uses of goods:

When the commodity has multiple uses then the demand will be more while the commodity is used for a single purpose.

Determinants of Individual Demand:

Let us discuss the variables which influence the individual demand.

1. Income of the Consumer:

The income of the consumer is another important variable which influences demand. The ability to buy a commodity depends upon the income of the consumer.

When the income of the consumers increases, they buy more and when income falls they buy less. A rich consumer demands more and more goods because his purchasing power is high.

2. Price of the Commodity:

This is the basic factor influencing the demand. There is a close relationship between the quantity demanded and the price of the product.

Normally a larger quantity is demanded at a lower price than at a higher price. There is inverse relationship between the price and quantity demanded. This is called the law of demand.

3. Prices of Related Goods:

The related goods are generally substitutes and complementary goods. The demand for a product is also influenced by the prices of substitutes and complements. When a want can be satisfied by alternative similar goods they are called substitutes, such as coffee and tea.

Whenever the price of one good and the demand for another are inversely related then the goods are said to be complementary, such as car and petrol.

4. Tastes and Preferences:

The demand for a product depends upon tastes and preferences of the consumers. If the consumers develop taste for a commodity they buy whatever may be the price.

A favourable change in consumer preference will cause the demand to increase. Likewise an unfavourable change in consumer preferences will cause the demand to decrease.

5. Consumer's Expectation:

A consumer's expectation about the future changes in price and income may also affect his demand. If a consumer expects a rise in prices he may buy large quantities of that particular commodity.

6. Advertisement and Sales Propaganda:

In modem times, the preferences of consumers can be altered by advertisement and sales propaganda.

Advertisement helps in increasing demand by informing the potential consumers about the availability of the product, by showing the superiority of the product and by influencing consumer choice against the rival products.The demand for products like detergents and cosmetics is mainly caused by advertisement.

Similarly, if he expects its prices to fall in future, he will tend to buy less at present. Similarly, expectation of rising income may induce him to increase his current consumption.

1.2.4 Elasticity of demand & its measurement (Simple numerical problems to be solved)

This represents the degree of responsiveness of quantity demanded to the changes in the determinants of demand.

Concept of Elasticity of demand was introduced by Alfred Marshall in the year 1890 to measure the magnitude of percentage change in the quantity demanded of a commodity to a certain percentage change in its price or the income of the buyer or in the prices of related goods. The three main determinants of demand are as follows:

1. Price of the good.

2. Income of the consumer.

3. Price of the related goods.

Types of elasticity

Elasticity of demand can be of three types as follows:

1. Price Elasticity of Demand

The sensitivity of demand for a product to a change in the product's own price since price elasticity of demand is predominantly used in economic analysis. It is alternatively referred to as elasticity of demand.

The degree of responsiveness of demand to a change in its price is termed as price elasticity of demand. In other words, it is the ratio of the percentage change in demand to the percentage change in price.

i.e., E_p = Percentage change in quantity demanded/Percentage change in price.

It is represented in mathematical form as,

$E_p = (\Delta q/\Delta p)\ (p/q)$

From the definition, it says that,

• When there is percentage change in the quantity demanded is greater than the percentage change in price, then the price elasticity will be greater than one. So, the demand is said to be elastic.

• When there is a percentage change in the quantity demanded is equal to the percentage change in price, then the price elasticity can be equal to one. So, demand is said to be unit elastic.

• When there is a percentage change in the quantity demanded, i.e., less than the percentage change in price, then the price elasticity will be less than one. So, the demand is said to be inelastic.

Diagrammatic representation of Price Elasticity of Demand:
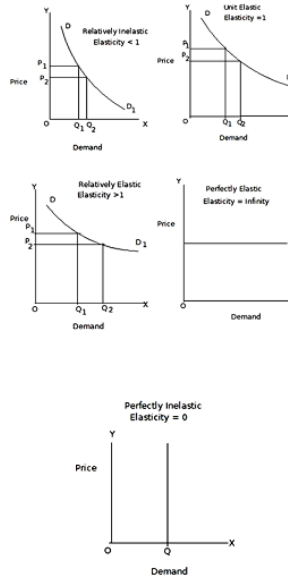
2. Cross Elasticity of Demand

Cross elasticity means a change in the demand for a commodity owing to change in the price of another commodity. The measure of the extent to which the demand for a good changes when the price of a substitute or complement changes, the other things are remaining as the same, is known as the cross elasticity of demand.

An economic concept that measures the responsiveness in the quantity demand of one good when a change in price takes place in another good. The cross elasticity of demand can be calculated as,

$$\text{Cross elasticity of demand} = \frac{\text{Percentage change in quantity demanded}}{\text{Percentage change in price of a substitute or complement}}$$

The cross elasticity of demand for a substitute is positive, whereas for a complement, it is negative. It is calculated by taking the percentage change in the quantity demanded of one good divided by the percentage change in price of the substitute good as follows:

$$E_C = \frac{P_1^A + P_2^A}{Q_1^B + Q_2^B} \times \frac{\Delta Q^B}{\Delta P^A}$$

Where,

P_1^A = The price of good A at time period 1

P_2^A = The price of good A at time period 2

Q_1^B = The quantity demanded of good B at time period 1

Q_2^B = The quantity demanded of good B at time period 2

ΔQ^B = The change in the quantity demand of good B

ΔP^A = The change in price of good A

In the concept of elasticity of demand, it is also useful is knowing the different market form.

• When the cross elasticity of demand is infinite, there is perfect competition in the market.

• When the cross elasticity of demand is greater than one (or E_c >1), there is monopolistic competition or imperfect competition.

• When the cross elasticity of demand is less than 1 (or E_c < 1), there is relative monopoly.

• When the cross elasticity is 0 (or E_c = 0), it is a case of absolute or pure monopoly.

2. Income Elasticity of Demand

Income elasticity means a change in demand in response to a change in the consumer's income.

The income elasticity of demand is a measure of the extent to which the demand for a good changes when income changes, other things remaining the same. In other words, a measure of the relationship between changes in the quantity demanded for a particular good and a change in real income. It is an economics term which refers to the sensitivity of the quantity demanded for a certain product in response to a change in consumer incomes.

The income elasticity of demand can be calculated by using the following formula,

$$\text{Income elasticity of demand} = \frac{\text{Percentage change in quantity demanded}}{\text{Percentage change in income}}$$

• For a normal, the income elasticity of demand is positive.

• For an inferior good, the income elasticity of demand is less than 0.

• When the income elasticity of demand is greater than 1, then the demand is income elastic.

• When the income elasticity of demand is between zero and 1, then the demand is income inelastic.

Example:

When the quantity demanded for a good increases by 15% in response to a 10% increase in income, then the income elasticity of demand would be 15%/10% = 1.5 and the degree to that the quantity demanded for a good changes in response to a change in income depends on whether the good is a necessity or a luxury.

Other types

(a) Perfectly Elastic Demand: When any quantity may be sold at a given price and when there is no need to reduce the price, the demand, is considered to be perfectly elastic. In such a case, even a small increase in price will result in complete face in demand, the below figure reveals that the quantity demand increases from OQ to OQ_1 from OQ to OQ_2 even though there is no change in the price.
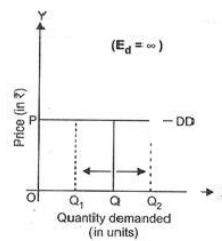
Perfectly Elastic Demand

(b) Perfectly Inelastic Demand:

When significant degree of change in price leads to little change in the quantity demand then the elasticity is said to be perfectly inelastic.

In other words, the demand is said to be perfectly inelastic when there is no change in the quantity ad_1 even though there is a big change in price.

It can be seen in the figure below, that despite the increase in price from OP_1 to OP_2, the quantity demand remains unchanged.
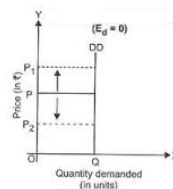
Perfectly Inelastic Demand

(c) Relatively Elastic Demand:

The demand is relatively elastic where the change in demand is more than the change in the price. The below figure reveals that the quantity demand increases from Oq_0 to Oq_1 because of a increase in the price from OP_0 to OP_1. The extent of D_{re} in the quantity demand is greater than the extent of face in the price.

Relatively Elastic Demand

(d) Relatively Inelastic Demand: The demand is relatively inelastic when the change in demand less than the charge in price. The below figure reveals that the quantity demand, increases from OB to ON because of a increase in the price from OA to OC.The extent of increase in quantity demand is less than the extent of all in price.

Relatively Inelastic Demand (eP < 1)
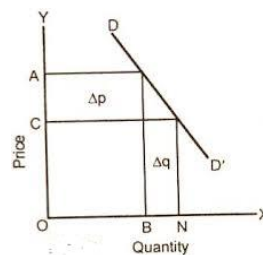
Relatively Inelastic Demand

(e) Unit Elasticity of Demand: The elasticity in demand is said to be in unity when the change in demand is equal to the change in price. The figure below reveals that the quantity demand increase from OQ_1 to OQ_2 because of increase in the price from QP_1 to OP_2. The extent of increase in the quantity demand is equal to extent of fall in the price.

Unit Elasticity of Demand (e_P = 1)
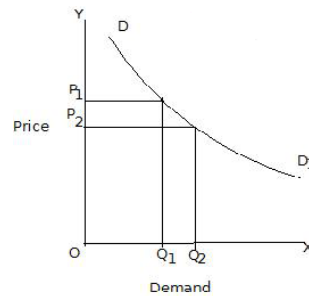
Unit Elasticity of Demand

Factors determining elasticity

The elasticity of demand for any commodity is determined or influenced by a number of factors. Sole of them are as follows:

(1) Nature of the Commodity

(2) Substitutes

(3) Variety of Uses

(4) Joint Demand

(5) Deferred Consumption

(6) Habits

(7) Income Groups

(8) Proportion of Income Spent

(9) Level of Prices

(10) Time Factor

(11) Brand

(12) Recurring Demand

(13) Distribution of Income

Measurement

Methods of measuring price elasticity of demand:

There are 4 methods of measuring elasticity of demand. They are:

• **The percentage method**

• **Arc method**

• **Point method**

• **Expenditure method**

(a) The Percentage Method

The price elasticity of demand is measured by its coefficient (E_p). This coefficient (E_p) measures the percentage change in the quantity of a commodity demanded resulting from a given percentage change in its price. Thus,

$$E_p = \frac{\% \text{change in q}}{\% \text{ change in p}} = \frac{\Delta q / q}{\Delta p / p} = \frac{\Delta q}{\Delta p} \times \frac{p}{q}$$

Where,

q refers to quantity demanded.

p refers to price.

Δ refers to change.

• If $E_p > 1$, demand is elastic.

• If $E_p < 1$ demand is inelastic.

• If $E_p = 1$, demand is unitary elastic.

With this formula, we will compute the price elasticities of demand on the basis of a demand schedule.

Demand Schedule

Combination	Price (Rs.) Per Kg. of X	Quantity Kgs. of X
A	6	0
B	5	10

C	4	20
D	3	30
E	2	40
F	1	50
G	0	60

First take combinations B and D.

(i) Assume the price of commodity X falls from Rs. 5 per kg to Rs. 3 per kg and its quantity demanded increases from 10 kg to 30 kg. Then,

$$E_p = \frac{\Delta q}{\Delta p} \times \frac{p}{q} = \frac{(30-10)}{(3-5)} \times \frac{5}{10} = \frac{20}{-2} \times \frac{5}{10} = -5 \text{ or} > 1$$

This shows elastic demand or elasticity of demand is greater than unitary.

Note:

The formula will be understood like this:

$\Delta q = q_2 - q_1$

where, q_2 is the new quantity (30 kg.) and q_2 is the original quantity (10 kg.).

$\Delta P = p_2 - p_1$

where, p_2 is the new price (Rs.3) and p is the original price (Rs. 5).

(ii) The opposite is the case in example:

Measure elasticity by moving in the reverse direction. Assume the price of X rises from Rs. 3 per kg. to Rs. 5 per kg and the quantity demanded decreases from 30 kg. to 10 kg. Then,

$$E_p = \frac{\Delta q}{\Delta p} \times \frac{p}{q} = \frac{(10-30)}{(5-3)} \times \frac{3}{30} = \frac{-20}{2} \times \frac{3}{30} = -1$$

This shows unitary elasticity of demand. Notice which the value of E_p differs.

(iii) Depending upon the direction in that we move, this difference in the elasticities is due to the use of a different base while computing the percentage changes in each case. Now, consider combinations D and F.

(iv) Assume the price of commodity X falls from Rs. 3 per kg to Re. 1 per kg. and its quantity demanded increases from 30 kg. to 50 kg. Then,

$$E_p = \frac{\Delta q}{\Delta p} \times \frac{p}{q} = \frac{(50-30)}{(1-3)} \times \frac{3}{30} = \frac{20}{2} \times \frac{3}{30} = -1$$

This is again unitary elasticity.

(v) Take the reverse order while the price rises from Re. 1 per kg. to Rs. 3 per kg. And the quantity demanded decreases from 50 kg. to 30 kg. Then,

$$E_p = \frac{\Delta q}{\Delta p} \times \frac{p}{q} = \frac{(30-50)}{(3-1)} \times \frac{1}{50} = \frac{-20}{2} \times \frac{1}{50} = -\frac{1}{5} < 1$$

This shows inelastic demand or less than unitary.

The value of E_p again differs for the reason stated above.

(b) The Point Method

Professor Marshall devised a geometrical method for measuring elasticity at a point on the demand curve. RS be a straight line demand curve in the figure. If the price falls from PB (= OA) to MD (= OC), the quantity demanded increases from OB to OD.

Elasticity at point P on the RS demand curve according to the formula is,

$E_P = \Delta q/\Delta p \times p/q$

where,

Δq represents change in quantity demanded.

Δp changes in price level.

p and q are initial price and quantity levels.
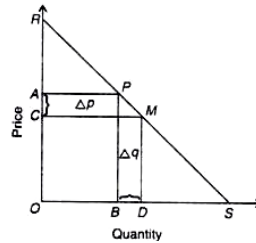
From the figure,

Δq = BD = QM

Δp = PQ

P = PB

q = OB

By substituting these values in the elasticity formula,

E_p = QM/PQ× PB/OB

= QM/PQ × BS/PB

[∠PQM = ∠PBS are similar Δs]

BS/PB × PB/OB = BS/OB

Since Δ PBS and ΔROS are similar,

E_p at point p = BS/OB = OA/AR = PS/PR = Lower Segment/Upper Segment.

It is easy to point out the elasticity at any point along a demand curve. Assume that the straight line demand curve DC in the below figure is 6 centimeters. The five points L, M, N, P and Q are taken on this demand curve. The elasticity of demand at each point can be known by the above method.
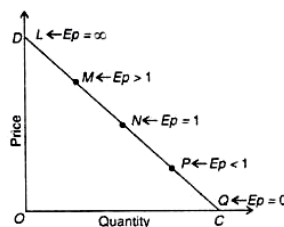
Consider the point N be in the middle of the demand curve. Thus, the elasticity of demand at point.

N = CN (Lower Segment) / ND (Upper Segment) = 3/3 = 1 (Unity)

Elasticity of demand at point:

M = CM/MD = 5/1 = 5 or > 1. It is greater than unity.

L = CL/LD = 6/0 = ∞ . It is infinity.

P = CP/PD = 1/5. It is less than unity.

Q = CQ/QD = 0/6 = 0. It is zero.

We arrive at the conclusion, at the mid-point on the demand curve, the elasticity of demand is unity. Then moving up the demand curve from the mid-point, elasticity becomes greater. When the demand curve touches the Y-axis elasticity is infinity. The factor at any point below the mid point towards the X-axis will show elastic demand. The elasticity becomes zero while the demand curve touches the X-axis.

(c) The Arc method

The measurement of elasticity at a point on a demand curve is carried in arc method. When the elasticity is measured between two points on the same demand curve, it is known as arc elasticity. Prof. Baumol states that, "the Arc elasticity is a measure of the average responsiveness to price change exhibited by a demand curve over some finite stretch of the curve".
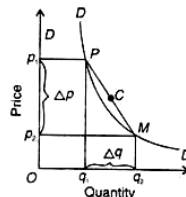
Thus, any two points on a demand curve make an arc. An area between P and M on the DD curve in the above figure is an arc that measures the elasticity over a certain range of price and quantities. At any two points of a demand curve, the elasticity coefficients are likely to be different depending upon the method of computation. The price quantity combinations P and M is given in the below table.

Demand Schedule:

Point	Price (Rs)	Quantity (Kg)
P	8	10

M	6	12

When we move from P to M, the elasticity of demand is,

$E_P = \Delta Q/\Delta P \times p/q = (12 - 10) / (6-8) \times 8/10 = 2/-2 \times 8/10 = 4/5$

When we move in the reverse direction from M to P, then,

$(10-20) / (6-8) \times 6/12 = -2/2 \times 6/12 = -1/2$

Thus, the point method of measuring the elasticity at two points on a demand curve gives different elasticity coefficients, because we use a different base in computing the percentage change in every case.

In order to avoid this discrepancy, elasticity for the arc is determined by taking the average of the two prices $[(p_1 + p_2)^{1/2}]$ and the average of the two quantities $[(q_1 + q_2)^{1/2}]$. Then the formula for price elasticity of demand at the mid-point of the arc on the demand curve is,

$$E_p = \frac{\frac{\Delta q}{(q_1 + q_2)^{1/2}}}{\frac{\Delta p}{(p_1 + p_2)^{1/2}}} = \frac{\Delta q}{(q_1 + q_2)^{1/2}} \times \frac{(p_1 + p_2)^{1/2}}{\Delta p} = \frac{\Delta q}{\Delta p} \times \frac{p_1 + p_2}{q_1 + q_2}$$

On the basis of this formula, we will measure arc elasticity of demand when there is a movement either from point P to M or from M to P.

From P to M at point P, $p_1 = 8$, $q_1 = 10$ and at point M, $p_2 = 6$, $q_2 = 12$.

Applying these values, we get,

$E_P = \Delta q/\Delta p \times (p_1 + p_2) / (q_1 + q_2) = (12-10) / 8-6 \times (8 + 6) \times (10+12)$

$= 2/-2 \times 14/22 = -7/11$

From M to P at point M, $P_1 = 6$, $q_1 = 12$ and at point, $p_2 = 8$, $q_2 = 10$.

Now we have $E_P = (10-12) / (8-6) \times (6+8)/12+10) = -2/2 \times 14/22 = -7/11$.

Thus, whether we move from M to P or P to M on the arc PM of the DD curve, the formula for arc elasticity of demand gives the same numerical value. Closer the 2 points P and M, more accurate is the measure of elasticity on the basis of this formula. If the two points which form the arc on the demand curve are so close which almost merge into each other, the numerical value of arc elasticity equals the numerical value of point elasticity.

(d) The Total Outlay Method:

Marshall states that the total outlay or total revenue or total expenditure method as a measure of elasticity. In comparing the total expenditure of a purchaser each before and after the change in price, it can be known whether it is a demand for a good is elastic, unity or less elastic. It can be represented as,

Total Outlay = Price x Quantity Demanded

It is explained with the help of the demand schedule in below table.

Price Rs. Per Kg	Quantity in Kgs.	TE in Rs	E_p
(1)	(2)	(3) = (1) x (2)	(4)
9	2	18	
8	3	24	>1
7	4	28	
6	5	30	
5	6	30	=1
4	7.5	30	
3	8	24	
2	9	18	<1
1	10	10	

(i) Elastic Demand

The demand is elastic, while with the fall in price, the total expenditure increases and with the rise in price, the total expenditure decreases where the above table shows that when the price falls from Rs. 10 to Rs. 9, the total expenditure increases from Rs. 19 to Rs. 25 and if the price rises from Rs. 8 to Rs. 9, the total expenditure falls from Rs. 29 to Rs. 23. Thus, the demand is elastic (E_p > 1) in this case.

(ii) Unitary Elastic Demand

If there is a fall or rise in the price, the total expenditure remains unchanged, then the elasticity of demand is unity which is shown in the table with the fall in price from Rs. 6 to Rs. 5 or with the rise in price from Rs. 4 to Rs. 5, the total expenditure remains unchanged at Rs. 30, i.e., $E_p = 1$.

(iii) Less Elastic Demand:

The demand is less elastic when with the fall in price, the total expenditure falls and with the rise in price, the total expenditure rises. If the price falls from Rs. 3 to Rs. 2, total expenditure falls from Rs. 24 to Rs. 18 and while the price rises from Re. 1 to Rs. 2, the total expenditure also rises from Rs. 10 to Rs. 18. Thus, the demand is inelastic or less elastic demand, $E_p < 1$.

Total Outlay Method

Price	TE	E_p
Falls Rises	Rises Falls	>1
Falls Rises	Unchanged Unchanged	=1
Falls Rises	Falls Rises	<1

The measurement of elasticity of demand in terms of the total outlay method is explained in the below figure which is divided into three stages by the relationship between price elasticity of demand and the total expenditure.
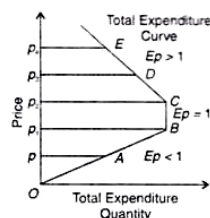
First, if the price falls from Op_4 to Op_3 and to Op_2 respectively, then the total expenditure rises from p_4E to p_3D and p_2C respectively, whereas when the price increases from Op_2 to Op_3 and Op_4, the total

expenditure decreases from p_2C to p_3D and p_4E respectively. Thus, the EC segment of total expenditure curve shows elastic demand ($E_p > 1$).

Secondly, if the price falls from Op_2 to Op_1 or rises from Op_1 to Op_2, the total expenditure equals, $p_2C = p_1B$ and the elasticity of demand is equal to the unity ($E_p = 1$).

Third, if the price falls from Op_1 to Op_2, the total expenditure also falls from p_1B to pA. Thus, with the rise in price from Op to Op_1, the total expenditure also increases from pA to p_1B and the elasticity of demand is less than unity ($E_p < 1$).

Significance

1. It allows the business in general and the monopolists in particular to fix the price.

2. It helps the Finance Minister to levy tax on goods.

3. It is very useful to fix the price of jointly supplied goods.

4. It is of greater significance in the sphere of international trade.

5. It guides the producers to fix wages for laborers.

6. The effect of machines on employment opportunities depends upon elasticity of demand for the goods produced by such machines.

7. It explains the paradox of poverty in the midst of plenty.

8. Incidence of tax lies on the person who ultimately pays the tax.

9. The knowledge of elasticity of demand is very important for the government in such matters as controlling of business cycles will remove inflationary and deflationary gaps in the economy.

10. Rate of exchange between two currencies can be changed through the devaluation or overvaluation of one currency in relation to other currencies.

11. The concept of elasticity of demand plays an important role by determining the price of joint products.

12. The concept of elasticity of demand is also useful in knowing the different market form.

13. The concept of elasticity of demand also plays a significant role in the international trade or in terms of trade.

14. This concept is significant in the determination of the prices of public utility services.

1.3 Supply - Meaning of supply, Law of supply and its exception

Supply is the amount of some product that producers are willing and able to sell at a given price, all other factors being held constant. In general, supply depicts a positive relationship which is between the price of a good or service and the quantity that the producer is willing to supply. If a supplier believes that they can sell the product for more, it will want to make more of the product. As a result, as the price of the good or service increases, suppliers increase the quantity available for purchase.

Law of supply

According to the law of supply, more quantities of a commodity will be offered for sale at higher prices and less quantity will be offered for sale at lower price. There is a direct relationship between the market price and supply.
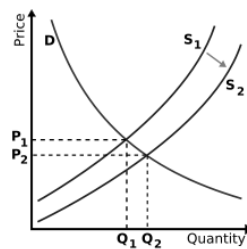
Law of supply

Law of supply states that, other factors remains constant, where price and quantity supply of a good are directly related to each other. In other words, when the price paid by buyers for a good rises, then suppliers increases the supply of that good in the market.

Assumptions in Law of Supply:

The law of supply expresses the change in supply with relation to the change in price. In other words, the main assumption of law of supply is that it studies the effect of the price on supply of a product while keeping other determinants of supply at constant. Apart from this, there are certain assumptions that are necessary for the application of law of supply, which are as follows:

i. Assume that the price of the product changes but the change in the cost of production is constant. This is because, if the cost of production rises with the increase in price, then sellers would not supply more due to the reduction in their profit margin. Therefore, law of supply would be applicable only when the cost of production remains constant.

ii. Assume that there is no change in the technique of production. This is because, the advanced technique would reduce the cost of production and make the seller supply more at a lower price.

iii. Assume that there is no change in the scale of production. This is because, if the scale of production changes with a period of time, then it would affect the supply. In such a case, the law of supply would not be applicable.

iv. Assume that the policies of the government remain constant. If there is an increase in tax rates, then the supply of product would decrease even at the higher price. Therefore, for the application of law of supply, it is necessary that government policies should remain constant.

v. Assume that the transportation cost remains same. If the transportation cost reduces, then the supply would increase, which is invalid according to the law of supply.

vi. Assume that there is no speculation about prices in future, which otherwise can affect the supply of a product. If there is no speculation about the products, then the economy is assumed to be at balance and people are satisfied with the available products and do not require any change.

Some of the exceptions of law of supply are as follows:

i. Agricultural products

Imply that law of supply is not valid in case of agricultural products, as the supply of these products depends on the particular seasons or climatic conditions. Thus, the supply of these products cannot be increased after a certain limit in spite of rise in their prices.

ii. Speculation

Refer to the fact that the supply of the product decreases instead of increasing in present when there is an expected increase in the price of the product. In such a case, sellers would not supply the whole quantity of the product and would wait for increase in price in future to earn high profits. This case is an exception to the law of demand.

iii. Changes in other situations

Refer to the fact that the law of supply ignores other factors that can influence the supply of the product. They can be natural factors, transportation conditions and government policies.

 1.3.1 Determinants of Supply

The determinants of supply are as follows:

1. Production costs

2. The technology used in production

3. The price of related goods

4. Firm's expectations about future prices

5. Number of suppliers.

Innumerable factors and circumstances could affect a seller's willingness or ability to produce and sell a good. The more common factors are:

(a) Goods own price: The basic supply relationship is between the price of the good and the quantity supplied. Though there is no "Law of Supply", generally the relationship is positive or direct meaning with an increase in price which shall will induce and increase in the quantity supplied.

(b) Price of related goods: For purposes of supply analysis, related goods refer to the goods from which inputs are derived to be used in the production of the primary good.

For example, a firm produces leather belts. The firms managers learn that leather pushes for smart phones are more profitable than belts.

Firm might reduce its production of belts and it shall begin production of cell phone pouches based on this information. Finally, a change in price of a joint product will affect supply.

(c) Conditions of Production: The most significant factor is the state of technology. If there is a technological advancement in good's production, the supply increases.

The other variables may also affect production conditions. For example: For agricultural goods, weather is crucial for it may affect the production outputs. A good weather condition would result in increased production of rice or wheat and vice-versa when the weather is not appropriate.

(d) Expectation: The sellers expectations concerning future market condition can directly affect supply. If the seller believes that the demand for the product will sharply increase in the foreseeable future, the firm owner shall immediately increase production in anticipation of future price increases. He will reduce supply if he expects the demand is going to fall.

(e) Price of Inputs: Inputs include land, labor, energy and raw materials. When the price of input increases, the supply curve will shift in as sellers are less willing or able to sell goods at existing prices. For instance, if the price of electricity increases a seller may reduce his supply because of the increased costs of production. The seller is likely to raise the price of the seller charges for each unit of output.

(f) Number of Suppliers: The market supply curve is the horizontal summation of the individual curves. As more firms enter the industry, the supply will increase driving down prices.

(g) Government Policies and Regulations: The government intervention can have a significant effect on supply. The government intervention can take many forms including environmental and health regulations, taxes, hour and wage laws, electrical and natural gas rates and zoning and land use regulations.

Demand Curve Shifts:

When consumers increase the quantity demanded at a given price, it is referred to as an increase in demand. Increased demand may be represented on the graph as the curve being shifted to right. At each price point, a greater quantity is being demanded, as from the initial curve D_1 to new curve D_2 and this raises the equilibrium price from P_1 to the higher P_2. This raises the equilibrium quantity from Q_1 to higher Q_2. A movement along the curve is described as a "change in the quantity

demanded" in order to distinguish it from "change demanded" to distinguish it from a "change in demand", which is a shift of the curve, there has been an increase in the demand that has caused an increase in (equilibrium) quantity.

The increase in demand could also come from changing the tastes and fashions, incomes, price changes in the complementary and substitute goods, market expectations and number of buyers.

This might cause the entire demand curve to shift, thereby changing the equilibrium price and quantity. Note in the diagram the shift of the demand curve, by causing new equilibrium price to emerge, resulted in the movement along the supply curve from point (Q_1 P_1) to the point ($Q_2 P_2$).

If the demand decreases, then opposite happens: a shift of the curve to the left. If the demand starts at D_2 and decreases to D_1, the decrease in the equilibrium and also in the equilibrium quantity.

The quantity supplied at each price is the same as before the demand shift, reflecting the fact that the supply curve has not shifted; but equilibrium quantity and price are different as a result of the change in demand.

The movement of demand curve in response to a change in a non-price determinant of the demand is caused by the change in the X-intercept, the constant term of the demand equation.
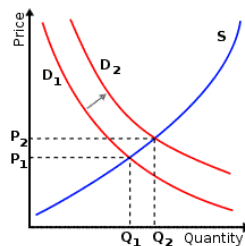
Demand Curve Shift

Supply Curve Shift:

When technological progress occurs, the supply curve shifts. For example, assume that someone invents a better way of growing wheat so that the cost of growing a given quantity of wheat decreases.

In other words, the producers will be willing to supply more wheat at every price and shifts in the supply curve S_1 outward, to S_2 - an increase in the supply. This increase in supply causes equilibrium price to decrease from P_1 to P_2. The equilibrium quantity increases from Q_1 to Q_2 as the consumers more along the demand curve to new lower price.

As a result of supply curve shift, the price and the quantity move in the opposite directions. If the quantity supplied decreases, then the vice versa happens.

If the supply curve starts at S_2 and shifts leftward to S_1, then the equilibrium price will increase and equilibrium quantity will automatically decrease as the consumers move along the demand curve to new higher price and the associated power quantity demanded.

The quantity demanded at each price is the same as before the supply shift, which reflects the fact that demand curve has not shifted.

Due to the change in supply, equilibrium quantity and the price have changed. The movement of the supply curve in response to a change in non-price determinant of supply is caused by the change in the Y-intercept, the constant term of supply equation.

The supply curve shifts up and down the Y-axis as non-price determinants of the demand change.
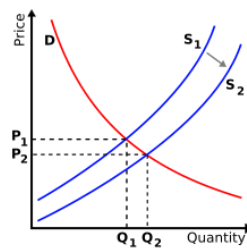
Supply Curve Shift

1.3.2 Elasticity of supply

Elasticity

Supply elasticity is defined as the percentage change in the quantity supplied divided by the percentage change in price. It is calculated as,

$$\text{SupplyElasticity} = \frac{\%\Delta \text{ in quantity supplied}}{\%\Delta \text{ in price}}$$

Elasticity of Supply

Elasticity of supply may be defined as a degree of responsiveness of the quantity of commodity supplied for a small change in its price. It may be also defined as a ratio or percentage changes in quantity supplied of a commodity to the change in its price.

$$\text{Elasticity of SS}_i = \frac{\text{Percentage in quantity supplied of commodity X}}{\text{Percentage change in price of commodity Y}}$$

Price Elasticity of Supply

Price elasticity of supply measures the responsiveness of quantity supplied to change in price, as the percentage change in quantity supplied induced by a one percent change in price. It is calculated for discrete changes as $(\Delta Q/\Delta P) \times P/Q$ and for smooth changes, differentiable supply functions as $(\delta Q/\delta P) \times P/Q$. Since supply is usually increasing in the price, so the price elasticity of supply is usually positive.

Determinants of Price Elasticity of Supply

(a) Reaction Time

The price elasticity of supply coefficient will largely be determined by how quickly producers react to price changes by increasing or decreasing production and delivering or cutting deliveries of goods to the market.

(b) Complexity of Production

Much depends on the complexity of the production process. Textile production is relatively simple.

The labor is largely unskilled and production facilities are little more than the buildings. No special structures are needed. Thus, the PES for textiles is elastic. On the other hand, the PES for specific types of motor vehicles is relatively inelastic.

Auto manufacturing is a multi-stage process that requires specialized equipment, skilled labor, a large suppliers network and large R&D costs.

(c) Time to Respond

More time a producer has to respond to price changes, more elastic the supply. For example, a cotton farmer cannot immediately respond to an increase in the price of soya beans.

(d) Excess Capacity

A producer who has unused capacity can quickly respond to price changes in his market assuming that variable factors are readily available.

(e) Inventories

A producer who has a supply of goods or available storage capacity can quickly respond to price changes.

Non-Price Elasticities of Supply

Other elasticities can be calculated for non-price determinants of supply.

Input Elasticity of Supply

The percentage change, the amount of the good supplied caused by a one percent increase in the price of a related good is an input elasticity of supply, if the related good is an input in the production process. For example, the change in the supply for sweets caused by a one percent increase in the price of sugar.

Perfectly Inelastic Supply (Vertical Supply Curve)
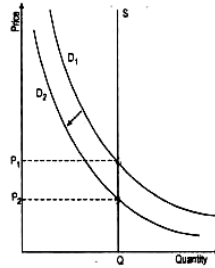
Perfectly Inelastic Supply

If the quantity supplied is fixed (Q) in the very short run, no matter what the price, the supply curve(S) is a vertical line and supply is called perfectly inelastic. Economists also distinguish the short-run market supply curve from the long-run market supply curve.

1.3.3 Determination of market equilibrium (Simple numerical problems to be solved)

The Supply function

Equilibrium is refers to the price-quantity pair where the quantity demanded is equal to the quantity that is supplied, which is represented by the intersection of the demand and supply curves.

Market Equilibrium:

It is a situation in a market when the price is in a way that the quantity which consumers wish to demand is accurately balanced by the quantity that many firms wish to supply.

Comparative Static Analysis:

It confronts the likely effect on equilibrium of a change in external conditions by affecting the market.

Changes in the Market Equilibrium:

Practical uses of supply and demand analysis often centers on different variables which change the equilibrium price and quantity, denoted as shifts in the respective curves. Comparative statics of this shift traces the effects from the initial equilibrium to the new equilibrium.

Perfect competition is defined as a market situation where there are large number of buyers and sellers dealing in homogeneous products.

Moreover, under perfect competition, there are no legal, social or technological barriers on the entry or exit of the organizations.

In the perfect competition, sellers and buyers are fully aware about the current market price of a product. Therefore, none of them sell or buy at a higher rate. As a result of this, the same price prevails in the market under perfect competition condition.

Under perfect competition condition, buyers and sellers cannot influence the market price by increasing or decreasing their purchases or output, respectively. The market price of the products in perfect competition is determined by industry. This means that in perfect competition condition, the market price of the products is found by taking two market forces into account, named as the market demand and the market supply.

According to Marshall, "Both the elements of demand and supply are required for the determination of price of a commodity in the same manner as both the blades of scissors are required to cut a cloth". Market demand is defined as a sum of the quantity demanded by each individual organizations in the industry.

On the other hand,the market supply refers to the sum of quantity that is supplied by individual organizations in the industry. In perfect competition, price of a product is determined at a point at which the demand and supply curve intersect each other. This point is called as equilibrium point as well as the price is called as the equilibrium price. Additionally, at this point, the quantity demanded and supplied is known as equilibrium quantity.

Demand under Perfect Competition:

Demand refers to the quantity of a product that consumers are willing to purchase at a particular price, while other factors remain constant. A consumer demands more quantity at lower price and less quantity at higher price. Therefore, the demand varies at different prices.
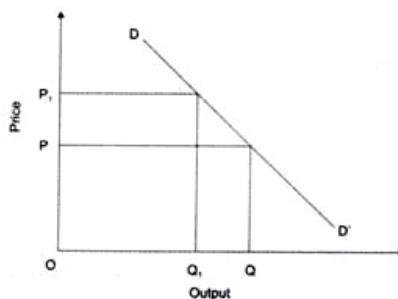
(a) Demand Curve under Perfect Competition

As shown in figure(a) when price is OP, the quantity demanded is OQ. On the other hand, when price increases to OP_1, the quantity demanded reduces to OQ_1. Therefore, under perfect competition, the demand curve (DD') slopes downward.

Supply under Perfect Competition: Supply refers to quantity of a product which producers are willing to supply at a particular price. Basically, the supply of a product increases at high price and decreases at a low price.
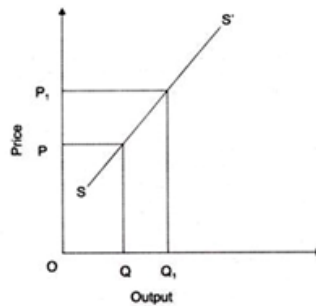
(b) Supply curve under perfect competition

In the above figure, the quantity supplied is OQ at price OP. When price increases, the quantity supplied increases to OQ_1. This is because the producers are able to earn large profits by supplying the products at a higher price. Hence, under perfect competition, the supply curves (SS') slopes upward.

Equilibrium under Perfect Competition:

In a perfect competition, the price of a product is found at a point at which demand and supply curve intersect each other. This point is called as the equilibrium point. At this point, the quantity demanded and supplied is known as equilibrium quantity.
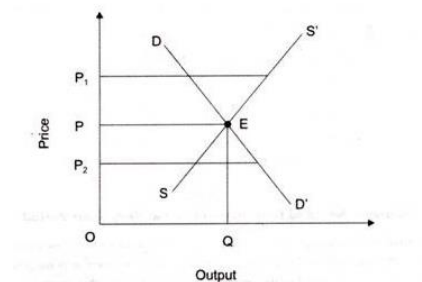
Price and output determiner under perfect competition

In the above figure, it can be seen that at price OP_1, supply is more than demand. Hence, prices will fall down to OP. Similarly, at price OP_2, demand is more than the supply. Similarly, in such a case, the prices will rise to OP. Thus, E is the equilibrium at which equilibrium price is OP and equilibrium quantity is OQ.

Equilibrium of the firm under perfect competition

In short run: In the short run, the firm will have temporary equilibrium where MR=MC and AR=AC. At this point, the equilibrium output and price is determined. The short run price is known as a sub-normal price and it is not a stable price.

In the short run, firm will not be in the position to cover its fixed costs but it should recover short run variable costs for its survival in the market. Short run price must be at least equal to the minimum AVC .
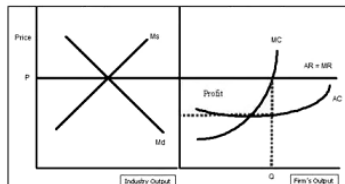
Firm is a price-taker where if the price is more than AC, then firm will attain supernormal profit. In this situation, MC=MR but AC<AR.
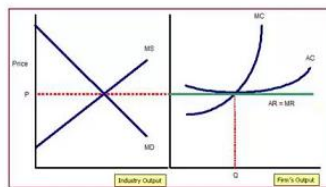
If AC is equal to price, then the firm will attain normal profit. In this condition AC=MC=AR=MR=P.
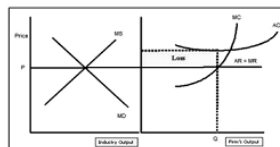
If AC is greater than price, there will be losses. In this situation, MC=MR but AC>AR.

Thus, in short run, a firm can either incur losses or earn supernormal profit or normal profit.

The main reason for this is that the firm does not get adequate time to make all kinds of adjustments to avoid losses in the short run.

In long run, a firm will attain only normal profit where P=AR=AC=MR=MC.

If AR is greater than AC, then the firm will earn supernatural profit and it will lead to the entry of new firms, as a result, increase in the total number of the firms and finally increase in supply and fall in price and ratio of profits. This process will continue till supernatural profits are reduced to zero. On the other hand, if AR is less than AC, loss will occur and this will lead to the exit of old

firms, decrease in the number of the firms, decrease in supply and rise in price and finally the rise in the ratio of profits. Such process will continue until the firm reaches to the equilibrium position where AC =AR.
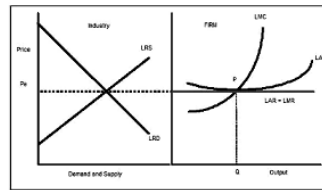
Long run equilibrium will be where, LMC=LMR=LAC=LAR=P.

In the long run, a competitive firm should be at the minimum point of the LAC curve in order to avoid losses.

In short run, demand plays an important role in the determination of price while in long run, supply is important than demand in price determination.

Problems:

1. Let us complete the following table when each unit of a commodity can be sold at Rs.5.

Quality sold	TR	MR	AR
1			
2			
3			
4			
5			
6			
7			

Solution:

It is case of perfect competition because price of a commodity is fixed at Rs.5

Quality sold	Price or AR (Rs)	TR= (Px Q) (Rs)	MR(ΔTR/(ΔQ) (Rs)
1	5	5	5
2	5	10	5
3	5	15	5

4	5	20	5
5	5	25	5
6	5	30	5
7	5	35	5

2. Following information is given about a firm. Let us find out producer's equilibrium or profit maximizing output, using MR- MC approach.

Output (units)	Price (Rs)	Total Cost (Rt)
1	10	30
2	10	35
3	10	39
4	10	41
5	10	44
6	10	49
7	10	56
8	10	66
9	10	80

10	10	95

Solution:

Given:

Output (units)	Price (Rs)	Total Cost (Rt)
1	10	30
2	10	35
3	10	39
4	10	41
5	10	44
6	10	49
7	10	56
8	10	66
9	10	80
10	10	95

Marginal profit is the difference between the marginal revenue and the marginal cost. To maximize its profits, marginal profit (= MR - MC) the firm chooses that level of output at which difference between MR and MC is zero.

Output (Q) (units)	Price (Rs)	Total Cost (Rs)	MC	Total Revenue (TR)=PxQ	MR	Addition to Profit = MR - MC (RS)
1	10	30	--	10	10	--
2	10	35	5	20	10	+5
3	10	39	4	30	10	+6
4	10	41	2	40	10	+8
5	10	44	3	50	10	+7
6	10	49	5	60	10	+5
7	10	56	7	70	10	+3
8	10	66	10	80	10	0
9	10	80	14	90	10	-4
10	10	95	15	100	10	-5

At Q= 8, it can maximize the profit. In other words, the firm is certain that addition to profit (Mli - MC) has stopped rising.

3. The following table shows the total cost schedule of a competitive firm. It is given that the price of the good is Rs 10. Let us determine the profit maximizing level of output.

Quantity:	0	1	2	3	4	5	6	7	8	9	10

Total cost (Rs)	5	15	22	27	31	38	49	63	81	101	123

Solution:

Quantity (units)	Price (Rs)	Total Revenue (Rs)	Total Cost (Rs)	Profit (Rs)
0	--	0	5	-5
1	10	10	15	-5
2	10	20	22	-2
3	10	30	27	+3
4	10	40	31	+9
5	10	50	38	+12
6	10	60	49	+11
7	10	70	63	+7
8	10	80	81	-1
9	10	90	101	-11
10	10	100	123	-23

At 5 unit of output, profit is maximum, that is, Rs 12. Thus, profit maximizing output level is 5 unit.

1.4 Production - Production function

A production function specifies the output of a firm, an industry or an entire economy for all combinations of inputs.

Uses of production function

1. It helps in determining how to obtain the optimum output from a given set of inputs.

2. It helps in determining how to obtain a given output from the minimum set of inputs.

Production Function

The production function relates the result of a firm to the amount of inputs, typically capital and labor. In a general mathematical form, the production function is expressed as:

$Q = f(X_1, X_2, X_3, ..., X_n)$

Where, Q = Quantity of output

$X_1, X_2, X_3, ..., X_n$ = Quantities of factor inputs such as capital, labour, land or raw materials.

This general form does not encompass joint production which mean a production process which has multiple co-products or outputs.

It can also be defined as a schedule (table, equation) which shows the maximum amount of output that can be produced from any specified set of inputs, that is given the existing technology or "state of the art."

In short, the production function is said to be the catalog of various possibilities of output.

$Q = f(X,Y)$ or (K,L)

It is important to keep in mind in which the production function describes technology, not economic behavior. The firm may maximize its profits that is given its production function but generally takes the production function as the given element of that problem. In specialized long-run models, a firm shall choose its capital investments in order to choose among various production technologies.

The production function expresses a functional relationship between the quantities of inputs and outputs. It shows how the output changes and also to what extent output changes with variations in inputs during a specified period of time. According to Stigler, "The production function is the name that is given to the relationship between the rates of input of productive services and the rate of output of the product.

It is the economist's summary of technical knowledge." Basically, the production function is a technological or engineering concept which can be expressed in the form of a table, graph and

equation showing the amount of output obtained from various combinations of inputs used in production, given the state of technology. Algebraically, it can be expressed in the form of an equation as,

Q =f (L, M, N, K, T) ...(1)

where Q stands for the output of a good per unit of time, L for labour, M for management, N for land, K for capital and T for the given technology and it refers to the functional relationship.

The production function with many inputs may not be depicted on a diagram. Moreover, given the specific values of the various inputs, it becomes difficult to solve such production function mathematically. Economists, thus, use a two-input production function. If we take two inputs, labour and capital, the production function assumes the form

Q = f (L, K) ...(2)

The production function as determined by technical conditions of production is of two types:

It can be rigid ox flexible. The former relates to the short run and the latter relates to the long run.

The Short-Run Production Function:

In short run, the technical conditions of production are rigid so that various inputs used to produce a given output are in fixed proportions. But, in the short run, it is possible to increase the quantities of one input while keeping the quantities of other inputs constant in order to have more output. This aspect of production function is called as the Law of Variable Proportions.

The short run production function in the case of two inputs, labour and capital, with capital as fixed and labour as the variable input may be expressed as

Q= f(L,K)...(3)

where K refers to the fixed input.
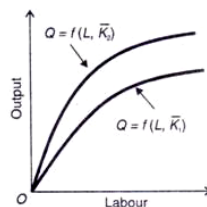
(a)

This production function is depicted in figure(a) where the slope of curve shows the marginal product of labour. A movement along production function shows the increase in output as labour

increases, given the amount of capital employed K. If the amount of capital increases to K at a point of time, the production function Q = f(L.K1) shifts upwards to Q = f(L.K2) as shown in the figure.

On the other hand, if labour is taken as a fixed input and capital as the variable input the production function takes the form Q = f(U).

This production function is depicted in figure(b) where the slope of curve denoted the marginal product of the capital. A movement along the production function shows the increase in output as capital increases, given the quantity of labour employed, L2 If the quantity of labour increases to L2 at a point of time, the production function Q = f(L.K2) shifts upwards to Q= f(KL2)
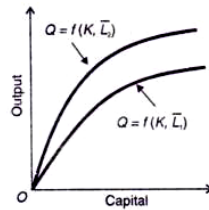
(b)

The Long-Run Production Function:

In the long run, all are variable inputs. Production may be increased by changing one or more of the inputs. The firm may change its plants or scale of production. Given the level of technology, a combination of the quantities of labour and capital produces a specified level of output.

The long-run production function is depicted in figure where the combination of OK of the capital and OL of labour produces 100 Q. With the increase in inputs of capital and labour to OK_1 and OL_1, the output increases to 200 Q. The long-run production function is shown in terms of the isoquant like 100 Q.
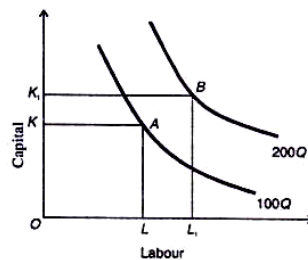
In the long run, it is possible for a firm to change all the inputs up or down in accordance with scale. This is called as returns to scale. The returns to scale are constant when the output increases in the same proportion as the increase in the input quantities. The returns to scale are increasing when increase in output is more than proportional to the increase in inputs. They are decreasing if the increase in output is less than proportional to the increase in the inputs.

Let us illustrate the case of constant returns to scale with the help of our production function.

Q= (L, M, N, K, 1)

Given T if the quantities of all inputs L, M, N, K are increased n-fold, the output Q also increases H-fold. Then the production function becomes nQ -f (nL, nM, nN, nK).

This is known as linear and homogeneous production function or a homogeneous function of the first degree. If the homogeneous function is of the Kth degree, the production function is nk.Q = f (nL, nM, nN, nK) it is a case of constant returns to scale; if it is greater than 1, it is a case of increasing returns of scale; and if it is less than 1, it is a case of decreasing returns to scale.

Three Stages of Law of Variable Proportion

The law of variable proportion operates in three stages. These three stages are illustrated in Figure The features of each stages are discussed below:
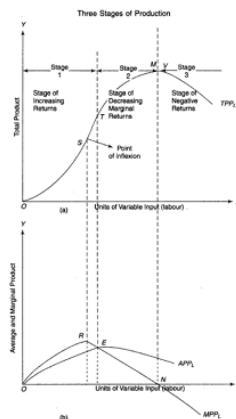
Representation of total, average and marginal production

Stage 1: Stage of Increasing Returns

Initially, as more and more units of variable factor (labour) are employed, fixed capital is utilised better and more efficiently. As a result marginal productivity of additional labour rises. Therefore both MI' and AP increases. AP rises fill its optimum (at point R) where MP and AP are equal. TP increases at an increasing rate. From point S to T, TP continues to rise at a diminishing rate. This stage begins from the point where total physical product is zero and ends at the point where average physical product is maximum.

Stage 2: Stage of Diminishing Returns

After point T, new labour finds the fixed capital inadequate, therefore, TP continues to increase but at a diminishing rate. In this stage both MP and AP are diminishing but they remain positive. At the end of stage, MP of variable factor is zero, that is corresponding to the optimum point of TP curve. This stage is called as the 'stage of diminishing returns' as both AP and MP are falling. It is an ideal

stage for rational producer because he can maximizes the total physical product in it. This stage begins from the point where AP is maximum and ends at the point where TP is maximum.

Stage 3: Stage of Negative Returns

In this stage, TP starts to decline and MP becomes negative. Because labour input become so crowded that there is no work for the new labour and so they disturb the earlier labour from carrying out their work. Point V, where TP is maximum, is known as point of saturation indicating that given amount of fixed inputs, there is no further positive use for more variable input. It indicates that we have entered the region of negative marginal returns. Which stage is an Ideal for a rational producer? All three stages of production are illustrated in Figure. shown by vertical dotted lines.

The first stage of production occurs when the AP is rising. In the second stage of production, both APPS and MPP_L is falling but remains positive. The third stage of production occurs when the MPP_L becomes negative. Stage III is obviously out, because additional labour in this stage actually reduce output, their MPP_L is negative. As a result, a firm will get less revenues and thus profit. Therefore a rational producer will never entertain stage III.

In Practice,Stage first is short. In this stage, marginal physical product of labours (MPPL) is maximum but marginal physical product of capital (MPPK) is actually negative. In stage second, marginal products of both the productive resources are positive. Marginal returns to an input is positive but at the same time,diminishing. In this stage, producer may increase output by using the optimal number of workers and can maximize profit. Thus, stage II, diminishing returns to factor is an ideal stage for a rational producer.

1.4.1 Laws of returns: Law of variable proportion

The production function as determined by technical conditions of production is of two types:

It may be rigid or flexible. The former relates to the short run and the latter to the long run.

Thus a production function is of two types:

(i) Linear homogeneous of the first degree in which the output would change in exactly the same proportion as the change in inputs. Doubling the inputs will exactly double the output and vice versa. Such a production function expresses constant returns to scale.

(ii) Non-homogeneous production function of a degree is greater or less than one. The former relates to increasing returns to scale and latter to decreasing returns to scale.

The Law of Variable Proportions:

If one input is variable and all other inputs are fixed the firm's production function exhibits the law of variable proportions. If the number of units of a variable factor is increased, keeping other

factors constant, how a output changes is a concern of this law. Suppose land, plant and equipment are the fixed factors,and labour the variable factor.

When the number of labourers is increased successively to have larger output, the proportion between fixed and variable factors is altered and the law of variable proportions sets in. The law states that as the quantity of a variable input is increased by equal doses keeping the quantities of other inputs constant, total product will increase, but after a point at a diminishing rate.

This principle can also be defined thus:

When more and more units of the variable factor are used, holding the quantities of fixed factors constant, a point is reached beyond which the marginal product, then the average and finally the total product will diminish. The law of variable proportions is also known as the law of diminishing returns. But, as we shall see below, the law of diminishing returns is only one phase of the more comprehensive law of variable proportions.

Its Assumption:

The law of diminishing returns is based on the following assumptions:

(1) All units of the variable factor are homogeneous.

(2) Only one factor is variable while others are held constant.

(3) It is possible to vary the proportions in which different inputs are combined.

(4) There is no change in technology.

(5) It assumes a short-run situation, for in the long-run all factors are variable.

(6) The product is measured in physical units, i.e., in tonnes, quintals, etc. The use of money in measuring the product may show increasing rather than decreasing returns if the price of the product rises, even though the output might have declined.

Its Explanation:

Given these assumptions, let us illustrate the law with the help of table 1, where on the fixed input land of 4 acres, units of the variable input labour are employed and the resultant output is obtained. The production function is revealed in the first two columns. The average product and marginal product columns are derived from the total product column.

The average product per worker is obtained by dividing column (2) by a corresponding unit in column (1). The marginal product is the addition to total product by employing an extra worker. 3 workers produce 36 units and 4 produce 48 units. Thus the marginal product is 12 i.e., (48-36) units.

Table: Output of Wheat in Physical Units(Quintals)

(1) Number of workers	(2) Total Product	(3) Average Product	(4) Marginal Product	
1	8	8		
2	20	10		
3	36	12		
4	48	12	8	
5	55	11	12	Stage I
6	60	10	16	
7	60	8.6		
8	56	7		
			12	
			7	Stage II
			5	
			0	
			-4	Stage III

An analysis of the Table shows that the total, average and marginal products increase at first, reach a maximum and then start declining. The total product reaches its maximum when 7 units of labour are used and then it declines. The average product continues to rise till the 4th unit while the marginal product reaches its maximum at the 3rd unit of labour, then they also fall. It should be noted that the point of falling output is not the same for total, average and marginal product.

The marginal product starts declining first, average product following it and the total product is the last to fall. This observation points out that the tendency to diminishing returns is ultimately found in the three productivity concepts.

The law of variable proportions is presented diagrammatically in figure (d). The TP curve first rises at an increasing rate up to point A where its slope is the highest. From point A upwards, the total product increases at a diminishing rate till it reaches its highest point C and then it starts falling.
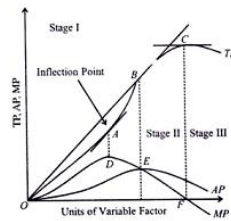
(d)

Point A where the tangent touches the TP curve is called the inflection point up to which the total product increases at an increasing rate and from where it starts increasing at a diminishing rate. The marginal product curve (MP) and the average product curve (AP) also rise with the TP. The MP curve reaches its maximum point D when the slope of the TP curve is the maximum at point A.

The maximum point on the AP curves is E where it coincides with the MP curve. This point also coincides with point B on TP curve from where the total product starts a gradual rise. When the TP curve reaches its maximum point C the MP curve becomes zero at point F. When TP starts declining, the MP curve becomes negative. This is only when the total product is zero that the average product also becomes zero. The rising, falling and the negative phases of the total, marginal and average products are in fact the different stages of the law of variable proportions which are discussed below.

Three Stages of Production:

Stage-I: Increasing Returns

Stage-II: Diminishing Returns

Stage-III: Negative Marginal Returns.

1.4.2 Law of returns to scale

Returns to Scale

Increasing Returns to Scale and the Long-run

In microeconomics, the diminishing returns is a short-run thing. In the long-run, all the inputs may be increased or decreased in proportions. The reduction in the marginal productivity of the labour due to an increase in the labour input can be offset by increasing the tools and equipment, where the workers have to work with. In the long-run, there can be three possible cases which are as follows:

Decreasing returns to scale

If an increase in all the inputs of same proportion K leads to an increase of output in a proportion that is less than K, there are decreasing returns to scale.

For instance, if the inputs to a dairy farm have increased by 50% and the milk output by only 40%, there are decreasing returns to scale in dairy farming. This is also known as the "diseconomies of scale", because the production is less cheap if the scale is larger.

Constant returns to scale

When an increase in all the inputs of the same proportion k leads to an increase in output in the same proportion k, there are constant returns to scale.

For instance, if the number of machinists and machine tools have been increased by 50% each and the number of standard pieces which is produced by 50%, there are constant returns in machinery production.

Increasing returns to scale

When an increase in all the inputs of the same proportion k leads to an increase of output of the proportion greater than k, there are increasing returns to scale.

For instance, if the inputs to a software engineering firm have been increased by 50% and the output by 60%, there are increasing returns to scale in software engineering. It might occur since in the larger workforce, where some of the programmers can concentrate more on particular kinds of programming and get better at them. It is also known as the "economies of scale," since production is cheaper when the scale is larger.

The long-run tendencies are usually discussed in the context of the cost analysis rather than marginal productivity analysis. Also, increasing returns to scale, in particular, which creates some complications for the application of the marginal productivity thinking.

Hence , there may be something to gain by exploring how the increasing returns to scale goes well with marginal productivity. To keep it as simple as possible, we consider a numerical example of the two-person labor market and a fictitious product which is produced with increasing returns to scale. The economists often talks about the production of "widgets". Hence, this fictitious industry is the widget-tying industry.

COST AND REVENUE CONCEPTS, BANKING, INFLATION, NATIONAL INCOME

2

Cost and revenue concepts, Basic understanding of different market structures, Determination of equilibrium price under perfect competition (Simple numerical problems to be solved), Break Even Analysis-linear approach (Simple numerical problems to be solved).

Banking -Commercial bank, Functions of commercial bank, Central bank, Functions of Central Bank.

Inflation-Meaning of inflation, types, causes, measures to control inflation.

National Income-Definition, Concepts of national income, Method of measuring national income.

2.1 Cost and revenue concepts

Understand and Identify various cost concepts that are associated or related to various stages of business operations and market situations.

Types of Cost:

• Average fixed costs (AFC)

• Total fixed costs (TFC)

• Average variable cost (AVC)

• Total variable costs (TVC)

• Average total cost (ATC)

• Total cost (TC)

• Marginal cost (MC)

When cost is expressed in terms of money, it is called as money cost. It relates to the money outlays by a firm on various factor inputs to produce a commodity.

The cost of producing a good or service includes the cost of all the resources used and the cost of not employing those resources in alternative uses.

Opportunity Cost

Since the resources of any firm operating in the market are said to be limited and the investment options are many, the firm has to select only the investment opportunities or options which will provide the firm with the best return or best income on the investment made. It means that if a firm can invest money or resources only in one investment option, then the firm will select the investment option which will promise the best return on investment to the firm.

In the same way, the firm gives up or rejects the next best option for investing the funds. Thus, the opportunity cost of a company is income or return which the firm could have earned on the next best investment alternative.

Example:

Let us assume that an individual has two job offers in hand. One job offer is ensure a salary of Rs. 40,000 per month whereas the other job offer ensures a salary of Rs. 35,000 per month. When the job profile and other factors related to the job offers are more or less same, then it is expected that the individual will select the job offer that will provide him with the highest salary that is salary of Rs. 40,000 per month.

In this case, the opportunity cost is the return involved in the next best alternative that is, Salary of Rs. 35,000 in the next best job offer. This is closely related to the concept of the Economic profit or Economic Rent. The firm earns or makes economic profit besides covering different costs of operation, a firm is also able to earn more than its opportunity cost. This is also termed as Implicit Cost.

The economic profit is earned only when the following statement is true:

Income of a Firm > Various Costs of Operations + Opportunity Cost

or

Economic Profit = Earnings or Revenue of Firm - Economic Costs.

where the economic cost is various expenses of the business plus the opportunity cost.

Explicit Costs vs Implicit Costs

Explicit Costs

They are paid directly in money - money costs. A firm incurs explicit costs if it pays for a factor of production, at the same time, it uses it.

Examples: Any cost that results from using an asset instead of selling, renting or lending it.

This is represented as,

Explicit Cost = The payments by a firm to purchase the service of productive resources (wages, interest, rent, capital)

Explicit Cost is a cost that is diagrammatic by lost chance within the use of a company's own resources, excluding money. The implicit price for a firm are often thought of because the cost associated with enterprise a precise project or call, like the loss of interest financial gain on funds or depreciation of machinery used for a capital project.

Implicit Costs

It is measured in units of money, but are not paid directly in money. The costs of non purchased inputs, to which a cash value should be imputed because the inputs are not purchased in a market transaction. Business firm will incur implicit costs when it uses capital, inventories or owner's resources.

Examples: Wage expense, rent or lease costs and the cost of materials that go into the production of goods.

This is represented as,

Implicit Costs = Opportunity costs associated with a firm's use of resources that it owns

For instance, the time and energy that associate degree owner puts into the upkeep of the corporate, instead of engaged on enlargement, are often viewed as associate degree implicit price of running the business. In finance choices, implicit prices should be thought of once coming back to a call on a way to allot resources.

Economic Cost

The monetary value of all the inputs which are used in a particular activity or enterprise over a given period. It reflects the opportunity cost of resources.

Accounting Costs

It measures the explicit costs of operating a business. That is, the results from the purchase of input services.

Economic Profit

It is the difference between the total revenue and the cost of all inputs used by a firm over a given period. It is the TR - OC.

The OC are the explicit and implicit costs of the best alternative actions.

Out of Pocket Costs vs Imputed Costs

Out of Pocket Costs

The out-of-pocket costs are actual expenses we incur. If we buy land for $100,000 and lose the opportunity to buy discounted machinery we will require to buy later at a price that will be $50,000 higher, our out-of-pocket costs on the land purchase is $100,000.

The out-of-pocket costs do not include any future repairs, improvements, depreciation, lawsuits or other expenses associated with our purchase. If we buy something on credit, the interest on the money we borrowed to create the purchase can be considered an out-of-pocket cost over the life of the loan.

Imputed or Notional cost

CIMA defines notional cost as "the value of benefits where no actual cost is incurred". Hence, imputed cost is the cost which does not involve any cash outlay. Though it is a hypothetical cost, it is relevant for decision making. The interest on capital, the payment for which is not actually made, is an example of imputed cost.

Also, it can be defined as, a cost that is incurred by virtue of using an asset instead of investing it or undertaking an alternative course of action. Thus, it is an invisible cost that is not incurred directly, as opposed to an explicit cost, which is incurred directly.

Absorption costing:

In absorption costing, the full costs are absorbed into production.

Marginal costing:

Marginal costing entails the allocation of only variable costs, i.e., direct labour, direct materials and other direct expenses, and variable overheads to the production. It does not consider the fixed cost of production. This type of costing emphasizes the distinction between the fixed and variable costs.

Historical costing:

Historical costing uses actual costs, which was determined after they have been incurred. Almost all the organizations use the historical costing system of accounting for costs.

Standard costing:

In standard costing, a cost is predicted in advance of production, based on the predetermined standards under a given set of operating conditions. Standard costs are compared with actual costs periodically, and revised to avoid the losses due to outdated costing.

Elements of costs

Cost function

The cost function is a function of input prices and output quantity. Its value is the cost of making that output given those input prices. There are three types of cost functions such as linear, quadratic and cubic.

Cost sheet

Cost sheet is a statement showing the total cost under proper classification in a logical order. It provides cost per unit in different stages and helps in comparison anti-control of cost. It also acts as a basis of fixation of selling price.

Cost of Determinants

The cost of production of goods and services depends on a number of factors; these factors may differ from firm to firm within an industry and from one industry to another. The important cost determinants are as under:

1. Level of Output

The larger the output, the greater will be the production cost. For there will be larger use of various factors of production who shall get larger payments. Thus, total cost varies directly with output.

2. Prices of Input Factors

A rise in factor prices also increases total production cost. The various factors of production viz., land, labour, capital and organization get rent, wages, interest and salary respectively as their reward. Obviously larger payments will have to be made for the factors of production when their prices go up. Thus, the cost of production varies directly with the prices of factors of production.

3. Productivities of Factors of Production

Productivity of a factor of production refers to the output per unit of that factor. The higher the productivity of a factor of production, the lower the cost per unit of the input factor. Thus, an increase in factor productivities would reduce the total production cost for producing a given output.

Productivity and efficiency are synonymous. Factor efficiency can increase in several ways such as increasing the machine spent, raising the number of hours per day and/or month the machine is operated and so on. Given a certain output, an increase in efficiency brings down the total production costs.

4. Size of Plant

Plant size is yet another important cost determinant. Production costs are generally lower in case of bigger plant than in smaller plants. This is because of economies of large scale production. Notably, with a bigger size, although initial fixed costs are high variable cost tend to be low compared with a small with sized plant.

5. Output Stability

Stability of output also leads to savings in various kinds of hidden costs of interruption and learning. Overall costs are generally lower where output is stable and constant over a period of time. Production by sudden breaks and disruption is bound to be costly.

6. Lot size

Lot size also affects production costs. Lot size here means the size of a single production job. In case where the installation costs of machinery are considerable, the economy of large lots is significant. Moreover, if it is possible to process a bigger lot at one time, the total cost of operation and thereby the unit cost will be lower compared with a processes in which only smaller lot sizes are produced.

7. Laws of Returns

In case the law diminishing return is operating, the cost will show a tendency to rise. The reverse will be the case when the law of increasing returns operates.

8. Level of Capacity Utilization

In the short run, level of capacity utilization determines the cost. This especially affects the per unit fixed cost. Thus, with higher capacity utilization, fixed cost per unit of output is bound.

9. Period under Consideration

If one considers the short period, the cost curve will rise steeply. However in case of long period, cost would not increase that steeply.

10. Technology

Technology is an important cost determinant. Technological progress or improvement leads to an increase in the efficiency or productivity of factors of production. This in turn leads to a reduction in the cost of production. In other words, cost varies inversely with technological progress. Also, most technological innovations aim at reducing costs.

A knowledge of the relationship between cost and technological progress is essential to forecast the cost. The change in technology generally changes the equipment, the size of the plant and plant flexibility to output changes.

A forecast of technology is also essential for the purpose of tacking the problem of equipment replacement. Here one has to determine the degree of obsolescence of the old machine to be replaced.

11. Learning Effect

Learning effect means that in many activities cost decline as the activity is repeated an increasing number of times. As workers and management becomes more familiar with production process or a

particular product, there will be cost reductions. If there are substantial learning effects, there will be first most advantages by virtue of being the first to undertake an activity as against late comers.

12. Breadth of Product Range

Costs are determined by the breadth of product range. Such cost advantages cost occur when the processing of different goods can share inputs or where distributed and promotion can take place jointly.

13. Degree of Vertical Integration

Cost advantages can be achieved by increasing the degree of vertical integration with the firm, moving closer to the final customer (forward vertical integration) or to sources of supply (backward vertical integration).

14. Geographical Location

Costs may be affected by geographical location when factor prices, tax regimes and government incentives vary from place to place.

15. Institutional Factors

Institutional factors like unionization, local content/indigenization rules and tariffs also affect costs.

16. Firm's Discretionary Policies

Costs also depend upon a wide range of firm's discretionary policies.

The examples are:

(1) Nature and design of the product being manufactured,

(2) Level of services provided to customers,

(3) Package of human resources policies adopted regarding pay, incentive schemes, employees benefits, training etc.

Revenue concept:

Revenue is another very important concept in economics. In fact the study of cost is not complete, if we do not talk about revenue.

Definition of Revenue

Revenue is defined as the amount a person receives by selling a certain quantity of the commodity.

We know that a commodity can be purchased in the market by paying a certain price. So revenue can be calculated by multiplying price and quantity of the commodity. Hence we can write,

Revenue = Price of the Commodity × Quantity of the Commodity

Total revenue(TR)

During a given period of time, the seller sells certain quantity of the commodity. So the total amount of money received by the seller during that time period is called total revenue. We denote it as TR where TR stands for total revenue. Let us denote price as 'P' and quantity as 'Q' then we can write,

Total Revenue = Price × Quantity or TR = P × Q

Average Revenue (AR)

Average Revenue is denoted as AR. It is calculated from the total revenue. The formula for average revenue is given as,

Average Revenue = Total Revenue/Quantity sold

Symbolically, AR = TR/Q

Take the case of a single commodity, we know that TR = P × Q

So, AR = P × Q/Q = P

Average Revenue and Price of the commodity are one and the same.

Marginal Revenue (MR)

Marginal Revenue (MR) is defined as increase in total revenue due to one unit increase in the sale of the quantity of output.

Refer to the above example. Let the vendor increased the sale to 21 kg. In that case the total revenue or TR becomes 50 × 21= Rs.1050. Earlier when the sale of output was 20 kg, TR = Rs. 1000. Hence the MR = 1050-1000 = Rs. 50.

We can show it in the table below:

Sale of output (kg)	Price or AR (Rs per kg)	TR (Rs.)	MR (Rs.)
20	50	1000	-
21	50	1050	50

Comparing AR and MR

It should be noted that average revenue is calculated for each and every given level of sale of the output while the marginal revenue is calculated for two successive levels of sale of the output.

USE OF REVENUE AND COST

Both the revenue and cost are important concepts in economics. While the cost is the expenditure incurred to produce a good or service during the production process, revenue is the money received by the producer by selling that good or service. So cost symbolizes sacrifice made by the producer and revenue symbolizes gains for the producer.

By getting the required revenue from sale of the commodity the producer is able to recover the cost he has incurred earlier. In that case we say that the producer earned his due share which is called profit. We can define that profit is the surplus of revenue over the total cost of production.

Profit = Total Revenue - Total Cost.

2.1.1 Basic understanding of different market structures

An industry consists of all firms making similar or identical products. An industry's market structure depends on the number of firms in the industry and how they compete. Here are the four basic market structures:

Perfect Competition:

Perfect competition happens when numerous small firms compete against each other. Firms in a competitive industry produce the socially optimal output level at the minimum possible cost per unit.

Perfect competition is a type of market characterized by:

• A very large number of small producers or sellers.

• A standardized, homogeneous product

• The inability of individual sellers to influence price

• The free entry and exit of sellers in the market and- Unnecessary non price actions.
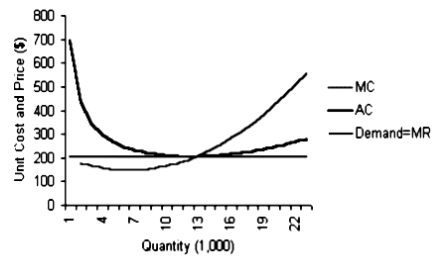
Perfect competition

Monopoly : One firm dominates the market, barriers to entry, possibly super-normal profit. A market structure characterized by a single seller, selling a unique product in the market. In a monopoly market, the seller faces has no competition, as he is the sole seller of goods with no close substitute.

Oligopoly : An industry can be dominated by a few firms, e.g. 5 firm concentration ratio of > 50% . An oligopoly is a market structure in which a few firms dominate. If a market is shared between a few firms, it is said to be highly concentrated. Though only a few firms dominate, it is possible that many small firms may also operate in the market.

Monopolistic Competition : The freedom of entry and exit, but firms have differentiated products. Likelihood of normal profits in the long term.

Contestable Markets : The industry with freedom of entry and exit, low sunk costs. The theory of contest ability suggests the number of firms is not so important, but the threat of competition.

One of the important determinants of how a societies resources are used and how its market are organized.

Competition:

An environment in which economic activities like production and distribution are carried out.

Classification of market structures:

Market is classified purely based on the nature of competition.

1. Perfect competition Ex. Agricultural commodities, Stocks and share market.

2. Monopolistic competition Ex. Retail Trade, Restaurants.

3. Oligopoly: Auto, Steel, Machinery.

4. Monopoly: Ex. Public Utilities.

1. Perfect Competition :

a. Homogeneity of products.

b. Many buyers and sellers.

c. Mobility of resources.

d. Freedom of entry and exit.

e. Perfect market.

2. Monopoly

Causes of monopoly:

1. Patents Ex. Microsoft corp. with its Ms.dos

2. Control of input: Ex. International, Nickel Company of Canada controls about 9/10th

of the proven nickel resource in the world.

3. Amount of capital: Manufacture of steel, telecommunication, bankwith expansion requires large amount of capital.

4. Government actions: Ex. Railway, Costal, BSNL, Postal,Electricity.

5. Smallness: Sometimes small neglected and insulated markets may also give raise to monopoly

3. Monopolistic Competition:

Conditions of competitions:

1. Product differentiation.

2. Large no. Of firms in the market.

3. Freedom of entry and exit.

4. Existence of selling cost.

5. Firms produce similar products. Ex. Tooth paste etc.

4. Oligopoly:

Features:

1. Dominated by few firms.

2. Interdependencies among the firms.

3. Price rigidity.

4. Economies of scale.

5. Entry of some industries may be blocked due to large financial investment.

6. As products are differentiated, firms in oligopoly enjoy some monopoly problems.

7. Advertisement and variation design and quality are simultaneously used to increase market share.

8. Possibility of price-rigging (Same price).

9. Demand curve depend on what other firms are doing.

2.1.2 Determination of equilibrium price under perfect competition(Simple numerical problems to be solved)

The equilibrium price of a commodity is the price that equates quantity demand to quantity supplied, that is, at a given price the same quantity is bought and sold. This is called the equilibrium quantity. DD and SS are demand and supply curve respectively. They meet at E, equilibrium point. So, OP and OQ are equilibrium price and equilibrium quantity respectively. This is shown in figure (a).
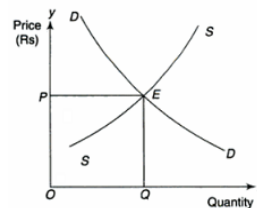
(a) Equilibrium Price and Quantity under Perfect competition

Determination of Equilibrium Price and Quantity under Perfect Competition

Under perfect competition, a single firm is unable to influence the market price and takes the market price as given. The price of the product is determined by intersection of the demand of all buyers of that product taken together and the supply of all firms selling that product taken together.

Alfered Marshal linked the price determination like that of a pair of scissors in cutting cloth. Neither the upper blade of scissors nor the lower one taken separately can do the work of cutting. Both are indispensable for the process of cutting. Hence, both the supply and demand are needed for price determination.

Equilibrium price or Market clearing price is a price at which quantity demanded is exactly equal to quantity supplied. It is the price at which there is no tendency for change. It is the situation in which the plans of buyers and the plans of sellers exactly match with each other. In any market, for a given supply curve and a given demand curve, the intersection gives an equilibrium price. Equilibrium quantity is the quantity at which quantity demanded is exactly equal to quantity supplied.

Let the demand and supply schedules of a good (pen per month) be as shown in table, of the ten possible prices given in table. Price of Rs 6 per pen would be the equilibrium price or market clearing price.

Table: Demand-Supply Schedule

Price (Rs per unit)	Quantity Demanded (units per month)	Quantity Supplied (units per months)	Excess Demand (units per months)	Excess Supplied (units per months)	Condition
(1)	(2)	(3)	(4)	(5)	(6)
10	4,500	8,500		4,000	
9	5,000	8,000		3,000	Surplus
8	5,500	7,500		2,000	
7	6,000	7,000		1,000	
6	6,500	6,500	0	0	No Surplus No shortage (Market clearing Price-Equilibrium)
5	7,000	6,000	1,000		
4	7,500	5,500	2,000		Shortage
3	8,000	5,000	3,000		
2	8,500	4,500	4,000		

1	9,000	4,000	5,000		

When Market Price is more than the Equilibrium Price

If the market price is Rs 10 per pen, the quantity supplied will exceed the quantity demanded and the result will be an excess quantity supplied or surplus. It will create competition among the seller and the market forces push the price towards Rs 6 per pen. This price will keep falling as long as there is an excess supply and it will finally settled at its 6 per pen at which there is no excess supply.

(b) Excess Supplied at a given price

When Market Price is less than the Equilibrium Price

Similarly, for some reason, if the market price is Rs 2 per pen. At this price, the quantity demanded exceeds the quantity supplied and the result will be an excess quantity demanded or shortage. It will create a competition among the buyers of that good and given demand and supply, forces prices to rise again towards Rs 6 per pen and it will again finally settle at Rs 6 per pen at which there is no excess demand.

At price of Rs 6, demand equals supply and so both sellers and buyer of the good, are satisfied. There is neither an excess quantity demanded (shortage) nor an excess quantity supplied (surplus). Shown in figure (c).

Therefore, market equilibrium is a situation of zero excess supply and zero excess demand. This price clears the market of all excess supply or excess demand, so it is called 'market clear price.' In figure (d), equilibrium price or market clearing price is shown at the point E.

Table: Behaviour of Seller and Buyer, when Price changes

Market situation	Price movement	Behaviour of	
		Sellers	Buyers
1. Excess Supply (Surplus)	Price falls	Willing to supply less than before.	Demand more than before.

2. Equilibrium(Zero, Excess Supply, Zero Excess Demand)	Price remains unchanged	No change in quantity supplied	No change in quantity demanded
3. Excess Demand (Shortage)	Price rises	Willing to supply more	Demand less than before
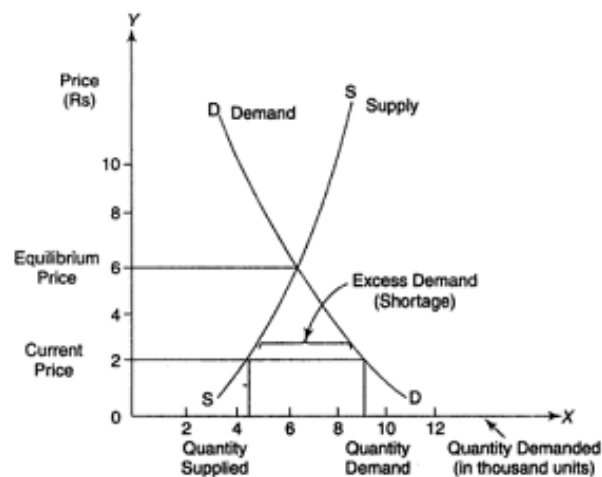
(c) Excess demand at a given price
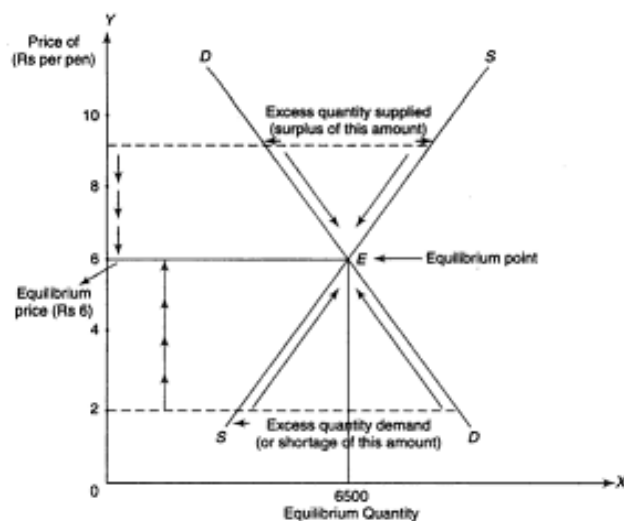
(d) Quality demanded and quantity supplied of Pen(per month)

Important Points about Market Equilibrium under Perfect Competition:

i. Each firm is a price-taker and industry is the price-maker.

ii. Each firm earns only normal profits in the long rim.

iii. Decisions of consumers and producers in the market are coordinated through free flow of prices known as price mechanism.

iv. It is assumed that both law of demand and law of supply operate.

v. Equilibrium Price is the price at which quantity demanded of a commodity is equal to the quantity supplied.

vi. At equilibrium price, there is neither shortage nor excess of demand and supply.

vii. Equilibrium Quantity is the quantity demanded and supplied at the equilibrium price.

2.2 Break-even analysis-Linear approach. (Simple numerical problems to be solved)

An analysis to determine the point at which the revenue received equals the costs associated with receiving the revenue. Break-even analysis calculates what is known as a margin of safety, the amount that revenues exceed the break-even point. This is the amount that revenues can fall while still staying above the break-even point.

Assumptions of Break-Even analysis

• All costs are categorized as either fixed or variable. If not impossible or impractical, by dividing the costs into variable and fixed cost elements is an extremely hard job. This is attributable to inherent nature or characteristic of cost perse.

• Fixed costs remain constant within relevant range. Fixed costs remains unchanged at any level of activity within relevant range, even at zero level.

• The behavior of the total revenues and total costs would be linear over relevant range, i.e. appears as a straight line on BE chart. This is based on idea that variable costs vary in proportion to the volume, fixed costs remains unchanged, thus drawn as a straight horizontal line on graph within the relevant range and that selling price is constant.

• In case of multiple product companies, selling prices, costs and proportion of units sold will never change. This cannot be correct always. Sales mix ratio can be due to the change in the consuming habits of customers. Selling prices of the individual products can likewise change due to the competition, popularity and salability of products, etc.

• There is no significant change in inventory levels during period under the review. Stated in another way, production volume is assumed to be almost equal to sales volume, that causes an immaterial difference between beginning and the ending inventories.

Terminology in Break-Even Analysis:

Fixed cost (FC): It does not change with production volume or output. For example: Cost of land and buildings, salaries of top management, insurance, depreciation, taxes on property, equipment, etc.

Variable cost (VC):

It changes depending on the output volume. For example: cost of raw materials, labour, transportation charges, packaging cost, etc.

If s is the selling price per unit, v is the variable cost per unit, FC is the fixed cost per period, Q is the volume of production, then,

Total Sales Revenue (sales) of the firm, S = s.Q in Rupees.
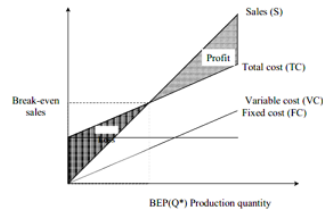
Break -even chart

Total cost (TC): It is the sum of Fixed cost (FC) and variable cost (VC).

TC = Total variable cost + Fixed cost = v.Q + FC

Profit = Total Sales Revenue – Total Cost = Total Sales Revenue – (Fixed cost + Variable cost)

i.e. Profit = s.Q – (FC + v.Q)

Break-even Quantity, $Q_{B.E.P}$ = Fixed cost/ (selling price per unit – Variable cost per unit)

$Q_{B.E.P}$ (in units) = FC/s-v

Break-even sales revenue = [Fixed cost/(selling price/unit – Variable cost/unit)].(Selling price/unit)

$S_{B.E.P}$ (in Rs) = [FC/s-v].s

For any production quantity which is more than the break-even quantity the total revenue will be more than the total cost. Hence, the firm will be making profit.

Profit = Sales – (Fixed cost + Variable costs)

Profit = sQ – (FC + v Q)

The formulas to find the break-even quantity and break-even sales quantity.

$$\text{Break-even quantity} = \frac{\text{Fixed cost}}{\text{Price/Unit - Variable cost/Unit}} \times \text{Selling}$$

$$= \frac{\text{FC}}{\text{s - v}} \quad \text{(in units)}$$

$$\text{Break-even sales} = \frac{\text{Fixed cost}}{\text{Selling price/Unit - Variable cost/Unit}} \times \text{Selling price/Unit}$$

$$= \frac{FC}{s - v} \times s \quad (Rs)$$

The contribution is the difference between the sales and the variable costs. The margin of safety (M.S.) is the sales over and above the break-even sales. The formular to compute these values are,

Contribution = Sales – Variable costs

Contribution/unit = Selling price/unit – Variable cost/unit

M.S. = Actual sales – Break-even sales

$$= \frac{Profit}{Contribution} \times Sales$$

M.S. as a percent of sales = (M.S./Sales) 100

The Break-Even Chart

Break-even chart is a graphical representation of costs at various levels of activity shown on the same chart as the variation of income (or sales, revenue) with the same variation in activity. The point at which neither profit nor loss is made is known as the "break-even point", and is represented on the chart below by the intersection of the two lines.
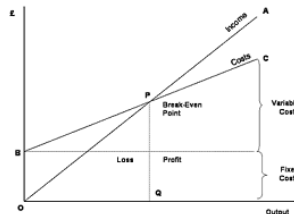
In the above diagram, the line OA represents the variation of income at varying levels of production activity ("output"). OB represents the total fixed costs in the business. As output increases, variable costs are incurred, meaning that total costs (fixed + variable) also increase.

At low levels of output, costs are greater than the income. At the point of intersection, P, costs are exactly equal to income, and hence neither profit nor loss is made.

Managerial Uses of Break-Even Analysis:

To the management, the utility of break-even analysis lies in the fact that it presents a microscopic picture of the profit structure of a business enterprise. The break-even analysis not only highlights the area of economic strength and weakness in the firm, but also sharpens the focus on certain leverages which can be operated upon to enhance its profitability. It guides the management to

take effective decision in the context of changes in the government policies of taxation and subsidies.

The break-even analysis can be used for the following purposes:

(i) Safety Margin:

The break-even chart helps the management to know the profits generated at the various levels of sales at a glance. The safety margin refers to the extent to which the firm can afford a decline before it starts incurring losses. The formula to determine the sales safety margin is expressed as,

Safety Margin = (Sales – BEP)/ Sales x 100

Example:

At the level of 250units of output and sales, the firm is earning profit, the safety margin can be found out by applying the formula,

Safety Margin = 250- 150 / 250 x 100 = 40%

This means that the firm which is now selling 250 units of the product can afford to decline sales upto 40%. The margin of safety may be negative as well, if the firm is incurring any loss. In that case, the percentage tells the extent of sales that should be increased, to reach the point where there will be no loss.

(ii) Target Profit:

The break-even analysis can be utilised for the purpose of calculating the volume of sales necessary to achieve a target profit. When a firm has some target profit, this analysis will help in finding out the extent of increase in sales by using the following formula,

Target Sales Volume = Fixed Cost + Target Profit / Contribution Margin per unit

(iii) Change In Price:

The management is often faced with a problem of whether to reduce prices or not. Before taking a decision on this question, the management will have to consider a profit. The reduction in price leads to a reduction in the contribution margin. This means that the volume of sales will have to be increased even to maintain the previous level of profit. Higher the reduction in the contribution margin, higher is the increase in sales needed to ensure the previous profit.

 Problems

1. Let the Alpha Associates has the following details:

Fixed cost = Rs. 20,00,000

Variable cost per unit = Rs. 100

Selling price per unit = Rs. 200. Let us determine

(a) The break-even sales quantity,

(b) The break-even sales

(c) If the actual production quantity is 60,000, also determine,

(i) Contribution

(ii) Margin of safety by all methods.

Solution:

Given:

Fixed cost = Rs. 20,00,000

Variable cost per unit = Rs. 100

Selling price per unit = Rs. 200

To find

(a) The break-even sales quantity,

(b) The break-even sales

(c) If the actual production quantity is 60,000, also determine (i) Contribution

(ii) Margin of safety by all methods.

$$= \frac{FC}{s - v}$$

(a) The break-even sales quantity,

$$= \frac{20,00,000}{200 - 100}$$

= 20,00,000/100 = 20,000 units.

b) Break Even Sales

$$= \frac{FC}{s-v} \times s$$

$$= \frac{20,00,000}{200-100} \times 200$$

$$= \frac{20,00,000}{100} \times 200$$

= Rs.40,00,000

(c) If the actual production quantity is 60,000, also determine

(i) Contribution = Sales - Variable cost

= s x Q– v x Q

= 200 x 60,000 – 100 x 60,000

= 1,20,00,000 – 60,00,000

= Rs. 60,00,000

(ii) Margin of safety

Method-1

M.S. = Sales – Break-even sales

= 60,000 x 200 – 40,00,000

= 1,20,00,000 – 40,00,000 = Rs. 80,00,000

Method II

$$M.S. = \frac{Profit}{Contribution} \times Sales$$

Profit = Sales – (FC+ v x Q)

= 60,000 x 20 – (20,00,000 + 100 x 60,000)

= 1,20,00,000 – 80,00,000

= Rs. 40,00,000

$$\text{M.S.} = \frac{40,00,000}{60,00,000} \times 1,20,00,000$$

$$\text{M.S. as a per cent of sales} = \frac{80,00,000}{1,20,00,000} \times 100$$

= 67%

2. Let us consider the following data of a company for the year 1997:

Sales = Rs. 1,20,000

Fixed cost = Rs. 25,000

Variable cost = Rs. 45,000. Let us determine the following:

(a) Contribution

(b) Profit

(c) BEP

(d) M.S.

Solution:

Given:

Sales = Rs. 1,20,000

Fixed cost = Rs. 25,000

Variable cost = Rs. 45,000

To find:

(a) Contribution

(b) Profit

(c) BEP

(d) M.S.

(a) Contribution = Sales – Variable costs

= Rs. 1,20,000 – Rs. 45,000

= Rs. 75,000

(b) Profit = Contribution – Fixed cost

= Rs. 75,000 – Rs. 25,000

= Rs. 50,000

c) Break even point

$$P/V \text{ ratio} = \frac{\text{Contribution}}{\text{Sales}}$$

$$= \frac{75{,}000}{1{,}20{,}000} \times 100$$

= 62.50%

$$BEP = \frac{\text{Fixed cost}}{P/V \text{ ratio}} = \frac{25{,}000}{62.50} \times 100 = \text{Rs. } 40{,}000$$

$$M.S. = \frac{\text{Profit}}{P/V \text{ ratio}} = \frac{50{,}000}{62.50} \times 100 = \text{Rs. } 80{,}000$$

1. A company manufactures and sells a telephone answering machine. The company's contribution format income statement for the most recent year is given below: all value dollar rate

	Total	Per unit	Present of sale
Sales	1,200,000	60	100%
Less variable expenses	900000	45	%
	-	-	-
Contribution margin	300000	15	%
Less fixed expenses	240000	-	-

	-		
Net operation income	60000		
	-		

Calculate break even point both in units and sales dollars. Use the equation method

Solution:

Sales = Variable expenses + Fixed expenses +Profit

$60Q = $45Q + $240,000 + $0

$15Q = $240,000

Q = $240,000 / 15 per unit

Q = 16,000 units; or at $60 per unit, $960,000

Alternative solution:

X = 0.75X + 240,000 + $0

0.25X = $240,000

X = $240,000 / 0.25

X = $960,000; or at $60 per unit, 16,000 units

2. A concrete mixer has the following cash flow details;

Initial purchase price = Rs.750000,

Annual operating and maintenance cost = Rs.45000

Salvage value = Rs.210000,

Useful life = 10 years

In addition one operator is required to operate the concrete mixer at cost of Rs.30 per hour. The production (preparation) rate of concrete of the mixer is 0.1 m^3 per hour. The revenue to be generated from production of 1 m^3 of concrete is Rs.1000. The interest rate is 11% per year. How

many 'm³¹ of concrete need to be produced per year so that the revenue generated break evens with the expenditure?

Solution:

In order to find out the break-even value of the concrete volume (in 'm³') per year, the equivalent uniform annual worth of expenditure will be equated to that of revenue.

Let 'x' m³ is the volume of concrete produced by the concrete mixer per year.

The operator cost is Rs.30 per hour.

$$\frac{Rs.30}{1\,hour} \times \frac{1\,hour}{0.1\,m^3} \times \frac{x\,m^3}{year} = Rs.300x$$

The operator cost (Rs.) per year is given by;

Now the equivalent uniform annual worth (Rs.) of expenditure is given by;

$$AW_e = 750000(A/P,i,n) + 45000 + 300x$$

$$AW_e = 750000(A/P,11\%,10) + 45000 + 300x$$

$$AW_e = 750000 \times 0.1698 + 45000 + 300x = 172350 + 300x$$

The equivalent uniform annual worth (Rs.) of revenue is calculated as follows;

$$AW_r = 210000(A/F,i,n) + 1000x$$

$$AW_r = 210000(A/F,11\%,10) + 1000x$$

$$AW_r = 210000 \times 0.0598 + 1000x = 12558 + 1000x$$

Now equating equivalent uniform annual worth of expenditure with that of revenue;

$$AW_e = AW_r$$

$$172350 + 300x = 12558 + 1000x$$

$$x = 228.274\,m^3$$

Thus the volume of concrete to be produced by the concrete mixer per year i.e. the break-even quantity at which the expenditure incurred is equal to the revenue generated is 228.274 m³. If the volume of concrete produced per year is different from the break-even value, then there will change in the net cash flow as shown below;

If x is equal to 200 m³ (i.e. less than break-even value), the equivalent uniform annual worth of expenditure and revenue are given by;

Expenditure

$$AW_e = 750000(A/P, 11\%, 10) + 45000 + 300x$$

$$AW_e = 750000 \times 0.1698 + 45000 + 300 \times 200 = Rs.232350$$

Revenue

$$AW_r = 210000(A/F, 11\%, 10) + 1000x$$

$$AW_r = 210000 \times 0.0598 + 1000 \times 200 = Rs.212558$$

$$AW_e > AW_r$$

If x is equal to 250 m³ (i.e. greater than break-even value), the equivalent uniform annual worth of expenditure and revenue are given by;

Expenditure

$$AW_e = 750000(A/P, 11\%, 10) + 45000 + 300x$$

$$AW_e = 750000 \times 0.1698 + 45000 + 300 \times 250 = Rs.247350$$

Revenue

$$AW_r = 210000(A/F, 11\%, 10) + 1000x$$

$$AW_r = 210000 \times 0.0598 + 1000 \times 250 = Rs.262558$$

$$AW_r > AW_e$$

Thus from above calculations it is observed that, equivalent annual worth of revenue is less than that of expenditure, when the volume of concrete produced per year is less than the break-even value and on the other hand, equivalent annual worth of revenue is more than that of expenditure, when the volume of concrete produced per year is greater than the break-even value.
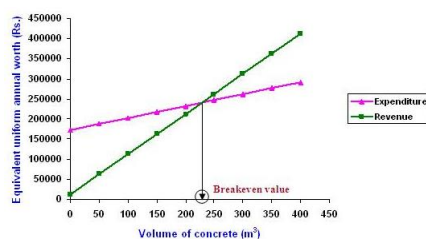
The break-even point is also graphically

The equivalent uniform annual worth of expenditure and revenue are calculated at different values of volume of concrete produced per year using the respective expressions as mentioned earlier and are shown in the above figure.

The break-even point can also be calculated by equating the equivalent present worth of expenditures to that of revenues as shown below.

Present worth of expenditure:

$$PW_e = 750000 + 45000(P/A, i, n) + 300x(P/A, i, n)$$
$$PW_e = 750000 + 45000(P/A, 11\%, 10) + 300x(P/A, 11\%, 10)$$
$$PW_e = 750000 + 45000 \times 5.8892 + 5.8892 \times 300x = 1015014 + 1766.76x$$

Present worth of revenue:

$$PW_r = 210000(P/F, i, n) + 1000x(P/A, i, n)$$
$$PW_r = 210000(P/F, 11\%, 10) + 1000x(P/A, 11\%, 10)$$
$$PW_r = 210000 \times 0.3522 + 5.8892 \times 1000x = 73962 + 5889.2x$$

Now equating equivalent present worth of expenditure with that of revenue;

$$PW_e = PW_r$$
$$1015014 + 1766.76x = 73962 + 5889.2x$$
$$x = 228.275 m^3$$

Thus the break-even value of volume of concrete to be produced by the concrete mixer per year is 228.275 m^3 which is same as the value obtained by annual worth method stated earlier.

2.3 Banking -Commercial bank, Functions of commercial bank, Central bank, Functions of Central Bank

Banking implies accepting the deposits of money from the public for the purpose of lending or investment, which is repayable on demand and can be withdrawn by means of cheques, draft order etc.

Central Bank

A central bank is an apex institution of a country that controls and regulates the monetary and financial system of the country.

Commercial Bank

A commercial bank is a financial institution engaged in the business of accepting the deposits and making loans to the people.

Actually,commercial banks, are profit-seeking institutions, i.e., they do banking business to earn more profit.

They basically finance trade and commerce with short-term loans. They charge high rate of interest from borrowers but pay much less rate of Interest to their depositors with the result that difference between the two rates of interest becomes the main source of profit for the banks. Most Indian joint stock Banks are Commercial Banks like Punjab National Bank, Allahabad Bank, Canara Bank, Andhra Bank, Bank of Baroda, etc.

Functions of Commercial Banks

Primary Functions

1. Accepting Deposits
2. Making Advances
3. Credit Creation

Secondary Functions

1. Clearance of Cheque
2. Sale / Purchase of Shares / Bonds
3. Transfer of Money
4. To work as Trusty
5. To work as a representative
6. To give / accept money
7. To provide letter of credit
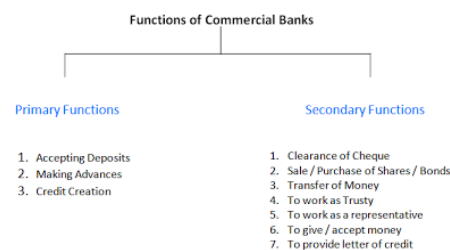
(1) Primary Function:

1. Accepting Deposits:

It is the most important function of the commercial banks. They accept deposits in several forms according to the requirements of different sections of the society. The main kinds of deposits are:

(i) Fixed Deposits or Time Deposits

Fixed deposits refer to those deposits, in which the amount is deposited with the bank for a fixed period of time.

1. These deposits carry a high rate of interest.

2. Such deposits do not enjoy cheque-able facility.

(ii) Current Account Deposits or Demand Deposits:

These deposits refer to those deposits which are repayable by the banks on demand:

1. They can be drawn upon by a cheque without any restriction.

2. Such deposits are generally maintained by businessmen with the intention of making transactions with such deposits.

3. Banks do not pay any interest on these accounts. Rather, banks impose service charges for running these accounts.

(iii) Saving Deposits

These deposits combine the features of both the current account deposits and fixed deposits.

1. The depositors are given cheque facility to withdraw money from their account. But, some restrictions are imposed on the number and amount of withdrawals, to discourage frequent use of saving deposits.

2. They carry a rate of interest which is less than the interest rate on fixed deposits. It must be noted that current account deposits and saving deposits are chequeable deposits, whereas, fixed deposit is a non-chequeable deposit.

2. Advancing of Loans

The deposits received by banks are not allowed to remain idle. So, after keeping certain cash reserves, the balance is given to needy borrowers and interest is charged from them, which is the main source of income for these banks.

Different types of loans and advances made by Commercial banks are as follows:

(i) Short-term Loans

They are given as personal loans against some collateral security. The money is credited to the account of borrower and the borrower can withdraw money from his account and interest is payable on the entire sum of loan granted.

(ii) Demand Loans

Demand loans refer to those loans which can be recalled on demand by the bank at any time. The entire sum of demand loan is credited to the account and interest is payable on the entire sum.

(iii) Cash Credit

Cash credit refers to a loan given to the borrower against his current assets like stocks, shares, bonds, etc. The credit limit is sanctioned and the amount is credited in his account. The borrower may withdraw any amount within his credit limit and interest is charged on the amount actually withdrawn.

(2) Secondary Functions

(i) Overdraft Facility

It refers to a facility in which a customer is allowed to overdraw his current account upto an agreed limit. This facility is generally given to the respectable and reliable customers for a short period. Customers have to pay interest to the bank on the amount overdrawn by them.

(ii) Discounting Bills of Exchange

It refers to a facility in which the holder of a bill of exchange can get the bill discounted with the bank before the maturity. After deducting the commission, bank pays the balance to the holder. On maturity, bank gets its payment from the party which had accepted the bill.

(3) Agency Functions

Commercial banks also perform certain agency functions for their customers. For these services, banks charge some commission from their clients. Some of the agency functions are as follows:

(i) Collection and Payment of Various Items

Commercial banks collect bills, cheques, dividends, interest, rents, subscriptions, and other periodical receipts on behalf of their customers and also make payments of taxes, insurance premium, etc. on standing instructions of their clients.

(ii) Transfer of Funds

Banks provide the facility of economical and easy remittance of funds from place-to-place with the help of instruments like demand drafts, mail transfers, etc.

(iii) Purchase and Sale of Securities

Commercial banks buy and sell stocks and shares of the private companies as well as government securities on behalf of their customers.

(iv) Purchase and Sale of Foreign Exchange

Some commercial banks are authorized by the central bank to deal in foreign exchange. They buy and sell foreign exchange on behalf of their customers and help in promoting the international trade.

(v) Trustee and Executor

Commercial banks preserve the wills of their customers as trustees and execute them after their death as executors.

(vi) Income Tax Consultancy

They also give advice to their customers on matters relating to income tax and even prepare their income tax returns.

(vii) Letters of Reference

They give information about the economic position of their customers to traders and provide the similar information about other traders to their customers.

(4) General Utility Functions

Commercial banks render some general utility services like:

(i) Traveller's Cheques

Commercial banks issue traveler's cheques to their customers to avoid risk of taking cash during their journey.

(ii) Locker Facility

Commercial banks provide facility of safety lockers to keep the valuable articles of customers in safe custody.

(iii) Underwriting Securities

Commercial banks also undertake the task of underwriting securities. As public has full faith in the creditworthiness of banks, public do not hesitate in buying the securities underwritten by banks.

(iv) Letter of Credit

They also issue letters of credit to their customers to certify their creditworthiness.

(v) Collection of Statistics

Banks collect and publish the statistics relating to trade, commerce and industry. Hence, they advice customers on financial matters. Commercial banks receive deposits from the public and use these deposits to give loans. However, loans offered are many times more than the deposits received by the banks. This function of bank is known as 'Money Creation'.

Central Bank/Reserve Bank of India (RBI)

In every country, there is a central bank whose main function is to supervise the working of the commercial banks and protect the interests of depositors. It helps the commercial banks when they are in difficulties and prevent them from failing.

The RBI has the right to issue all the currency notes in the country. No other bank has this right. The central bank (RBI) is also the banker to the government and as such, it keeps the cash balances of the government. It also advises the government on all money and banking matters. It is also the banker to all other banks in the country.

The Reserve Bank of India is the central bank in India. It was started as a private bank owned by the share holders. But, the government of India took it over in 1949. It is called the Reserve Bank of India because, it keeps the cash reserves at all the commercial banks in India.

Function of RBI

Major functions of RBI are as follows:

1. Banker to Government

As banker to the government, the Reserve Bank manages the banking needs of the government. It has to maintain and operate the government's deposit accounts. It collects the receipts of funds and makes payments on behalf of the government. It represents the Government of India as the member of the IMF and the World Bank.

2. Issue of Bank Notes:

The Reserve Bank of India has the sole right to issue currency notes except one rupee notes which are issued by the Ministry of Finance. Currency notes issued by the Reserve Bank are declared as unlimited legal tender throughout the country. This concentration of notes issue function with the Reserve Bank has a number of advantages such as:

(i) It makes possible effective state supervision.

(ii) It brings uniformity in notes issue.

(iii) It keeps faith of the public in the paper currency.

(iv) It is easier to control and regulate the credit in accordance with the requirements in the economy.

3. Custodian of Country's Foreign Currency Reserves

The Reserve Bank has the custody of the country's reserves of international currency, and this enables the Reserve Bank to deal with crisis connected with adverse balance of payments position.

4. Custodian of Cash Reserves of Commercial Banks

The commercial banks hold deposits in the Reserve Bank and the latter has the custody of the cash reserves of the commercial banks.

5. Central Clearance and Accounts Settlement

Since commercial banks have their surplus cash reserves deposited in the Reserve Bank, it is easier to deal with each other and settle the claim of each on the other through book keeping entries in the books of the Reserve Bank. The clearing of accounts has now become an essential function of the Reserve Bank.

6. Lender of Last Resort

The commercial banks approach the Reserve Bank in times of emergency to tide over financial difficulties, and the Reserve bank comes to their rescue though it might charge a higher rate of interest.

7. Controller of Credit

Since credit money forms the most important part of supply of money, and since the supply of money has important implications for economic stability, the importance of control of credit becomes obvious. Credit is controlled by the Reserve Bank in accordance with the economic priorities of the government.

2.4 Inflation-Meaning of inflation

Inflation is the rate of increase in prices of goods per period. So, it has a compounding effect. Hence, the prices that are inflated at a rate of 7% per year will increase 7% in the first year and for the next year, the expected increase will be 7% of these new prices.

If economic decisions are taken without considering the effect of inflation into account, most of them would become meaningless and thus, the organizations would end up with unpredictable return.

Inflation and Capital Budgeting

1. Inflation has ramifications for the realized value of a capital project.

2. When evaluating capital projects, companies can evaluate capital projects in nominal or real terms.

3. Real cash flows are based on purchasing power at the time the decision to invest would be made.

4. Under a real cash flow approach, the discount rate would remove the expected inflation rate, as the cash flows will already reflect the effects of inflation.

5. Commonly, capital projects are analyzed in nominal terms, so the discount rate applied is inclusive of expected inflation, however actual inflation may vary from expectations and inflation may impact the different project variables in different ways.

There are several aspects of inflation that an analyst must consider when evaluating a capital project:

Inflation and Depreciation Tax Shied: If inflation is higher than expected at the time of the investment decision, then the value of the depreciation tax shield is lowered and true net present value of the project is lowered.

Inflation and Debt Payments: The discount rate may be based on a company's cost of debt, if debt is used to finance the capital project. When inflation is lower than expected, this increases the firm's debt costs and lowers the net present value of the project.

Inflation, Revenues and Expenses: The revenues and expenses associated with a capital project will not be equally affected by inflation. When a firm is not able to pass the costs of inflation to product inputs on to customers in the form of higher prices, the net present value of the project will be lower.

Procedure to adjust inflation

A procedure to deal with this situation is as follows:

1. Estimate all the costs/returns associated with the investment proposal in terms of today's rupees.

2. Modify the costs/returns estimated in step-1 using the assumed inflation rate so that at each future date, they represent the costs/returns at that date in terms of the rupees that must be expended/received at that time, respectively.

3. As per our requirement, calculate either the annual equivalent amount or the future amount or present amount of the cashflow resulting from step-2 by considering the time value of the money.

Meaning of Inflation:

Inflation means, a rise in general level of prices of goods and services in an economy over a period of time.In other words, prices of many goods and services such as housing, apparel, food, transportation, and fuel increase.. Inflation cannot be measured by an increase in the cost of one product or service, or even several products or services.Inflation is a general increase in the overall price level of the goods and services in the economy.

To say in a single line Inflation is an upward movement in the average level of prices in the economy.

2.4.1 Types, causes, measures to control inflation

Inflation can be classified into two types as :

1) Demand pull Inflation :

When prices increase as result of excessive demand over supply for the economy as a whole then it is called as a Demand pull Inflation. Imbalance between the aggregate supply and demand is the main cause behind this scenario. It occurs when pressure of demand is such that it cannot be met by the currently available supply of output. Thus , we can say that it is case of full utilization of critical factors of production which can't be substituted by any other inputs.

Main causes for demand pull inflation :

1. Improper fiscal policy

2. Improper monetary policy

3. Economy growth > Normal long run growth rate.

2) Cost Push inflation :

Cost push inflation occurs when we experience rising prices due to higher costs of production. Cost of production may increase due to an increase in factors of production like Raw materials , Wages , and any other overheads. Shortage of supply of labor, raw materials and capital drives up prices.Cost-push inflation occurs if demand for the products or services is inelastic.The increased price of the factors of production causes to a decreased supply of these goods/services. But the demand remains constant, the prices of commodities increase causing a rise in the overall price level.

Main causes for cost push inflation

1. Extreme monopolistic conditions.

2. Natural disasters

3. Government regulation and Improper taxation policy.

4. Increase in wage rates.

5. Increase in the cost of raw materials imparted from foreign due to various reasons.

Measures to control Inflation :

A) Monetary Measures:

The most important and commonly used method to control inflation is monetary policy of the Reserve Bank Of India.

1. Increase or decrease in Reserve Ratios :

It Involves increase or decrease in reserve ratios by the Reserve bank of India to reduce the credit creation capacity of commercial banks , so that the flow of money in the economy will be controlled.

2. Open Market Operations of RBI :

In this RBI issues some securities and bonds to commercial banks from which in turn it gets the money which controls the flow of money in the economy.

3. RBI Makes the borrowing of money costlier:

Here Reserve bank of India increases the interest rate on loans and advances to be sanctioned by commercial banks. This makes the borrowing of money expensive for general public.

B) Fiscal Measures :

Fiscal measures to control inflation include taxation policy, government expenditure and public borrowings etc.,

Causes of inflation

1. Unfavourable agricultural production: Indian agriculture is largely dependent on monsoon. In case of drought or famine the agricultural production is adversely affected. Due to this, price of agricultural as well as agro-based industrial products increases.

2. Hoarding: Most of the wholesalers and businessmen practices hoarding of commodities which leads to inflation.

3. Deficit financing: If the government resorts to deficit financing in order to meet its developmental expenditure, then it makes available funds for the growth of economy. But huge deficit financing leads to inflation.

4. Population and black money: Rapid growth of population causes inflation. Tax is the most significant and major source of public revenue. But, most of the people practices tax evasion. It turns into black money which is responsible for inflation.

5. Upward revision of administered prices: Commodities produced in the public sector have government administration of price level. The government keeps on raising prices in order to compensate the losses. This leads to inflation.

Problems

1. Suppose a 40-year old man is planning for his retirement. He plans to retire at the age of 60 and estimates that he can live comfortably on Rs. 24,000 per year in terms of today's rupee value. He can invest his savings at 15% compounded annually. Assume an average inflation rate of 9% for the next 30 years.

Let us determine the equal amount that he must save each year until he retires so that he can make withdrawals at the end of each year commencing from the end of the 21st year from now that will allow him to live as comfortably as he desires for 10 years beyond his retirement.

Solution:

Step 1: The estimated future requirement per year in terms of today's rupees from his age 61 through 70 is Rs. 24,000.

Step 2: Modification of the costs estimated in step 1 is summarized in table. The formula which is given below is used to get future equivalent of Rs. 24,000 with the inflation of 9% per year (IR-inflation rate).

$F = P (1 + IR)^n$

Table: Inflated Future Requirements

End of year	Age (years)	Inflated value of Rs. 24,000 at each year end
21	61	$24,000 \times (1 + 0.09)^{21}$ = Rs. 1,46,61
22	62	$24,000 \times (1 + 0.09)^{22}$ = Rs. 1,59,806
23	63	$24,000 \times (1 + 0.09)^{23}$ = Rs. 1,74,189
24	64	$24,000 \times (1 + 0.09)^{24}$ = Rs. 1,89,866
25	65	$24,000 \times (1 + 0.09)^{25}$ = Rs. 2,06,954

26	66	$24{,}000 \times (1 + 0.09)^{26}$ = Rs. 2,25,580
27	67	$24{,}000 \times (1 + 0.09)^{27}$ = Rs. 2,45,882
28	68	$24{,}000 \times (1 + 0.09)^{28}$ = Rs. 2,68,011
29	69	$24{,}000 \times (1 + 0.09)^{29}$ = Rs. 2,92,132
30	70	$24{,}000 \times (1 + 0.09)^{30}$ = Rs. 3,18,424

Step 3: Now, the calculation of the equivalent amount of cash flow as per the requirement is presented.

The overall cash flow diagram for the savings and withdrawal in terms of future rupees is shown in figure.
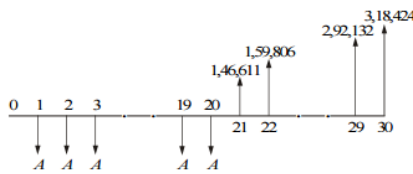
Overall cash flow diagram

The sum of the present equivalents of the year end withdrawals from the year 21 to 30 is computed by assuming the end of the year 20 as the base (time zero) and it is shown at the end of the year 20 in figure. The method of computing the present equivalent of the withdrawals is as follows:

$PW(i = 15\%) = 1{,}46{,}611/(1 + 0.15)^1 + 1{,}59{,}806/(1 + 0.15)^2$

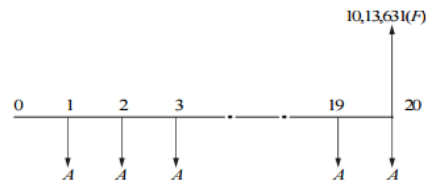$+ 1{,}74{,}189/(1 + 0.15)^3 + 1{,}89{,}866/(1 + 0.15)^4$

$+ 2{,}06{,}954/(1 + 0.15)^5 + 2{,}25{,}580/(1 + 0.15)^6$

$+ 2{,}45{,}882/(1 + 0.15)^7 + 2{,}68{,}011/(1 + 0.15)^8$

+ 2,92,132/(1 + 0.15)^9 + 3,18,424/(1 + 0.15)^{10}

= Rs. 10,13,631.

Equivalent cash flow diagram

The annual equivalent amount (A), which should be invested from the end of year 1 (age 41) to year 20 (age 60), is computed using the following formula.

A = F(A/F, 15%, 20)

= 10,13,631 x (0.0098)

= Rs. 9,934

Recommendation: The person has to invest an amount of Rs. 9,934 at the end of every year starting from his age 41 (year 1) through 60 (year 20) which will enable him to make withdrawals at the end of every year starting from his age 61 (year 21) through 70 (year 30) as shown in the table (also in figure).

2.5 National Income-Definition

The total net value of all goods and services produced within a nation over a specified period of time, representing the sum of wages, profits, rents, interest and pension payments to residents of the nation.

The definitions of national income can be grouped into two classes: One, the traditional definitions advanced by Marshall, Pigou and Fisher and two, the modern definitions.

The Marshallian Definition:

According to Marshall: "The labour and the capital of a country acting on its natural resources produce annually a certain net aggregate of commodities, material and immaterial including services of all kinds. This is true net annual income or revenue of the country or national dividend." In this definition, the word 'net' refers to deductions from the gross national income in respect of depreciation and wearing out of machines. And to this, must be added income from abroad.

It's Defects:

Though the definition advanced by Marshall is simple and comprehensive, yet it suffers from a number of limitations. First, in the present day world, so varied and numerous are the goods and services produced that it is very difficult to have a correct estimation of them.

Consequently, the national income cannot be calculated correctly. Second, there always exists the fear of the mistake of double counting and hence the national income cannot be correctly estimated. Double counting means that a particular commodity or service like raw material or labour, etc. might get included in the national income twice or more than twice.

For example, a peasant sells wheat worth Rs.2000 to flour mill which sells wheat flour to the wholesaler and the wholesaler sells it to the retailer who, in turn, sells it to the customers. If each time, this wheat or its flour is taken into consideration, it will work out to Rs.8000, whereas, in actuality, there is only an increase of Rs.2000 in the national income.

Third, it is again not possible to have a correct estimation of national income because many of the commodities produced are not marketed and the producer either keeps the produce for the self-consumption or exchanges it for other commodities. This generally happens in an agriculture-oriented country like India. Thus the volume of national income is underestimated.

The Pigouvian Definition:

A.C. Pigou has in his definition of national income included that the income which can be measured in terms of money. In the words of Pigou, "National income is that part of objective income of the community, including of course income derived from abroad which can be measured in money."

This definition is better than the Marshallian definition. It has been proved to be more practical also. While calculating the national income now-a- days, estimates are prepared in accordance with the two criteria laid down in this definition.

First, avoiding double counting, the goods and services which can be measured in money are included in national income. Second, income received on account of investment in foreign countries is included in national income.

It's Defects:

The Pigouvian definition is precise, simple and practical but it is not free from criticism. First, in the light of the definition put forth by Pigou, we have to unnecessarily differentiate between the commodities which can and which cannot be exchanged for money.

But, in actuality, there is no difference in the fundamental forms of such commodities, no matter they can be exchanged for money. Second, according to this definition when only such commodities as can be exchanged for money are included in estimation of national income, the national income cannot be correctly measured.

According to Pigou, a woman's services as a nurse would be included in national income but excluded when she worked in the home to look after her children because she did not receive any

salary for it. Similarly, Pigou is of the view that if a man marries his lady secretary, the national income diminishes as he has no longer to pay for her services.

Thus the Pigovian definition gives rise to a number of paradoxes. Third, the Pigovian definition is applicable only to the developed countries where goods and services are exchanged for money in the market.

According to this definition, in the backward and underdeveloped countries of the world, where a major portion of the produce is simply bartered, correct estimate of national income will not be possible, because it will always work out less than the real level of income. Thus the definition advanced by Pigou has a limited scope.

Fisher's Definition:

Fisher adopted 'consumption' as the criterion of national income whereas Marshall and Pigou regarded it to be production. According to the Fisher, "The National dividend or income consists solely of services as received by ultimate consumers, whether from their material or from the human environments. Thus, a piano, or an overcoat made for me this year is not a part of this year's income, but an addition to the capital. Only the services rendered to me during this year by these things are income."

Fisher's definition is considered to be better than Marshall or Pigou, because the Fisher's definition provides an adequate concept of economic welfare which is dependent on consumption and consumption represents our standard of living.

It's Defects:

But from the practical point of view, this definition is less useful, because there are certain difficulties in measuring the goods and services in terms of money. First, it is more difficult to estimate the money value of the net consumption than that of net production.

In one country there are several individuals who consume a particular good and that too at different places and, therefore, it is very difficult to estimate their total consumption in terms of money. Second, in certain consumption goods are durable and last for many years.

If we consider the example of piano or overcoat, as given by Fisher, only the services rendered for use during one year by them will be included in income. If an overcoat costs Rs. 100 and lasts for ten years, Fisher will take into account only Rs. 100 as national income during one year, whereas Marshall and Pigou will include Rs. 100 in the national income for the year, when it is made.

Besides, it cannot be said with certainty that the overcoat will last only for ten years. It may last longer or for a shorter period. Third, the durable goods generally keep changing hands leading to a change in their ownership and value too.

It therefore, becomes difficult to measure in money the service-value of these goods from the point of view of consumption. For instance, the owner of a Maruti car sells it at price higher than its real price and the purchaser after using it for a number of years further sells it at its actual price.

Now the question is as to which of its price, whether actual or black market one, should we take into account and afterwards when it is transferred from one person to another, which of its value according to its average age should be included in national income?

But the definitions advanced by Marshall, Pigou and Fisher are not altogether flawless. However, the Marshallian and Pigovian definitions tell us of the reasons influencing economic welfare, whereas Fisher's definition helps us compare economic welfare in different years.

Modern Definitions:

From modern point of view, Simon Kuznets has defined national income as "the net output of commodities and services flowing during the year from the country's productive system in the hands of the ultimate consumers".

On the other hand, in one of the reports of United Nations, national income has been defined on the basis of the systems of estimating national income, as net national product, as addition to the shares of different factors, and as net national expenditure in a country in a year's time. In practice, while estimating national income, any of these three definitions may be adopted, because the same national income would be derived, if different items were correctly included in the estimate.

2.5.1 Concepts of national income

There are various concepts of National Income. The main concepts of NI are: GDP, GNP, NNP, NI, PI, DI and PCI. These different concepts explain about the phenomenon of economic activities of the various sectors of the various sectors of the economy.

Gross Domestic Product (GDP)

The most important concept of the national income is Gross Domestic Product. Gross domestic product is the money value of all the final goods and services produced within the domestic territory of a country during a year.

Algebraic expression under product method is,

GDP = (P*Q)

where,

GDP = Gross Domestic Product

Q = Quantity of goods and service

P = Price of goods and service

Denotes the summation of all values.

According to expenditure approach, GDP is the sum of investment, consumption, government expenditure, net foreign exports of a country during a year.

Algebraic expression under expenditure approach is,

GDP = C+I+G+(X-M)

Where,

C = Consumption

G = Government expenditure

I = Investment

(X-M) = Export minus import

GDP includes the following types of final goods and services. They are:

1. Consumer goods and services.

2. Gross private domestic investment in capital goods.

3. Government expenditure.

4. Exports and imports.

Gross National Product (GNP)

Gross National Product is the total market value of all final goods and services produced annually in a country plus net factor income from abroad. Thus, GNP is the total measure of the flow of goods and services at market value resulting from current production during a year in a country including net factor income from abroad. The GNP can be expressed as the following equation:

GNP = GDP+NFIA (Net Factor Income from Abroad)

or, GNP=C+I+G+(X-M)+NFIA

Hence, GNP includes the following:

1. Consumer goods and services.

2. Gross private domestic investment in capital goods.

3. Government expenditure.

4. Net exports (exports-imports).

5. Net factor income from abroad.

Net National Product (NNP)

Net National Product is the market value of all the final goods and services after allowing for depreciation. It is also called National Income at market price. When charges for depreciation are deducted from the gross national product, we get it. Thus,

NNP = GNP-Depreciation

or, NNP=C+I+G+(X-M)+NFIA-Depreciation

National Income (NI)

National Income is also referred as National Income at factor cost. National income at factor cost means the sum of all incomes earned by resources suppliers for their contribution of land, labor, capital and organizational ability which go into the years net production. Hence, the sum of the income received by factors of production in the form of rent, wages, interest and profit is called National Income. Symbolically,

NI = NNP+Subsidies-Interest Taxes

or, GNP-Depreciation+Subsidies-Indirect Taxes

or, NI = C+G+I+(X-M)+NFIA-Depreciation-Indirect Taxes+Subsidies

Personal Income (PI)

Personal Income is the total money income received by the individuals and households of a country from all possible sources before the direct taxes. Therefore, a personal income can be expressed as follows:

PI = NI-Corporate Income Taxes-Undistributed Corporate Profits-Social Security Contribution+Transfer Payments

Disposable Income (DI)

The income left after the payment of direct taxes from personal income is called Disposable Income. Disposable income means actual income which can be spent on consumption by individuals and families. Thus, it can be expressed as:

DI = PI-Direct Taxes

From consumption approach,

DI = Consumption Expenditure+Savings

Per Capita Income (PCI)

Per Capita Income of a country is derived by dividing the national income of the country by the total population of a country. Thus,

PCI = Total National Income/Total National Population.

2.5.2 Method of measuring national income

Methods of Measuring National Income:

There are four methods of measuring national income. Which method is to be used depends on the availability of data in a country and the purpose in hand.

(1) Product Method:

According to this method, total value of final goods and services produced in a country during a year is calculated at market price. To find out the GNP, data of all productive activities, such as wood received from forests, agricultural products, minerals received from mines, the contributions to production made by transport, commodities produced by industries, communications, insurance companies, lawyers, teachers, doctors, etc. are collected and assessed at market prices. Only the final goods and services are included and the intermediary goods and services are left out.

(2) Income Method:

According to this method, the net income payments received by all the citizens of a country in a particular year are added up, i.e., net incomes that accrue to all factors of production by way of net rents, net wages, net interest and net profits are all added together but incomes received in the form of transfer payments are not included in it. The data pertaining to income are obtained from different sources, for instance, from income tax department in respect of high income groups and in case of workers from their wage bills.

(3) Expenditure Method:

According to this method, the total expenditure incurred by the society in a particular year is added together and also includes personal consumption expenditure, net domestic investment, government expenditure on goods and services and net foreign investment. This concept is based on the assumption that national income equals national expenditure.

(4) Value Added Method:

Another method of measuring the national income is value added by industries. The difference between the value of material outputs and inputs at each stage of production is the value added. If all such differences are added up for all industries in the economy, we arrive at the gross domestic product.

TIME VALUE OF MONEY, EVALUATION OF ENGINEERING PROJECTS, DEPRECIATION

3

Time value of money- Interest - Simple and compound, nominal and effective rate of interest, Cash flow diagrams, Principles of economic equivalence.

Evaluation of engineering projects-Present worth method, Future worth method, Annual worth method, Internal rate of return method, Cost benefit analysis for public projects.

Depreciation- Depreciation of capital asset, Causes of depreciation, Methods of calculating depreciation (Straight line method, Declining balance method), After tax comparison of project.

3.1 Time value of money- Interest - Simple and compound, nominal and effective rate of interest

Time value of money - It denotes the growth of capital per unit period. The period can be a month, a quarter, semi-annual or a year.

An interest rate 15% compounded annually implies that for every hundred rupees invested now ,an amount of Rs. 15 will be added to the account at the end of first year. So the total amount at the end of the first year will be Rs. 115.

At the end of the second year, again 15% of Rs. 115, i.e. Rs. 17.25 will be added to the account.

Thus,the total amount at the end of the second year will be Rs. 132.25. The process will continue thus till the specified number of years.

If an investor invests a sum of Rs. 100 in a fixed deposit for five years with an interest rate of 15% compounded annually the accumulated amount at the end of every year will be as shown in table.

Compound amounts

Amount of deposit = Rs.100.00

Tear end	Interest (Rs)	Compound amount (Rs)

0		100
1	15.00	115
2	17.25	132.25
3	19.84	152.09
4	22.81	174.90
5	26.24	201.14

The formula to find the future worth in the third column is,

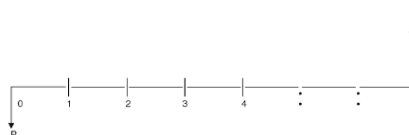$F = P(1+i)^n$

Where,

F = Future amount.

P = Principal amount invested at time 0.

i = Interest rate compounded annually.

n = Period of deposit.

The maturity value at the end of the fifth year is Rs. 201.14. This means that the amount Rs. 201.14 at the end of the fifth year is equivalent to Rs. 100.00 at time 0. This explanation assumes that the inflation is at zero percentage.

Single-payment compound amount: The objective is to find the single future sum (F) of the initial payment (P) made at time 0 after n periods at an interest rate i compounded every period.

Cash flow diagram of single-payment compound amount

The formula to obtain the single-payment compound amount is given by,

$F = P(1 + i)^n = P (F/P, i, n)$

Where, $(F/P, i, n)$ is called as single-payment compound amount factor.

Single-payment present worth amount - To determine the present worth amount (P) of a single future sum (F), which will be received after n periods at an interest rate of i compounded at the end of every interest period.

Cash flow diagram of single-payment present worth amount

The formula to obtain the present worth is,
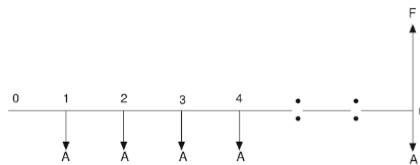
$$P = \frac{F}{(1+i)^n} = F (P/F, i, n)$$

Where,

$(P/F, i, n)$ is termed as single-payment present worth factor .

Equal-payment series sinking fund:

In this type of investment mode, the objective is to find the equivalent amount (A) that must be deposited at the end of every interest period for n interest periods to realize a future sum (F) at the end of the nth interest period at an interest rate of i.

Cash flow diagram of Equal payment series sinking fund

The formula to get F is,

$$A = F \frac{i}{(1+i)^n - 1} = F (A/F, i, n)$$

Where, $(A/F, i, n)$ is called as equal-payment series sinking fund factor.

A = Equal amount to be deposited at the end of each interest period.

i = Rate of interest.

n = No of interest periods.

F = Single future amount at the end of the nth period.

Equal-payment series present worth amount :

The objective of this mode of investment is to find the present worth of an equal payment made at the end of every interest period for n interest periods at an interest rate of i compounded at the end of every interest period.

The corresponding cash flow diagram is shown in figure.
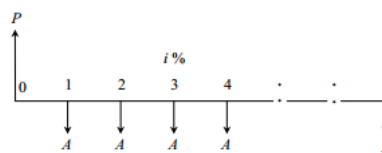
Cash flow diagram of equal-payment series present worth amount.

P = Present worth.

A = Annual equivalent payment.

i = Interest rate.

n = No. of interest periods.

The formula to compute P is given by,

$$P = A \frac{(1+i)^n - 1}{i(1+i)^n} = A \ (P/A, i, n)$$

Where, (P/A, i, n) is called equal-payment series present worth factor.

Nominal rate of interest:

Interest is the money that a lender receives from a borrower in exchange for the borrower's use of the lender's money (called the principal). The nominal interest rate is the rate of interest that is reported on loan documents and investment accounts that are not adjusted for inflation. You should keep in mind, however, that a sophisticated lender takes the expected rate of inflation into account when determining the interest rate it will charge on a loan. Nevertheless, the expected inflation rate and the actual rate of inflation usually is not the same.

How to Calculate the Nominal Interest Rate

Before we jump into calculating the nominal interest rate, let's start simple with the simple interest formula: $I = PRT$, where I = interest, P = principal, R = interest rate, and T = time.

Now, let's do some algebraic operations to get the formula for finding the simple interest rate: $R = I/PT$, where I = interest, P = principal, R = interest rate, and T = time. For example, imagine you took out a loan one year ago that is now due. The principal amount of the loan is $10,000 and you owe $1,000 in interest. What is the annual nominal interest rate on the loan?

Here's our formula with these numbers plugged in: $R = 1,000/(10,000)(1)$. Note that since unit of time in this question is a year, we use 1. If the unit of time was monthly, we would use 12. If it were daily, you would use either 365 or 360, depending upon how a year is defined in the loan documents (360 is often used):

R = 1,000/10,000

R = .10 (you can convert this decimal to a percent by multiplying by 100)

R = .10 * 100

R = 10%

Now, let's turn to the nominal interest rate from the view of the lender. Remember that a smart lender will factor in the expected rate of inflation to ensure the desired rate of return (profit). Here's an equation that a lender may use to calculate the nominal interest rate it wishes to charge a borrower: nominal interest rate = real interest rate + expected inflation rate.

Effective interest rate:

Let i be the nominal interest rate compounded annually. But in practice the compounding may occur less than a year. An example compounding may be monthly,quarterly or semi-annually. Compounding monthly means that the interest is computed at the end of every month.

There are 12 interest periods in a year if the interest is compounded monthly. Under such situations the formula to compute the effective interest rate which is compounded annually is,

Effective interest rate, $R = 1 + i/C^c - 1$

Where,

i = The nominal interest rate.

C_c = The number of interest periods in a year.

 Problems

1. A person invests a sum of Rs. 5,000 in a bank at a nominal interest rate of 12% for 10 years. The compounding is quarterly. Let us determine the maturity amount of the deposit after 10 years.

Solution:

Given:

P= Rs. 5,000

n= 10 years

i = 12% (Nominal interest rate)

To find:

F= ?

Effective interest rate, $R = 1 + i / C^c - 1$

Method -1

No. of interest periods in 10 years = 10 x 4 = 40

No. of interest periods per year = 4

Revised No. of periods (No. of quarters), N= 40

Interest rate per quarter, r= 12%/4

= 3%, compounded quarterly.

F= $P(1 + r)^N$= $5,000(1 + 0.03)^{40}$

= Rs. 16,310.19

Method -2

No. of interest periods per year, C= 4

Effective interest rate, R= $(1 + i/C)^c - 1$

= $(1 + 12\%/4)^4 - 1$ = 12.55%, compounded annually.

F= $P(1 + R)^n$ = $5,000(1 + 0.1255)^{10}$ = Rs. 16,308.91

Single-Payment Compound Amount

1. A person deposits a sum of Rs. 20,000 at the interest rate of 18% compounded annually for 10 years. Let us determine the maturity value after 10 years.

Solution:

Given:

P = Rs.20,000

i = 18% compounded annually

n = 10years

$F = P(1+ i)^n = P(F/P, i, n)$

= 20,000 (F/P,18%, 10)

= 20,000 × 5.234= Rs.1,04,680

The maturity value of Rs.20,000 invested now at 18% compounded yearly is equal to Rs.1,04,680after 10 years.

Single-Payment Present Worth Amount

2. A person wishes to have a future sum of Rs.1,00,000 for his son's education after 10 Years from now. Let us determine the single-payment that we should deposit now so that we gets the desired amount after 10 years. The bank gives 15% interest rate compounded annually.

Solution:

Given:

F = Rs.1,00,000

i = 15%, compounded annually

n = 10 years

P = F/(1 + i)

n = F(P/F, i, n) = 1,00,000 (P/F,15%, 10)

= 1,00,000 0.2472

= Rs. 24,720

The person has to invest Rs. 24,720 now so that we will get a sum of Rs.1,00,000 after 10 years at 15% interest rate compounded annually.

Equal-Payment Series Present Worth Amount

3. A company wants to set up a reserve, which will help the company to have an annual equivalent amount of Rs.10,00,000 for the next 20years towards its employee welfare measures. The reserve is assumed to grow at the rate of 15% annually. Let us determine the single-payment that must be made now as the reserve amount.

$\boxed{Solution:}$
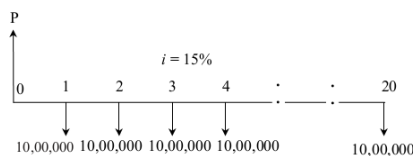
Given:

A = Rs.10,00,000

i = 15%

n = 20years

P = ?

P$_i$= 15%

Cashflow diagram of equal-payment series present worth amount

The formula to compute P is given by,

$$P = A \frac{(1+i)^n - 1}{i(1+i)^n}$$

= A (P/A, i, n)

= 10,00,000 (P/A, 15%, 20)

= 10,00,000 × 6.2593

= Rs. 62,59,300

The amount of reserve which must be set-up now is equal to Rs. 62,59,300.

Equal-Payment Series Capital Recovery Amount

4. A bank gives a loan to a company to purchase an equipment worth Rs.10,00,000at an Interest rate of 18% compounded annually. This amount should be repaid in 15yearly equal installments. Let us determine the installment amount that the company has to pay to the bank.

Solution:

Given:

P = Rs.10,00,000

i = 18%

n = 15years

A = ?
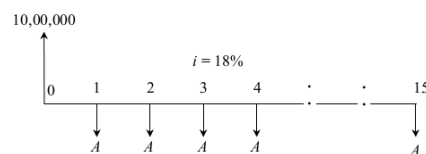
The corresponding cashflow diagram is shown in the below figure.

Cashflow diagram of equal-payment series capital recovery amount.

$$A = P \frac{i(1+i)^n}{(1+i)^n - 1} = P(A/P, i, n)$$

= 10,00,000 (A/P, 18%, 15)

= 10,00,000 (0.1964)

= Rs. 1,96,400

The annual equivalent installment to be paid by the company to the bank is Rs. 1,96,400.

3.1.1 Cash flow diagrams

An examination of cash inflows of a company and the outflows during a specific period. The analysis starts with a starting balance and generates an ending balance after accounting for all cash receipts and the paid expenses during the period. Often ,the cash flow analysis is used for the financial reporting purposes.

Let us see the cash-flow statement

A cash flow statement, also called as statement of cash flows or funds flow statement, is a financial statement that shows how the changes in balance sheet accounts and income affect the cash and cash equivalents and breaks the analysis down to investing, operating and financing activities.

The cash flow statement is partitioned into three segments, such as:

1) Cash flow resulting from financing activities.

2) Cash flow resulting from investing activities.

3) Cash flow resulting from operating activities.

Operating Activities

Operating activities includes the production, sales and delivery of the company's product as well as collecting payment from its customers. This also include purchasing raw materials, building inventory, advertising, advertising and shipping the product.

Operating cash flows include:

• Payments to employees or on behalf of employees.

• Receipts for the sale of loans, debt or equity instruments in a trading portfolio.

• Receipts from the sale of goods or services.

• Payments to suppliers for goods and services.

• Interest received on loans.

• Interest payments.

Investing Activities

Examples of Investing activities are,

• Payments related to mergers and acquisitions.

• Loans made to suppliers or received from customers.

• Purchase or Sale of an asset.

Financing Activities

Financing activities include the inflow of cash from the **investors** like **banks** and **shareholders,** as well as the outflow of cash to shareholders as **dividends** as the company generates income.

• Repayment of debt principal, including capital leases.

• Payments of dividends.

• For non-profit organizations, receipts of donor-restricted cash that is limited to long-term purposes.

• Proceeds from issuing short-term or long-term debt.

• Payments for repurchase of company shares.

Sample cash flow statement using the direct method

Cash flows from operating activities

Cash receipts from customers9,500

Cash paid to suppliers and employees(2,000)

Cash generated from operations (**sum**)**7,500**

Interest paid(2,000)

Income taxes paid(3,000)

Net cash flows from operating activities2,500

Cash flows from (used in) investing activities

Dividends received3,000

Proceeds from the sale of equipment7,500

Net cash flows from investing activities10,500

Cash flows from (used in) financing activities

Dividends paid(2,500)

Cash and cash equivalents, beginning of year1,000

Net cash flows used in financing activities(2,500)

Cash and cash equivalents, end of yearRs. 11,500.

Net increase in cash and cash equivalents10,500

Let us solve the problem based on the given information and determine whether the purchase of the machine is worth or not.

Year	Cash Flow	P.V @10%	Present value
1	50,000	0.909	45,450
2	50,000	0.826	41,300
3	50,000	0.751	37,550
4	50,000	0.682	34,150
5	50,000	0.621	31,050
		P.V. of future cash flow	1,89,500
		Initial Investment	1,50,00
		NPV	39,500

Since it is positive net present value, machine can be purchased.

3.1.2 Principle of economic equivalence

The observation that money has a time value results us to an important question: If receiving $100 today is not the same thing as receiving $100 at any future point, how do we measure and compare various cash flows? How do we know, for example, whether we should prefer to have $20,000 today and $50,000 ten years from now or $8000 each year for the next ten years? In this section, we describe the basic analytical techniques for making such comparisons. we will use these techniques in order to develop a series of formulae that may greatly simplify our calculations.

The central question in deciding among the alternative cash flows involves comparing their economic worth. This will be a simple matter if, in the comparison, we don't need to consider the time value of money: We can simply add the individual payments within a cash flow, treating receipts as positive cash flows and payments as negative cash flows. The fact that money has a time

value, makes our calculations even more complicated. We have to know more than just size of a payment in order to determine its economic effect completely.

• The direction of the payment: Is it a receipt or a disbursement?

• The magnitude of the payment.

• The timing of the payment: When is it made?

• The interest rate in operation during the period under consideration.

It follows that, to assess the economic impact of series of payments, we should consider the impact of each payment individually.

Calculations for determining the economic effects of one or more cash flows are based on the concept of the economic equivalence. Economic equivalence exists between the cash flows that have the same economic effect and can thus be traded for one another in the financial marketplace, which we assume to exist.

Economic equivalence refers to fact that a cash flow whether a single payment or a series of payments can be converted to an equivalent cash flow at any point in time. For example, we can find the equivalent future value for a present amount Pat interest rate i at period n; or we can determine the equivalent present value P of N equal payments A.

The preceding strict concept of equivalence, that limits us to convert a cash flow into another equivalent cash flow, can be extended to include the comparison of alternatives. For example, we can compare the value of two proposals by finding the equivalent value of each at any common point in time. If financial proposals which appear to be quite different turn out to have the same monetary value, then we may be economically in different to choose between them: In terms of economic effect, one could be an even exchange for the other, so no reason exists to prefer one over the other in terms of their economic value.

A way to see the concepts of equivalence and economic indifference at work in the real world is to notice the variety of payment plans offered by the lending institutions for consumer loans. The table extends the example we developed earlier in order to include the three different repayment plans for a loan of $20,000 for five years at 9% interest. We will notice that , perhaps , that the three plans needs significantly different repayment patterns and different total amounts of repayment. Because money has a time value, these plans are equivalent and economically, the bank is indifferent to a consumer's choice of plan.

3.2 Evaluation of engineering projects – Present worth method

Executives will be forced to select best alternative from a set of competing alternatives.Assume that an organization has a huge sum of money for the potential investment and there are three different projects whose initial outlay and the annual revenues during their lives are known. Executive has to select the best alternative among these three competing projects.

In the real world,majority of the engineering economic analysis problems have alternative comparisons. In these problems, mutually exclusive two or more investments compete for the limited funds. Variety of methods exists for selecting superior alternative from a group of proposals. Each method has its own merits and applications. There are various bases for comparing the worthiness of the projects. These bases are as follows:

1. Future worth method

2. Rate of return method

3. Present worth method

4. Annual equivalent method

Present worth method

In this method of comparison, the cash flows of each alternative will be reduced to time zero by assuming the interest rate i. Then, depending on the type of decision, the best alternative will be selected by comparing the present worth amounts of the alternatives.

At a cost dominated cashflow diagram, the costs (outflows) will be assigned with positive sign and the profit, revenue, salvage value (all inflows), etc., will be assigned with the negative sign. In a revenue or profit dominated cashflow diagram, profit, revenue, salvage value will be assigned with the positive sign. The costs (out flows) will be assigned with the negative sign.

When two or more alternatives are capable of performing the same functions, the economically superior alternative will have the largest present worth. The present worth method is restricted to evaluating the alternatives that are mutually exclusive and that have the same lives. This method is suitable for ranking the desirability of the alternatives.

Comparison by present worth method:

First, the comparison of equal life span mutually exclusive alternatives by present worth method will be illustrated followed by comparison of different life span alternatives. The following examples are formulated only to demonstrate the use of different methods for comparison of alternatives.

The values of different cost and incomes mentioned in the examples are not the actual ones pertaining to a particular item. In addition, it may also be noted here that the cash flow diagrams have been drawn not to the scale.

REVENUE-DOMINATED CASH FLOW DIAGRAM

A generalized revenue-dominated cash flow diagram to demonstrate the present worth method of comparison is presented in figure below.
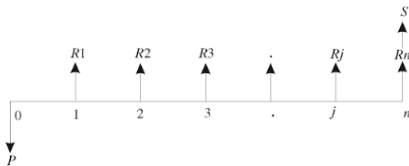
Revenue dominated cash flow diagram

In the above figure, P represents an initial investment and Rj the net revenue at the end of the jth year. The interest rate is i, compounded annually. S is the salvage value at the end of the nth year.

To find the present worth of the above cash flow diagram for a given interest rate, the formula is,

$PW(i) = - P + R1[1/(1 + i)^1] + R2[1/(1 + i)^2] + ... + Rj[1/(1 + i)^j] + Rn[1/(1 + i)^n] + S[(1/(1 + i)^n]$

In this formula, expenditure is assigned a negative sign and revenues are assigned a positive sign.

If we have some more alternatives which are to be compared with this alternative, then the corresponding present worth amounts are to be computed and compared. Finally, the alternative with the maximum present worth amount should be selected as the best alternative.

COST-DOMINATED CASH FLOW DIAGRAM

A generalized cost-dominated cash flow diagram to demonstrate the present worth method of comparison is presented in figure below.
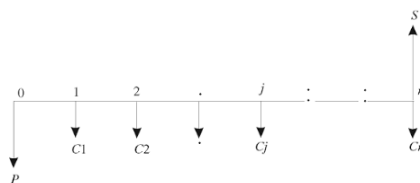
Cost dominated cash flow diagram

In figure, P represents an initial investment, Cj the net cost of operation and maintenance at the end of the jth year and S the salvage value at the end of the nth year.

To compute the present worth amount of the above cash flow diagram for a given interest rate i, we have the formula,

PW(i) = P + C1 [1/(1 + i)^1] + C2[1/(1+ i)^2] + ... + Cj[1/(1 + i)^j] + Cn[1/(1 + i)^n] - S [1/(1 + i)^n]

In the above formula, the expenditure is assigned a positive sign and the revenue a negative sign. If we have some more alternatives which are to be compared with this alternative, then the corresponding present worth amounts are to be computed and compared. Finally, the alternative with the minimum present worth amount should be selected as the best alternative.

Problems

1. A company expects the cost of equipment maintenance to be Rs.5,000 in year one, Rs.5,500 in year two and amount is increasing by Rs.500 per year through 10 years. At an interest rate of 10% per year, let us determine the present worth of the maintenance cost.

$\boxed{Solution:}$

Given data:

Maintenance cost/Year = Rs. 5000

Interest rate = 10 %

To find :

Present worth of the maintenance cost.

This is an increasing gradient (use + sign) with G = Rs.500 and base amount A = 5,000:

Convert a gradient cash flow into an equivalent uniform series, A, in one of two ways:

Find the present worth P and then convert the P value to an A value using the A =P(A/P, i, n) factor or Use the uniform gradient annual worth factor, (A/G, i, n), directly in A= G(A/G, i, n).

When using (A/G, i, n), it is important to remember that this factor converts only the gradient into an A value, just like the P/G factor affects only the gradient. The base amount in year one is simply added to the A value obtained from A= G(A/G, i, n). The general equation for the total A value, A_T is

$A_T = A_1 + A_G$

The future worth F of a gradient cash flow is found by either first finding P and then using the F/P factor or first finding A and then using the F/A factor.

P = 5000(P/A, 10%, 10)+500(P/G, 10%, 10)

= 5,000(6.1446)+500(22.8913)

= Rs. 42,168.65

2. The cash flow associated with a stripper oil well is expected to be Rs.3,000 in month one Rs.2,950 in month two and amounts decreasing by Rs.50 each month through year five. At an interest rate of 12% per year compounded monthly then let us determine the equivalent uniform monthly cash flow is closest.

Solution:

Given data:

Amount decreasing/Month = Rs. 50

Interest rate = 12 %

To find:

Equivalent uniform monthly cash flow.

The negative gradient is G = - Rs.50. The total equivalent monthly cash flow, A_T is:

$A_T = A_1 - A_G$

= 3,000 - 50 (A/G, 1%, 60)

= 3,000 - 50(26.5333)

= Rs. 1,673.34.

3. A person deposits a sum of 15,000 at the interest rate of 18% compounded annually for 5 years. Let us determine the maturity value after 5 years.

Solution

Given data:

P= 15,000

i = 18% compounded annually

n = 5 years

To find:

Maturity amount after 5 years.

$F = P(1+i)n$

= P (F/P, n)

= 15,000 (F/P, 18%, 5)

= 15,000 x 2.2878 = Rs. 34,317

4. The maturity value of Rs. 15,000 invested now at 18% compounded yearly is equal to Rs. 34,317 after 5 years. A person wishes to have a future sum of 50,000 for his son's education 10 years from now. Let us find the single payment that he should deposit now so that he gets the desired amount over 10 years. The bank gives 15% interest rate compounded annually.

Solution:

Given data:

F = 50,000

i = 15% compounded annually

n = 10 years

P = F (1 + i)n

= F (P/F, i, n)

= 50,000 (P/F, 15%, 10)

= 50,000 x 0.2472 = Rs. 12,360

The person has to invest Rs. 12,360 now, so that we will get a sum of Rs. 50,000 after 10 years at 15% interest rate compounded annually.

5. There are two alternatives for purchasing concrete mixer. Both alternatives have the same useful life. The cash flow details of alternatives are as follows.

Alternative-1:

Initial purchase cost = Rs.3,00,000, Annual operating and maintenance cost = Rs.20,000, Expected salvage value = Rs.1,25,000, Useful life = 5 years.
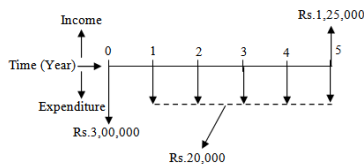
Alternative-2:

Initial purchase cost = Rs.2,00,000, Annual operating and maintenance cost = Rs.35,000, Expected salvage value = Rs.70,000, Useful life = 5 years.

By using present worth method, let us determine which alternative should be selected, if the rate of interest is 10% per year.

Solution:

As both the alternatives have same life span i.e., 5years, the present worth of the alternatives will be compared over a period of 5 years. The cash flow diagram of Alternative-1 is depicted in the below figure.

The cash outflows i.e. costs or expenditures are denoted by vertically downward arrows whereas the cash inflows i.e. revenue or income are represented by vertically upward arrows. The same

convention is being adopted here.

Cash flow diagram of Alternative-1

The equivalent present worth of Alternative-1

i.e. PW1 is calculated as follows:

The initial cost, P = Rs.3,00,000 (cash outflow)

Annual operating and maintenance cost, A = Rs.20,000 (cash outflow)

Salvage value, F = Rs.1,25,000 (cash inflow)
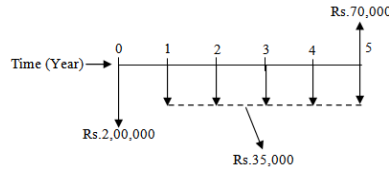
PW1 = - 3,00,000 - 20,000(P/A, i, n) + 1,25,000(P/F, i, n)

PW1 = - 3,00,000 - 20,000(P/A, 10%, 5) + 1,25,000(P/F, 10%, 5)

Now putting the mathematical expressions of different compound interest factors in the above expression for PW1 (in Rs.) results in the following:

PW1 = - 3,00,000 -75,816 + 77,613

PW1= - Rs.2,98,203

The cash flow diagram of Alternative-2 is shown in the below figure.

Cash flow diagram of Alternative-2

3.2.1 Future worth method

**Comparison by the future worth method**

In the future worth method for the comparison of mutually exclusive alternatives, the equivalent future worth of all expenditures and incomes occurring at different periods of time are found at the given interest rate per interest period. The cash flow of the mutually exclusive alternatives consist of the expenditures and incomes in different forms.

Therefore the equivalent future worth of these expenditures and incomes will be obtained using different compound interest factors such as single payment compound amount factor, uniform series compound amount factor and future worth factors for arithmetic and geometric gradient series etc.

The use of future worth method for the comparison of mutually exclusive alternatives can be illustrated in the following examples. Similar to the present worth method, first comparison of equal life span alternatives by the future worth method can be illustrated followed by comparison of different life span alternatives.

Revenue-Dominated Cash Flow Diagram:

A generalized revenue dominated cashflow diagram to demonstrate the future worth method of comparison is presented in the below figure.
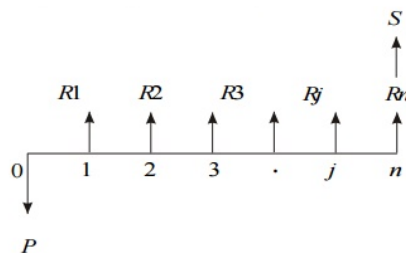
Revenue dominated cashflow

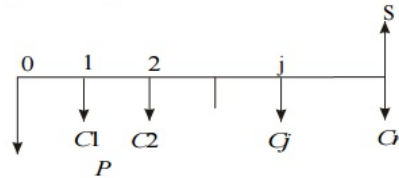P represents an initial investment, R_j the net revenue at the end of the jth year and S, the salvage value at the end of the nth year. The formula for the future worth of the above cash flow diagram for given interest rate, i is given by,

$$FW(i) = -P (1 + i)^n + R_1(1 + i)^{n-1} + R_2(1 + i)^{n-2} + ... + R_j(1 + i)^{n-j} + ... + R_n + S$$

In the above formula, the expenditure is assigned with the negative sign and the revenues are assigned with the positive sign.

Cost-Dominated Cash Flow Diagram:

A generalized cost dominated cash flow diagram to demonstrate the future worth method of comparison is given in the figure.

Cost dominated cashflow

In the figure above, P represents an initial investment, C_j the net cost of operation and maintenance at the end of the jth year and S, the salvage value at the end of the nth year. The formula for the future worth of the above cashflow diagram for a given interest rate, i is

$$FW(i) = P (1 + i)^n + C_1 (1 + i)^{n-1} + C_2 (1 + i)^{n-2} + ... + C_j (1 + i)^{j-1} + C_n + S$$

Problem

Comparison by future worth method

In the following example, the comparison of three mutually exclusive alternatives by future worth method will be illustrated.

A construction contractor has three options to purchase the dump truck for transportation and dumping of earth at a construction site. All the alternatives have the same useful life. The cash flow details of all the alternatives are presented as follows:

Option-1:

Initial purchase price = Rs.2500000, Annual operating cost Rs.45000 at the end of 1 st year and increasing by Rs.3000 in the subsequent years till the end of useful life, Annual income = Rs.120000, Salvage value = Rs.550000, Useful life = 10 years.
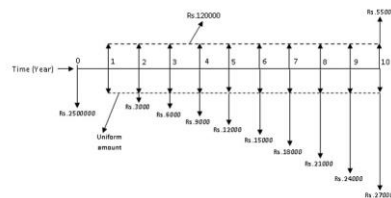
Option-2:

Initial purchase price = Rs.3000000, Annual operating cost = Rs.30000, Annual income Rs.150000 for first three years and increasing by Rs.5000 in the subsequent years till the end of useful life, Salvage value = Rs.800000, Useful life = 10 years.

Option-3:

Initial purchase price = Rs.2700000, Annual operating cost Rs.35000 for first 5 years and increasing by Rs.2000 in the successive years till the end of useful life, Annual income = Rs.140000, Expected salvage value = Rs.650000, Useful life = 10 years.

Using future worth method, let us find out which alternative should be selected, if the rate of interest is 8% per year.

Solution:

The cash flow diagram of Option-1 is shown here again for ready reference.

Cash flow diagram of Option-1 with the annual operating cost split into uniform base amount and gradient amount. The equivalent future worth (in Rs.) of Option-1 is determined as follows;

FW_1=-2500000(F/P, 8%, 10)-45000(F/A, 8%, 10)-3000(F/G, 8%, 10)+1200000(F/A, 8%, 10)+5500000

FW_1=-2500000(F/P, 8%, 10)+(120000-45000)(F/A, 8%, 10)-3000(F/G, 8%, 10)+550000

Now putting the values of different compound interest factors in the above expression for FW_1 results in the following;

FW_1 = -2500000 x 2.1589 + 75000 x 14.4866 - 3000 x 56.0820 + 550000

Fw_1 = -5397250 + 1086495- 168246 + 550000

FW_1 = - Rs.3929001.

In the future worth method of comparison of alternatives, the future worth of various alternatives will be computed. Then, the alternatives with the maximum future worth of net revenue or with the minimum future worth of net cost will be selected as the best alternative for implementation.

3.2.2 Annual worth method

Comparison of alternatives by annual worth method:

In this method, the mutually exclusive alternatives are compared on the basis of the equivalent uniform annual worth. The equivalent uniform annual worth represents the annual equivalent value of all the cash inflows and cash outflows of the alternatives at the given rate of interest per interest period.

In this method of comparison, the equivalent uniform annual worth of all the expenditures and incomes of the alternatives are determined using different compound interest factors namely capital recovery factor, sinking fund factor and annual worth factors for arithmetic and geometric gradient series, etc. Since the equivalent uniform annual worth of the alternatives over the useful life are determined, same procedure is followed irrespective of the life spans of the alternatives i.e. whether it is the comparison of equal life span alternatives or that of different life span alternatives.

In other words, in case of comparison of different life span alternatives by annual worth method, the comparison is not made over the least common multiple of the life spans as it is done in case of the present worth and future worth method.

The reason is that even if the comparison is made over the least common multiple of years, the equivalent uniform annual worth of the alternative for more than one cycle of cash flow will be exactly same as that of the first cycle provided the cash flow i.e. the costs and incomes of the alternative in the successive cycles is exactly same as that in the first cycle.

Thus, the comparison is made only for one cycle of cash flow of the alternatives. This serves as one of the greatest advantages of using this method over other methods of comparison of alternatives. However if the cash flows of the alternatives in the successive cycles are not the same as that in the first cycle, then a study period is selected and then the equivalent uniform annual worth of the cash flows of the alternatives are computed over the study period.

Revenue-Dominated Cash Flow Diagram:

A generalized revenue dominated cashflow diagram to demonstrate the annual equivalent method of comparison is presented in the below figure.
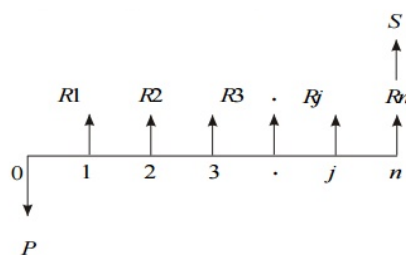
Revenue dominated cashflow diagram

P represents an initial investment, Rj the net revenue at the end of the jth year and S, the salvage value at the end of the nth year. The formula for the future worth of the above cash flow diagram for a given interest rate, i is given by,

$$PW(i) = -P + R1/(1 + i)^1 + R2/(1 + i)^2 + ... + Rj/(1 + i)^j + ... + Rn/(1 + i)^n + S/(1 + i)^n$$

In the above formula, the expenditure is assigned with the negative sign and the revenues are assigned with the positive sign.

Cost-Dominated Cash Flow Diagram:

A generalized cost dominated cash flow diagram to demonstrate the annual equivalent method of comparison is given in the figure.
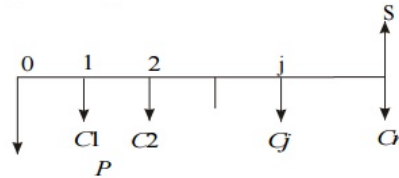
Cost dominated cashflow diagram

In the below figure, P represents an initial investment, Cj the net cost of operation and maintenance at the end of the jth year and S, the salvage value at the end of the nth year. The formula for the future worth of the above cashflow diagram for a given interest rate, i is,

$$PW(i) = P + C1/(1 + i)^1 + C2/(1 + i)^2 + ... + Cj/(1 + i)^j + Cn/(1 + i)^n - S/(1 + i)^n$$

Problems

1. There are two alternatives for purchasing a concrete mixer and following are the cash flow details.

Alternative-1:

Initial purchase cost = Rs.300000, Annual operating and maintenance cost = Rs.20000, Expected salvage value = Rs.125000, Useful life = 5 years.

Alternative-2:

Initial purchase cost = Rs.200000, Annual operating and maintenance cost = Rs.35000, Expected salvage value = Rs.70000, Useful life = 5 years.

The annual revenue to be generated from production of concrete (by concrete mixer) from Alternative-1 and Alternative-2 are Rs.50000 and Rs.45000 respectively. Let us compute the equivalent uniform annual worth of the alternatives at the interest rate of 10% per year and let us determine the economical alternative.

Solution:

Given:

Alternative-1:

Initial purchase cost = Rs.300000, Annual operating and maintenance cost = Rs.20000, Expected salvage value = Rs.125000, Useful life = 5 years.
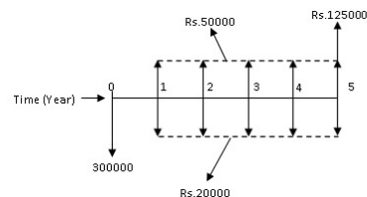
Alternative-2:

Initial purchase cost = Rs.200000, Annual operating and maintenance cost = Rs.35000, Expected salvage value = Rs.70000, Useful life = 5 years.

The cash flow diagram of Alternative-1 is shown here again for ready reference.

Cash flow of Alternative -1

The equivalent uniform annual worth of Alternative-1 i.e. AW1 is computed as follows:

AW_1=-300000(A/P,i,n)-20000+50000+125000(A/F,i,n)

AW_1=-300000(A/P,10%,5)-20000+50000+125000(A/F,10%,5)

Here Rs.20000 and Rs.50000 are annual amounts.

Now putting the values of different compound interest factors,

AW_1=-300000 x 0.2638 +(50000-20000)+125000x0.1638

AW_1=-79140+30000+20475

AW_1= - Rs.28665

In the annual equivalent method of comparison, first the annual equivalent cost or the revenue of each alternative will be computed. Then the alternative with the maximum annual equivalent revenue in the case of revenue-based comparison or with the minimum annual equivalent cost in case of cost based comparison will be selected as the best alternative.

Alternatives that accomplish the same purpose but that have unequal lives must be compared by the annual cost method. The annual cost method assumes that each alternative will be replaced by the identical twin at the end of its useful life (i.e., infinite renewal). This method, which may also be used to rank the alternatives according to their desirability is also called the annual return method. The alternatives must be mutually exclusive and repeatedly renewed upto the duration of the longest-lived alternative. The calculated annual cost is termed as the equivalent uniform annual cost (EUAC) or equivalent annual cost (EAC). Cost is a positive number when expenses exceed income.

3.2.3 Internal rate of return method

The Internal Rate of Return (IRR) is the rate of return promised by an investment project over its useful life. This is some time referred to simply as yield on project. The internal rate of return is computed by finding the discount rate which equates the present value of a project's cash out flow with the present value of its cash inflow. It is also said that the internal rate of return is that discount rate that will cause the net present value of a project to be equal to zero.

It is the discount rate at which net present value of the project becomes zero. Higher IRR should be preferred. This can be represented as,

$$IRR: \sum_{t=0}^{n} \frac{CF_t}{(1+IRR)^t} = \$0 = NPV.$$

It is also known as time adjusted rate of return, error method, yield method, discounted rate of return and discounted cash flow and trial . Here, the cash flow of a project is discounted at a

suitable rate by hit and trial method. It is the rate where present value of cash inflow which is equal present value of cash outflow.

The rules for IRR are as follows:

IRR < minimum required rate of return than reject the proposal

IRR > minimum required rate of return than accept the proposal

IRR = minimum required rate of return than indifferent

Steps to calculate internal rate of return:

• First, determine the future net cash flow.

• Then, determine the discount rate at which cash inflow = cash outflow.

Advantages of internal rate of return method

1. It is compatible with the firm's maximizing owners' welfare.

2. This takes into account maximum profitability.

3. This will consider the cash flows over the entire life of the project.

4. It gives better view of profitability.

5. Similar to the NPV method, it considers the time value of money.

6. This will satisfy the users in terms of the rate of return on capital.

7. Unlike the NPV method, the calculation of the cost of capital is not a precondition.

Disadvantages of internal rate of return method:

1. This involves complicated computation problems.

2. It is difficult to understand.

3. It may yield negative rate or multiple rates under certain circumstances. It may not give unique answer in all situations.

4. The result of NPV and IRR differs.

5. This implies that the intermediate cash inflows which is generated by the project are reinvested at the internal rate unlike at the firm's cost of capital under NPV method.

Example:
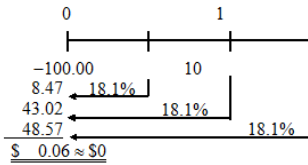
IRR$_L$=18.1%

IRR$_s$=23.6%

When the projects are independent, accept both because IRR > k.

When the projects are mutually exclusive, accept Project S since IRR$_s$ > IRR$_L$.

IRR is independent of the cost of capital.

k	NPV$_I$	NPV$_s$
0%	$50	$40
5	33	29
10	19	20
15	7	12
20	(4)	5
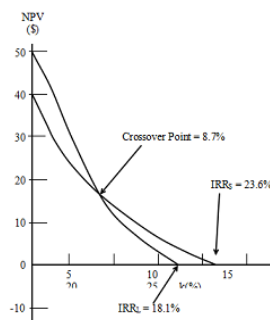
Problem based on given data

Proposal A

A.R.R = Annual Average net earnings/Original Investment × 100

$$= \frac{2,000}{10,000} = 20\%$$

$$\text{Annual Average net earnings} = \frac{3,000 + 2,500 + 500}{3}$$

$$= 2000$$

Proposal B

A.R.R = Annual Average net earnings/Original investment × 100

$$= \frac{6,250}{20,000} \times 100 = 31.25\%$$

$$\text{Annual Average net earnings} = \frac{10,000 + 7,500 + 5,000 + 2500}{4} = 6250$$

Proposal B is preferable since it has a higher ARR.

The rate of return technique is one of the methods that are used in selecting the alternative for a project. In this method, the interest rate per interest period may be determined, that equates the equivalent worth of cash outflows to that of cash inflows of an alternative. The rate of return is also called by other names namely internal rate of return (IRR), profitability index etc. It is usually the interest rate on the unrecovered balance of an investment that becomes zero at the end of the useful life or the study period. The rate of return is represented by "ir".

Using present worth method, equation for the rate of return maybe written as follows:

PWc = PW1 ...(1)

Where,

PWc = Present worth of cash outflows (cost or expenditure)

PWi = Present worth of cash inflows (income or revenue)

Cost or expenditures are taken as the negative cash flows whereas the income or revenues are taken as the positive cash flows.

Equation (1) may be rewritten as,

0 = − PWc + PW1 ...(2)

The net present worth in the above equation is zero.

Now putting the expressions for the present worth of cash outflows and that of cash inflows in equation (1) results in the following expression.

$$P_o + F_C(P/F, i_r, n) + A_C(P/A, i_r, n) = F_I(P/F, i_r, n) + A_I(P/A, i_r, n) \quad \text{...(3)}$$

On left hand side of the above equation, P_o is the initial cost at time zero and F_c (single amount) and A_c (uniform amount series) are the expenditures occurring at future period of time. Similarly on the right hand side of the equation, F_I (single amount) and A_I (uniform amount series) are the incomes or revenues occurring at future period of time. The value of interest period 'n' will vary depending upon the occurrence of the future amounts (either expenditure or income).

$$0 = -\left[P_o + F_C(P/F, i_r, n) + A_C(P/A, i_r, n)\right] + \left[F_I(P/F, i_r, n) + A_I(P/A, i_r, n)\right] \ldots(4)$$

The value of rate of return 'ir' can be calculated by solving the above equation. The equation (4) can be solved either manually through the trial and error process or using Microsoft Excel spreadsheet.

The first method is the trial and error process for the determination of the rate of return eats more time whereas the second method is faster. But , the trial and error method gives clear understanding of the analysis of calculation for rate of return. Same like its equivalent present worth, the rate of return may also be determined by finding out interest rate at which the net future worth or net annual worth is zero.

After the determination of the rate of return for a given alternative, it is compared with the minimum attractive rate of return (MARR) to determine the acceptability of this alternative for the project. If the rate of return i.e. "ir" is larger than or equal to MARR, then alternative will be selected or else it won't be selected.

The MARR is the minimum rate of return from investment, which is acceptable. It is the minimum rate of return below which investment alternatives are not economically acceptable. The minimum attractive rate of return (MARR) serves as important criteria while selecting the single alternative or comparing the mutually exclusive alternatives whenever the investments are made.

For an organization, it is governed by various parameters namely the availability of the financially viable projects, amount of fund available for investment with the associated risk and type of organization.

An intuitive definition of the rate of return (ROR) is the effective annual interest rate at which an investment accrues income. That is, the rate of return of an investment is the interest rate which yield the identical profits if all money was invested at that rate. Although this definition is correct, it does not provide the method of determining the rate of return. The present worth of a $100 investment invested at 5% is zero, when i = 5% is used to determine the equivalence. Therefore, a working definition of rate of return would be the effective annual interest rate that makes the present worth of the investment zero. Alternatively, the rate of return could be defined as the effective annual interest rate that makes the benefits and costs equal.

A company may not know what the effective interest rate, i, to use in the engineering economic analysis. In such a case, the company can establish a minimum level of economic performance that it would like to realize on all the investments. This criterion is termed as the minimum attractive rate of return or MARR.

Once a rate of return for an investment is known, it may be compared with the minimum attractive rate of return. If the rate of return is equal to or exceeds the minimum attractive rate of return, the investment is qualified. This is basis for rate of return method of alternative viability analysis.

If rate of return is used to select among two or more investments, an incremental analysis should be performed. An incremental analysis starts by ranking the alternatives in order of increasing initial investment. Then, cash flows for the investment with lower initial cost are subtracted from the cash flows for the higher-priced alternative on year-by-year basis. This produces the third alternative representing the costs and benefits of added investment. The added expense of higher-priced investment is not warranted unless the rate of return of this third alternative exceeds the minimum attractive rate of return.

The alternative with the higher initial investment is superior if the incremental rate of return exceeds the minimum attractive rate of return. Finding the rate of return may be a long, iterative process, requiring either the interpolation or trial and error. The actual numerical value of rate of return is sometimes not needed; it is sufficient to know whether or not the rate of return exceeds the minimum attractive rate of return analysis may be accomplished without calculating the rate of returns simp1y by finding the present worth of the investment using minimum attractive rate of return as effective interest rate .

If the present worth is zero or positive, the investment is qualified. If the present worth is negative, the rate of return is less than the minimum attractive rate of return and the additional investment is not warranted. The present worth, annual cost and the rate of return methods of comparing the alternatives yield equivalent results, but they are distinctly different approaches.

Both present worth and annual cost methods can use either the effective interest rates or the minimum attractive rate of return to rank the alternatives or compare them to MARR. If the incremental rate of return of pairs of alternatives are compared with MARR, the analysis is taken as a rate of return analysis.

The rate of return of a cash flow pattern is the interest rate at which the present worth of that cash flow pattern reduces to zero.

In this method of comparison, the rate of return for each alternative is computed. Then the alternative which has the highest rate of return is selected as the best alternative.

A generalized cash flow diagram to demonstrate the rate of return method of comparison is presented in figure.
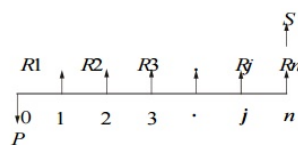
Generalized cash flow

In the above cash flow diagram, P represents an initial investment, Rj the net revenue at the end of the jth year, and S the salvage value at the end of the nth year.

The first step is to find the net present worth of the cash flow diagram using the following expression at a given interest rate, i.

$$PW(i) = -P + R1/(1 + i)^1 + R2/(1 + i)^2 + ... + Rj/(1 + i)^j + ... + Rn/(1 + i)^n + S/(1 + i)^n$$

Problems

Present worth method (Revenue dominated cash flow diagram):

1. Alpha Industry is planning to expand its production operation. It identified the three different technologies for meeting the goal. The initial outlay and annual revenues with respect to each of the technologies are summarized in the below table. Let us suggest the best technology which is to be implemented based on the present worth method of comparison assuming 20% interest rate, compounded annually.

	Initial Outlay(RS.)	Annual Revenue(Rs.)	Life(Years)
Technology 1	12,00,000	4,00,000	10
Technology 2	20,00,000	6,00,000	10
Technology 3	18,00,000	5,00,000	10

Solution:

Given:

	Initial Outlay(RS.)	Annual Revenue(Rs.)	Life(Years)
Technology 1	12,00,000	4,00,000	10
Technology 2	20,00,000	6,00,000	10
Technology 3	18,00,000	5,00,000	10

In all the technologies, the initial outlay is assigned a negative sign and the annual revenues are assigned a positive sign.

Technology 1:

Initial outlay, P = Rs. 12,00,000

Annual revenue, A = Rs. 4,00,000

Interest rate, i = 20%, compounded annually

Life of this technology, n = 10 years,

The cash flow diagram of this technology is as shown in figure,

Cashflow for Technology 1

The present worth expression for this technology is obtained as,

PW(20%)$_1$ = −12,00,000 + 4,00,000 (P/A, 20%, 10)

= −12,00,000 + 4,00,000 (4.1925)

= −12,00,000 + 16,77,000

= Rs. 4,77,000

Technology 2:

Initial outlay, P = Rs.20,00,000

Annual revenue, A = Rs.6,00,000

Interest rate, i = 20%, compounded annually

Life of this technology, n = 10 years

The cash flow diagram of this technology is shown in figure.

Cashflow for Technology 2

The present worth expression for this technology is given by,

PW(20%)$_2$ = − 20,00,000 + 6,00,000 (P/A, 20%, 10)

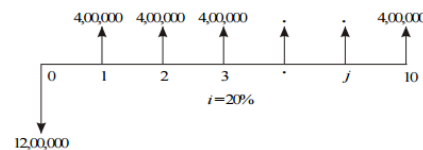= − 20,00,000 + 6,00,000 (4.1925)

= − 20,00,000 + 25,15,500

= Rs. 5,15,500

Technology 3:

Initial outlay, P = Rs.18,00,000

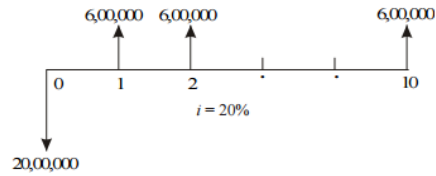Annual revenue, A = Rs.5,00,000

Interest rate, i = 20%,compounded annually

Life of this technology, n = 10 years

The cash flow diagram of this technology is shown in figure.
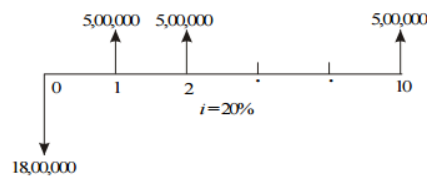
Cashflow for Technology 3

The present worth expression for this technology is given by,

PW(20%)$_3$ = −18,00,000 + 5,00,000 (P/A, 20%, 10)

= −18,00,000 + 5,00,000 (4.1925)

= −18,00,000 + 20,96,250

= Rs. 2,96,250

From the above calculations, we can understand that the present worth of technology 2 is the highest among all the technologies. Therefore, technology 2 is suggested for the implementation to expand the production.

Future worth method (Revenue dominated cash flow diagram, Cost dominated cash flow diagram):

2. Consider the following two mutually exclusive alternatives.

End of Year					
Alternative	0	1	2	3	4
A(Rs.)	-50,00,000	20,00,000	20,00,000	20,00,000	20,00,000
B(Rs.)	-45,00,000	18,00,000	18,00,000	18,00,000	18,00,000

At i = 18%, let us select the best alternative based on the future worth method of comparison.

Solution:

Given:

End of Year					
Alternative	0	1	2	3	4
A(Rs.)	-50,00,000	20,00,000	20,00,000	20,00,000	20,00,000
B(Rs.)	-45,00,000	18,00,000	18,00,000	18,00,000	18,00,000

Alternative A:

Initial investment, P = Rs.50,00,000

The annual equivalent revenue, A = Rs.20,00,000

Interest rate, i = 18%, compounded annually

Life of alternative A = 4 years

The cashflow diagram of alternative A is shown in the below figure.
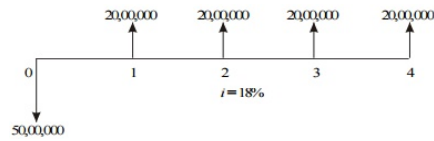
Cashflow for alternative A

The future worth amount of alternative B is computed as

$FW_{A}(18\%) = -50,00,000(F/P, 18\%, 4) + 20,00,000(F/A, 18\%, 4)$

$= -50,00,000(1.939) + 20,00,000(5.215)$

= Rs.7,35,000

Alternative B:

Initial investment, P = Rs.45,00,000

Annual equivalent revenue, A = Rs.18,00,000

Interest rate, i = 18%, compounded annually

Life of alternative B = 4 years

The cash flow diagram of alternative B is illustrated in the figure.
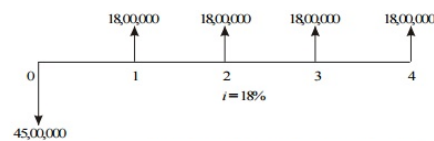
Cashflow for alternative B

The future worth amount of alternative B is computed as given by,

$FW_{B}(18\%) = -45,00,000(F/P, 18\%, 4) + 18,00,000(F/A, 18\%, 4)$

$= -45,00,000(1.939) + 18,00,000(5.215)$

= Rs.6,61,500

Annual equivalent method (Revenue dominated cash flow diagram, Cost dominated cash flow diagram):

3. A company provides the car to its chief executive. The owner of the company is concerned about increasing cost of the petrol. The cost per liter of petrol for the first year of operation is Rs.21. He feels that the cost of the petrol will be increasing by Re.1 every year. His experience with his company car indicates that it averages 9km per liter of petrol. The executive expects to drive an average of 20,000km each year for the next four years.

Let us determine the annual equivalent cost of fuel over this period of time. If he is offered similar service with the same quality on the rental basis at Rs.60,000 per year, should the owner continue to provide company car for his executive or alternatively provide a rental car to his executive. Assume i = 18%. If the rental car is preferred, then the company car will find some other use within the company.

Solution:

Given data:

Average number of km run/year = 20,000km

Number of km/liter of petrol = 9 km

Therefore,

Petrol consumption/year = 20,000/9 = 2222.2 liter

Cost/liter of petrol for the 1st year = Rs. 21

Cost/liter of petrol for the 2nd year = Rs. 21.00 + Re. 1.00 = Rs.22.00

Cost/liter of petrol for the 3rd year = Rs. 22.00 + Re. 1.00 = Rs. 23.00

Cost/liter of petrol for the 4th year = Rs. 23.00+ Re. 1.00 = Rs. 24.00

Fuel expenditure for 1st year = 2222.2 21 = Rs. 46,666.20

Fuel expenditure for 2nd year = 2222.2 22 = Rs. 48,888.40

Fuel expenditure for 3rd year = 2222.2 23 = Rs. 51,110.60

Fuel expenditure for 4th year = 2222.2 24 = Rs. 53,332.80

The annual equal increment of the above expenditures is Rs.2,222.20(G).

The cashflow diagram for this situation is depicted in figure
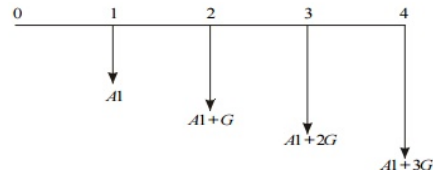
Uniform gradient series cashflow

A_1 = Rs.46,666.20 and G = Rs.2,222.20

A = A_1 + G(A/G,18%, 4)

= 46,666.20+ 2222.2(1.2947)

= Rs. 49,543.28

The proposal of using the company car by spending the petrol by the company will cost an annual equivalent amount of Rs.49,543.28 for four years. This amount is less than the annual rental value of Rs.60,000. Thus, the company should continue to provide its own car to its executive.

Rate of return method:

4. A person is planning a new business. The initial outlay and cash flow pattern for the new business areas are listed below. The expected life of the business is five years. Let us determine the rate of return for the new business.

period	0	1	2	3	4	5
Cash flow (Rs)	-1,00,000	30,000	30,000	30,000	30,000	30,000

Solution:

Given data:

Initial investment = Rs.1,00,000

Annual equal revenue = Rs.30,000

Life = 5years
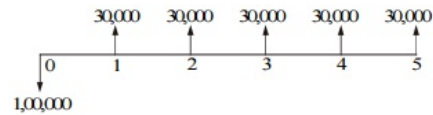
Cash flow diagram

The present worth function for the business is given by,

PW(i) = –1,00,000 + 30,000(P/A, i, 5)

When i =10 %,

PW(10%) = -1,00,000 + 30,000(P/A, 10%, 5)

= -1,00,000 + 30,000(3.7908)

= Rs. 13,724

When i = 15 %,

PW(15%) = -1,00,000 + 30,000(P/A, 15%, 5)

= -1,00,000 + 30,000(3.3522)

= Rs. 566

When i = 18 %,

PW(18%) = -1,00,000 + 30,000(P/A, 18%, 5)

= -1,00,000 + 30,000(3.1272)

= Rs. -6,184

$$i = 15\% + \frac{566 - 0}{566 - (-6184)} \ (3\%)$$

= 15% + 0.252 % = 15.252 %

3.2.4 Cost-benefit analysis in public projects

Cost-Benefit Analysis (CBA) is an analytical tool for judging economic advantages or disadvantages of an investment decision by assessing its costs and benefits in order to assess welfare change attributable to it.

The analytical framework of CBA refers to a list of underlying concepts which is as follows:

• **Opportunity cost.** The opportunity cost of a good or service refers to the potential gain from best alternative forgone.

When a choice requires to be made between several mutually exclusive alternatives. The rationale of CBA lies in the observation

That investment decisions taken on the basis of profit motivations and price mechanisms lead, in some circumstances (e.g.market failures such as asymmetry of information, externalities, public goods, etc.), to socially undesirable outcomes.

On the contrary,when input, output and external effects of an investment project are valued at their social opportunity costs, the return obtained is a proper measure of the project's contribution to social welfare.

• **Long-term perspective.** A long-term outlook is followed, ranging from a minimum of 10 to a maximum of 30 years or more, depending on sector of intervention. Thus it is necessary to:

Take into account uncertainty by assessing the project's risks.

Forecast future costs and benefits (looking forward);

Set a proper time horizon;

Adopt appropriate discount rates to calculate the present value of future costs and benefits;

The main application is for project appraisal in the ex-ante phase, CBA can also be used for in medias res and ex post evaluation.

• **Calculation of economic performance indicators expressed in monetary terms.**

CBA is based on a set of predetermined project objectives, giving a monetary value to all the positive (benefits) and negative (costs) welfare effects of the intervention. These values are discounted and then total in order to calculate a net total benefit. The project overall performance is measured by indicators, namely the Economic Net Present Value (ENPV), expressed in monetary values and the Economic Rate of Return (ERR), allowing comparability and ranking for competing projects or alternatives.

• **Microeconomic approach.** CBA is typically a microeconomic approach enabling the assessment of the project's impact on society as a whole via the calculation of economic performance indicators, thereby providing an assessment of expected welfare changes. While direct employment or external environmental effects realised by the project are reflected in the ENPV, indirect (i.e. on secondary markets) and wider effects (i.e. on public funds, employment, regional growth, etc.) should be excluded. This is for two main reasons:

Most indirect and wider effects are usually transformed, redistributed and capitalised forms of direct effects, thus, the need to limit the potential for benefits double-counting.

There remains little practice on how to translate them into robust techniques for project appraisal, thus the need to avoid the analysis relies on assumptions whose reliability is difficult to check.

It is recommended, however, to provide a qualitative description of these impacts to better explain the contribution of the project to the EU regional policy goals.

• **Incremental approach.** CBA compares a scenario with-the-project with a counterfactual baseline scenario without-the-project. The incremental approach requires that: A counterfactual scenario is defined as what would happen in the absence of the project. For this scenario, projections

are made of all cash flows related to the operations in the project area for each year during the project lifetime. In cases where a project consists of a completely new asset, e.g. there is no pre-existing service or infrastructure, the without the project scenario is one with no operations. In cases of investments aimed at improving an already existing facility, it should include the costs and the revenues/benefits to operate and maintain the service at a level that it is still operable (Business As Usual (BAU)) or even small adaptation investments that were programmed to take place anyway. In particular, it is recommended to carry out an analysis of the promoter's historical cash-flows as a basis for projections, where relevant. The choice between BAU or do-minimum as counterfactual should be made case by case, on the basis of the evidence about the most feasible and likely, situation.

If uncertainty exists, the BAU scenario shall be adopted as a rule of thumb. If do-minimum is used as counterfactual, this scenario should be both feasible and credible and not cause undue and unrealistic additional benefits or costs. As illustrated in the box below the choice made may have important implications on the results of the analysis;

Secondly, projections of cash-flows are made for the situation with the proposed project. This takes into account all the investment, financial and economic costs and benefits resulting from the project. In cases of pre-existing infrastructure, it is recommended to carry out an analysis of historical costs and revenues of the beneficiary (at least three previous years) as a basis for the financial projections of the with-project scenario and as a reference for the without-project scenario, otherwise the incremental analysis is very vulnerable to manipulation;

Finally, the CBA only considers the difference between the cash flows in the with-the-project and the counterfactual scenarios. The financial and economic performance indicators are calculated on the incremental cash flows only.

The rest of the presents conceptual framework of a standard CBA15, i.e. the 'steps' for project appraisal, enriched with focuses, didactical examples or shortcuts, presented in boxes, to support the comprehension and practical application of the steps proposed. At the end of each section, a review of good practices and common mistakes drawn from empirical literature, ex-post evaluations and experience gained from major projects funded during the 2007-13 programming period, is also illustrated.

Identification Of The Project

The presented the legal basis for the definition of a project. Here, some analytical issues involved in project identification are developed. In particular, a project is clearly identified when:

• The physical elements and the activities that will be implemented to provide a given good or service and to achieve a well-defined set of objectives, consist of a self-sufficient unit of analysis;

• The body responsible for implementation (often referred to as 'project promoter' or 'beneficiary') is identified and its technical, financial and institutional capacities analysed; and

• The impact area, the final beneficiaries and all relevant stakeholders are duly identified **Physical elements and activities**

A project is defined as 'as a series of works, activities or services intended in itself to accomplish an indivisible task of a precise economic or technical nature which has clearly identified goals' (Article 100 (Content) of Regulation (EU) No 1303/2013). These works, activities or services should be instrumental in the achievement of the previously defined objectives.

A description of the type of infrastructure (railway line, power plant, broadband, waste water treatment plant, etc.), type of intervention (new construction, rehabilitation, upgrade, etc.), service provided (cargo traffic, urban solid waste management, access to broadband for businesses, cultural activities, etc.) and location should be provided in order to define the project activities

In this regard, the key aspect is that appraisal needs to focus on the whole project as a self-sufficient unit of analysis, which is to say that no essential feature or component is left outside the scope of the appraisal (under-scaling). For example, if there are no connecting roads for waste delivery, a new landfill will not be operational. In that case, both the landfill and the connecting roads are to be considered as a unique project.

In general, a project can be defined as technically self-sufficient if it is possible to produce a functionally complete infrastructure and put a service into operation without dependence on other new investments. At the same time, including components in the project that are not essential to provide the service under consideration should be avoided (over-scaling).

The Body Responsible For Project Implementation

The project owner, i.e. the body responsible for project implementation, should be identified and described in terms of its technical, financial and institutional capacity. The technical capacity refers to the relevant staff resources and staff expertise available within the organisation of the project promoter and allocated to the project to manage its implementation and subsequent operation. In the case of the need to recruit additional staff, evidence should be provided that no constraints exist to find the necessary skills on the local labour market. The financial capacity refers to the financial standing of the body,

which should demonstrate that it is able to guarantee adequate funding both during implementation and operations. This is particularly important when the project is expected to

require substantial cash inflow for working capital or other financial imbalances (e.g. medium-long term loan, clearing cycle of VAT, etc.).

The institutional capacity refers to all the institutional arrangements needed to implement and operate the project [e.g. set up of a Project Implementation Unit (PIU)] including the legal and contractual issues for project licensing. Where necessary, special external technical assistance may need to be foreseen and included in the project. When the infrastructure owner and its operator are different, a description of the operating company or agency who will manage the infrastructure (if already known) and its legal status, the criteria used for its selection and the contractual arrangements foreseen between the partners, including the funding mechanisms (e.g. collection of tariffs and service fees, presence of government subsides), should be provided.

3.3 Depreciation

Any equipment which is purchased today will not work for ever. This may be due to the wear and tear of the equipment of technology. Hence, it can be replaced at the proper time for continuance of any business.

The replacement of the equipment at the end of its life involves money. This must be internally generated from the earnings of the equipment.

The recovery of the money from the earnings of an equipment for its replacement purpose is known as depreciation fund since we make an assumption that the value of the equipment decreases with the passage of the time. Hence, the word depreciation means decrease in the value of any physical asset with the passage of time.

Hence , the policy must include the following:

(1) To select appropriate method of depreciation.

(2) To review the current provision for the depreciation whether there is any under provision for the depreciation or over provision for depreciation.

(3) To evaluate existing policy of depreciation from the stand point of tax consideration

(4) To constitute committee for the "Depreciation Policy"

(5) To ascertain the proper amount of depreciation and its recording procedure

(6) To disclose policy of depreciation in published annual report for benefit of shareholders, outsiders etc.

The depreciation policy to be followed in an organization is decided at the peak level. Depreciation policy relates to the choice of method of depreciation and its suitability for the organization. Various methods may be evaluated in the light of many factors like effect of obsolescence, repairs and the maintenance, future operating efficiency of asset in use, service cost of asset, etc.

Objectives of Depreciation Policy:

The management has to consider the following objectives while framing a proper depreciation policy:

(a) To determine the correct profit.

(b) Creating funds to replace the asset in future.

(c) Sometimes to create a source of fund for working capital.

(d)To recover the cost of fixed assets before its effective life.

(e) Following a uniform rate of return.

(f) To take advantages of tax benefit.

Any equipment which is purchased today will not work for ever. This may be due to the wear and tear of the equipment of technology. Hence, it can be replaced at the proper time for continuance of any business.

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The recovery of the money from the earnings of an equipment for its replacement purpose is known as depreciation fund since we make an assumption that the value of the equipment decreases with the passage of the time. Hence, the word depreciation means decrease in the value of any physical asset with the passage of time.

There are several methods of accounting depreciation fund. These are as follows:

1. Straight line method of depreciation

2. Declining balance method of depreciation

3. Sum of the years -digits method of depreciation

4. Sinking-fund method of depreciation

5. Service output method of depreciation

Inputs to Depreciation Accounting

There are three factors to consider when we calculate depreciation, which are:

1. Useful life:

This is the time period over which the company expects that the asset will be productive. It is no longer cost-effective to continue operating the asset, so it is expected that the company will dispose it of. Depreciation is recognized over the useful life of an asset.

2. Salvage value:

When a company eventually disposes of an asset, it may be able to sell it for some reduced amount, which is the salvage value. Depreciation is calculated based on the asset cost, less any estimated salvage value. If salvage value is expected to be quite small, then it is generally ignored for the purpose of calculating depreciation.

3. Depreciation method:

We can calculate depreciation expense using an accelerated depreciation method or evenly over the useful life of the asset. The advantage of using an accelerated method is that we can recognize more depreciation early in the life of a fixed asset, which defers some income tax expense recognition into a later period. The advantage of using a steady depreciation rate is the ease of calculation.

Examples of accelerated depreciation methods are the declining balance and sum-of-the-years digits methods. The primary method for steady depreciation is the straight-line method. The units of production method is also available if we want to depreciate an asset based on its actual usage level as, is commonly done with airplane engines that have specific life spans tied to their usage levels.

In midway through the useful life of an asset, we expect its useful life or the salvage value to change, we should incorporate the alteration into the calculation of depreciation over the remaining life of the asset, do not retrospectively change any depreciation that has already been recorded.

Depreciation Journal Entries

When we record depreciation, it is a debit to the Depreciation Expense account and a credit to the Accumulated Depreciation account. The Accumulated Depreciation account is a contra account, which means that it appears on the balance sheet as a deduction from the original purchase price of an asset.

Once we dispose of an asset, we credit the Fixed Asset account in which the asset was originally recorded and debit the Accumulated Depreciation account, thereby flushing the asset out of the balance sheet. If an asset was not fully depreciated at the time of its disposal, it will also be necessary to record a loss on undepreciated portion. This loss will be reduced by any proceeds from sale of the asset.

Other Depreciation issues

Depreciation has nothing to do with the market value of a fixed asset, which may vary considerably from the net cost of the asset at any given time.

Depreciation is a major issue in the calculation of a company's cash flows, because it is included in the calculation of net income, but does not involve any cash flow. Thus, a cash flow analysis calls for the inclusion of net income, with an add-back for any depreciation recognized as expense during the period.

3.3.1 Depreciation of capital assets

Depreciation is the systematic reduction in the recorded cost of a fixed asset. Examples of fixed assets that can be depreciated are buildings, furniture, leasehold improvements and office equipment. The only exception is land, which is not depreciated (since land is not depleted over time, with the exception of natural resources). The reason for using depreciation is to match a

portion of the cost of a fixed asset to the revenue that it generates; this is mandated under the matching principle, where we record revenues with their associated expenses in the same reporting period in order to give a complete picture of the results of a revenue-generating transaction. The net effect of depreciation is a gradual decline in the reported carrying amount of fixed assets on the balance sheet.

It is very difficult to directly link a fixed asset with a revenue-generating activity, so we do not try - instead, we incur a steady amount of depreciation over the useful life of each fixed asset, so that the remaining cost of the asset on the company's records at the end of its useful life is only its salvage value.

Inputs to Depreciation Accounting

There are three factors to take when we calculate depreciation.They are.,:

Useful life: This is the time period over which the company expects that asset will be productive. It is no longer cost-effective to continue operating the asset, so it is expected that the company will dispose of asset. Depreciation is remembered over the useful life of an asset.

Salvage value: When a company eventually disposes of an asset, it can able to sell it for some reduced amount, which is salvage value. Depreciation is calculated based on the asset cost, less any estimated salvage value. If the salvage value is expected to be quite small, then it is basically ignored for the purpose of calculating the depreciation.

Depreciation method

We may calculate depreciation expense using an accelerated depreciation method or evenly over the useful life of the asset. The advantage of using an accelerated method is that we may recognize more depreciation early in the life of a fixed asset, that postpones some income tax expense recognition into a later period. The advantage of using a steady depreciation rate is the ease of calculation. Examples of the accelerated depreciation methods are declining balance and sum-of-the-years digits methods. The primary method for the steady depreciation is the straight-line method. The units of production method is available if we want to depreciate an asset based on its actual usage level, as is commonly done with the airplane engines that have specific life spans tied to their usage levels.

If, midway through useful life of an asset, we expect its useful life or the salvage value to change, we must incorporate the alteration into the calculation of depreciation over the remaining life of the asset; looking back does not change any depreciation which has already been recorded

Depreciation Journal Entries

When we record depreciation, it is a debit to the Depreciation Expense account and a credit to the Accumulated Depreciation account. The Accumulated Depreciation account is a contra account, which implies that it appears on the balance sheet as a deduction from original purchase price of an asset.

Once we dispose of an asset, we credit the Fixed Asset account where the asset was originally recorded and debit the Accumulated Depreciation account, thereby flushing asset out of the balance sheet. If an asset was not fully depreciated at the time of its disposal, it may also be required to record a loss on undepreciated portion. This loss might be reduced by any proceeds from the sale of asset.

Other Depreciation Issues

The market value of a fixed asset may vary considerably from the net cost of the asset at any given time.

Depreciation is a major issue in the calculation of a company's cash flows, as it is included in the calculation of net income, but does not involve any cash flow. Therefore, a cash flow analysis calls for the inclusion of net income, with an add-back for any depreciation recognized as the expense during the period.

3.3.2 Causes of depreciation

1. Wear And Tear

Wear and tear refer to a decline in the efficiency of asset due to its constant use. When an asset losses its efficiency, its value goes down and depreciation arises. This is true in case of tangible assets like plant and machinery, furniture, building, tools and equipment used in the factory.

2. Effusion Of Time

The value of asset may decrease due to passage of time even if it is not in use. There are some intangible fixed assets like copyright, patent right and lease hold premises that decrease its value as time elapse.

3. Exhaustion

An asset may sometimes lose its value because of exhaustion too. This is the case with wasting assets like mines, quarries, oil-wells and forest-stand. On account of continuous extraction, a stage will come where the mines and oil-wells gets completely exhausted.

4. Obsolescence

Changes in fashion are the external factors that are responsible for throwing out of assets even if those are in good condition. For example black and white televisions have become outdated with the introduction of color TVs, the users have discarded black and white TVs even when they are in good condition. Such as loss on account of new invention or changed fashions is termed as obsolescence.

5. Other Causes

Market value and accident of an asset are other causes of depreciation which decrease in the value of assets.

Accountants rightly do not differentiate between the physical deterioration and the obsolescence and are not interested in identifying specific causes of depreciation for determining the amount of depreciation. These and other causes are only helpful in estimating an asset's useful life in which the accountants are interested because the useful life of an asset is used to measure amount of depreciation.

3.3.3 Methods of calculating depreciation (Straight line method, Declining balance method)

Straight line method of depreciation

Straight line depreciation is the default method used to gradually reduce the carrying amount of a fixed asset over its useful life. The method is designed to reflect the consumption pattern of the underlying asset and is used when there is no particular pattern to the manner in which the asset is to be used over time. Use of the straight-line method is highly recommended, since it is the easiest depreciation method to calculate which results in few calculation errors.

Under the straight-line method of depreciation, recognize the depreciation expense evenly over the estimated useful life of an asset.

The straight-line calculation steps are:

1. Determine the initial cost of the asset that has been recognized as a fixed asset.

2. Subtract the estimated salvage value of the asset from the amount at which it is recorded on the books.

3. Determine the estimated useful life of the asset. It is easiest to use a standard useful life for each class of assets.

4. Divide the estimated useful life into 1 to arrive at the straight-line depreciation rate.

5. Multiply the depreciation rate by the asset cost.

In this method of depreciation, a fixed sum is charged as the depreciation amount throughout the lifetime of an asset such that the accumulated sum at the end of the life of the asset is exactly equal to the purchase value of the asset.

Here, we make an important assumption that inflation is absent.

Let,

P = First cost of the asset

F = Salvage value of the asset

n = Life of the asset

B_t = Book value of the asset at the end of the period t

D_t = Depreciation amount for the period t.

The formula for depreciation are as follows:

$D_t = (P - F)/n$

$B_t = B_t - 1 - D_t = P - t\ [(P-F)/n]$

Declining balance method of depreciation

In this method of depreciation, a constant percentage of the book value of the previous period of the asset will be charged as the depreciation amount for the current period. This approach is a realistic approach, since the depreciation charge decreases with the life of the asset which matches with the earning potential of the asset. The book value at the end of the life of the asset may not be exactly equal to the salvage value of the asset. This is the major limitation of this approach.

Let,

P = First cost of the asset

F = Salvage value of the asset

n = Life of the asset

B_t = Book value of the asset at the end of the period t

K = A fixed percentage

D_t = Depreciation amount at the end of the period t.

The formula for depreciation and its book value are as follows:

$D_t = K\ B^{t-1}$

$B_t = B^{t-1} - D_t = B^{t-1} - K\ B^{t-1}$

$= (1 - K)\ B^{t-1}$

The formula for depreciation and the book value in terms of P are as follows:

$D_t = K(1 - K)^{t-1}$

$P\ B_t = (1-K)^t$

While availing income-tax exception for the depreciation amount paid in each year, the rate K is limited to 2/n. If this rate is used, then the corresponding approach is termed as the double declining balance method of depreciation.

3.3.4 After tax comparison of project

Estimation of cash flows is based on the following principles:

1. All costs and benefits are measured in terms of cash flows. Non-cash charges like depreciation which arc considered for the purpose of determining the profit after tax are added back to the profit after tax to obtain the net cash flow.

2. Net cash flows are those that accrue after paying tax. Cash flows arc defined in post-tax terms.

3. Cash flows are measured in incremental terms. Only the increments that occur in the present level of costs and benefits on account of the project are considered relevant.

Cash flows have three basic components:

(a) Initial investment: This includes the cost of the project plus the working capital required for operations. In case of a replacement project, the after tax salvage value realized from the disposal of the old asset and the net working capital required for operation of the old asset is deducted in keeping with the principle of measuring cash flows in incremental terms.

(b) Operating cash flows: These constitute the after tax cash flows obtained from operating the assets created by the project. In case of a replacement project, the operating cash flows from the old asset, had it not been replaced. are deducted.

(c) Terminal cash flow: This consists of the after tax salvage value of the assets and the recovery of net working capital associated with it. In case of a replacement project, the after tax salvage value, had the asset not been replaced. and the recovery of net working capital associated with the old asset is deducted.

NPV and Taxes

Net present value (NPV) is a technique used in capital budgeting to find out whether a project will add value or not. It involves finding future cash flows of an option and discounting them to find their present worth and comparing it to the initial outlay required.

Any calculation of net present value is incomplete if we ignore the income tax implications of the project. This is because governments in most of the countries collect tax from companies, which is based on the profits they generate. Taxes eat away a company's profits and cash flows.

Taxes affect a net present calculation in two ways: first, they affect periodic operating cash flows; second, they affect the final salvage value of the project because any gain or loss on sale carries tax implications. Adjustment for taxes involves calculating after-tax net cash flows and after-tax salvage value (also called terminal value).

Formula: after-tax net cash flows

The complexity in net present value calculation due to taxes arises from the simple fact that capital budgeting decisions are based on cash flows while income tax is calculated on net income. Net cash flows are different from net income because some expenses are non-cash such as depreciation, etc.

Following formulas are used in net present value calculation when there are tax implications.

After-tax net cash flows = (cash inflows – cash out flows) – income taxes

Income taxes = net income × tax rate

Where net income = cash inflows – cash out flows – non-cash expenses

Hence, income taxes = (cash inflows – cash out flows – non-cash expenses)×tax rate

After some algebraic manipulation, these formulas can be merged and simplified as follows:

After-tax net cash flows = cash inflows – cash outflows – (cash inflows – cash outflows – non-cash expenses) × tax rate

After-tax net cash flows = (cash inflows – cash outflows – non-cash expenses) × (1 – tax rate) + non-cash expenses

The increase in net cash flows due to decrease in taxes due to depreciation in called tax shield.

Formula: after-tax salvage value

After tax salvage value = cash proceeds – tax on gain or loss

Tax on gain on loss = (cash proceeds – book value) × tax rate

After-tax salvage value = cash proceeds – (cash proceeds – book value) × tax rate.

 Problems

1. A company has purchased an equipment whose first cost is Rs.1,00,000 with an Estimated life of eight years. The estimated salvage value of the equipment at the end of its lifetime is Rs.20,000. Let us determine the depreciation charge and book value at the end of various years using the straight line method of depreciation.

$\boxed{Solution:}$

Given:

P = Rs.1,00,000

F = Rs.20,000

n = 8 years

Formula to be used:

$D_t = (P - F)/n = (1,00,000 - 20,000)/8$

= Rs. 10,000

In this method of depreciation, the value of D_t is same for all the years. The calculations pertaining to B_t for different values of t are summarized in below table.

D_t and B_t Values under Straight line Method of Depreciation.

End of year (t)	Depreciation (D_t)	Book value ($B_t = B_{t-1} - D_t$)
0		100000
1	10000	90000
2	10000	80000
3	10000	70000
4	10000	60000
5	10000	50000
6	10000	40000
7	10000	30000
8	10000	20000

If we are interested in computing D_t and B_t for a specific period (t), the formula can be used. In this approach, it should be noted that the depreciation is the same for all the periods.

Let us compute the depreciation and the book value for period 5.

P = Rs. 1,00,000

F = Rs. 20,000

n= 8 years

$D_5 = (P - F)/n$

=(1,00,000 - 20,000)/8

= Rs. 10,000 (This is independent of the time period)

$B_t = p - t (P - F)/n$

B_5 = 1,00,000 - 5 (1,00,000 - 20,000)/8

= Rs. 50,000.

2. Let us demonstrate the calculations of the declining balance method of depreciation by assuming 0.2 for K.

Solution:

Given:

P = Rs.1,00,000

F = Rs.20,000

n = 8years

K = 0.2

Formula to be used:

$D_t = K B_{t-1}$

$B_t = B_{t-1} - D_t$

The calculations pertaining to D_t and B_t for different values of t are summarized in table using the following formula:

$D_t = K B_{t-1}$

$B_t = B_{t-1} - D_t$

D_t and B_t according to Declining Balance Method of Depreciation

End of year (n)	Depreciation (D_t)	Book value (B_t)
0		1,00,000.00
1	20,000.00	80,000.00
2	16,000.00	64,000.00
3	12,800.00	51,200.00
4	10,240.00	40,960.00
5	8,192.00	32,768.00
6	6,553.60	26,214.40
7	5,242.88	20,971.52
8	4,194.30	16,777.22

If we are interested in computing D_t and B_t for a specific period t, its respective formula can be used.

3. A4, Inc. is considering setting up a new paper mill at a cost of $100 million. It is expected to stay economical for 5 years after which the company expects to upgrade to a more efficient technology and sell it for $30 million.

Following is an extract from a report prepared by the marketing department and engineering department. All amounts are in million USD.

Year	1	2	3	4	5
Revenue inflows	90	85	80	70	60

| Costs outflows | 50 | 46 | 40 | 36 | 40 |

| Net cash flows before tax | 40 | 39 | 40 | 34 | 20 |

A tax rate of 30% is applicable to both income and gains and is not expected to change in 5 years. Tax code requires the company to depreciate the plant over 5 years with $10 million salvage value.

A discount rate of 8% is appropriate.

Let us calculate NPV. Consider tax implications.

Solution:

Given:

Tax rate = 30%

Discount rate = 8%

Year	1	2	3	4	5
Revenue inflows	90	85	80	70	60
Costs outflows	50	46	40	36	40
Net cash flows before tax	40	39	40	34	20

All amounts are in million USD.

Year	1	2	3	4	5
Revenue inflows	90.0	85.0	80.0	70.0	60.0
Costs outflows	- 50.0	46.0	40.0	36.0	40.0

Before tax net cash flows	40.0	39.0	40.0	34.0	20.0
Depreciation	- 18.0	18.0	18.0	18.0	18.0
Income before taxes21.022.016.02.0	22.0	21.0	22.0	16.0	2.0
Taxes @ 30%	- 6.6	6.3	6.6	4.8	0.6
After tax net income	15.4	14.7	15.4	11.2	1.4
Depreciation	+ 18.0	18.0	18.0	18.0	18.0
After-tax cash flows After-tax salvage value+	33.4	32.7	33.4	29.2	19.4
After-tax total net cash flows	33.4	32.7	33.4	29.2	43.4
Discount rate @ 8%	x 0.926	0.857	0.794	0.735	0.681
Present value of cash flows	30.9	28.0	26.5	21.5	29.5
Total present value	136.5				

After-tax salvage value included in the schedule above

= $30 million – ($30 million – $10 million) × 30%

= $24 million

Net present value

= present value of cash flows – initial outlay

= $136.5 million – $100 million

= $36.5 million.

Since the NPV is positive, the company should go ahead with the setup of paper mill.

Please note that we will get the same after-tax total net cash flows if we subtract taxes from before-tax cash flows directly (instead of finding net income and then adding non-cash items to arrive at after-tax cash flows). Calculation for Year 1 is illustrated below.

After-tax cash flows in Year 1

= before-tax cash flows – taxes

= $40 million – $6.6 million

= $33.4 million.