

## UNIT I

Micro and Macro Economics and its applications; Nature and scope of economics science; micro economics, Macro economics concept of equilibrium; Economic efficiency, Technical efficiency; Demand and Supply concepts; elasticity of demand and supply, Determination of demand, fixed cost, variable cost, average cost, marginal cost, opportunity cost; standard cost; concept of iso-quant; price of products, Break even analysis, Nature and functions of Money, National Income, GNP and savings, Inflation and deflation, Business cycles. Types and principles of management, Elements of Management; Planning, organizing, staffing, co-ordinating, etc Types of firm

### **Economics:**

Economics is the science that deals with the production and consumption of goods and services and the distribution and rendering of these for human welfare. The following are the economic goals;

- A high level of employment
- Price stability
- Efficiency
- An equitable distribution of income
- Growth

The field of economics is divided into two broad subfields: *macroeconomics* and *microeconomics*.

### **Macro Economics;**

Macroeconomics is the study of aggregate economic behavior. Macroeconomists are concerned with such issues as national income, employment, inflation, national output, economic growth, interest rates, and international trade.

Macroeconomics is the study of entire economies and economic systems and specifically considers such broad economic aggregates as gross domestic product, economic growth, national income, employment, unemployment, inflation, and international trade. In general, the topics covered in macroeconomics are concerned with the economic environment within which firm managers operate. For the most part, macroeconomics focuses on the variables over which the

managerial decision maker has little or no control but may be of considerable importance in the making of economic decisions at the micro level of the individual, firm, or industry.

### **Micro Economics;**

Microeconomics is the study of individual economic behavior. Micro economists are concerned with output and input markets, product pricing, input utilization, production costs, market structure, capital budgeting, profit maximization, production technology, and so on.

By contrast, microeconomics is the study of the behavior and interaction of individual economic agents. These economic agents represent individual firms, consumers, and governments. Microeconomics deals with such topics as profit maximization, utility maximization, revenue or sales maximization, *production efficiency*, market structure, capital budgeting, environmental protection, and governmental regulation.

## **CONCEPT OF ENGINEERING ECONOMICS**

Science is a field of study where the basic principles of different physical systems are formulated and tested. Engineering is the application of science. It establishes varied applications systems based on different scientific principles.

It is clear that price has a major role in deciding the demand and supply of the product. Hence from the organizations point of view, efficient and effective functioning of the organization would certainly help it to provide goods/services at a low cost which in turn will enable it to fix a lower price for its goods or services.

The following discusses the different types of efficiency and their impact on the operation of businesses and the definition and scope of engineering economics.

### **Types of Efficiency**

Efficiency of a system is generally defined as the ratio of its output to input. The efficiency can be classified into technical efficiency and economic efficiency.

#### **Technical Efficiency**

It is the ratio of the output to input of a physical system. The physical system may be a diesel engine, a machine working in a shop floor, furnace etc,

$$\text{Technical efficiency (\%)} = \frac{\text{Output}}{\text{Input}} \times 100$$

The technical efficiency of a diesel engine is as follows

$$\text{Technical efficiency (\%)} = \frac{\text{Heat equivalent of mechanical energy produced}}{\text{Heat equivalent of fuel used}} \times 100$$

In practice technical efficiency can never be more than 100% . This is mainly due to frictional loss and incomplete combustion of fuel, which are considered to be unavoidable phenomena in the working of a diesel engine.

### **Economic efficiency**

Economic efficiency is the ratio of output to input of a business system.

$$\text{Economic efficiency (\%)} = \frac{\text{Output}}{\text{Input}} \times 100 = \frac{\text{Worth}}{\text{Cost}} \times 100$$

Worth is the annual revenue generated by way of operating the business and cost is the total annual expenses incurred in carrying out the business. For the survival and growth of any business the economic efficiency should be more than 100%.

Economic efficiency is also called productivity. There are several ways of improving productivity.

- Increased output for the same input
- Decreased output for the same output
- By a proportionate increase in the output which is more than the proportionate increase in the input
- By a proportionate decrease in the input which is more than the proportionate decrease in the output
- Through simultaneous increase in the output with decrease in the input.

*Increased output for the same input.* In this strategy, the output is increased while keeping the input constant. Let us assume that in a steel plant, the layout of the existing facilities is not proper. By, slightly altering the location of the billet-making section., and bringing it closer to the furnace which produces hot metal , the scale formation at the top of ladles will be considerably reduced. The molten metal is usually carried in ladles to the billet-making section. In the long run, this would give more yield in terms of tonnes of billet produced. In this exercise, there is no extra cost involved. The only task is the relocation of the billet-making facility which involves an insignificant cost.

*Decreased input for the same output.* In this strategy, the input is decreased to produce the same output . let us assume that there exists a substitute raw material to manufacture a product and it is available at a lower price. If we can identify such a material and use it for manufacturing the product then certainly it will reduce the input. In this exercise, the job of the purchase department is to identify an alternate substitute material. The process of identification does not involve any extra cost. So, the productivity ratio will increase because of the decreased input by way of using cheaper raw materials to produce the same output.

*Less proportionate increase in output is more than that of the input.* consider the example of introducing a new product into the existing product mix of an organization. Let us assume that the existing facilities are not fully utilized and the R&D wing of the company has identified a new product which has a very good market and which can be manufactured with the surplus facilities of the organization. If the new product is taken up for production, it will lead to

- An increase in the revenue of the organization by way of selling the new product in addition to the existing product mix and
- An increase in the material cost and operation and maintenance cost of machineries because of producing the new product.

If we examine these two increases closely, the proportionate increase in the revenue will be more than the proportionate increase in the input cost. Hence, there will be a net increase in the productivity ratio.

*When proportionate decrease in input is more than that of the output.* let us consider the converse of the previous example, i.e dropping an uneconomical product from the existing product mix. This will result in the following:

- A decrease in the revenue of the organization
- A decrease in the material cost, and operation and maintenance cost of machinery

If we closely examine these two decreases, we will see that the proportionate decrease in the input cost will be more than the proportionate decrease in the revenue. Hence, there will be a net increase in the productivity ratio.

*Simultaneous increase in output and decrease in input.* let us assume that there are advanced automated technologies like robots and automated guided vehicle system (AGVS, available in the market which can be employed in the organization we are interested in. If we employ these modern tools, then:

- There will be drastic reduction in the operation cost, initially, the cost on equipment would be very high. But in the long run, the reduction in the operation cost would break-even the high initial investment and offer more savings on the input.
- These advanced facilities would help in producing more products because they do not experience fatigue. The increased production will yield more revenue.
- In this example in the long run, there is an increase in the revenue and a decrease in the input. hence, the productivity ratio will increase at a faster rate.

### **1.2.2 Definition and scope of engineering economics**

As stated earlier, efficient functioning of any business organization would enable it to provide goods/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 investment, operating and maintenance expenditures besides increasing the revenue, savings and other related gains of the organization.

#### **Definition**

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

#### **Scope**

The issues that covered in this book are elementary economic analysis, interest formulae, bases for comparing alternatives, present worth method, future worth method, annual equivalent method, rate of return method, replacement analysis, depreciation, evaluation of public alternatives, inflation adjusted investment decisions, make or buy decisions, inventory control, project management, value engineering and linear programming

## **CIRCULAR FLOW OF ECONOMIC ACTIVITY**

The individuals own or control resources which are necessary inputs for the firms in the production process. These resources (factors of production) are classified into four types.

**Land:** It includes all natural resources on the earth and below the earth. Non renewable resources such as oil, coal etc once used will never be replaced. It will not be available for our children. Renewable resources can be used and replaced and is not depleted with use.

**Labor:** is the work force of an economy. The value of the worker is called as human capital.

**Capital:** It is classified as working capital and fixed capital (not transformed into final products)

**Entrepreneurship:** It refers to the individuals who organize production and take risks.

All these resources are allocated in an effective manner to achieve the objectives of consumers (to maximize satisfaction), workers (to maximize wages), firms (to maximize the output and profit) and government (to maximize the welfare of the society).

The fundamental economic activities between households and firms are shown in the diagram. The circular flows of economic activities are explained in a clockwise and counterclockwise flow of goods and services.

The four sectors namely households, business, government and the rest of the world can also be considered to see the flow of economic activities. The circular flow of activity is a chain in which production creates income, income generates spending and spending in turn induces production.

The major four sectors of the economy are engaged in three economic activities of production, consumption and exchange of goods and services. These sectors are as follows:

**Households:** Households fulfill their needs and wants through purchase of goods and services from the firms. They are owners and suppliers of factors of production and in turn they receive income in the form of rent, wages and interest.

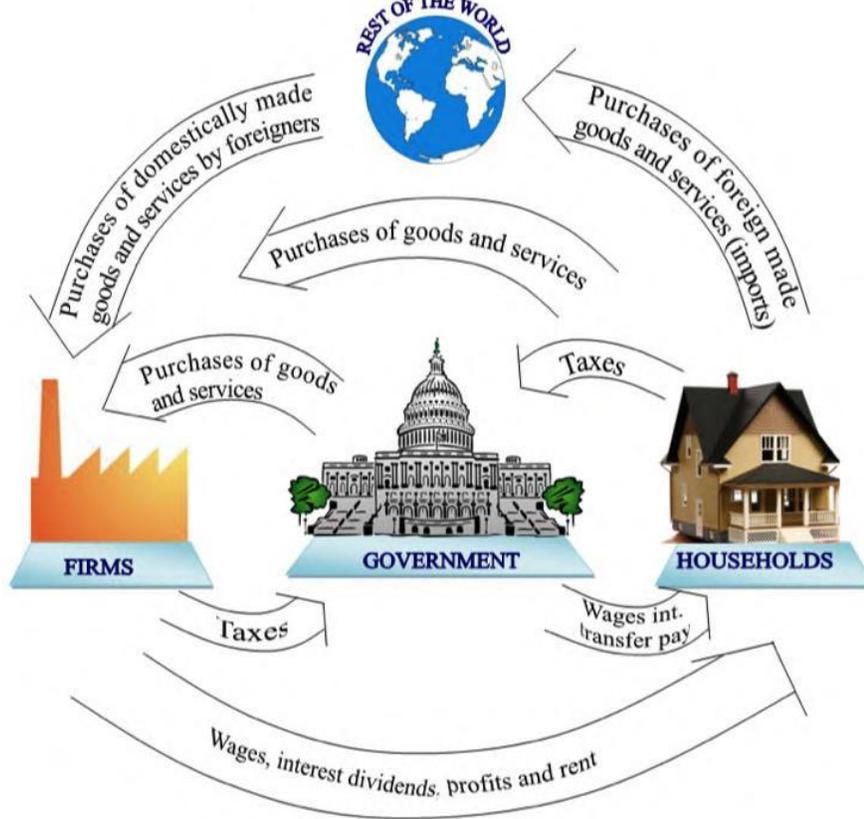
**Firms:** Firms employ the input factors to produce various goods and services and make payments to the households.

**Government:** The government purchases goods and services from firms and also factors of production from households by making payments.

**Foreign sector:** Households, firms and government of India purchase goods and services (import) from abroad and make payments. On the other hand all these sectors sell goods and services to various countries (export) and in turn receive payments from abroad

**Chart - 1**

**Circular Flow Of Economic Activity**



The above said four agents take economic decisions to produce goods and services and to exchange them and to consume them for satisfying the wants of the economy as a whole. Understanding the opportunities and constraints in the exchange is essential to take better decision in business. This is discussed in the forthcoming chapters in detail.

The economy comprises of the interaction of households, firms, government and other nations. Households own resources and supply factor services like land, raw material, labour and capital to the firms which helps them to produce goods and services.

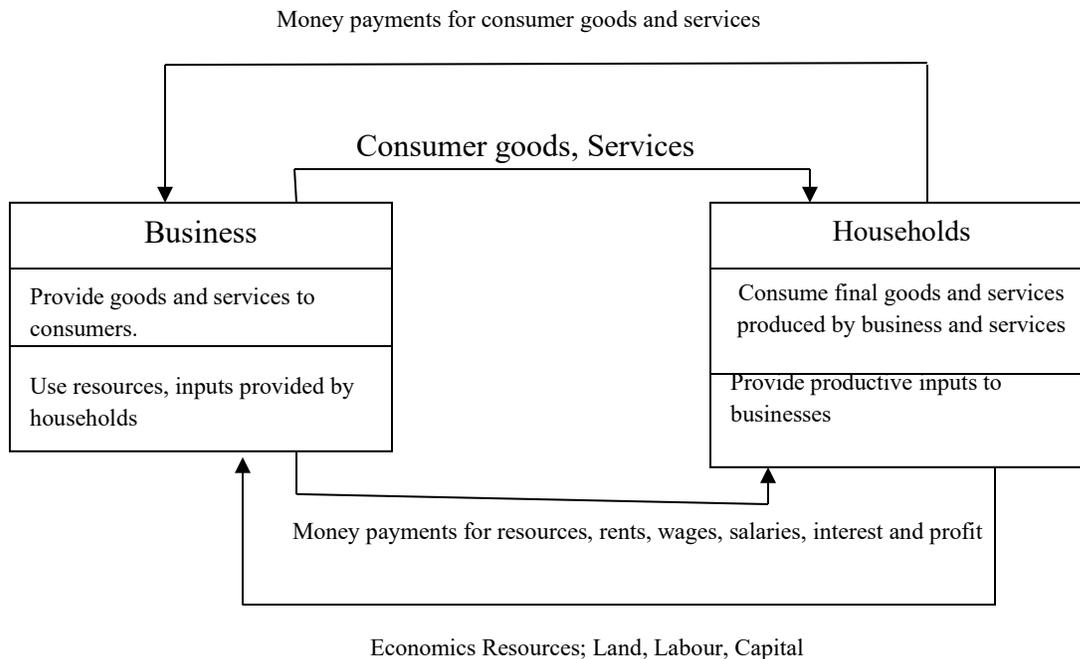
In turn, firms pay rent for land, wages for their labour and interest against the capital invested by the households. The earnings of the household are used to purchase goods and services from the firms to fulfill their needs and wants, the remaining is saved and it goes to the capital market and is converted as investments in various businesses.

The household and business firms have to pay taxes to the government for enjoying the services provided. On the other hand firms and households purchase goods and services (import) from various countries of the world. Firms tend to sell their products to the foreign customers (export) who earn income for the firm and foreign exchange for the country.

Therefore, it is clear that households supply input factors, which flow to firms. Goods and services produced by firms flow to households

### **Flow in an Economy;**

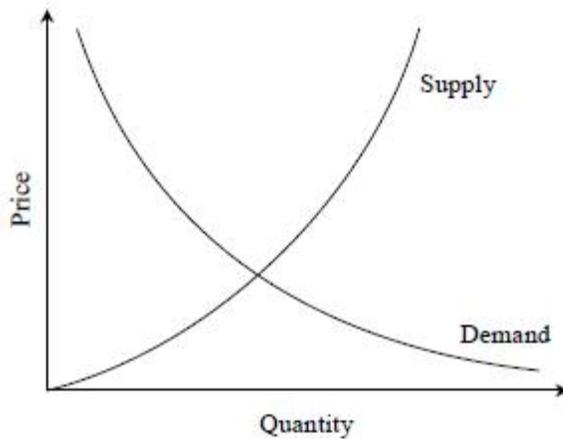
The flow of goods, services, resources and money payments in a simple economy are shown in below diagram. Households and business are the two major entities in a simple economy. Business organizations use various economics resources like land, labour and capital which will be used by them. Business organizations make payment of money to the households for receiving various resources. The households in turn make payment of money to business organization for receiving consumer goods and services. This cycle shows the interdependence between the two major entities in a simple economy



## Law of supply and Demand

An interesting aspect of the economy is that the demand and supply of a product are interdependent and they are sensitive with the respect to the price of that product. The interrelationships between them are shown in above diagram.

And also it is clear that when there is a decrease in the price of a product, the demand for product increases and its supply decreases. Also, the product is more in demand for the product increases. At the same time, lowering of the price of the product makes the producers restrain from releasing more quantities of the product in the market. Hence the supply of the product is decreased. The point of intersection of the supply curve and the demand curve is known as the equilibrium point. At the price corresponding to this point, the quantity of supply is equal to the quantity of demand. Hence this point is called equilibrium point.



### Factors influencing demand

The shape of the demand curve is influenced by the following factors;

- Income of the people
- Prices of related goods
- Tastes of consumers

If the income level of the people increases significantly, then their purchasing power will naturally improve. This would definitely shift the demand curve to the north east direction. A converse situation will shift the demand curve to the south west direction.

If, for instance the price of television sets is lowered drastically its demand would naturally go up. As a result, the demand for its associated product, namely VCDs, would also increase. Hence the prices of related goods influence the demand of products.

Over a period of time, the preferences of the people for a particular product may increase, which in turn, will affect the demand. For instance diabetic people prefer to have sugar free products. If the incidence of diabetes rises naturally there will be increased demand for sugar free products.

### Factors influencing supply

The shape of the supply curve is affected by the following factors:

- 1) Cost of the inputs
- 2) Technology
- 3) Weather
- 4) Prices of related goods

If the cost of inputs increases, then naturally, the cost of the product will go up. In such a situation, at the prevailing price of the product the profit margin per unit will be less. The

producers will then reduce the production quantity, which in turn will affect the supply of the product. For instance if the prices of fertilizers and cost of labor are increased significantly in agriculture the profit margin per bag of paddy will be reduced. So, the farmers will reduce the area of cultivation, and hence the quantity of supply of paddy will be reduced at the prevailing prices of the paddy.

If there is advancement in technology used in manufacture of the product in the long run, there will be a reduction in the production cost per unit. This will enable the manufacturer to have a greater profit margin per unit at the prevailing price of the product. Hence, the producer will be tempted to supply more quantity to the market.

Weather also has a direct bearing on the supply of products. For example demand for woolen products will increase during winter. This means the prices of woolen goods will be increased in winter. So, naturally, manufacturers will supply more volume of woolen goods during winter.

Again take the case of television sets. If the price of TV sets is lowered significantly then its demand would naturally go up. As a result, the demand for associated products like VCDs would also go up. Over a period of time, this will lead to an increase in the price of VCDs, which would result in more supply of VCD's

### **DETERMINANTS OF DEMAND:**

There are various factors affecting the demand for a commodity. They are:

**1. Price of the good:** The price of a commodity is an important determinant of demand. Price and demand are inversely related. Higher the price less is the demand and vice versa.

**2. Price of related goods:** The price of related goods like substitutes and complementary goods also affect the demand. In the case of substitutes, rise in price of one commodity lead to increase in demand for its substitute. In the case of complementary goods, fall in the price of one commodity lead to rise in demand for both the goods.

**3. Consumer's Income:** This is directly related to demand. A change in the income of the consumer significantly influences his demand for most commodities. If the disposable income increases, demand will be more.

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

**5. Population:** If the size of the population is more, demand for goods will be more . The market demand for a commodity substantially changes when there is change in the total population.

**6. Money Circulation:** More the money in circulation, higher the demand and vice versa.

**7. Value of money:** The value of money determines the demand for a commodity in the market. When there is a rise or fall in the value of money there may be changes in the relative prices of different goods and their demand.

**8. Weather Condition:** Weather is also an important factor that determines the demand for certain goods.

**9. Advertisement and Salesmanship:** If the advertisement is very attractive for a commodity, demand will be more. Similarly if the salesmanship and publicity is effective then the demand for the commodity will be more.

**10. Consumer's future price expectation:** If the consumers expect that there will be a rise in prices in future, he may buy more at the present price and so his demand increases.

**11. Government policy (taxation):** High taxes will increase the price and reduce demand, while low taxes will reduce the price and extend the demand.

**12. Credit facilities:** Depending on the availability of credit facilities the demand for commodities will change. More the facilities higher the demand.

**13. Multiplicity of uses of goods:** if the commodity has multiple uses then the demand will be more than if the commodity is used for a single purpose.

### **DEMAND DISTINCTIONS: TYPES OF DEMAND**

Demand may be defined as the quantity of goods or services desired by an individual, backed by the ability and willingness to pay.

**1. Direct and indirect demand: (or) Producers' goods and consumers' goods:** demand for goods that are directly used for consumption by the ultimate consumer is known as direct demand (example: Demand for T shirts). On the other hand demand for goods that are used by producers for producing goods and services. (example: Demand for cotton by a textile mill)

**2. Derived demand and autonomous demand:** when a produce derives its usage from the use of some primary product it is known as derived demand. (example: demand for tyres derived from demand for car) Autonomous demand is the demand for a product that can be independently used. (example: demand for a washing machine)

**3. Durable and non durable goods demand:** durable goods are those that can be used more than once, over a period of time (example: Microwave oven) Non durable goods can be used only once (example: Band-aid)

**4. Firm and industry demand:** firm demand is the demand for the product of a particular firm. (example: Dove soap) The demand for the product of a particular industry is industry demand (example: demand for steel in India )

**5. Total market and market segment demand:** a particular segment of the markets demand is called as segment demand (example: demand for laptops by engineering students) the sum total of the demand for laptops by various segments in India is the total market demand. (example: demand for laptops in India)

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

**7. 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 called as joint or complementary demand. (example: demand for petrol and two wheelers) A composite demand is one in which a good is wanted for several different uses. ( example: demand for iron rods for various purposes)

**8. Price demand, income demand and cross demand:** demand for commodities by the consumers at alternative prices are called as price demand. Quantity demanded by the consumers

at alternative levels of income is income demand. Cross demand refers to the quantity demanded of commodity 'X' at a price of a related commodity 'Y' which may be a substitute or complementary to X.

**Price Demand:** The ability and willingness to buy specific quantities of a good at the prevailing price in a given time period.

**Income Demand:** The ability and willingness to buy a commodity at the available income in a given period of time.

**Market Demand:** The total quantity of a good or service that people are willing and able to buy at prevailing prices in a given time period. It is the sum of individual demands.

**Cross Demand:** The ability and willingness to buy a commodity or service at the prevailing price of the related commodity i.e. substitutes or complementary products. For example, people buy more of wheat when the price of rice increases.

### **EXCEPTIONAL DEMAND CURVE:**

The demand curve slopes from left to right upward if despite the increase in price of the commodity, people tend to buy more due to reasons like fear of shortages or it may be an absolutely essential good.

The law of demand does not apply in every case and situation. The circumstances when the law of demand becomes ineffective are known as exceptions of the law. Some of these important exceptions are as under

#### **1. Giffen Goods:**

Some special varieties of inferior goods are termed as Giffen goods. Cheaper varieties millets like bajra, cheaper vegetables like potato etc come under this category. Sir Robert Giffen of Ireland first observed that people used to spend more of their income on inferior goods like potato and less of their income on meat. After purchasing potato the staple food, they did not have staple food potato surplus to buy meat. So the rise in price of potato compelled people to buy more potato and thus raised the demand for potato. This is against the law of demand. This is also known as Giffen paradox.

## **2. Conspicuous Consumption / Veblen Effect:**

This exception to the law of demand is associated with the doctrine propounded by Thorsten Veblen. A few goods like diamonds etc are purchased by the rich and wealthy sections of society. The prices of these goods are so high that they are beyond the reach of the common man. The higher the price of the diamond, the higher its prestige value. So when price of these goods falls, the consumers think that the prestige value of these goods comes down. So quantity demanded of these goods falls with fall in their price. So the law of demand does not hold good here.

## **3. Conspicuous Necessities:**

Certain things become the necessities of modern life. So we have to purchase them despite their high price. The demand for T.V. sets, automobiles and refrigerators etc. has not gone down in spite of the increase in their price. These things have become the symbol of status. So they are purchased despite their rising price.

## **4. Ignorance:**

A consumer's ignorance is another factor that at times induces him to purchase more of the commodity at a higher price. This is especially true, when the consumer believes that a high-priced and branded commodity is better in quality than a low-priced one.

## **5. Emergencies:**

During emergencies like war, famine etc, households behave in an abnormal way. Households accentuate scarcities and induce further price rise by making increased purchases even at higher prices because of the apprehension that they may not be available. . On the other hand during depression, , fall in prices is not a sufficient condition for consumers to demand more if they are needed.

## **6. Future Changes In Prices:**

Households also act as speculators. When the prices are rising households tend to purchase large quantities of the commodity out of the apprehension that prices may still go up. When prices are expected to fall further, they wait to buy goods in future at still lower prices. So quantity demanded falls when prices are falling.

## **7. Change In Fashion:**

A change in fashion and tastes affects the market for a commodity. When a digital camera replaces a normal manual camera, no amount of reduction in the price of the latter is sufficient to clear the stocks. Digital cameras on the other hand, will have more customers even though its price may be going up. The law of demand becomes ineffective.

### **8. Demonstration Effect:**

It refers to a tendency of low income groups to imitate the consumption pattern of high income groups. They will buy a commodity to imitate the consumption of their neighbors even if they do not have the purchasing power.

### **9. Snob Effect:**

Some buyers have a desire to own unusual or unique products to show that they are different from others. In this situation even when the price rises the demand for the commodity will be more.

### **10. Speculative Goods/ Outdated Goods:**

Speculative goods such as shares do not follow the law of demand. Whenever the prices rise, the traders expect the prices to rise further so they buy more.

Goods that go out of use due to advancement in the underlying technology are called outdated goods. The demand for such goods does not rise even with fall in prices

### **11. Seasonal Goods:**

Goods which are not used during the off-season (seasonal goods) will also be subject to similar demand behaviour.

### **12. Goods In Short Supply:**

Goods that are available in limited quantity or whose future availability is uncertain also violate the law of demand.

## **ELASTICITY OF DEMAND**

In economics, the term elasticity means a proportionate (percentage) change in one variable relative to a proportionate (percentage) change in another variable. The quantity demanded of a good is affected by changes in the price of the good, changes in price of other goods, changes in income and changes in other factors. Elasticity is a measure of just how much of the quantity demanded will be affected due to a change in price or income.

Elasticity of Demand is a technical term used by economists to describe the degree of responsiveness of the demand for a commodity due to a fall in its price. A fall in price leads to an increase in quantity demanded and vice versa.

The elasticity of demand may be as follows:

- Price Elasticity
- Income Elasticity and
- Cross Elasticity

**PRICE ELASTICITY**

The response of the consumers to a change in the price of a commodity is measured by the price elasticity of the commodity demand. The responsiveness of changes in quantity demanded due to changes in price is referred to as price elasticity of demand. The price elasticity of demand is measured by dividing the percentage change in quantity demanded by the percentage change in price.

**Price Elasticity**= Proportionate change in the Quantity Demanded/Proportionate change in price

$$= \frac{\text{Percentage change in quantity demanded}}{\text{Percentage change in price}}$$

$$= \frac{\frac{\Delta Q}{Q} \quad 10}{\frac{\Delta P}{P} \quad 20} = 0.5$$

$\Delta Q$  = change in quantity demanded  
 $\Delta P$  = change in price

P = price  
 Q = quantity demanded

### For example:

Quantity demanded is 20 units at a price of Rs.500. When there is a fall in price to Rs. 400 it results in a rise in demand to 32 units. Therefore the change in quantity demanded is 12 units resulting from the change in price of Rs.100.

The Price Elasticity of Demand is =  $500 / 20 \times 12/100 = 3$

### The Determinants Of Price Elasticity Of Demand

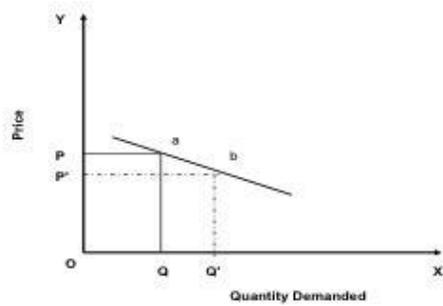
The exact value of price elasticity for a commodity is determined by a wide variety of factors. The two factors considered by economists are the **availability of substitutes** and **time**. The better the substitutes for a product, the higher the price elasticity of demand.. The longer the period of time, the more the price elasticity of demand for that product. The price elasticity of necessary goods will have lower elasticity than luxuries.

The elasticity of demand depends on the following factors:

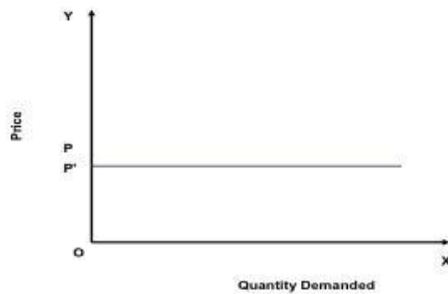
1. Nature of the commodity: The demand for necessities is inelastic because the demand does not change much with a change in price. But the demand for luxuries is elastic in nature.
2. Extent of use: A commodity having a variety of uses has a comparatively elastic demand.
3. Range of substitutes: The commodity which has more number of substitutes has relatively elastic demand. A commodity with fewer substitutes has relatively inelastic demand.
4. Income level: People with high incomes are less affected by price changes than people with low incomes.
5. Proportion of income spent on the commodity: When a small part of income is spent on the commodity, the price change does not affect the demand therefore the demand is inelastic in nature.
6. Urgency of demand / postponement of purchase: The demand for certain commodities are highly inelastic because you cannot postpone its purchase. For example medicines for any sickness should be purchased and consumed immediately.
7. Durability of a commodity: If the commodity is durable then it is used it for a long period. Therefore elasticity of demand is high. Price changes highly influences the demand for durables in the market.
8. Purchase frequency of a product/ recurrence of demand: The demand for frequently purchased goods are highly elastic than rarely purchased goods.
9. Time: In the short run demand will be less elastic but in the long run the demand for commodities are more elastic.

The following are the possible combination of changes in Price and Quantity demanded. The slope of each combination is depicted in the following graphs.

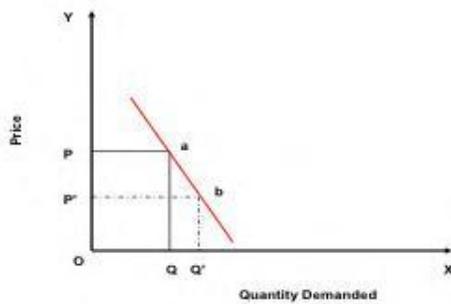
1. Relatively Elastic Demand ( $E_d > 1$ ) a small percentage change in price leading to a larger change in Quantity demanded.



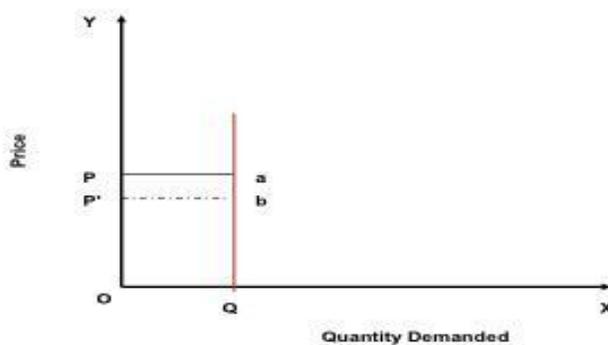
2. Perfectly Elastic Demand ( $E_d = \infty$ ) a small change in price will change the quantity demanded by an infinite amount.



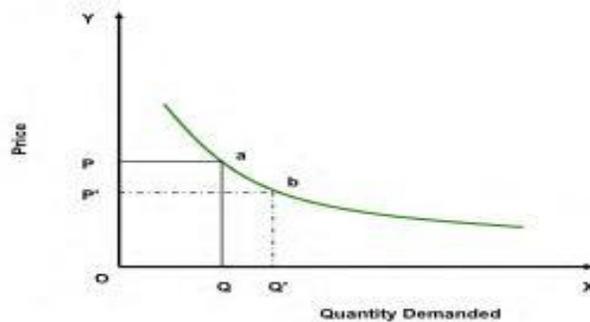
3. Relatively Inelastic Demand ( $E_d < 1$ ) a change in price leads to a smaller percentage change in quantity demanded.



4. Perfectly Inelastic Demand ( $E_d = 0$ ) the quantity demanded does not change regardless of the percentage change in price.



5. Unit Elasticity of Demand ( $E_d = 1$ ) the percentage change in quantity demanded is the same as the percentage change in price that caused it.



## INCOME ELASTICITY

Income elasticity of demand measures the responsiveness of quantity demanded to a change in income. It is measured by dividing the percentage change in quantity demanded by the percentage change in income. If the demand for a commodity increases by 20% when income increases by 10% then the income elasticity of that commodity is said to be positive and relatively high. If the demand for food were unchanged when income increases, the income elasticity would be zero. A fall in demand for a commodity when income rises results in a negative income elasticity of demand.

The following are the various types of income elasticity:

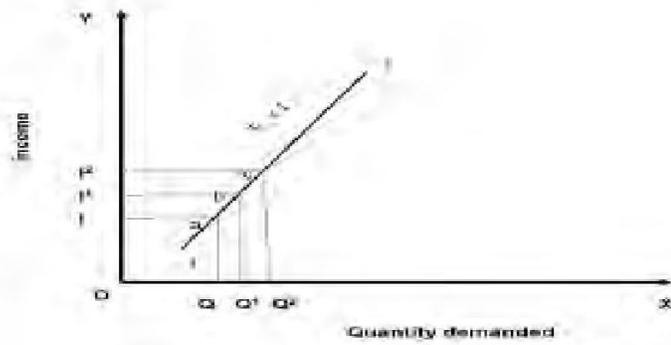
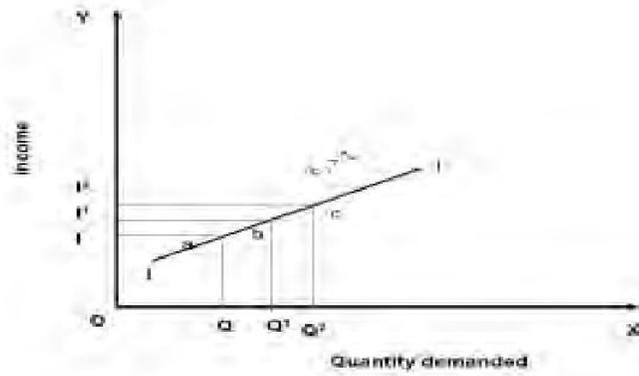
**Zero Income Elasticity:** The increase in income of the individual does not make any difference in the demand for that commodity. ( $E_i = 0$ )

**Negative Income Elasticity:** The increase in the income of consumers leads to less purchase of those goods. ( $E_i < 0$ ).

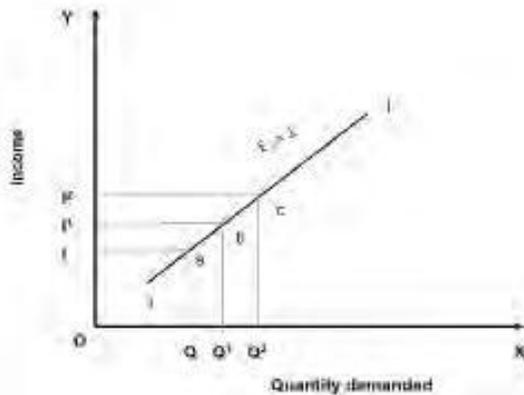
**Unitary Income Elasticity:** The change in income leads to the same percentage of change in the demand for the good. ( $E_i = 1$ ).

**Income Elasticity is Greater than 1:** The change in income increases the demand for that commodity more than the change in the income. ( $E_i > 1$ ).

**Income Elasticity is Less than 1:** The change in income increases the demand for the commodity but at a lesser percentage than the change in the Income. ( $E_i < 1$ ).

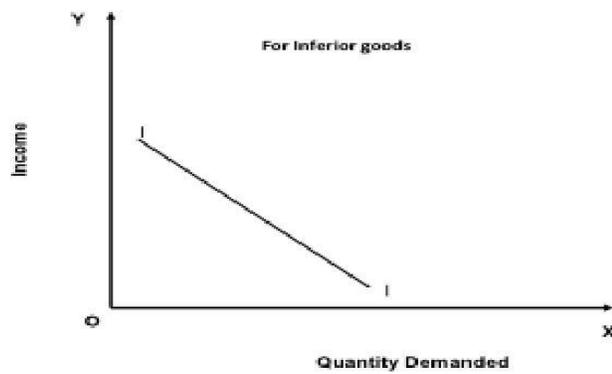
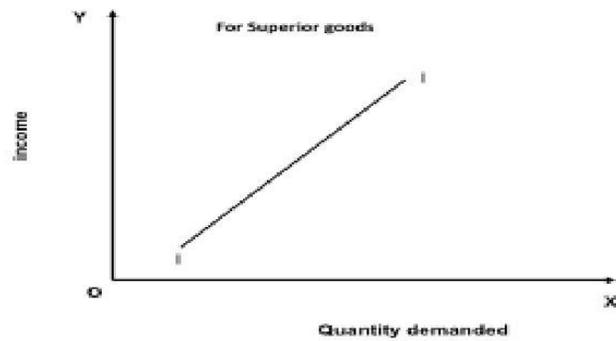


The positive income elasticity of demand can be classified as unity, more than unity and less than unity. We can understand from the above graphs that the product which is highly elastic in nature will grow faster when the economy is expanding. The performance of firms having low income elasticity on the other hand will be less affected by the economic changes of the country.



With a rise in consumer's income, the demand increases for superior goods and decreases for inferior goods and vice versa.

The income elasticity of demand is positive for superior goods or normal goods and negative for inferior goods since a person may shift from inferior to superior goods with a rise in income.



## CROSS ELASTICITY

The quantity demanded of a particular commodity varies according to the price of other commodities. Cross elasticity measures the responsiveness of the quantity demanded of a commodity due to changes in the price of another commodity.

For example the demand for tea increases when the price of coffee goes up. Here the cross elasticity of demand for tea is high. If two goods are substitutes then they will have a positive cross elasticity of demand. In other words if two goods are complementary to each other then negative income elasticity may arise.

The responsiveness of the quantity of one commodity demanded to a change in the price of another good is calculated with the following formula.

$$\begin{aligned} & \text{\% change in demand for commodity A } E_c \\ & = \frac{\text{\% change in demand for commodity A}}{\text{\% change in price of commodity B}} \end{aligned}$$

If two commodities are unrelated goods, the increase in the price of one good does not result in any change in the demand for the other goods. For example the price fall in Tata salt does not make any change in the demand for Tata Nano.

### **Significance Of Elasticity Of Demand:**

The concept of elasticity is useful for the managers for the following decision making activities

1. In production i.e. in deciding the quantity of goods to be produced
2. Price fixation i.e. in fixing the prices not only on the cost basis but also on the basis of prices of related goods.

3. In distribution i.e. to decide as to where, when, and how much etc.
4. In international trade i.e. what to export, where to export
5. In foreign exchange
6. For nationalizing an industry
7. In public finance

## **ELEMENTS OF COSTS**

Cost can be broadly classified into variable cost and overhead cost. Variable cost varies with the volume of production while overhead cost is fixed, irrespective of the production volume.

Variable cost can be further classified into direct material cost, direct labour cost, and direct expenses. The overhead cost can be classified into factory overhead, administration overhead, selling overhead, and distribution overhead.

Direct material costs are those costs of materials that are used to produce the product. Direct labour cost is the amount of wages paid to the direct labour involved in the production activities. Direct expenses are those expenses that vary in relation to the production volume, other than the direct material costs and direct labour costs.

Overall cost is the aggregate of indirect material costs, indirect labour costs and indirect expenses. Administration overhead includes all the costs that are incurred in administering the business. Selling overhead is the total expense that is incurred in the promotional activities and the expenses relating to sales force. Distribution overhead is the total cost of shipping the items from the factory site to the customer sites

The selling price of a product is derived as shown below:

- a)  $\text{Direct material costs} + \text{Direct labour costs} + \text{Direct expenses} = \text{Prime cost}$
- b)  $\text{Prime cost} + \text{Factory overhead} = \text{Factory cost.}$
- c)  $\text{Factory cost} + \text{office and administrative overhead} = \text{cost of production.}$
- d)  $\text{cost of production} + \text{opening finished stock} - \text{Closing finished stock} = \text{cost of goods sold.}$
- e)  $\text{cost of goods sold} + \text{selling and distribution overhead} = \text{cost of sales}$
- f)  $\text{cost of sales} + \text{profit} = \text{sales}$
- g)  $\text{sales} / \text{Quantity sold} = \text{selling price per unit}$

in the above calculations, if the opening finished stock is equal to the closing finished stock, then the cost of production is equal to the cost of goods sold.

## **1.4 OTHER COSTS/ REVENUES**

The following are the costs/revenue other than the costs which are presented in the previous section:

- Marginal cost
- Marginal revenue
- Sunk cost
- Opportunity cost

### **Marginal cost:**

Marginal cost of a product is the cost of producing an additional unit of that product. Let the cost of producing 20 units of a product be Rs.10,000, and the cost of producing 21 units of the same product be Rs. 10045. Then the marginal cost of producing the 21 units is Rs.45.

### **Marginal revenue:**

Marginal revenue of a product is the incremental revenue of selling an additional unit of that product. Let the revenue of selling 20 units of a product be Rs.15,000 and the revenue selling 21 units of the same product be Rs.15085. then, the marginal revenue of selling the 21st unit is Rs. 85.

### **Sunk Cost:**

This is known as the past cost of an equipment/asset. Let us assume that an equipment has been purchased for Rs 1,00,000 about three years back. If it is considered for replacement, then its present value is not Rs. 100000. Instead, its present market value should be taken as the present value of the equipment for further analysis. So, the purchase value of the equipment in the past is known as its sunk cost. The sunk cost should not be considered for any analysis done from now onwards.

### **Opportunity Cost**

In practice, if an alternative (X) is selected from a set of competing alternatives(X, Y), then the corresponding investment in the selected alternative is not available for any other purpose. If the same money is invested in some other alternative (Y), it may fetch some return. Since the money is invested in the selected alternative(X), one has to forego the return from the other

alternative (Y). The amount that is foregone by not investing in the other alternative(Y) is known as opportunity cost of the selected alternative(X). So the opportunity cost of an alternative is the return that will be foregone by not investing the same money in another alternative.

Consider that a person has invested a sum of Rs 50, 000 in shares. Let the expected annual return by this alternative be rs 7500. If the same amount is invested in fixed deposit, a bank will pay a return of 18%. Then, the corresponding total return per year for the investment in the bank is rs 9000. This return is greater than the return from shares. The foregone excess return of rs 1500 by way of not investing in the bank is the opportunity cost of investing in shares.

### **BREAK EVEN ANALYSIS**

The main objective of break even analysis is to find the cutt off production volume from where a firm will make profit. Let

,  $s$  = selling price per unit

,  $v$  = variable cost per unit

FC = fixed cost per period

Q = volume of production

The total sales revenue (s) of the firm is given by the following formula;

$$S = s \times Q$$

The total cost of the firm for a given production volume is given as

$$TC = \text{Total variable cost} + \text{Fixed cost}$$

$$= v \times Q + FC$$

The linear plots of the above two equations are shows in below diagram. The intersection point of the total sales revenue line and the total cost line is called the break even point. The corresponding volume of production on the X axis us known as break even sales quantity. At the intersection point, the total cost is equal to the total revenue. This point is also called as no loss or no gain situation. For any production quantity which is less than the break even quantity, the total cost is more than the total revenue. Hence, the firm will be making loss. 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.

$$\text{Profit} = \text{Sales} - (\text{Fixed cost} + \text{Variable cost})$$

$$= s \times Q - (FC + v \times Q)$$

The formulae to find the break even quantity and break even sales quantity

$$\text{Break-even quantity} = \frac{\text{Fixed cost}}{\text{Selling price/unit} - \text{Variable cost/unit}}$$

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

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

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

The contribution is the difference between the sales and the variable costs. The margin of safety is the sales over and above the break even sales. The formulae to compute these values are

$$\text{Contribution} = \text{Sales} - \text{Variable costs}$$

$$\text{Contribution /unit} = \text{Selling Price/ unit} - \text{Variable cost/unit}$$

$$M. S = \text{Actual Sales} - \text{Break even sales}$$

$$= \frac{\text{Profit}}{\text{Contribution}} \times \text{sales}$$

$$M.S \text{ as a per cent of sales} = (M.S/ \text{Sales}) \times 100$$

**EXAMPLE 1.1** Alpha Associates has the following details:

Fixed cost = Rs. 20,00,000; Variable cost per unit = Rs. 100; Selling price per unit = Rs. 200  
Find

- The break-even sales quantity,
- The break-even sales
- If the actual production quantity is 60,000, find (i) contribution; and (ii) margin of safety by all methods.

**Solution**

Fixed cost (FC) = Rs. 20,00,000

Variable cost per unit (v) = Rs. 100

Selling price per unit (s) = Rs. 200.

$$\begin{aligned} \text{(a) Break-even quantity} &= \frac{FC}{s - v} = \frac{20,00,000}{200 - 100} \\ &= 20,00,000/100 = 20,000 \text{ units} \end{aligned}$$

$$\begin{aligned} \text{(b) Break-even sales} &= \frac{FC}{s - v} \times s \text{ (Rs.)} \\ &= \frac{20,00,000}{200 - 100} \times 200 \\ &= \frac{20,00,000}{100} \times 200 = \text{Rs. } 40,00,000 \end{aligned}$$

$$\begin{aligned} \text{(c) (i) Contribution} &= \text{Sales} - \text{Variable cost} \\ &= s \times Q - v \times Q \\ &= 200 \times 60,000 - 100 \times 60,000 \\ &= 1,20,00,000 - 60,00,000 \\ &= \text{Rs. } 60,00,000 \\ &= \text{Rs. } 60,00,000 \end{aligned}$$

(ii) Margin of safety

#### METHOD I

$$\begin{aligned} \text{M.S.} &= \text{Sales} - \text{Break-even sales} \\ &= 60,000 \times 200 - 40,00,000 \\ &= 1,20,00,000 - 40,00,000 = \text{Rs. } 80,00,000 \end{aligned}$$

#### METHOD II

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

$$\begin{aligned} \text{Profit} &= \text{Sales} - (FC + v \times Q) \\ &= 60,000 \times 200 - (20,00,000 + 100 \times 60,000) \\ &= 1,20,00,000 - 80,00,000 \\ &= \text{Rs. } 40,00,000 \end{aligned}$$

$$\text{M.S.} = \frac{40,00,000}{60,00,000} \times 1,20,00,000 = \text{Rs. } 80,00,000$$

$$\text{M.S. as a per cent of sales} = \frac{80,00,000}{1,20,00,000} \times 100 = 67\%$$

### PROFIT/VOLUME RATIO (*P/V* RATIO)

*P/V* ratio is a valid ratio which is useful for further analysis. The different formulae for the *P/V* ratio are as follows:

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

The relationship between BEP and *P/V* ratio is as follows:

$$\text{BEP} = \frac{\text{Fixed cost}}{P/V \text{ ratio}}$$

The following formula helps us find the M.S. using the *P/V* ratio:

$$\text{M.S.} = \frac{\text{Profit}}{P/V \text{ ratio}}$$

**EXAMPLE 1.2** 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

Find the following:

(a) Contribution (b) Profit (c) BEP (d) M.S.

#### **Solution**

$$\begin{aligned} \text{(a) Contribution} &= \text{Sales} - \text{Variable costs} \\ &= \text{Rs. } 1,20,000 - \text{Rs. } 45,000 \\ &= \text{Rs. } 75,000 \end{aligned}$$

$$\begin{aligned} \text{(b) Profit} &= \text{Contribution} - \text{Fixed cost} \\ &= \text{Rs. } 75,000 - \text{Rs. } 25,000 \\ &= \text{Rs. } 50,000 \end{aligned}$$

(c) BEP

$$\begin{aligned} P/V \text{ ratio} &= \frac{\text{Contribution}}{\text{Sales}} \\ &= \frac{75,000}{1,20,000} \times 100 = 62.50\% \end{aligned}$$

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

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

**EXAMPLE 1.3** Consider the following data of a company for the year 1998:  
Sales = Rs. 80,000; Fixed cost = Rs. 15,000; Variable cost = 35,000  
Find the following:

(a) Contribution (b) Profit (c) BEP (d) M.S.

Solution;

$$\begin{aligned} \text{(a) Contribution} &= \text{Sales} - \text{Variable costs} \\ &= \text{Rs. } 80,000 - \text{Rs. } 35,000 \\ &= \text{Rs. } 45,000 \end{aligned}$$

$$\begin{aligned} \text{(b) Profit} &= \text{Contribution} - \text{Fixed cost} \\ &= \text{Rs. } 45,000 - \text{Rs. } 15,000 \\ &= \text{Rs. } 30,000 \end{aligned}$$

(c) BEP

$$P/V \text{ ratio} = \frac{\text{Contribution}}{\text{Sales}} = \frac{45,000}{80,000} \times 100 = 56.25\%$$

$$\text{BEP} = \frac{\text{Fixed cost}}{P/V \text{ ratio}} = \frac{15,000}{56.25} \times 100 = \text{Rs. } 26,667$$

$$\text{(d) M.S.} = \frac{\text{Profit}}{P/V \text{ ratio}} = \frac{30,000}{56.25} \times 100 = \text{Rs. } 53,333.33$$

## **ISO-Quants:**

### **Definitions:**

“The Iso-product curves show the different combinations of two resources with which a firm can produce equal amount of product.” Bilas

“Iso-product curve shows the different input combinations that will produce a given output.” Samuelson

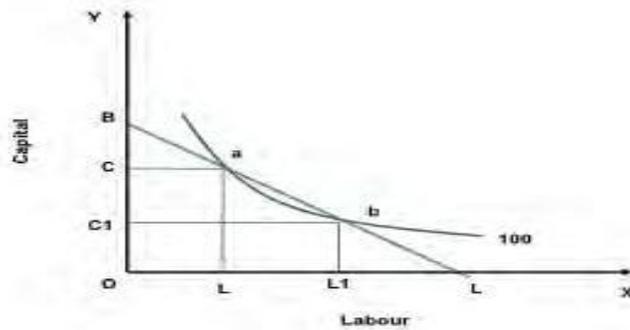
“An Iso-quant curve may be defined as a curve showing the possible combinations of two variable factors that can be used to produce the same total product.” Peterson

“An Iso-quant is a curve showing all possible combinations of inputs physically capable of producing a given level of output.” Ferguson

To understand the production function with two variable inputs, iso-quant curve is used. These curves show the various combinations of two variable inputs resulting in the same level of output. The shape of an Iso-quant reflects the ease with which a producer can substitute among inputs while maintaining the same level of output.

From the graph we can understand that the iso-quant curve indicates various combinations of capital and labour usage to produce 100 units of motor pumps. The points a, b or any point in the curve indicates the same quantum of production. If the production increases to 200 or 300 units definitely the input usage will also increase therefore the new iso-quant curve for 200 units (Q1) is shifted upwards. Various iso-quant curves presented in a graph is called as iso-quant map.

**Iso-cost:** different combination of inputs that can be purchased at a given expenditure level.



**Optimal input combination:**

The above graph explains clearly that the iso quant curve for 100 units of motor consists of 'n' number of input combinations to produce the same quantity. For example at 'a' to produce 100 units of motors the firm uses OC amount of capital and OL amount of labour i.e., more capital and less labour force. At 'b' OC1 amount of capital and OL1 labour force is used to produce the same that means more labour and less capital.

**Optimal input combination:** (the above graph) the points of tangency between iso quant and iso cost curves depict optimal input combination at different activity levels.

**Expansion path:** Optimal input combinations as the scale of production expand. From the graph it is clear that the optimum combination is selected based on the tangency point of iso cost (budget line) and iso-quant i.e., a, b respectively. The point 'a' indicates that to produce 100 units of motor the best combination of capital and labour are OC and OM which is within the budget. Over a period of time a firm will face various optimum levels if we connect all points we derive expansion path of a firm.

### The Law of Returns to Scale

In the long run the fixed inputs like machinery, building and other factors will change along with the variable factors like labor, raw material etc. With the equal percentage of increase in input factors various combinations of returns occur in an organization.

**Returns to scale:** the change in percentage output resulting from a percentage change in all the factors of production. They are increasing, constant and diminishing returns to scale.

**Increasing returns to scale may arise:** if the output of a firm increases more than in proportionate to an increase in all inputs. For example the input factors are increased by 50% but the output has doubled (100%).

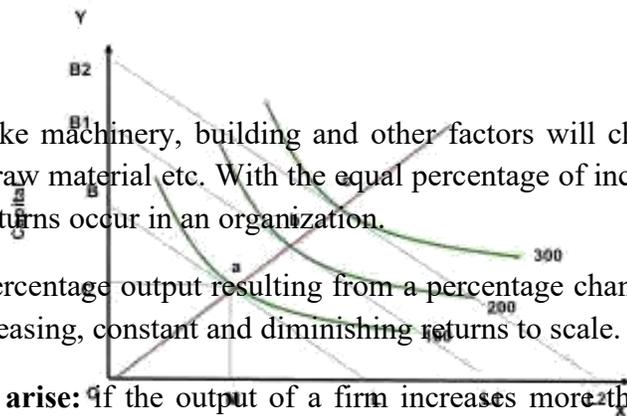
**Constant returns to scale:** when all inputs are increased by a certain percentage the output increases by the same percentage.

For example input factors are increased by 50% then the output has also increased by 50 percentages. Let us assume that a laptop consists of 50 components we call it as a set. In case the firm purchases 100 sets they can assemble 100 laptops but it is not possible to produce more than 100 units.

**Diminishing returns to scale:** when output increases in a smaller proportion than the increase in inputs it is known as diminishing return to scale. For example 50% increment in input factors lead to only 20% increment in the output.

### Managerial Uses Of Production Function:

Production functions are logical and useful. Production analysis can be used as aids in decision making because they can give guidance to obtain the maximum output from a given set of inputs



and how to obtain a given output from the minimum aggregation of inputs. The complex production functions with large numbers of inputs and outputs are analyzed with the help of computer based programmes.

## UNIT – II

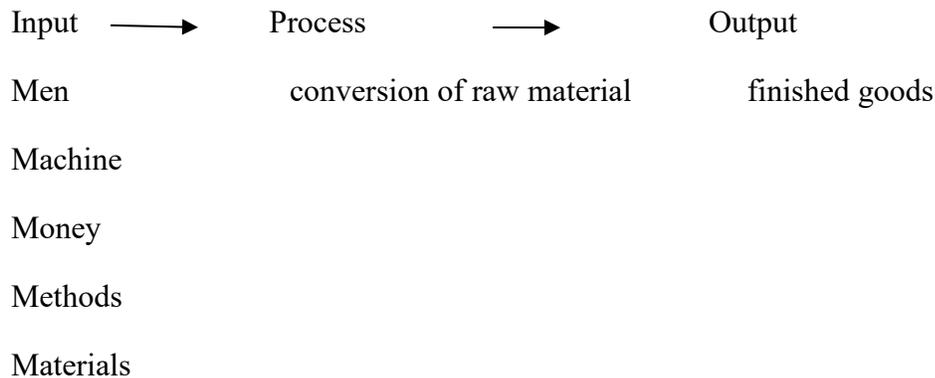
**Production Management & Marketing Management: Types of Production; process of planning, scheduling, Routing, material control; product concept concepts of productivity, Core concepts of Marketing- Needs, Wants, Demand- Marketing Vs Selling- Products and Markets- Pricing and its related factors- Channels of Distribution- Promotion- Advertising- Market Research- Sales Forecasting.**

### Production

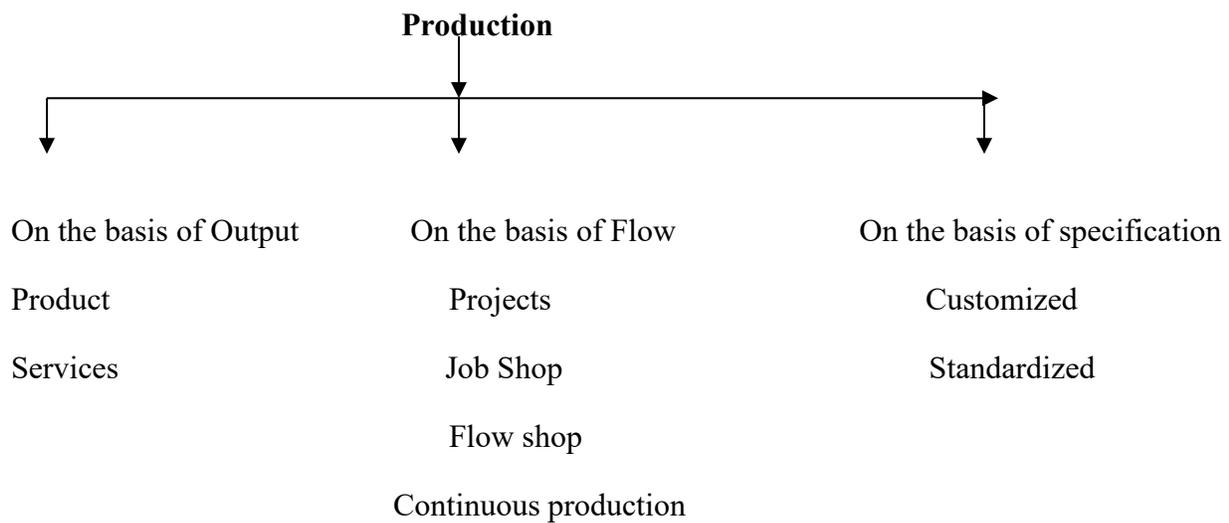
#### Production Management

**According to Buffa** “production is the process by which goods and services are created.”

#### Schematic representation of production system



#### Types of Production



**Product:** Produced goods which can be seen are called as product. **E.g.** Consumer goods like furniture, T.V, radio.

**Services:** Goods which cannot be seen and only can be felt are called as services. **E.g.** Transportation, health, services, education system etc.

**Project:** It is complex non-routine one time effort limited by time, budget and resources. **E.g.** dam constructions, starting new industries, fabricating boilers etc.

**Job shop:** This is a conversion process in which units of different types follow different sequences through different shops. **E.g.** Hospitals, auto repair, machine shop etc

**Flow shop:** This is a conversion process in which successive units of output undergo the same sequence of operations. **E.g.**T.V factory, auto factory.

**Customized:** A goods produced vary from person to person. E.g. production of shirts.

**Standardized:** A goods produced remains the same for all. E.g. insurance whole sale services.

## **Productivity**

It is a relationship between output and the input of a business system.

$$\text{Productivity} = \frac{\text{output}}{\text{Input}}$$

There are several strategies for improving the productivity which are :

- Increased output for the same input.
- Decreased input for the same output.
- Proportionate increase in output with increase in input.
- Proportionate decrease in input with decrease in output
- Simultaneous increase in output with decrease in input.

**Increased output for the same input:** In this strategy the output is increased while keeping the input constant. Let us assume that in a steel plant layout of the existing shops is not proper. By altering the location of the billet-making section, i.e bringing it more closely produces hot metal this would give more yields in terms of tons of billet gets produced. So this is an example where the output is increased without any increase in input.

**Decreased input for the same output.** In this strategy, the input is decreased to produce the same output. Let us assume that there exists a substitute of raw material to manufacture a product

which has the required properties and it is available at lower prices. If we identify such material and use it for manufacturing the product then certainly it will reduce the input cost. The process of identification does not involve any extra cost. So naturally, the productivity ratio will increase because of the decreased input by using the cheaper raw material to produce the same input.

**Proportionate increase in output with increase in input:** consider the example of introducing a new product into the existing product mix of an organization. The company has identified a new product which has a very good market and which can be manufactured with the surplus facilities of the organization. If the new product is taken for production then the following will be the result

There will be an increase in the revenue of the organization by way of selling new product hence we find that proportionate increase in the revenue will be more than a proportionate increase in the input cost.

**Proportionate decrease in input with decrease in output:** consider the reverse case of previous example i.e. dropping an uneconomical product from the existing market. This will result in the following:

There will be a decrease in the revenue of the organization because of dropping a product from the existing market. Hence we find that proportionate decrease in input will be more than a proportionate decrease in output.

**Increase in output with decrease in input:** let us assume that advanced automated technologies like robot, automated guided vehicle system are available in the market which can be employed in the organization of our interest. The outcome of these modern tools can be summarized as following:

These advanced facilities would help in producing more number of goods because the machine works faster than a human and it never gets tired. Hence the productivity ratio will increase at a faster rate.

### **PROCESS PLANNING:**

It is the systematic determination of the goods by which a product is to be manufactured economically and competitively.

In a nutshell process planning is the preparation of detailed work plan.

#### ***Process planning procedure:***

- It develops the broad plan of manufacturing a product or a component.
- Information required for Process planning:
- Quality of work to be performed

- Detailed specification of the product
- Availability of equipments, tools, and manpower
- Sequence of operations to be performed
- Standard time for each operation.

***Steps involved in process planning:***

1. Current production commitments, delivery date, and quality to be produced
2. Selection of materials: right quality, shape and size of raw material
3. Selection of jigs, fixtures and special attachment
4. Selection of cutting tools
5. Selection of inspection gauges
6. Documentation of process.

**SCHEDULING**

**Concept.** In brief, scheduling means-when and in what sequence the work will be done. It involves deciding as to when the work will start and in certain duration of time how much work will be finished. Scheduling deals with orders and machines, *i.e.*, it determines which order will be taken up on which machine and in which department by which operator. While doing so, the aim is to schedule as large amount of work as the plant facilities can conveniently handle by maintaining a free flow of material along the production line.

Scheduling may be called the time phase of Loading. Loading means the assignment of task or work load facility whereas scheduling includes in addition, the specification of time and sequence in which the order/Work will be taken up.

A production schedule is similar to a railway time table and shows which machine is doing what and when.

**Factors Affecting Scheduling.**

The following factors affect production scheduling and are considered before establishing the scheduling plan.

***(a) External factors:***

1. Customer's demand,
2. Customer's delivery dates, and
3. Stock of goods already lying with the dealers and retailers.

***(b) Internal factors:***

1. Stock of finished goods with the firm,
2. Time interval to process finished goods from raw material. In other words - how much time will be required to manufacture each component, subassembly and then assembly (*i.e.*, the final Product),
3. Availability of equipment and machinery; their total capacity and specifications,
4. Availability of materials; their quantity and specifications,
5. Availability of manpower (number, type and kind of skills),
6. Additional manufacturing facilities if required, and
7. Feasibility of economic production runs.

### **Scheduling Procedure - and Techniques.(Refer Notes for the diagrams)**

Scheduling normally starts with the *Master Schedule*. Figure 7.18 shows the master schedule for a foundry shop.

A master schedule resembles central office which possesses information about all the orders in hand. Master schedule, in Fig. 7.18, is a weekly breakdown of the production requirements. The total capacity in any week is of 100 hours of work in the foundry shop.

As the orders are received, depending upon their delivery dates (or priorities, if any) they are marked on the master schedule. When the shop capacity is full for the present week the newly acquired orders are carried over to the next week and so on. A master schedule is thus updated continuously; it depicts a running total of the production requirements and shows the work ahead –yet to be completed. Master schedule is actually the 'basis for all subsequent scheduling techniques.

#### **Advantages**

1. It is simple and easy to understand,
2. It can be kept running (*i.e.*, current),
3. It involves less cost to make it and maintain,
4. It can be maintained by non-technical staff, and
5. A certain percentage of total weekly capacity can be allocated for rush orders.

#### **Disadvantages**

1. It provides only overall picture, and
2. It does not give detailed information.

#### **Applications**

##### **It finds applications:**

1. In big firms, for the purpose of loading the entire plant,
2. In Research and Development organizations, and
3. For the overall planning in foundries, computer centres, repair shops, etc.

#### **Perpetual Scheduling.**

Like master scheduling, it is also simple and easy to understand, is kept Current, involves less cost and can be maintained by clerical staff. But, the information which it provides is very gross and at the same time it is not clear from the chart -when the work will take place.

Making of perpetual schedule involves two steps ':

- (i) Preparation of Load Analysis sheet from the orders in hand.
- (ii) The total load against each section is added up and knowing the weekly capacity of a section (Department), the number of weeks load against each department is calculated and plotted on a Gantt load chart.

#### **Order Scheduling.**

It is a most elaborate technique. Fig. 7.21 shows an order schedule chart.

Time is marked horizontally and the vertical axis shows the particular facility (say a machine), the information required to generate an order schedule is, regarding the number of parts to be

manufactured, name of the machines, their set-up times, total production time and the date of completion of the order.

The scheduling is started by placing the last operation at the date of completion and then working backwards. For example, if order *X* takes 3 days to complete and it is to be delivered to the customer on 7th of January, the work will be started on 5th of January.

Order schedule chart has the following advantages and limitations.

### **Advantages**

- (1) It is very detailed.
- (2) The earliest possible completion dates can be met.

### **Limitations**

- (1) It is very costly.
- (2) It requires accurate (production) time standards and good communication system.
- (3) It is difficult to maintain effectively if there are many active orders.

## **MANUFACTURING SCHEDULE**

A master schedule is too general to permit adequate day-to-day planning by line supervision is usually unnecessary in a small organisation.

Weekly departmental *manufacturing schedules* supplement the master schedule and must be made to reflect immediate factors, some of which are

- (1) Tool downtime due to broken and worn tools,
- (2) Equipment downtime for repair and maintenance,
- (3) Shortages and defects in materials,
- (4) Absenteeism and
- (5) Cancellations and rush orders.

## **ROUTING**

### **Meaning:**

- Defined as the selection of path, which part of the product will follow while being transformed from raw materials to finished products.
- Path to be followed by department to department and machine to machine till raw materials get its final shape.

### ***Routing in industries:***

#### **A) Continuous Industry:**

- Such industries are almost automatic therefore their routing is simple.
- Raw material enters the plant and automatically moves through different process till it gets final shape.
- Once the route is decided in the beginning no further control is needed.

#### **B) Assembly Industry:**

- Such industries require various components to be assembled at a particular time.
- The component should reach at the proper time and proper place to avoid wastage of time and production delay.
- Eg: industries producing cycle, scooter, car, Radio, Typewriter, watch etc

**C) Job Order Industry:**

- Such industries always handle different products, therefore after receiving manufacturing orders; the planning department has to prepare detailed drawing and planning each time.
- The planning can be made after receiving manufacturing order.

**MATERIAL MANAGEMENT**

***Meaning and Scope:***

It includes several aspects connected with materials like

- ✓ Materials planning and programming
- ✓ Store keeping
- ✓ Purchasing, Transportation
- ✓ Inventory control, Materials handling
- ✓ Simplification, Codification and standardization in stores
- ✓ Disposal of scrap and surplus

**Objectives of material management:**

- Maintaining continuous production by ensuring a uniform flow of materials
- Reducing working costs by systematic use of scientific techniques
- Releasing working capital for productive purpose
- Increasing the competitiveness by ensuring right quality at right prices, especially in foreign market
- Establishing good buyer-seller relations.
- Ensuring low departmental cost and high efficiency.

**Function of material management:**

- Material planning
- Procurement and purchasing of material

- Receiving and Warehousing
- Storage and store administration
- Inventory control
- Standardization, simplification and value analysis
- Disposal of scrap and surplus

## **STORES AND MATERIAL CONTROL**

### **Introduction:**

Materials and supplies are the most important assets in the majority of business. The success of business depends to a large extent on the efficient storage and material control.

Materials pilferage, deterioration of material and careless handling of stores leads to reduce profits.

### **STORES MANAGEMENT:**

- Required material is never out of stock
- No material is available in excess
- Purchasing materials on the basis of economic order quantity
- Protect stores against damage, theft.
- This can be achieved through:
  - Proper purchasing practice
  - Proper methods of storing materials
  - Effective system of physical control materials
  - Proper method of keeping store records.

## **Definition for Market**

An actual or nominal place where forces of demand and supply operate, and where buyers and sellers interact (directly or through intermediaries) to trade goods, services, or contracts or instruments, for money or barter.

Markets include mechanisms or means for (1) determining price of the traded item, (2) communicating the price information, (3) facilitating deals and transactions, and (4) effecting distribution. The market for a particular item is made up of existing and potential customers who need it and have the ability and willingness to pay for it.

**Dr. Philip Kotler** defines **marketing** as “the science and art of exploring, creating, and delivering value to satisfy the needs of a target market at a profit. **Marketing** identifies unfulfilled needs and desires. ... Marketing are activities of a company associated with buying and selling a product or service. It includes advertising, selling and delivering products to people.

It includes the coordination of four elements called the **4 P's of marketing**:

- (1) identification, selection and development of a **product**,
- (2) determination of its **price**,
- (3) selection of a distribution channel to reach the customer's **place**, and
- (4) development and implementation of a **promotional** strategy.

## **Definition of Marketing**

**According to American marketing association** “it is the process of planning and executing the conception, pricing, promotion and distribution of ideas, goods and services to create exchanges that will satisfy individual and organizational objectives”.

**Marketing = Market + Consumer Satisfaction**

## **Concepts of marketing**

### ➤ **Production concept :**

It says that customers will favor those products which are widely available at low cost. Hence such firms concentrate on **reducing the cost of production** and develop wide distribution net work. Under this concept price and availability are the major influencing factors on the customers while purchasing a product.

### ➤ **Product concept :**

It suggests that customers will favor those products which offer the best quality or performance. The managers of such organization focus their energy on **improving the quality of products** produced by them.

### ➤ **Selling concept :**

Customers will not buy enough of the products of an organization. The focus on this concept is to somehow sell what the company manufactures. Hence the company must take an

aggressive selling *effort to push its products* like heavy advertising, large scale sales promotion, heavy price discounts and public relations are the tools used by organizations that rely on this concept.

➤ **Marketing concept:**

The marketing concept holds that the key to achieve organizational goals consists in *determining the needs and wants of target markets* and delivering the desired satisfactions more effectively and efficiently than competitors.

## CONCEPT OF NEEDS, WANTS AND DEMAND

**NEED** is the unsatisfactory condition which get arise in human being.

### *Types of Needs*

- Stated needs: The customer expects the particular product.
- Unstated needs: The customer expects to buy the particular brand in the product.
- Delight needs: The customer would like the dealer to include the additional service.
- Secret needs: the customer wants to be seen by friends as a savvy consumer.

**WANTS** deals with need for a specifying the particular object or event.

**DEMAND** it deals with the ability and willingness of the person to buy the particular product.

For example: many people want a Mercedes or BMW but only few are willing and able to buy one.

### **Types of Demand**

- **Latent demand:** consumer may have a strong need to purchase the product but may not have the ability to buy it.
- **Full demand:** Consumers buy the product adequately.
- **Over full demand** more consumers want the product than supply can meet.
- **Negative demand:** consumers dislike the product.
- **Seasonal demand:** consumer buys the product for the particular time period.
- **Declining demand:** consumer buy less frequently.
- **Nonexistent demand:** consumers are unaware or uninterested in a product.

## DIFFERENCES BETWEEN MARKETING & SELLING

S. No.	Marketing	S. No.	Selling
1	Marketing starts with the buyer and focuses constantly on buyer's needs.	1	Selling starts with the seller and is preoccupied all the time with the seller's needs.
2	Seeks to convert "customer needs" into 'products'.	2	Seeks to convert 'products' into "Cash".
3	Views business as a customer satisfying process.	3	Views business as a goods producing process.
4	Marketing effort leads to the products that the customers actually want to buy in their own interest.	4	The company makes the product first and then figures out how to sell it and make a profit.
5	Marketing communication is looked upon as a tool for communicating the benefits/ satisfactions provided by the product	5	Seller's motives dominate marketing communication (promotions).
6	Consumers determine the price; price determines costs.	6	Cost determines the price.
7	Marketing views the customer as the very purpose of the business. It sees the business from the point of view of the customer. Customer consciousness permeates the entire organization – all departments, all the people and all the time.	7	Selling views the customer as the last link in the business.
8	'Customer satisfaction' is the primary motive.	8	'Sales' is the primary motive.
9	External market orientation.	9	Internal company orientation.
10	Marketing concept takes an <b>outside in</b> perspective	10	Selling concept takes an <b>inside-out</b> perspective.
11	It is a broad composite and worldwide concept, more so in this era of globalisation.	11	It is a narrow concept related to product, seller and sales activity.
12	Marketing is more 'pull' than 'push'.	12	Selling involves 'push' strategy.
13	Marketing begins much before the production of goods and services, i.e. with identification of customers' needs. It continues even after the sale to ensure customer satisfaction through after sales services.	13	Selling comes after production and ends with the delivery of the product and collection of payment.
14	Marketing has a wider connotation and includes many activities like marketing research, product planning & development, pricing, promotion, distribution, selling etc.	14	Selling is a part of marketing.
15	It concerns itself primarily and truly with the 'value satisfactions' that should flow to the customer from the exchange.	15	It over emphasizes "the exchange" aspect, without caring for the 'value satisfactions' inherent in the exchange.
16	It assumes: "Let the seller beware".	16	It assumes: "Let the buyer beware".
17	Marketing generally has a matrix type of organizational structure.	17	It has a functional structure.
18	The main job is to find the right products for your customers.	18	The main job is to find the customers for your products.
19	The mindset is "What is that we can make here or source from outside to satisfy the needs of the target customers".	19	The mindset is "Hook the customer".
20	Conceptual and analytical skills are required.	20	Selling and conversational skills are required.

## PRODUCT

**Definition:** Alderson defines “a product is a bundle of utilities consisting of various product features for satisfying the customers.”

### **Important features of a product:**

**Tangibility:** It should be perceptible by the touch. An item to be called as product should have a tangibility character touch, seen or feeling, for instance: car shirt, book etc.

**Intangible Attributes:** The product may be intangible, in the form of services, for instance banking insurance services; repairing etc. it is an associated feature. For instance: scooter is a tangible product and when free servicing is offered by the seller, then the product is not only a tangible item but also an intangible one.

**Associated Attributes:** Such attributes may be brand, package, warranty etc. For instance, Hindustan lever’s vanaspathi ghee has a brand name DALDA and with its package it can be identified by the consumers.

**Exchange value:** Whether the product is tangible or intangible, it should have exchange value and must be capable of being exchanged between seller and buyer for mutually agreed price.

**Consumer satisfaction:** Products should have the ability to offer value satisfaction to the consumer. The satisfaction may be either real or psychological.

### **Classifications of products or services:**

Goods may also be called as product. They are tangible. They are:

A. **CONSUMER’S GOODS:** These types of goods are purchased by ultimate users or consumers for their personal use. For example: food, biscuits, toys, clothes etc. are purchased by consumers to satisfy their non-business wants. These goods may be further classified as:

**Convenience goods:** Consumers or purchasers get commodities such as bread, drug, soap, sugar, toothpaste, newspapers, petrol, cool drinks, at minimum effort and at low cost. They are often required by the consumers. These types of goods are available at places, where consumers need. The purchase of such goods cannot be postponed because they are daily necessities of life.

**Shopping goods:** Before making final selection, the consumers make an enquiry as to the products .comparative prices, durability, style etc. from different shops. Goods like furniture, readymade garments etc. are mostly costly than convenience goods.

**Speciality goods:** Certain products possess special attention to the customers. As such the consumer may wait or suffer inconveniences to get the desired needs. These types of goods are of high value and manufactured by reputed firms. For example: cars, diamond.

**B. INDUSTRIAL GOODS:** Goods are those which are used for further production of goods and services.

**Raw Materials:** These are goods that enter physically into the final products. For example: building stones, raw cotton. Raw jute etc.

**Fabricated materials:** Materials of this category will enter into the final products but some type of processing is already undergone .for example: bricks, copper sheets, leather, yarn etc.

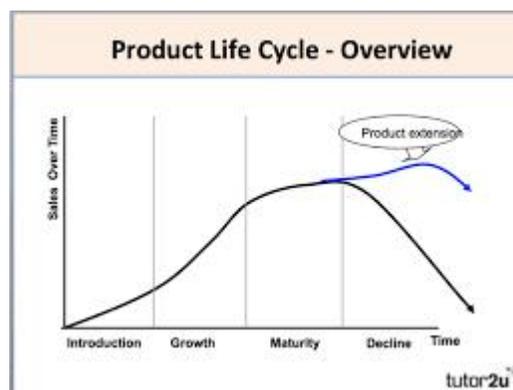
**Installation:** Machines, buildings equipments etc. do not enter into final products and are durable for a long period. They are essential for production .for example: gas, power installation etc. they need heavy expenses for installation and sometimes decide the nature, scope and efficiency of an organization.

**Accessories:** They are light machines or tolls which are used for the operation of a business. This is not used for manufacturing a product. For example: typewriters, calculators, accounting machine etc

**C.SERVICES:** Services are intangible activities which are offered for sale as such or in connection with sale of goods. For example: banking, consultation etc.

## PRODUCT LIFE CYCLE (PLC)

When a Product is commercialized it enters into the market and competes with the rival products for making sale and earning profit. Like human beings, products also have a length of life and they pass through different stages in this life period. These stages are termed as product life cycle of that product.



### Stages of product life cycle

- Introductory stage
- Growth stage

- Maturity stage or saturation stage
- Decline stage

#### **Introduction stage:**

- The information on product acceptance, product image and distribution system are needed.
- The new product means “a product that opens up an entirely new market, replaces an existing product or significantly broadens the market for an existing product.
- Product is new one, awareness in market is low, cost of marketing is high, and profits are low.
- In this stage, the product is introduced into market and made available to the customers with a slow rise in sales
- The profit may be low, because of heavy advertising and sales promotion in order to stimulate the demand.

#### **Growth stage:**

- During the growth stage the products start yielding very good profits but there is a threat from the competitors who try to enter the market and take the market share
- The product given first satisfaction to the first buyers. Others follow: sales increases rapidly and product start generates profits.
- This is the stage where competitors appear along with substitute products in large numbers.
- The success of firms depends upon the efficient manufacturing and distributing system of the product.

#### **Maturity stage:**

- In this stage, the product’s sales reach the highest point but the profits starts declining slowly thereafter.
- The product reaching its maturity and sales are good. But battle for market share is about begin.
- At this stage, keen competition increases. Market expenses increase, even after mark-down price, which enable to face competition.
- Profit is thinned. Additional expenses are involved in product modification and improvement in the marketing mix to attract the customer and retain the market.

#### **Saturation stage:**

- The sales are at peak and further increase is not possible.
- The demand for the product is stable. But battle for market share is about to begin.
- At this stage, a replacement of product is needed, because the sale of the existing product cannot be increased.

#### **Decline stage:**

- When sales start declining buyers go for newer and better product.

- This is because of many reasons technological advances, consumers shifts in taste, increased competition etc.
- It exhibits a sharp decline in sales of the product.
- The firm has to decide whether to drop the product or continue with it.

### **Classification of Markets**

Markets have been classified, on the basis of different approaches, in various ways. They are given below.

#### ***A. On the Basis of Geographical Area:***

1. **Family Market:** When exchanges are confined within a family or close members of the family, such a market can be called as family members.

2. **Local market:** When people –buyers and sellers, belong to a local area or areas, say a town or village, participate in market it is called local market. The demands are limited. For example, perishable goods like fruits, fish, vegetables etc...

3. **National Market:** For a certain type of commodities, a country may be regarded as a market, through the fast development of industrialization; it is called as national market. At the present stage, in India, the goods of one corner can reach another corner because of the efficient systems of communications and transportation facilities.

4. **World Market:** international market comes up when the buyers and sellers of goods evolve on world level. That is involvement of buyers and sellers beyond the boundaries of a nation.

#### ***B. On the Basis of Commodities /Goods:***

Commodity markets are subdivided into:

**Produce Exchange Market:** One market deals in one commodity only. Generally sellers and buyers of a particular commodity set up such markets and run them regulated and controlled by certain rules. Ex: the cotton exchange market of Bombay.

**Manufactured Goods Market:** such type of markets deals with manufactured goods. Ex: leather goods, machinery etc.

**Bullion market:** This type of market deals with the purchase or sale of gold, silver etc. Bullion markets of Bombay, Calcutta, Kanpur etc, are examples of such markets.

#### ***C. On the Basis of Economics:***

**Perfect market:** A market is said to be perfect if it satisfies the following conditions:

- Large number of buyers and sellers
- Prices should be uniform throughout the market
- Buyers and sellers have a perfect knowledge of market
- Goods can be moved from one place to another without restrictions.

**Imperfect market:** A Market is said to be imperfect when

- Products are similar but not identical
- Prices are not uniform
- There is a lack of communications
- There are restrictions on the movement of goods.
- 

***D. On the Basis of Transaction:***

**Spot Market:** In such a market goods are exchanged and the physical delivery of goods takes place immediately.

**Future Market:** In such a market contracts are made over the price for future delivery. The dealing and settlement takes place on different dates.

***E. On the basis of regulation:***

**Regulated market:** These are types of markets which are organized, controlled and regulated by statutory measures. Example: stock exchange of Mumbai, Chennai, Kolkata etc...

**Unregulated market:** This is free market. There is no control with regard to price, quality; commission etc. demand and supply determine the price of goods.

***F. On the Basis of Time:***

**Very short period market:** Markets which deal in perishable goods like, fruits, milk, vegetables etc., are for a very short period. There is no change in the supply of goods. Price is determined on the basis of demand.

**Short period market:** In certain goods, supply is adjusted to meet the demand. The demand is greater than supply. Such markets are known as short period.

**Long period market:** This type of market deals in durable goods.

***G. On the Basis of Volume of Business:***

**Wholesale Market:** In wholesale market goods are supplied in bulky quantity to dealers.

**Retail Market:** In retail market goods are sold in small quantities directly to the users or consumers. The consumer gets the goods for consumption and not for profit making.

## Pricing

Method adopted by a firm to set its selling price. It usually depends on the firm's average costs, and on the customer's perceived value of the product in comparison to his or her perceived value of the competing products. Different pricing methods place varying degree of emphasis on selection, estimation, and evaluation of costs, comparative analysis, and market situation.

### Factors affecting price fixation

1. **Fair trade laws.** Manufacturers make agreement, with dealers who retail their products, on the price it can be sold to the public.
2. Nationally advertised prices and **government restricted prices** of different products.
3. **Desired customer clientele.** Pricing policy depends upon the buying habits of the customers who buy the products and whether, they (i.e., customers) are price conscious people.
4. **Company monopoly.** Whether the company has a monopoly or it is in a competitive position.
5. **Manufacturer's suggested prices,** depending upon the cost of manufacture and selling the product.
6. **Type of Merchandises,** i.e., whether they are novelties or special interest items, etc.
7. **Nature of sales.** Whether the product sells seasonally, (e.g., refrigerators) or throughout the year  
(e.g., televisions and transistor radios).
8. **Price lining** is a policy of keeping merchandise in fairly well defined price range, e.g., selling shoes at Rs. 139.95 Rs. 254.95 and Rs. 371.95, etc.
9. .Whether large volume with low unit profit or relatively small volume with high unit profit is desired. .

### 10.. Suitable channels of distribution.

### 11. Sales promotional strategy.

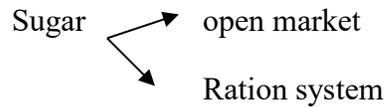
## PRICING PRACTICES

### ➤ Administered pricing:

Administered prices are those prices, which are statutorily fixed by the government, taking into account the cost and the stipulated profit per unit .steel, fertilizer, coal etc are generally fixed by the Government.

### ➤ Dual pricing:

Under this dual pricing system, a producer is required compulsorily to sell a part of his production to the government or its authorized agency at a substantially low price. The rest of the product may be sold in the open market at a price fixed by the producer.



➤ **Discriminatory pricing:**

It occurs when company sells a products or services at two or more prices these variations in price are not proportionate to the cost incurred. There are several forms of discriminatory pricing:

- **Customer segment pricing:**

Here different customer groups are charged at different prices for the same product or services. E.g.: Museums, entertainment, parks charge different admission fee from students and others.

- **Time price differentials:**

In these case price may vary within 24 hours period. Example: gold rate.

- **Calendar use pricing:**

In these case prices may fixed on season basis or time of the usage. Example: in a tourist place a hotel may charge different prices during season and off season.

- **Product form pricing:**

Here different versions of the same products are charged differently. For e.g.: liquid soap, soap bar.

➤ **Geographical pricing:**

In this approach the company takes the location of manufacturing and buyers place into consideration while fixing prices. Cost of transportation is a major component in this pricing method.

## **CHANNELS OF DISTRIBUTION**

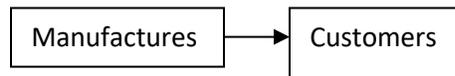
### **DEFINITION**

A set of independent organization involved in the process of making a product or service available to the final customers for consumption.

### **Different Types of Channel Level**

- **Zero Level Channel or Direct marketing**

In this case company does not depend upon any channel member to reach the customer. It directly sells the product to the end consumer. Hence these level is also knows direct marketing or direct selling. The manufacturer in this case directly interacts with the customer. Different method of direct marketing includes door to door selling, mail order, telephonic order and selling through company owned shops.



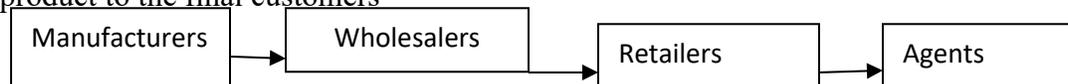
- **One –level channels or single**

When there is a single intermediary in between the producer and the buyer it is known as a one level channel for eg. A company sells the product through a retailer to the customer.



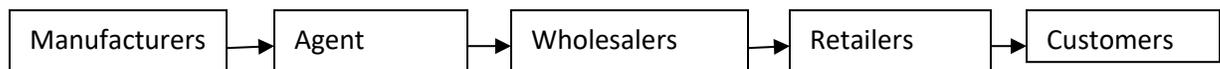
- **Two level channels or Double level channel**

Here there are two intermediaries between the manufacturers as the customer eg. A manufacturer sells the product to a wholesaler who sells it again to retailers who in turn passes the product to the final customers



- **Three level channels or Triple Level channel**

In these cases the product passes through the hands of three intermediaries before reaching the final customers.



## **SALES PROMOTION-Introduction**

All the activities that go into the development of sales or those that are intended to raise the demand level for a product very quickly can be grouped under the title Sales Promotion. Sales promotion includes those marketing activities, other than personal selling, advertising, and publicity, that stimulate consumer purchasing and dealer effectiveness, such as displays, shows and exhibitions, demonstrations, and various non-recurrent selling efforts not in the ordinary routine.

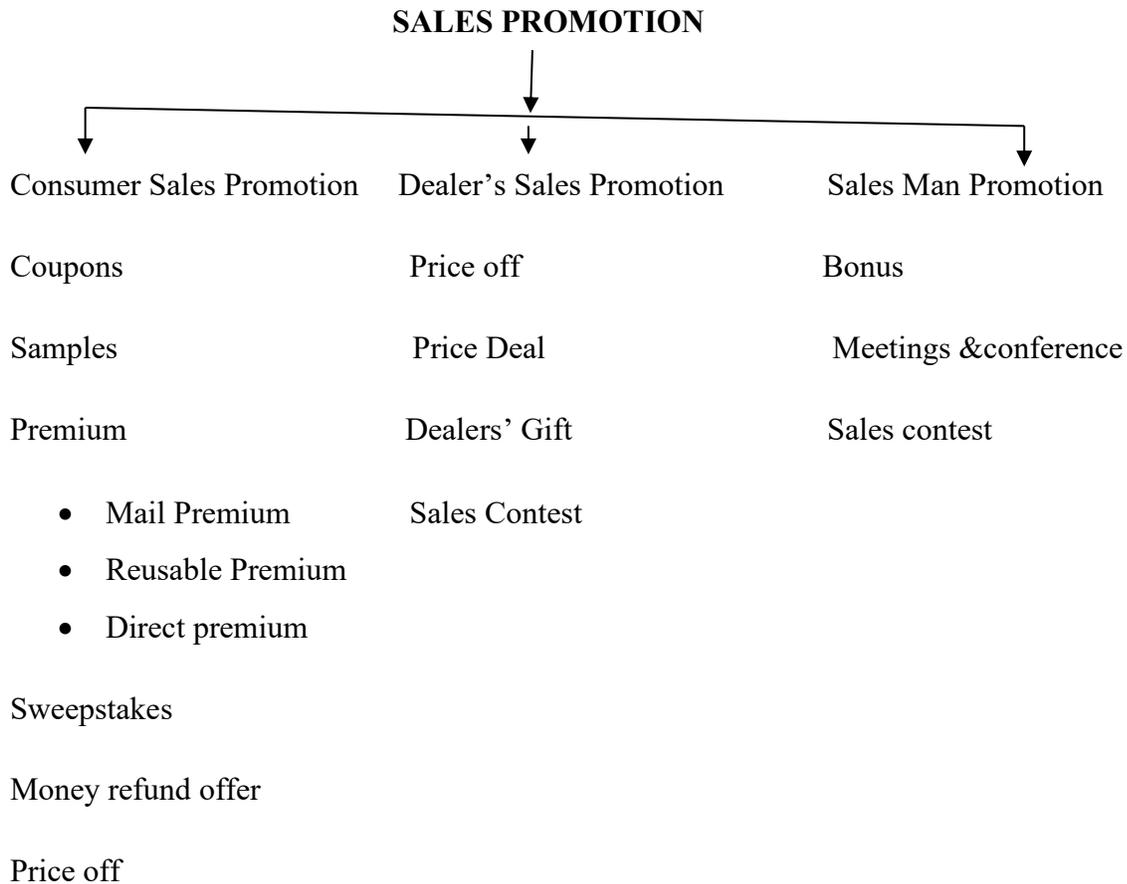
Sales promotion focuses the attention of the customer at the actual point of sales in the shops with such effectiveness that both the advertiser and the dealer are benefited. The main purpose is to increase sales.

Sales promotion plays a critical role in introductory and maturity stages of the product life cycle and also appears to be especially effective during periods of rapid inflation.

Sales promotion, intended to educate the consumers better and to bring about an increase in sales is used more extensively in highly competitive businesses.

The whole idea behind sales promotion is to bring the name of product and that of the manufacturer constantly before wholesalers, retailers and the consumers in order to stimulate their interest in the product.

**TYPES OF SALES PROMOTION**



## **Consumer Sales Promotion**

**Samples:** Free samples are given to consumers to increase their interest in the product. It is an effective device when the product is purchased often. Examples: soaps, detergent, tea and expand.

**Coupons:** certificated entitling the bearer to a stated saving on the purchase of a specific product mailed enclosed in other products or attached to them. The coupons are used to

- Introduce new products.
- To sell new and larger size of a product
- To encourage repeated sale.

**Premium:** Merchandise offered at a relatively low cost or free as an incentive to purchase a particular product.

**Direct Premium:** Premium accompanies the product inside or outside the package. Example: one bowl for good day biscuit.

**Free in mail premium:** The Company sends these items by mail to consumers who are requested to send the proof of their purchase.

**Reusable Premium:** It is a container which can be reused after the product is used. Example: plastic jar.

**Sweepstakes:** Consumers submit their names for inclusion in a list of prizes –winning contest.

**Price off:** It stimulates sales during a slump season. It gives a temporary discount to the consumer's i.e. goods are offered at a rate less than the labeled rate.

**Money Refund Offer:** if the purchaser is not satisfied with the product, a part or all of the purchaser's money will be refund. It is stated on the package.

## **Dealer's Sales Promotion**

**Price off:** A straight discount off the list price on each case purchased during a stated time period.

**Price deal:** Apart from the regular discounts special discounts are also allowed to the dealers for a specified quantity of purchase.

**Dealers Gift:** manufacturers give attractive and useful articles to dealers against their orders. The articles are radio, T.V, clock, watch etc.

### **Salesman Promotion**

**Bonus:** The manufacturer sets a target of sales for a year. If the sales force sell the students above the targeted sales bonus is offered to them.

**Meetings & conference:** The idea behind these is to educate, inspire and reward the salesman. New selling techniques are described to them and discussed in the conference.

**Sales contest:** A sales contest aims at inducing the sales force or dealers to increase their sales over a stated period, with prizes going to those who succeed.

### **Objectives of sales promotion**

- To increase buying response at the consumers level.
- To attract new customers.
- To capture the major market share
- To meet the competition of other firms.
- To create brand image
- To stimulate the demand by popularizing the product.

## **ADVERTISING**

### **Introduction and Definition**

- Advertising can become an established essential of a country's economy. It contributes to broad Geographic system of distribution; to the volume sales, an essential corollary of mass production ;and to the pricing of many products within the economic means of the average man .
- Just as communication is vital to good internal management, so is advertising vital to the earning of profit.
- Running a business without advertising is just like winking at a beautiful girl in the dark- you know what you are doing but she does not know it.
- Advertising is generally regarded as a form of communication the purpose of which is to convey concepts about companies, goods and services by means of words, pictures,

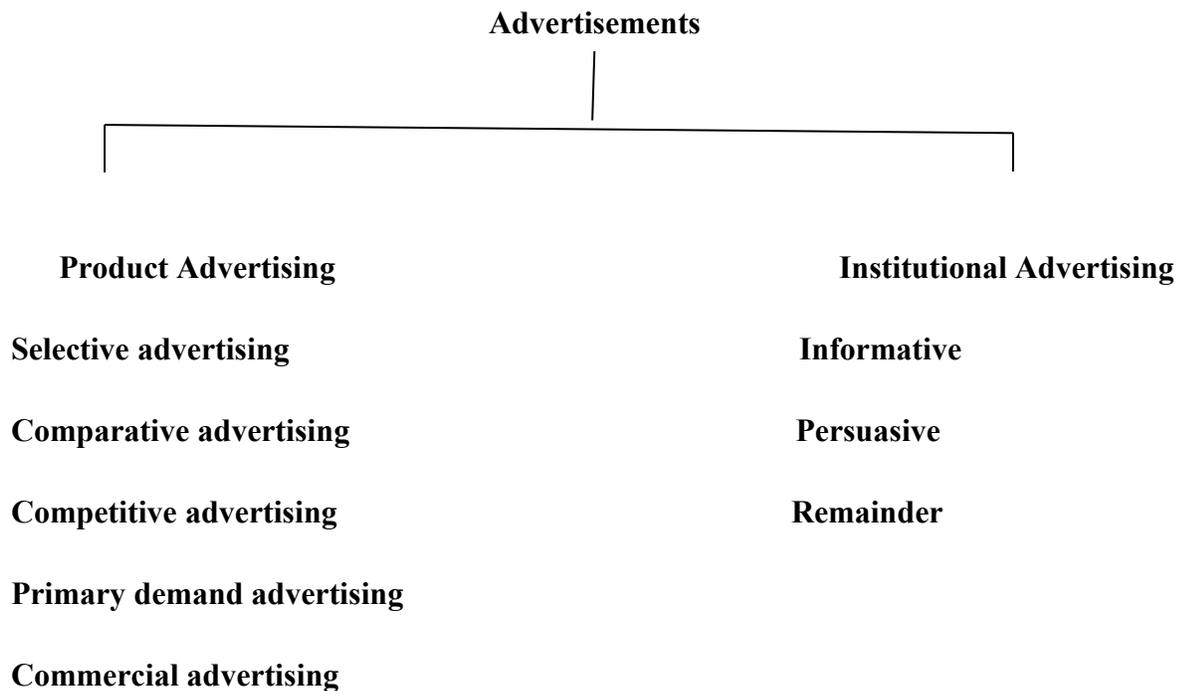
diagrams, sound, music, color, shapes and symbol on two levels of significance-the national and the emotional.

- Advertising is any paid form of non-personal presentation and promotion of ideas, goods or services by an indentified sponsor.
- Advertising may be defined as commercial messages to the public, designed to inform potential and established consumers and to encourage sales for the advertiser.
- Advertising can stimulate demand and, where necessary, can even create demand where none exists.
- Advertising arouses public interest, fosters a buying attitude and raises consumer demand for the products of a company.

### **Functions and Objectives of Advertising**

1. Advertising introduces existing and new company products to the public.
2. Advertising enhances potential buyer's responses to the company and its offerings.
3. Advertising tells that a product which the customers want exists and from where it can be procured and at what price.
4. Advertising is undertaken to reduce selling costs; because large volume of production will lead to economies, if, through advertising, it can be supported by mass distribution.
5. Advertising makes a product stand against its competitor products.
6. Advertising
  - ✓ finds new users
  - ✓ supports salesmen
  - ✓ increases profit
  - ✓ reaches customers who would otherwise be inaccessible to sales staff,
  - ✓ tells the public, the good qualities of the product, i.e.,why people should purchase only this brand'
7. Advertising convinces retailers that they should keep the products of that company.
8. Advertising creates a confidence in the minds of buyers regarding quality of those goods or products.
9. Advertising builds ,up reputation for the company goods and services.

## Types of Advertisements



**Product Advertising:** The Company tries to sell its product or services through advertising. It may be referred to as product advertising.

**Selective Advertising:** The goal of advertisement is to influence demand for a specific product on the particular period of time.

**Comparative Advertising:** It stresses on comparative features of two or more specific brands in terms of product or services.

**Competitive Advertising:** Advertising may begin to stress subtle differences in brands, with heavy emphasis on brand name recall.

**Primary demand advertising:** It is intended to stimulate primary demand for a new product or product category.

**Industrial advertising:** It is also termed as business advertising, as the name suggests such advertising is solely meant for effecting increase in sales. Usually the following forms of commercial advertising are recognized.

- Trade advertisement: Advertisement relates to trade is trade advertisement.
- Professional advertising: Advertisements undertaken by professional people is professional advertising.
- Farmers Advertising: advertisements exclusively used for selling farm products such as fertilizers, insecticides, farm implements etc.

**Institutional advertising:** where the objective of advertising is to promote the image of a company or its services it is called institutional advertising.

**Informative Advertising:** It is designed to inform about the product information to the targeted customers.

**Persuasive Advertising:** It is designed to make the customers to buy the products.

**Remainder Advertising:** It is designed to make the customers to recall the products which is existing in the market.

## MEANING OF MARKET RESEARCH

“The systematic gathering, recording and analyzing of data about problems relating to the marketing of goods and services”.

### Objectives of market research:

- To define the probable market for a particular product
- To assess competitive strength and policies.
- To understand customer acceptance.
- To assess the probable volume of future sales.

### *Types of market research*

**Market research:** it covers the aspects regarding size and nature of market including export market, dividing the consumers in terms of their age, sex, income. It may include market trends, market share, and market potential.

**Sales research:** it relates to the problem of regional variations in sales, fixing sales territories, measurement of the effectiveness of a salesman, evaluation and impact of sales methods and incentives.

**Product research:** it relates to the analysis of the strength and weakness of the existing product, product testing problems related to diversification.

**Packaging research:** to know the impact and its response in the market has become as independent research field.

**Advertising research:** it undertakes a study relating to the preparation of the advertisement copy.

**Business economic research :** Problems relating to input – output analysis forecasting ,price and profit analysis and preparation of break even charts are the main fields of this research .\

### ***Process of market research***

#### **Define the problem:**

In this step the problem is clearly and accurately stated to determine what issues are involved in the research. What questions to ask and what types of solutions are needed. This is the crucial step that should not be rushed.

#### **Make a preliminary investigation:**

The objective of preliminary investigation is to develop both a sharper definition of the problem and a set of tentative answers. The tentative answers are developed by examining internal information and published data and by talking with persons who have some experience with the problem. Theses answers will be tested by future research.

#### **Plan the research:**

At this stage researchers know what facts are needed to resolve the identified problem and what facts are available. They make plans on how together needed but missing data.

#### **Gather factual information:**

Once the basic research plan has been completed, the needed information can be collected by mail, telephone or personal interviews, by observation or form commercial or government data sources. The choice depends on the plan and the available sources of information.

#### **Interpret the information:**

Facts by themselves do not always provide a sound solution to a marketing problem. They must be interpreted and analyzed to determine the choices available to management.

#### **Report preparation:**

The finals step in marketing research is summarizing the result and making a report. The findings and recommendations are put in such a manner that the recipient of the report can understand them clearly enough to use them effectively.

### **Market information system**

It consists of people, equipment and procedures to gather, sort, analyze, evaluate and distribute needed timely and accurate information to market decision makers.

## **Market Research Techniques**

Some of the techniques used by persons engaged in market research for collecting the data are as follows:

1. **Desk research.** The data is collected from the information published by the company or outside sources, e.g. government agencies, trade associations, etc. Desk research is done on :  
(a) Sales analysis, i.e. past sales, fluctuations sales and promotional expenditures, economics of order size, etc.

(b) Correlation studies, concerned with finding the relationship between two or more variables, e.g., number of new cars produced and number of car batteries sold.'

(c) Ratios, such as stock-turn (the relationship between sales and stocks), profit per rupee invested (earnings/capital) etc.

2. **Postal Questionnaire** carefully prepared questionnaires, consisting of questions -short, specific and statistical or open minded are posted to a selected sample of respondents for collecting specific data from them.

3. **Telephone interviews** Telephone interviews are conducted at a personal level with a selected sample of people for collecting their views.

4. **Personal Interviews** Personal interviews are conducted on a simple question and answer basis. Such interviews give best results with greater reliability.

5. **Observational Method** The marketing research personnel silently observe others and collect the desired information, e.g., ~standing outside or in a wine shop, the brands more frequently purchased can be found out. 6. **Statistical Methods** – Statistical methods make use of large precollected data and logically conclude the market investigations. – Bar chart, histogram, frequency polygon, frequency distribution curve and the concepts of average, median, and standard deviation help serve the purpose.

## **SALES FORECASTING:**

Forecasting is essentially the art of anticipating what buyers are likely to do under a given set of conditions. – The market research conducted by a firm plus the analyses of current sales experience and trends form the basis for the construction of a sales forecast. – The sales forecast is a commitment on the part of the-sales department and each of its division's of the expected sales likely to be achieved in a given period at stated prices. – Sales forecasting should be very accurate because production and stock holding plans and the whole train of events following from these are based on them.

## **Sales Forecasting Techniques**

*Forecasting* is the formal process of predicting future events that will significantly affect the functioning of the enterprise. Sales forecasting techniques may be categorized as follows:

- (a) Historic estimate,
- (b) Sales force estimate,
- (c) Trend line (or Time series analysis) technique,
- (d) Market survey,
- (e) Delphi method,
- (f) Judgmental techniques,
- (g) Prior knowledge,
- (h) Forecasting by past average,
- (i) Forecasting from last period's sales,
- (j) Forecasting by Moving average,
- (k) Forecasting by Weighted Moving average,
- (l) Forecasting by Exponential Smoothing,
- (m) Correlation Analysis,
- (n) Linear Regression Analysis.

### **Historic estimate**

- This technique makes use of the assumption that *what happened in past will happen in future*. example if a concern has sold 5000 blankets in winter last year, it will be able to sell the sales quantity in winter this year also.
- Historic estimate is useful if the activity is affected by pattern of seasonality.
- It is useful for determining model, size and colour distribution.
- Manager in consultation with other related factory executives formulates the final estimate of sales.
- This technique is useful when an industry is making a limited number of products (*e.g.*, commercial power generating equipment) and there are a few large customers.

### **Trend line technique**

- Trend line technique is employed when there is an appreciable amount of historical data. - This technique is more reliable than the historic estimate (a) above.
- This technique involves plotting historical data, *i.e.*, a diagram between activity indicator, *e.g.*, tons of material (say past sales) on Y-axis and time on X-axis
- A single best fitting line (using statistical technique) is drawn and projected to show sales estimate for future.
  
- This technique is more accurate as it makes use of a large past data and possesses scientific validity.

### **Market Survey, *ie*: Market Research Technique**

- This technique finds application when a concern introduces a new product in the market and is interested to estimate its *sales* forecast. For a new product, naturally, no historic or past data regarding sales will be available.
- This technique may be very informal, utilizing the sales force to *feel out* the potential customer's in order to establish the extent of the market or it may be a systematically conducted survey using special mathematical tools.

### **Delphi Method**

A panel of experts is interrogated by a sequence of questionnaires in which the response to one questionnaire is used to produce the next questionnaire. Any set of information available to some experts and not others is thus passed on to the others, enabling all the experts to have access to all the information for forecasting. The method solicits and collates opinion from experts to arrive at a reliable consensus.

### **Judgmental techniques.**

They involve 1. **Opinions of consumers and customers.** Questionnaires related to buying the product may be sent to selected group of consumers and to the customers who have already purchased the product. The information thus received can be very useful in estimating product performance and its probable demand in future. 2. **Retail and wholesale dealers** can provide some insight into the pace of current and future sales. 3. The opinion of area sales managers can also be quite useful.

### **Prior knowledge**

This is used by ancillary units which are more or less a part of the large organisation. The large organisation informs each ancillary unit how many component parts to make. The forecast estimate is needed only to establish the material and tool requirements, etc.

### **Econometric Forecasting –**

In econometric forecasting the analyst tries to uncover the cause-and-effect relationship between sales and some other phenomena that are related to sales. For example, an appliance manufacturer might discover that the sales of television sets respond to the disposable income of customers with a 1-month lag. That is, 1 month after a change in disposable income, there a proportionate change in the sales of T.V. sets, this process is called econometric forecasting. Here, the analyst tries to identify those factors that best explain the level of sales for a product. - Econometric forecasting utilizes correlation and Regression techniques. The objective is to establish a cause-and-effect relationship between changes in the sales level of the product and a set of relevant explanatory variables.

## **UNIT III**

Financial management: Sources of finance (Internal and External) - Preparation of Balance Sheet and Profit and Loss Statements, Types of Accounting and significance of each types, interest formulas and their applications.

### **MEANING OF FINANCE**

Finance also is referred as the provision of money at the time when it is needed. Finance is the science that describes the management, creation and study of money, banking, credit, investments, assets and liabilities. Finance consists of financial systems, which include the public, private and government spaces, and the study of finance and financial instruments, which can relate to countless assets and liabilities.

### **Objectives of Financial Management**

Profit maximization

Wealth maximization

### **SOURCES OF FINANCE**

There are two main sources of finance; these are internal sources and external sources.

#### **Internal sources include:**

- Retained profit - profit made is reinvested into the business.
- Controlling working capital - reducing costs, delaying outflows and speeding up inflows.
- Sale of assets - Assets the company owns can be sold and then leased back which frees up a large amount of capital in the short term.

#### **External sources of finance:**

- Increasing trade credit - delaying payments on purchases for as long as possible.
- Factoring - use a company to collect all debts.
- Overdraft - an agreement with a bank to be allowed to overdraw a certain amount.
- Grants - an agreed amount of money given for a special reason by government or other organisation.
- Venture capital - people invest in the company when it is unable to float on the stock market.
- Debentures - business equivalent of a mortgage. Loan for a set length of time at a set interest rate.
- Share issues - selling of new shares to raise capital.
- Owner's savings - the owners investing money into the business.
- Bank loans - medium or long term loans but interest is charged.
- Leasing - instead of buying.

## **Accounting**

It is a systematic process of identifying, recording, measuring, classifying, verifying, summarizing, interpreting and communicating financial information. It reveals profit or loss for a given period, and the value and nature of a firm's assets, liabilities and owners' equity.

Accounting provides information on the

1. resources available to a firm,
2. The means employed to finance those resources, and
3. The results achieved through their use.

## **TYPES OF ACCOUNTING**

The financial literature classifies accounting into two broad categories, viz, Financial Accounting and Management Accounting. Financial accounting is primarily concerned with the preparation of financial statements whereas management accounting covers areas such as interpretation of financial statements, cost accounting, etc. Both these types of accounting are examined in the following paragraphs.

### **Financial accounting**

As mentioned earlier, financial accounting deals with the preparation of financial statements for the basic purpose of providing information to various interested groups like creditors, banks, shareholders, financial institutions, government, consumers, etc. Financial statements, i.e. the income statement and the balance sheet indicate the way in which the activities of the business have been conducted during a given period of time.

Financial accounting is charged with the primary responsibility of external reporting. The users of information generated by financial accounting, like bankers, financial institutions, regulatory authorities, government, investors, etc. want the accounting information to be consistent so as to facilitate comparison. Therefore, financial accounting is based on certain concepts and conventions which include separate business entity, going concern concept, money measurement concept, cost concept, dual aspect concept, accounting period concept, matching concept, realization concept and conventions of conservatism, disclosure, consistency, etc. All such concepts and conventions would be dealt with detail in subsequent lessons.

The significance of financial accounting lies in the fact that it aids the management in directing and controlling the activities of the firm and to frame relevant managerial policies related to areas like production, sales, financing, etc. However, it suffers from certain drawbacks which are discussed in the following paragraphs.

The information provided by financial accounting is consolidated in nature. It does not indicate a break-up for different departments, processes, products and jobs. As such, it becomes difficult to evaluate the performance of different sub-units of the organisation.

Financial accounting does not help in knowing the cost behaviour as it does not distinguish between fixed and variable costs.

The information provided by financial accounting is historical in nature and as such the predictability of such information is limited.

The management of a company has to solve certain ticklish questions like expansion of business, making or buying a component, adding or deleting a product line, deciding on alternative methods of production, etc. The financial accounting information is of little help in answering these questions.

The limitations of financial accounting, however, should not lead one to believe that it is of no use. It is the basic foundation on which other branches and tools of accounting analysis are based. It is the source of information, which can be further analyzed and interpreted according to the tailor-made requirements of decision-makers.

### **Management accounting**

Management accounting is 'tailor-made' accounting. It facilitates the management by providing accounting information in such a way so that it is conducive for policy making and running the day-to-day operations of the business. Its basic purpose is to communicate the facts according to the specific needs of decision-makers by presenting the information in a systematic and meaningful manner. Management accounting, therefore, specifically helps in planning and control. It helps in setting standards and in case of variances between planned and actual performances, it helps in deciding the corrective action.

An important characteristic of management accounting is that it is forward looking. Its basic focus is one future activity to be performed and not what has already happened in the past.

Since management accounting caters to the specific decision needs, it does not rest upon any well-defined and set principles. The reports generated by a management accountant can be of any duration— short or long, depending on purpose. Further, the reports can be prepared for the organisation as a whole as well as its segments.

### **Cost accounting**

One important variant of management accounting is the cost analysis. Cost accounting makes elaborate cost records regarding various products, operations and functions. It is the process of determining and accumulating the cost of a particular product or activity. Any product, function, job or process for which costs are determined and accumulated, are called cost centres.

The basic purpose of cost accounting is to provide a detailed break-up of cost of different departments, processes, jobs, products, sales territories, etc., so that effective cost control can be exercised.

Cost accounting also helps in making revenue decisions such as those related to pricing, product-mix, profit-volume decisions, expansion of business, replacement decisions, etc.

The objectives of cost accounting, therefore, can be summarized in the form of three important statements, viz, to determine costs, to facilitate planning and control of business activities and to supply information for short- and long-term decision.

Cost accounting has certain distinct advantages over financial accounting. Some of them have been discussed succeedingly. The cost accounting system provides data about profitable and non-profitable products and activities, thus prompting corrective measures. It is easier to segregate and analyse individual cost items and to minimize losses and wastages arising from the manufacturing process. Production methods can be varied so as to minimize costs and increase profits. Cost accounting helps in making realistic pricing decisions in times of low demand, competitive conditions, technology changes, etc.

Various alternative courses of action can be properly evaluated with the help of data generated by cost accounting. It would not be an exaggeration if it is said that a cost accounting system ensures maximum utilization of physical and human resources. It checks frauds and manipulations and directs the employer and employees towards achieving the organisational goal.

**Governmental Accounting**, also known as *public accounting or federal accounting*, refers to the type of accounting information system used in the public sector. This is a slight deviation from the financial accounting system used in the private sector. The need to have a separate accounting system for the public sector arises because of the different aims and objectives of the state owned and privately owned institutions. Governmental accounting ensures the financial position and performance of the public sector institutions are set in budgetary context since financial constraints are often a major concern of many governments. Separate rules are followed in many jurisdictions to account for the transactions and events of public entities.

**Tax Accounting** refers to accounting for the tax related matters. It is governed by the tax rules prescribed by the tax laws of a jurisdiction. Often these rules are different from the rules that govern the preparation of financial statements for public use (i.e. GAAP). Tax accountants therefore adjust the financial statements prepared under financial accounting principles to account for the differences with rules prescribed by the tax laws. Information is then used by tax professionals to estimate tax liability of a company and for tax planning purposes.

**Forensic Accounting** is the use of accounting, auditing and investigative techniques in cases of litigation or disputes. Forensic accountants act as expert witnesses in courts of law in civil and criminal disputes that require an assessment of the financial effects of a loss or the detection of a

financial fraud. Common litigations where forensic accountants are hired include insurance claims, personal injury claims, suspected fraud and claims of professional negligence in a financial matter (e.g. business valuation).

**Project Accounting** refers to the use of accounting system to track the financial progress of a project through frequent financial reports. Project accounting is a vital component of project management. It is a specialized branch of management accounting with a prime focus on ensuring the financial success of company projects such as the launch of a new product. Project accounting can be a source of competitive advantage for project-oriented businesses such as construction firms.

**Social Accounting**, also known as *Corporate Social Responsibility Reporting and Sustainability Accounting*, refers to the process of reporting implications of an organization's activities on its ecological and social environment. Social Accounting is primarily reported in the form of Environmental Reports accompanying the annual reports of companies. Social Accounting is still in the early stages of development and is considered to be a response to the growing environmental consciousness amongst the public at large.

## **Balance Sheet**

A statement of the assets, liabilities, and capital of a business or other organization at a particular point in time, detailing the balance of income and expenditure over the preceding period. A balance sheet is a financial statement that summarizes a company's assets, liabilities and shareholders' equity at a specific point in time. These three balance sheet segments give investors an idea as to what the company owns and owes, as well as the amount invested by shareholders.

The balance sheet adheres to the following formula:

$$\text{Assets} = \text{Liabilities} + \text{Shareholders' Equity}$$

## **Profit & Loss Statement**

A profit and loss statement (P&L) is a financial statement that summarizes the revenues, costs and expenses incurred during a specific period of time, usually a fiscal quarter or year. These records provide information about a company's ability – or lack thereof – to generate profit by increasing revenue, reducing costs, or both. The P&L statement is also referred to as "statement of profit and loss", "income statement," "statement of operations," "statement of financial

results," and "income and expense statement." It is prepared to ascertain the net profit or net loss made by the company during the accounting period.

## INTEREST FORMULAS

While making investment decisions, computations will be done in many ways. To simplify all these computations, it is extremely important to know how to use interest formulas more effectively. Before discussing the effective application of the interest formulas for investment-decision making, the various interest formulas are presented first.

Interest rate can be classified into *simple interest rate* and *compound interest rate*.

In simple interest, the interest is calculated, based on the initial deposit for every interest period. In this case, calculation of interest on interest is not applicable. In compound interest, the interest for the current period is computed based on the amount (principal plus interest up to the end of the previous period) at the beginning of the current period.

The notations which are used in various interest formulae are as follows:

$P$  = principal amount

$n$  = No. of interest periods

$i$  = interest rate (It may be compounded monthly, quarterly, semiannually or annually)

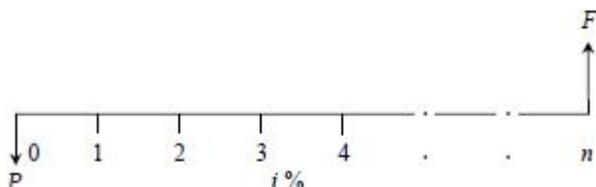
$F$  = future amount at the end of year  $n$

$A$  = equal amount deposited at the end of every interest period

$G$  = uniform amount which will be added/subtracted period after period to/  
from the amount of deposit  $A_1$  at the end of period 1

### Single-Payment Compound Amount

Here, 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. The cash flow diagram of this situation is shown in Fig. 3.2



The formula to obtain the single-payment compound amount is

$$F = P(1 + i)^n = P(F/P, i, n)$$

where

$(F/P, i, n)$  is called as single-payment compound amount factor

**EXAMPLE 3.1** A person deposits a sum of Rs. 20,000 at the interest rate of 18% compounded annually for 10 years. Find the maturity value after 10 years.

**Solution**

$P = \text{Rs. } 20,000$   $i = 18\%$  compounded annually  $n = 10$  years

$$F = P(1 + i)^n = P(F/P, i, n)$$

$$= 20,000 (F/P, 18\%, 10)$$

$$= 20,000 \times 5.234$$

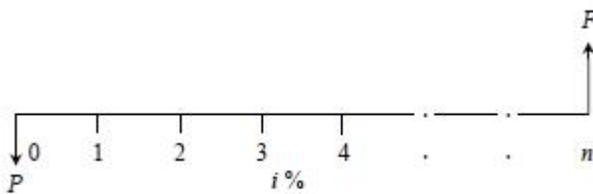
$$= \text{Rs. } 1,04,680$$

The maturity value of Rs. 20,000 invested now at 18% compounded yearly is equal to Rs. 1,04,680 after 10 years.

### Single-Payment Present Worth Amount

Here, the objective is to find 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.

The corresponding cash flow diagram is shown in Fig. 3.3.



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*.

**EXAMPLE 3.2** A person wishes to have a future sum of Rs. 1,00,000 for his son's education after 10 years from now. What is the single-payment that he should deposit now so that he gets the desired amount after 10 years? The bank

gives 15% interest rate compounded annually.

**Solution**

$$F = \text{Rs. } 1,00,000$$

$$i = 15\%, \text{ compounded annually}$$

$$n = 10 \text{ years}$$

$$P = F/(1 + i)^n = F(P/F, i, n)$$

$$= 1,00,000 (P/F, 15\%, 10)$$

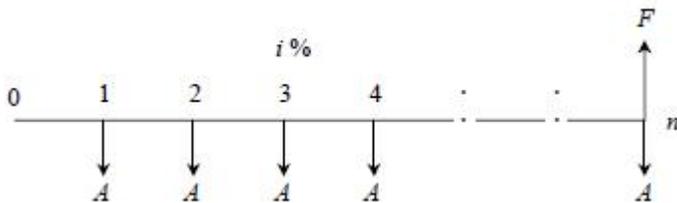
$$= 1,00,000 \times 0.2472$$

$$= \text{Rs. } 24,720$$

The person has to invest Rs. 24,720 now so that he will get a sum of Rs. 1,00,000 after 10 years at 15% interest rate compounded annually.

**Equal-Payment Series Compound Amount**

In this type of investment mode, the objective is to find the future worth of  $n$  equal payments which are made at the end of every interest period till the end of the  $n$ th interest period at an interest rate of  $i$  compounded at the end of each interest period. The corresponding cash flow diagram is shown in Fig. 3.4.



**Fig. 3.4** Cash flow diagram of equal-payment series compound amount.

In Fig. 3.4,

$A$  = equal amount deposited at the end of each interest period

$n$  = No. of interest periods

$i$  = rate of interest

$F$  = single future amount

The formula to get  $F$  is

$$F = A \frac{(1+i)^n - 1}{i} = A(F/A, i, n)$$

where  $(F/A, i, n)$  is termed as *equal-payment series compound amount factor*.

**EXAMPLE 3.3** A person who is now 35 years old is planning for his retired life. He plans to invest an equal sum of Rs. 10,000 at the end of every year for the next 25 years starting from the end of the next year. The bank gives 20% interest rate, compounded annually. Find the maturity value of his account when he is 60 years old.

**Solution**

$$A = \text{Rs. } 10,000$$

$$n = 25 \text{ years}$$

$$i = 20\%$$

$$F = ?$$

The corresponding cash flow diagram is shown in Fig. 3.5.

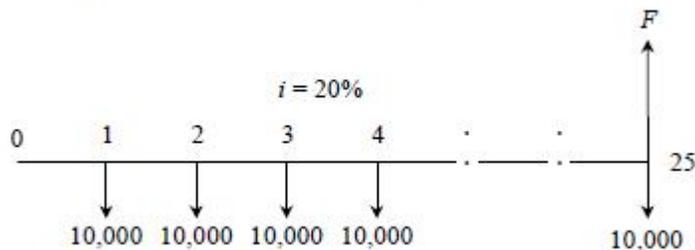


Fig. 3.5 Cash flow diagram of equal-payment series compound amount.

$$F = A \frac{(1+i)^n - 1}{i}$$

$$= A(F/A, i, n)$$

$$= 10,000(F/A, 20\%, 25)$$

$$= 10,000 \times 471.981$$

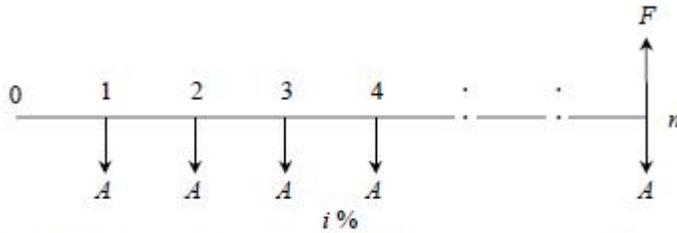
$$= \text{Rs. } 47,19,810$$

The future sum of the annual equal payments after 25 years is equal to Rs. 47,19,810.

### Equal-Payment Series Sinking Fund

In this type of investment mode, the objective is to find the equivalent amount ( $A$ ) that should be deposited at the end of every interest period for  $n$  interest periods to realize a future sum ( $F$ ) at

the end of the  $n$ th interest period at an interest rate of  $i$ . The corresponding cash flow diagram is shown in Fig. 3.6.



**Fig. 3.6** Cash flow diagram of equal-payment series sinking fund.

In Fig. 3.6,

$A$  = equal amount to be deposited at the end of each interest period

$n$  = No. of interest periods

$i$  = rate of interest

$F$  = single future amount at the end of the  $n$ th period

The formula to get  $F$  is

$$A = F \frac{i}{(1+i)^n - 1} = F(A/F, i, n)$$

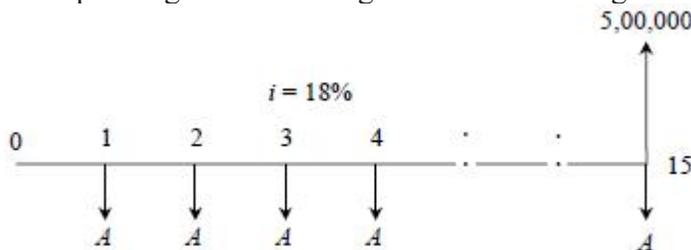
Where  $(A/F, i, n)$  is called as *equal-payment series sinking fund factor*.

**EXAMPLE 3.4** A company has to replace a present facility after 15 years at an outlay of Rs. 5,00,000. It plans to deposit an equal amount at the end of every year for the next 15 years at an interest rate of 18% compounded annually. Find the equivalent amount that must be deposited at the end of every year for the next 15 years.

**Solution**

$F$  = Rs. 5,00,000,  $n$  = 15 years  $i$  = 18%  $A$  = ?

The corresponding cash flow diagram is shown in Fig. 3.7.



**Fig. 3.7** Cash flow diagram of equal-payment series sinking fund.

$$A = F \frac{i}{(1+i)^n - 1} = F(A/F, i, n)$$

$$= 5,00,000(A/F, 18\%, 15)$$

$$= 5,00,000 \times 0.0164$$

= Rs. 8,200

The annual equal amount which must be deposited for 15 years is Rs. 8,200

### 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 Fig. 3.8. Here

$P$  = present worth

$A$  = annual equivalent payment

$i$  = interest rate

$n$  = No. of interest periods

The formula to compute  $P$  is

$$P = A \frac{(1+i)^n - 1}{i(1+i)^n} = A(P/A, i, n)$$

where

$(P/A, i, n)$  is called *equal-payment series present worth factor*.

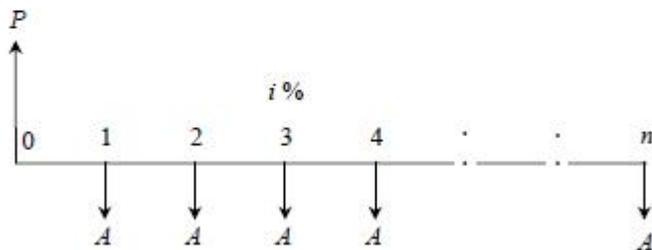


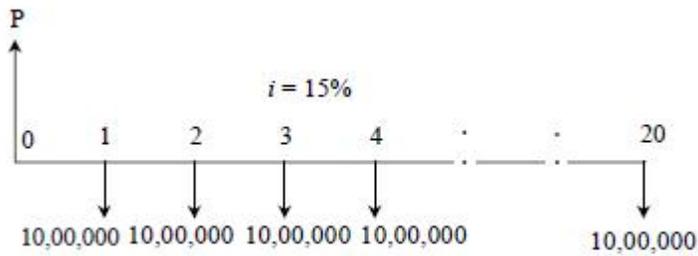
Fig. 3.8 Cash flow diagram of equal-payment series present worth amount.

**EXAMPLE 3.5** 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 20 years towards its employees welfare measures. The reserve is assumed to grow at the rate of 15% annually. Find the single-payment that must be made now as the reserve amount.

#### Solution

$A = \text{Rs. } 10,00,000$ ,  $i = 15\%$ ,  $n = 20$  years  $P = ?$

The corresponding cash flow diagram is illustrated in Fig. 3.9.



3.9 Cash flow diagram of equal-payment series present worth amount.

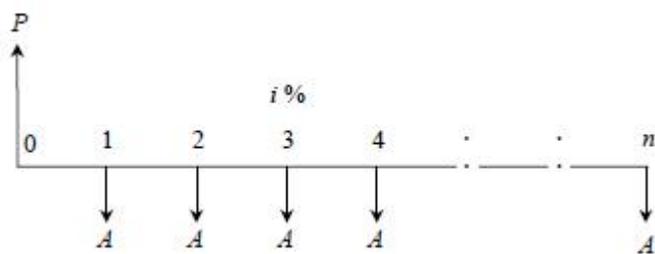
$$P = A \frac{(1 + i)^n - 1}{i(1 + i)^n} = A(P/A, i, n)$$

$$\begin{aligned}
 &= 10,00,000 \times (P/A, 15\%, 20) \\
 &= 10,00,000 \times 6.2593 \\
 &= \text{Rs. } 62,59,300
 \end{aligned}$$

The amount of reserve which must be set-up now is equal to Rs. 62,59,300.

### Equal-Payment Series Capital Recovery Amount

The objective of this mode of investment is to find the annual equivalent amount ( $A$ ) which is to be recovered at the end of every interest period for  $n$  interest periods for a loan ( $P$ ) which is sanctioned now at an interest rate of  $i$  compounded at the end of every interest period (see Fig. 3.10).



Cash flow diagram of equal-payment series capital recovery amount

In Fig. 3.10,

$P$  = present worth (loan amount)

$A$  = annual equivalent payment (recovery amount)

$i$  = interest rate

$n$  = No. of interest periods

The formula to compute  $P$  is as follows:

$$A = P \frac{i(1+i)^n}{(1+i)^n - 1} = P(A/P, i, n)$$

where,

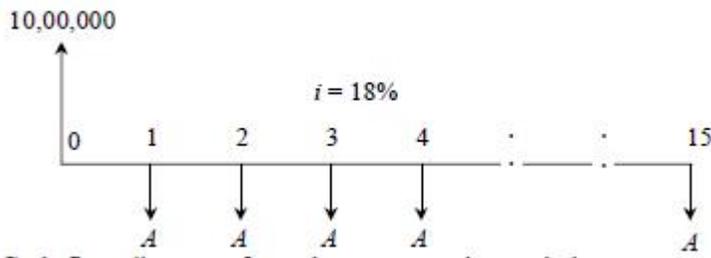
$(A/P, i, n)$  is called *equal-payment series capital recovery factor*.

**EXAMPLE 3.6** A bank gives a loan to a company to purchase an equipment worth Rs. 10,00,000 at an interest rate of 18% compounded annually. This amount should be repaid in 15 yearly equal installments. Find the installment amount that the company has to pay to the bank.

**Solution**

$P = \text{Rs. } 10,00,000, i = 18\% n = 15 \text{ years } A = ?$

The corresponding cash flow diagram is shown in Fig. 3.11.



**Fig. 3.11** Cash flow diagram of equal-payment series capital recovery amount.

$$A = P \frac{i(1+i)^n}{(1+i)^n - 1} = P(A/P, i, n)$$

$$= 10,00,000 (A/P, 18\%, 15)$$

$$= 10,00,000 (0.1964)$$

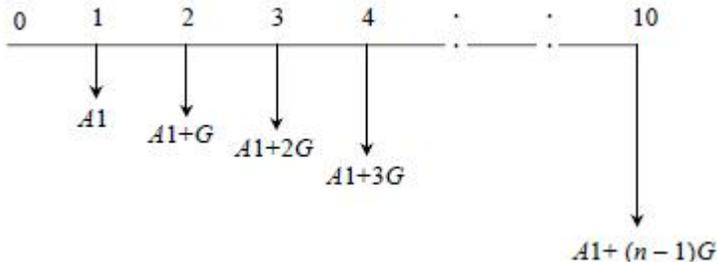
$$= \text{Rs. } 1,96,400$$

The annual equivalent installment to be paid by the company to the bank is Rs. 1,96,400.

### Uniform Gradient Series Annual Equivalent Amount

The objective of this mode of investment is to find the annual equivalent amount of a series with an amount  $A_1$  at the end of the first year and with an equal increment ( $G$ ) at the end of each of the following  $n - 1$  years with an interest rate  $i$  compounded annually.

The corresponding cash flow diagram is shown in Fig. 3.12.



**Fig. 3.12** Cash flow diagram of uniform gradient series annual equivalent amount.

The formula to compute  $A$  under this situation is

$$A = A_1 + G \frac{(1+i)^n - in - 1}{i(1+i)^n - i}$$

$$= A_1 + G (A/G, i, n)$$

where

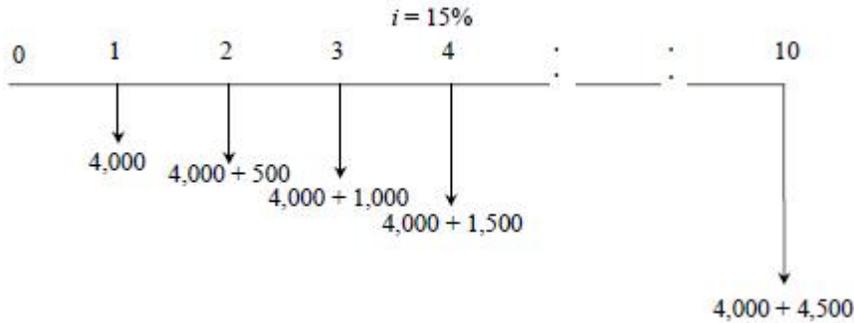
$(A/G, i, n)$  is called uniform gradient series factor.

**EXAMPLE 3.7** A person is planning for his retired life. He has 10 more years of service. He would like to deposit 20% of his salary, which is Rs. 4,000, at the end of the first year, and thereafter he wishes to deposit the amount with an annual increase of Rs. 500 for the next 9 years with an interest rate of 15%. Find the total amount at the end of the 10th year of the above series.

#### **Solution**

Here,  $A_1 = \text{Rs. } 4,000$   $G = \text{Rs. } 500$   $i = 15\%$   $n = 10$  years  $A = ?$  &  $F = ?$

The cash flow diagram is shown in Fig. 3.13.



Cash flow diagram of uniform gradient series annual equivalent amount.

$$A = A_1 + G \frac{(1+i)^n - in - 1}{i(1+i)^n - i}$$

$$= A_1 + G(A/G, i, n)$$

$$= 4,000 + 500(A/G, 15\%, 10)$$

$$= 4,000 + 500 \times 3.3832$$

$$= \text{Rs. } 5,691.60$$

This is equivalent to paying an equivalent amount of Rs. 5,691.60 at the end of every year for the next 10 years. The future worth sum of this revised series at the end of the 10th year is obtained as follows:

$$F = A(F/A, i, n)$$

$$= A(F/A, 15\%, 10)$$

$$= 5,691.60(20.304)$$

$$= \text{Rs. } 1,15,562.25$$

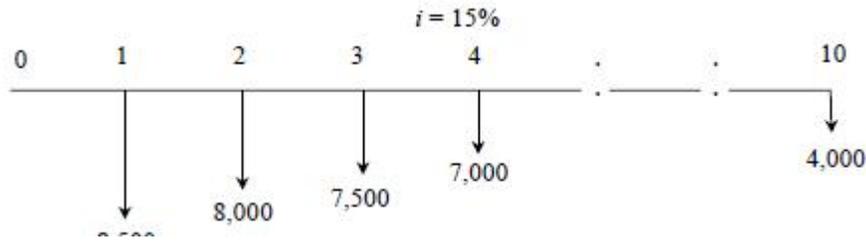
At the end of the 10th year, the compound amount of all his payments will be Rs. 1,15,562.25.

**EXAMPLE 3.8** A person is planning for his retired life. He has 10 more years of service. He would like to deposit Rs. 8,500 at the end of the first year and thereafter he wishes to deposit the amount with an annual decrease of Rs. 500 for the next 9 years with an interest rate of 15%. Find the total amount at the end of the 10th year of the above series.

**Solution** Here,

$$A_1 = \text{Rs. } 8,500, \quad G = -\text{Rs. } 500, \quad i = 15\%, \quad n = 10 \text{ years, } A = ? \text{ \& } F = ?$$

The cash flow diagram is shown in Fig. 3.14.



**Fig. 3.14** Cash flow diagram of uniform gradient series annual equivalent amount.

$$\begin{aligned}
 A &= A_1 - G \frac{(1+i)^n - in - 1}{i(1+i)^n - i} \\
 &= A_1 - G (A/G, i, n) \\
 &= 8,500 - 500(A/G, 15\%, 10) \\
 &= 8,500 - 500 \times 3.3832 \\
 &= \text{Rs. } 6,808.40
 \end{aligned}$$

This is equivalent to paying an equivalent amount of Rs. 6,808.40 at the end of every year for the next 10 years.

The future worth sum of this revised series at the end of the 10th year is obtained as follows:

$$\begin{aligned}
 F &= A(F/A, i, n) \\
 &= A(F/A, 15\%, 10) \\
 &= 6,808.40(20.304) \\
 &= \text{Rs. } 1,38,237.75
 \end{aligned}$$

At the end of the 10th year, the compound amount of all his payments is Rs. 1,38,237.75.

### 3.3.8 Effective Interest Rate

Let  $i$  be the nominal interest rate compounded annually. But, in practice, the compounding may occur less than a year. For 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 where,

$i$  = the nominal interest rate

$C$  = the number of interest periods in a year.

**EXAMPLE 3.9** 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. Find the maturity amount of the deposit after 10 years.

**Solution**

$P = \text{Rs. } 5,000$ ,  $n = 10$  years,  $i = 12\%$  (Nominal interest rate),  $F = ?$

**METHOD 1**

No. of interest periods per year = 4

No. of interest periods in 10 years =  $10 \times 4 = 40$

Revised No. of periods (No. of quarters),  $N = 40$

Interest rate per quarter,  $r = 12\%/4$

= 3%, compounded quarterly.

$$F = P(1 + r)^N = 5,000(1 + 0.03)^{40}$$

$$= \text{Rs. } 16,310.19$$

**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.

$$F = P(1 + R)^n = 5,000(1 + 0.1255)^{10}$$

$$= \text{Rs. } 16,308.91$$

## UNIT – IV

**Method of Depreciation: Straight Line Method of Depreciation-Declining Balance Method of Depreciation -Sum-of-the-Years-Digits Method of Depreciation-Sinking Fund Method of Depreciation- Service Output Method of Depreciation.**

# DEPRECIATION

## INTRODUCTION

Any equipment which is purchased today will not work for ever. This may be due to wear and tear of the equipment or obsolescence of technology. Hence, it is to 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 money from the earnings of an equipment for its replacement purpose is called *depreciation fund* since we make an assumption that the value of the equipment decreases with the passage of time. Thus, the word “depreciation” means *decrease* in value of any physical asset with the passage of time.

## METHODS OF DEPRECIATION

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

### **Straight Line Method of Depreciation**

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 formulae for depreciation and book value are as follows:

$$D_t = (P - F)/n$$

$$B_t = B_{t-1} - D_t = P - t \times [(P - F)/n]$$

**EXAMPLE 9.1** 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. Determine the depreciation charge and book value at the end of various years using the straight line method of depreciation.

*Solution*

$$P = \text{Rs. } 1,00,000$$

$$F = \text{Rs. } 20,000$$

$$n = 8 \text{ years}$$

$$D_t = (P - F)/n$$

$$= (1,00,000 - 20,000)/8$$

$$= \text{Rs. } 10,000$$

In this method of depreciation, the value of  $D_t$  is the same for all the years. The calculations pertaining to  $B_t$  for different values of  $t$  are summarized in Table 9.1.

**Table 9.1**  $D_t$  and  $B_t$  Values under Straight line Method of Depreciation

<i>End of year</i> ( $t$ )	<i>Depreciation</i> ( $D_t$ )	<i>Book value</i> ( $B_t = B_{t-1} - D_t$ )
0		1,00,000
1	10,000	90,000
2	10,000	80,000
3	10,000	70,000
4	10,000	60,000
5	10,000	50,000
6	10,000	40,000
7	10,000	30,000
8	10,000	20,000

If we are interested in computing  $D_t$  and  $B_t$  for a specific period ( $t$ ), the formulae can be used. In this approach, it should be noted that the depreciation is the same for all the periods.

### 9.2.2 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 more 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 a 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, and

$D_t$  = depreciation amount at the end of the period  $t$ .

The formulae for depreciation and book value are as follows:

$$D_t = K \times B_{t-1}$$

$$\begin{aligned} B_t &= B_{t-1} - D_t = B_{t-1} - K \times B_{t-1} \\ &= (1 - K) \times B_{t-1} \end{aligned}$$

The formulae for depreciation and book value in terms of  $P$  are as follows:

$$D_t = K(1 - K)^{t-1} \times P$$

$$B_t = (1 - K)^t \times P$$

While availing income-tax exception for the depreciation amount paid in each year, the rate  $K$  is limited to at the most  $2/n$ . If this rate is used, then the corresponding approach is called the *double declining balance method of depreciation*.

**EXAMPLE 9.3** Consider Example 9.1 and demonstrate the calculations of the declining balance method of depreciation by assuming 0.2 for  $K$ .

*Solution*

$$P = \text{Rs. } 1,00,000$$

$$F = \text{Rs. } 20,000$$

$$n = 8 \text{ years}$$

$$K = 0.2$$

The calculations pertaining to  $D_t$  and  $B_t$  for different values of  $t$  are summarized in Table 9.2 using the following formulae:

$$D_t = K \times B_{t-1}$$

$$B_t = B_{t-1} - D_t$$

**Table 9.2**  $D_t$  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  $t$ , the respective formulae can be used.

### 9.2.3 Sum-of-the-Years-Digits Method of Depreciation

In this method of depreciation also, it is assumed that the book value of the asset decreases at a decreasing rate. If the asset has a life of eight years, first the sum of the years is computed as

$$\begin{aligned}\text{Sum of the years} &= 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 \\ &= 36 = n(n + 1)/2\end{aligned}$$

The rate of depreciation charge for the first year is assumed as the highest and then it decreases. The rates of depreciation for the years 1–8, respectively are as follows:  $8/36$ ,  $7/36$ ,  $6/36$ ,  $5/36$ ,  $4/36$ ,  $3/36$ ,  $2/36$ , and  $1/36$ .

For any year, the depreciation is calculated by multiplying the corresponding rate of depreciation with  $(P - F)$ .

$$D_t = \text{Rate} \times (P - F)$$

$$B_t = B_{t-1} - D_t$$

The formulae for  $D_t$  and  $B_t$  for a specific year  $t$  are as follows:

$$D_t = \frac{n - t + 1}{n(n + 1)/2} (P - F)$$

$$B_t = (P - F) \frac{(n - t)}{n} \frac{(n - t + 1)}{(n + 1)} + F$$

**EXAMPLE 9.5** Consider Example 9.1 and demonstrate the calculations of the sum-of-the-years-digits method of depreciation.

**Solution**

$$P = \text{Rs. } 1,00,000$$

$$F = \text{Rs. } 20,000$$

$$n = 8 \text{ years}$$

$$\text{Sum} = n(n + 1)/2 = 8 \times 9/2 = 36$$

The rates for years 1–8, are respectively  $8/36$ ,  $7/36$ ,  $6/36$ ,  $5/36$ ,  $4/36$ ,  $3/36$ ,  $2/36$  and  $1/36$ .

The calculations of  $D_t$  and  $B_t$  for different values of  $t$  are summarized in Table 9.3 using the following formulae:

$$D_t = \text{Rate} \times (P - F)$$

$$B_t = B_{t-1} - D_t$$

**Table 9.3**  $D_t$  and  $B_t$  under Sum-of-the-years-digits Method of Depreciation

<i>End of year</i> ( $n$ )	<i>Depreciation</i> ( $D_t$ )	<i>Book value</i> ( $B_t$ )
0		1,00,000.00
1	17,777.77	82,222.23
2	15,555.55	66,666.68
3	13,333.33	53,333.35
4	11,111.11	42,222.24
5	8,888.88	33,333.36
6	6,666.66	26,666.70
7	4,444.44	22,222.26
8	2,222.22	20,000.04

If we are interested in calculating  $D_t$  and  $B_t$  for a specific  $t$ , then the usage of the formulae would be better.

### 9.2.4 Sinking Fund Method of Depreciation

In this method of depreciation, the book value decreases at increasing rates with respect to the life of the asset. Let

$P$  = first cost of the asset,

$F$  = salvage value of the asset,

$n$  = life of the asset,

$i$  = rate of return compounded annually,

$A$  = the annual equivalent amount,

$B_t$  = the book value of the asset at the end of the period  $t$ , and

$D_t$  = the depreciation amount at the end of the period  $t$ .

The loss in value of the asset ( $P - F$ ) is made available in the form of cumulative depreciation amount at the end of the life of the asset by setting up an equal depreciation amount ( $A$ ) at the end of each period during the lifetime of the asset.

$$A = (P - F) \times [A/F, i, n]$$

The fixed sum depreciated at the end of every time period earns an interest at the rate of  $i\%$  compounded annually, and hence the actual depreciation amount will be in the increasing manner with respect to the time period. A generalized formula for  $D_t$  is

$$D_t = (P - F) \times (A/F, i, n) \times (F/P, i, t - 1)$$

The formula to calculate the book value at the end of period  $t$  is

$$B_t = P - (P - F) (A/F, i, n) (F/A, i, t)$$

The above two formulae are very useful if we have to calculate  $D_t$  and  $B_t$  for any specific period. If we calculate  $D_t$  and  $B_t$  for all the periods, then the tabular approach would be better.

**EXAMPLE 9.7** Consider Example 9.1 and give the calculations regarding the sinking fund method of depreciation with an interest rate of 12%, compounded annually.

**Solution**

$$P = \text{Rs. } 1,00,000$$

$$F = \text{Rs. } 20,000$$

$$n = 8 \text{ years}$$

$$i = 12\%$$

$$\begin{aligned} A &= (P - F) \times [A/F, 12\%, 8] \\ &= (1,00,000 - 20,000) \times 0.0813 \\ &= \text{Rs. } 6,504 \end{aligned}$$

In this method of depreciation, a fixed amount of Rs. 6,504 will be depreciated at the end of every year from the earning of the asset. The depreciated amount will earn interest for the remaining period of life of the asset at an interest rate of 12%, compounded annually. For example, the calculations of net depreciation for some periods are as follows:

$$\text{Depreciation at the end of year 1 } (D_1) = \text{Rs. } 6,504.$$

$$\begin{aligned} \text{Depreciation at the end of year 2 } (D_2) &= 6,504 + 6,504 \times 0.12 \\ &= \text{Rs. } 7,284.48 \end{aligned}$$

Depreciation at the end of the year 3 ( $D_3$ )

$$\begin{aligned} &= 6,504 + (6,504 + 7,284.48) \times 0.12 \\ &= \text{Rs. } 8,158.62 \end{aligned}$$

Depreciation at the end of year 4 ( $D_4$ )

$$\begin{aligned} &= 6,504 + (6,504 + 7,284.48 + 8,158.62) \times 0.12 \\ &= \text{Rs. } 9,137.65 \end{aligned}$$

These calculations along with book values are summarized in Table 9.4.

**Table 9.4**  $D_t$  and  $B_t$  according to Sinking Fund Method of Depreciation

<i>End of year</i> <i>t</i>	<i>Fixed</i> <i>depreciation</i> (Rs.)	<i>Net depreciation</i> $D_t$ (Rs.)	<i>Book value</i> $B_t$ (Rs.)
0	6,504	–	1,00,000.00
1	6,504	6,504.00	93,496.00
2	6,504	7,284.48	86,211.52
3	6,504	8,158.62	78,052.90
4	6,504	9,137.65	68,915.25
5	6,504	10,234.17	58,681.08
6	6,504	11,462.27	47,218.81
7	6,504	12,837.74	34,381.07
8	6,504	14,378.27	20,002.80

$B_t = B_{t-1} - D_t$

### 9.2.5 Service Output Method of Depreciation

In some situations, it may not be realistic to compute depreciation based on time period. In such cases, the depreciation is computed based on service rendered by an asset. Let

$P$  = first cost of the asset

$F$  = salvage value of the asset

$X$  = maximum capacity of service of the asset during its lifetime

$x$  = quantity of service rendered in a period.

Then, the depreciation is defined per unit of service rendered:

$$\text{Depreciation/unit of service} = (P - F)/X$$

$$\text{Depreciation for } x \text{ units of service in a period} = \frac{P - F}{X}(x)$$

**EXAMPLE 9.9** The first cost of a road laying machine is Rs. 80,00,000. Its salvage value after five years is Rs. 50,000. The length of road that can be laid by the machine during its lifetime is 75,000 km. In its third year of operation, the length of road laid is 2,000 km. Find the depreciation of the equipment for that year.

*Solution*

$$P = \text{Rs. } 80,00,000$$

$$F = \text{Rs. } 50,000$$

$$X = 75,000 \text{ km}$$

$$x = 2,000 \text{ km}$$

$$\text{Depreciation for } x \text{ units of service in a period} = \frac{P - F}{X}x$$

$$\begin{aligned} \text{Depreciation for year 3} &= \frac{(80,00,000 - 50,000)}{75,000} \times 2,000 \\ &= \text{Rs. } 2,12,000 \end{aligned}$$

## UNIT – V

Methods of Comparison of Alternatives–Present Worth Method of Comparison ( Revenue Dominated Cash flow Diagram, Cost Dominated Cash Flow Diagram),Future Worth Method Comparison (Revenue Dominated Cash Flow Diagram, Cost Dominated Cash Flow Diagram), Annual Equivalent Method of Comparison (Revenue Dominated Cash Flow Diagram, Cost Dominated Cash Flow Diagram), Rate of Return Method, Examples in all the methods.

### BASES FOR COMPARISON OF ALTERNATIVES

In most of the practical decision environments, executives will be forced to select the best alternative from a set of competing alternatives. Let us assume that an organization has a huge sum of money for potential investment and there are three different projects whose initial outlay and annual revenues during their lives are known. The executive has to select the best alternative among these three competing projects

There are several bases for comparing the worthiness of the projects. These bases are:

1. Present worth method
2. Future worth method
3. Annual equivalent method
4. Rate of return method

## PRESENT WORTH METHOD OF COMPARISON

### INTRODUCTION

In this method of comparison, the cash flows of each alternative will be reduced to time zero by assuming an 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.

The sign of various amounts at different points in time in a cash flow diagram is to be decided based on the type of the decision problem. In a cost dominated cash flow diagram, the costs (outflows) will be assigned with positive sign and the profit, revenue, salvage value (all inflows), etc. will be assigned with negative sign. In a revenue/profit-dominated cash flow diagram, the profit, revenue, salvage value (all inflows to an organization) will be assigned with positive sign. The costs (outflows) will be assigned with negative sign.

In case the decision is to select the alternative with the minimum cost, then the alternative with the least present worth amount will be selected. On the other hand, if the decision is to select the alternative with the maximum profit, then the alternative with the maximum present worth will be selected.

## REVENUE-DOMINATED CASH FLOW DIAGRAM

A generalized revenue-dominated cash flow diagram to demonstrate the present worth method of comparison is presented in Fig. 4.1.

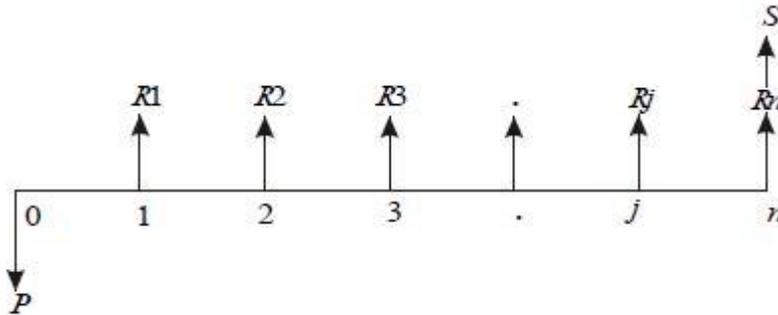


Fig. 4.1 Revenue-dominated cash flow diagram.

In Fig. 4.1,  $P$  represents an initial investment and  $R_j$  the net revenue at the end of the  $j$ th year. The interest rate is  $i$ , compounded annually.  $S$  is the salvagevalue at the end of the  $n$ th year. To find the present worth of the above cash flow diagram for a given Interest rate, the formula is

$$PW(i) = -P + R1[1/(1+i)^1] + R2[1/(1+i)^2] + \dots$$

$$+ Rj[1/(1+i)^j] + Rn[1/(1+i)^n] + S[1/(1+i)^n]$$

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 Fig. 4.2.

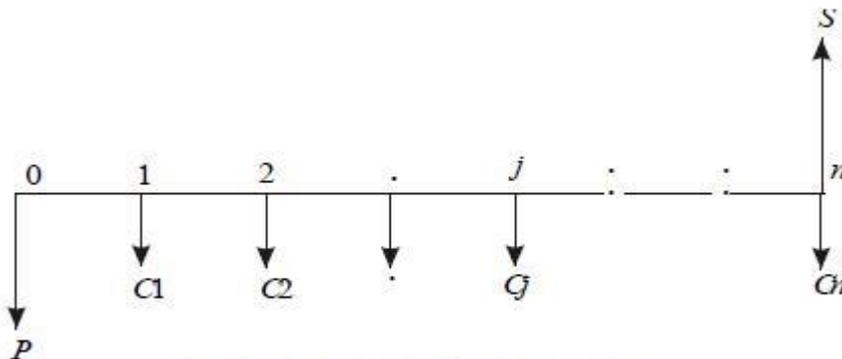


Fig. 4.2 Cost-dominated cash flow diagram.

In Fig. 4.2,  $P$  represents an initial investment,  $C_j$  the net cost of operation and maintenance at the end of the  $j$ th year, and  $S$  the salvage value at the end of the  $n$ th year.

To compute the present worth amount of the above cash flow diagram for a given interest rate  $i$ , we have the formula

$$PW(i) = P + C_1[1/(1+i)^1] + C_2[1/(1+i)^2] + \dots + C_j[1/(1+i)^j] + C_n[1/(1+i)^n] - S[1/(1+i)^n]$$

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.

**EXAMPLE 4.1** Alpha Industry is planning to expand its production operation. It has identified three different technologies for meeting the goal. The initial outlay and annual revenues with respect to each of the technologies are summarized in Table 4.1. Suggest the best technology which is to be implemented based on the present worth method of comparison assuming 20% interest rate, compounded annually.

**Table 4.1**

	<i>Initial outlay</i> (Rs.)	<i>Annual revenue</i> (Rs.)	<i>Life</i> (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** 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,  $P = \text{Rs. } 12,00,000$

Annual revenue,  $A = \text{Rs. } 4,00,000$

Interest rate,  $i = 20\%$ ,

compounded annually Life of this technology,  $n = 10$  years

The cash flow diagram of this technology is as shown in Fig. 4.3.

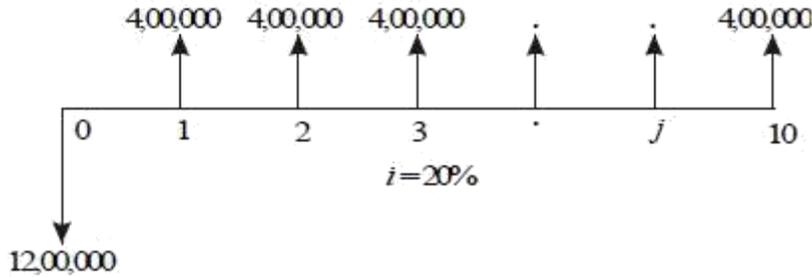


Fig. 4.3 Cash flow diagram for technology 1.

The present worth expression for this technology is

$$PW(20\%)_1 = -12,00,000 + 4,00,000 \times (P/A, 20\%, 10)$$

$$= -12,00,000 + 4,00,000 \times (4.1925)$$

$$= -12,00,000 + 16,77,000$$

$$= \text{Rs. } 4,77,000$$

TECHNOLOGY 2

Initial outlay,  $P = \text{Rs. } 20,00,000$

Annual revenue,  $A = \text{Rs. } 6,00,000$

Interest rate,  $i = 20\%$ , compounded annually

Life of this technology,  $n = 10$  years

The cash flow diagram of this technology is shown in Fig. 4.4.

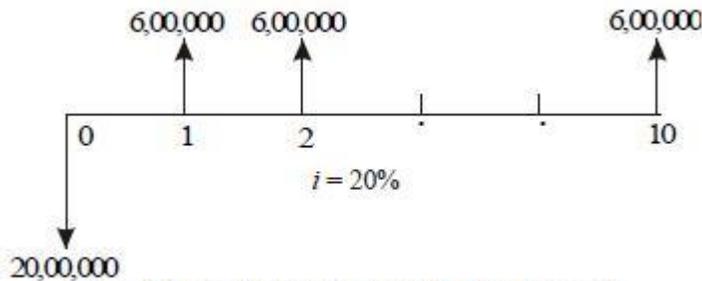


Fig. 4.4 Cash flow diagram for technology 2.

The present worth expression for this technology is

$$\begin{aligned}PW(20\%)_2 &= -20,00,000 + 6,00,000 \times (P/A, 20\%, 10) \\ &= -20,00,000 + 6,00,000 \times (4.1925) \\ &= -20,00,000 + 6,00,000 \times (4.1925) \\ &= -20,00,000 + 25,15,500 \\ &= \text{Rs. } 5,15,500\end{aligned}$$

### TECHNOLOGY 3

Initial outlay,  $P = \text{Rs. } 18,00,000$

Annual revenue,  $A = \text{Rs. } 5,00,000$

Interest rate,  $i = 20\%$ , compounded annually

Life of this technology,  $n = 10$  years

The cash flow diagram of this technology is shown in Fig. 4.5

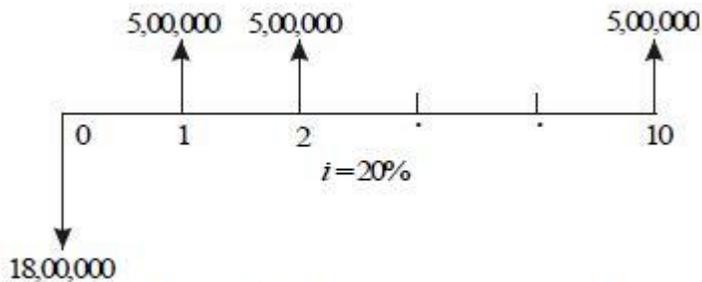


Fig. 4.5 Cash flow diagram for technology 3.

The present worth expression for this technology is

$$\begin{aligned}PW(20\%)_3 &= -18,00,000 + 5,00,000 \times (P/A, 20\%, 10) \\ &= -18,00,000 + 5,00,000 \times (4.1925) \\ &= -18,00,000 + 20,96,250 \\ &= \text{Rs. } 2,96,250\end{aligned}$$

From the above calculations, it is clear that the present worth of technology 2 is the highest among all the technologies. Therefore, technology 2 is suggested for implementation to expand the production.

**EXAMPLE 4.2** An engineer has two bids for an elevator to be installed in a new building. The details of the bids for the elevators are as follows:

<i>Bid</i>	<i>Engineer's estimates</i>		
	<i>Initial cost</i> (Rs.)	<i>Service life</i> (years)	<i>Annual operations &amp; maintenance cost</i> (Rs.)
Alpha Elevator Inc.	4,50,000	15	27,000
Beta Elevator Inc.	5,40,000	15	28,500

Determine which bid should be accepted, based on the present worth method of comparison assuming 15% interest rate, compounded annually.

**Solution**

**Bid 1: Alpha Elevator Inc.**

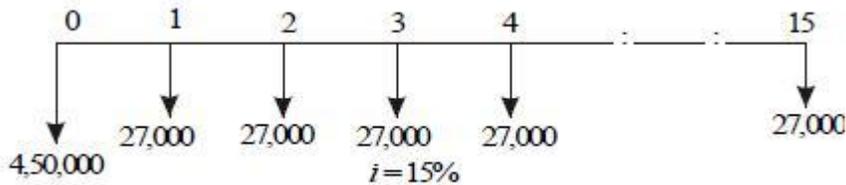
Initial cost,  $P = \text{Rs. } 4,50,000$

Annual operation and maintenance cost,  $A = \text{Rs. } 27,000$

Life = 15 years

Interest rate,  $i = 15\%$ , compounded annually

The cash flow diagram of bid 1 is shown in Fig. 4.6.



**Fig. 4.6** Cash flow diagram for bid 1.

The present worth of the above cash flow diagram is computed as follows:

$$PW(15\%) = 4,50,000 + 27,000(P/A, 15\%, 15)$$

$$\begin{aligned}
&= 4,50,000 + 27,000 \times 5.8474 \\
&= 4,50,000 + 1,57,879.80 \\
&= \text{Rs. } 6,07,879.80 \\
&=
\end{aligned}$$

**Bid 2: Beta Elevator Inc.**

Initial cost,  $P = \text{Rs. } 5,40,000$

Annual operation and maintenance cost,  $A = \text{Rs. } 28,500$

Life = 15 years

Interest rate,  $i = 15\%$ , compounded annually.

The cash flow diagram of bid 2 is shown in Fig. 4.7.

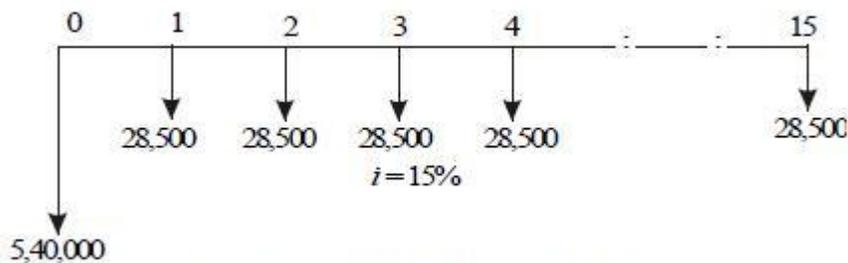


Fig. 4.7 Cash flow diagram for bid 2.

The present worth of the above cash flow diagram is computed as follows:

$$PW(15\%) = 5,40,000 + 28,500(P/A, 15\%, 15)$$

$$= 5,40,000 + 28,500 \times 5.8474$$

$$= 5,40,000 + 1,66,650.90$$

$$= \text{Rs. } 7,06,650.90$$

The total present worth cost of bid 1 is less than that of bid 2. Hence, bid 1 is to be selected for implementation. That is, the elevator from Alpha Elevator Inc. is to be purchased and installed in the new building.

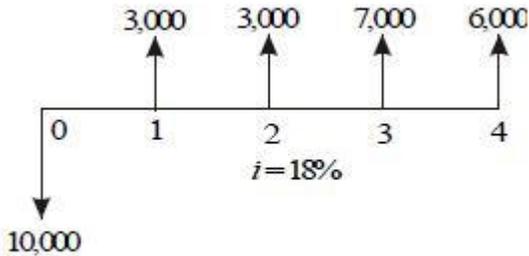
**EXAMPLE 4.3** Investment proposals A and B have the net cash flows as follows:

Proposal	End of years				
	0	1	2	3	4
A (Rs.)	-10,000	3,000	3,000	7,000	6,000
B (Rs.)	-10,000	6,000	6,000	3,000	3,000

Compare the present worth of A with that of B at  $i = 18\%$ . Which proposal should be selected?

**Solution**

**Present worth of A at  $i = 18\%$ .** The cash flow diagram of proposal A is shown in Fig. 4.8.

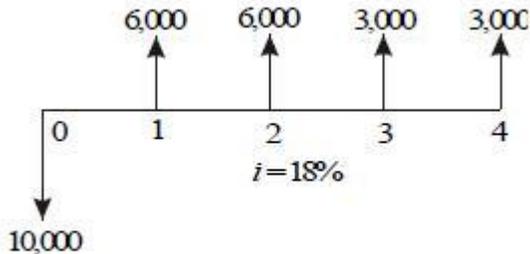


**Fig. 4.8** Cash flow diagram for proposal A.

The present worth of the above cash flow diagram is computed as

$$\begin{aligned}
 PWA(18\%) &= -10,000 + 3,000(P/F, 18\%, 1) + 3,000(P/F, 18\%, 2) \\
 &\quad + 7,000(P/F, 18\%, 3) + 6,000(P/F, 18\%, 4) \\
 &= -10,000 + 3,000(0.8475) + 3,000(0.7182) + 7,000(0.6086) \\
 &\quad + 6,000(0.5158) \\
 &= \text{Rs. } 2,052.10
 \end{aligned}$$

**Present worth of B at  $i = 18\%$ .** The cash flow diagram of the proposal B is shown in Fig. 4.9.



**Fig. 4.9** Cash flow diagram for proposal B.

The present worth of the above cash flow diagram is calculated as

$$\begin{aligned}
PW(18\%) &= -10,000 + 6,000(P/F, 18\%, 1) + 6,000(P/F, 18\%, 2) + 3,000(P/F, 18\%, 3) + \\
& 3,000(P/F, 18\%, 4) \\
&= -10,000 + 6,000(0.8475) + 6,000(0.7182) + 3,000(0.6086) + 3,000(0.5158) \\
&= \text{Rs. } 2,767.40
\end{aligned}$$

At  $i = 18\%$ , the present worth of proposal B is higher than that of proposal A. Therefore, select proposal B.

**EXAMPLE 4.4** A granite company is planning to buy a fully automated granite cutting machine. If it is purchased under down payment, the cost of the machine is Rs. 16,00,000. If it is purchased under installment basis, the company has to pay 25% of the cost at the time of purchase and the remaining amount in 10 annual equal installments of Rs. 2,00,000 each. Suggest the best alternative for the company using the present worth basis at  $i = 18\%$ , compounded annually.

**Solution** There are two alternatives available for the company:

1. Down payment of Rs. 16,00,000
2. Down payment of Rs. 4,00,000 and 10 annual equal installments of Rs. 2,00,000 each

**Present worth calculation of the second alternative.** The cash flow diagram of the second alternative is shown in Fig. 4.10.

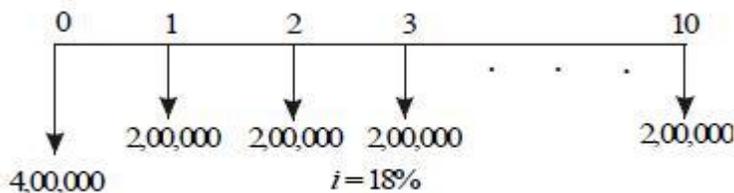


Fig. 4.10 Cash flow diagram for the second alternative.

The present worth of the above cash flow diagram is computed as

$$\begin{aligned}
PW(18\%) &= 4,00,000 + 2,00,000(P/A, 18\%, 10) \\
&= 4,00,000 + 2,00,000 \times 4.4941 \\
&= \text{Rs. } 12,98,820
\end{aligned}$$

The present worth of this option is Rs. 12,98,820, which is less than the first option of complete down payment of Rs. 16,00,000. Hence, the company should select the second alternative to buy the fully automated granite cutting machine.

**EXAMPLE 4.5** A finance company advertises two investment plans. In plan 1, the company pays Rs. 12,000 after 15 years for every Rs. 1,000 invested now. In plan 2, for every Rs. 1,000 invested, the company pays Rs. 4,000 at the end of the 10th year and Rs. 4,000 at the end of 15th year. Select the best investment plan from the investor's point of view at  $i = 12\%$ , compounded annually.

**Solution Plan 1.** The cash flow diagram for plan 1 is illustrated in Fig. 4.11.

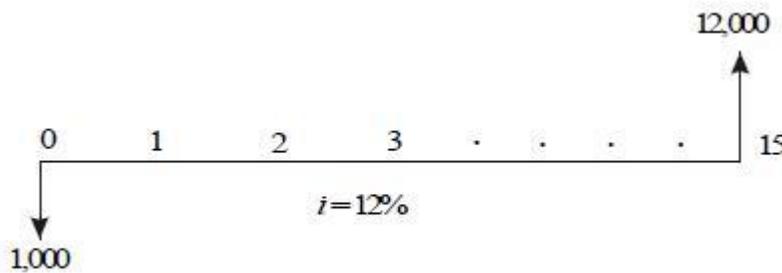


Fig. 4.11 Cash flow diagram for plan 1.

The present worth of the above cash flow diagram is calculated as

$$PW(12\%) = -1,000 + 12,000(P/F, 12\%, 15)$$

$$= -1,000 + 12,000(0.1827)$$

$$= \text{Rs. } 1,192.40$$

**Plan 2.** The cash flow diagram for plan 2 is shown in Fig. 4.12.

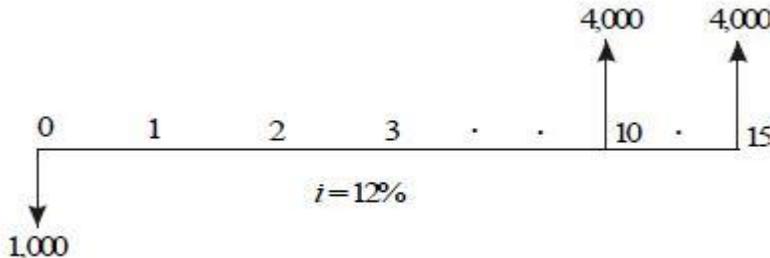


Fig. 4.12 Cash flow diagram for plan 2.

The present worth of the above cash flow diagram is computed as

$$PW(12\%) = -1,000 + 4,000(P/F, 12\%, 10) + 4,000(P/F, 12\%, 15)$$

$$= -1,000 + 4,000(0.3220) + 4,000(0.1827)$$

= Rs. 1,018.80

The present worth of plan 1 is more than that of plan 2. Therefore, plan 1 is the best plan from the investor's point of view.

**EXAMPLE 4.6** Novel Investment Ltd. accepts Rs. 10,000 at the end of every year for 20 years and pays the investor Rs. 8,00,000 at the end of the 20th year. Innovative Investment Ltd. accepts Rs. 10,000 at the end of every year for 20 years and pays the investor Rs. 15,00,000 at the end of the 25th year. Which is the best investment alternative? Use present worth base with  $i = 12\%$

**Solution**

*Novel Investment Ltd's plan.*

The cash flow diagram of Novel Investment Ltd's plan is shown in Fig. 4.13.

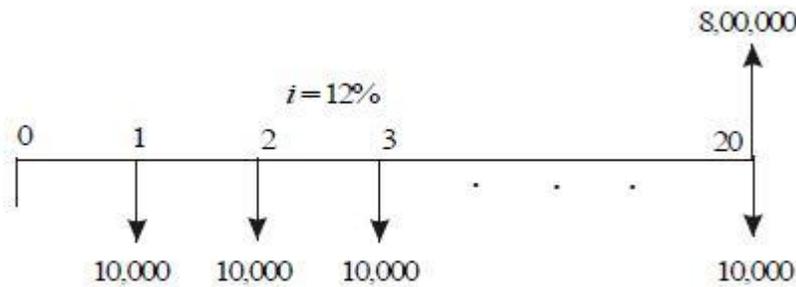


Fig. 4.13 Cash flow diagram for Novel Investment Ltd.

The present worth of the above cash flow diagram is computed as

$$PW(12\%) = -10,000(P/A, 12\%, 20) + 8,00,000(P/F, 12\%, 20)$$

$$= -10,000(7.4694) + 8,00,000(0.1037)$$

$$= Rs. 8,266$$

*Innovative Investment Ltd's plan.* The cash flow diagram of the Innovative Investment Ltd's plan is illustrated in Fig. 4.14.

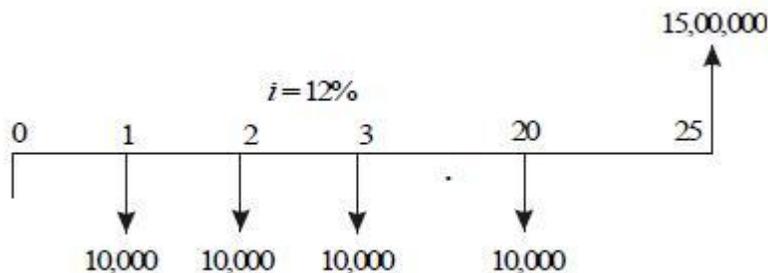


Fig. 4.14 Cash flow diagram for Innovative Investment Ltd.

The present worth of the above cash flow diagram is calculated as

$$\begin{aligned}
 PW(12\%) &= -10,000(P/A, 12\%, 20) + 15,00,000(P/F, 12\%, 25) \\
 &= -10,000(7.4694) + 15,00,000(0.0588) \\
 &= \text{Rs. } 13,506
 \end{aligned}$$

The present worth of Innovative Investment Ltd's plan is more than that of Novel Investment Ltd's plan. Therefore, Innovative Investment Ltd's plan is the best from investor's point of view.

**EXAMPLE 4.7** A small business with an initial outlay of Rs. 12,000 yields Rs. 10,000 during the first year of its operation and the yield increases by Rs. 1,000 from its second year of operation up to its 10th year of operation. At the end of the life of the business, the salvage value is zero. Find the present worth of the business by assuming an interest rate of 18%, compounded annually.

**Solution**

Initial investment,  $P = \text{Rs. } 12,000$

Income during the first year,  $A = \text{Rs. } 10,000$

Annual increase in income,  $G = \text{Rs. } 1,000$   $n = 10$  years

$i = 18\%$ , compounded annually

The cash flow diagram for the small business is depicted in Fig. 4.15.

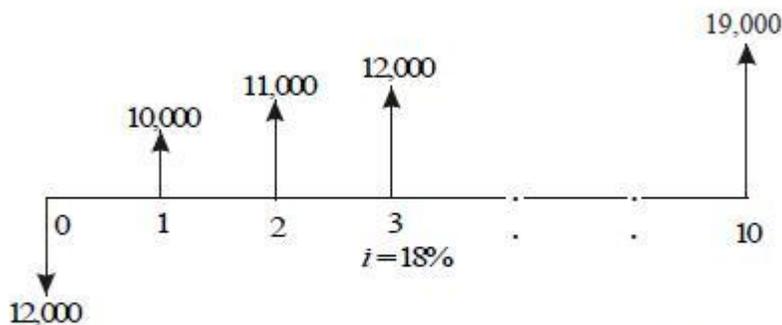


Fig. 4.15 Cash flow diagram for the small business.

The equation for the present worth is

$$PW(18\%) = -12,000 + (10,000 + 1,000 \times (A/G, 18\%, 10)) \times (P/A, 18\%, 10)$$

$$\begin{aligned}
&= -12,000 + (10,000 + 1,000 \times 3.1936) \times 4.4941 \\
&= -12,000 + 59,293.36 \\
&= \text{Rs. } 47,293.36
\end{aligned}$$

The present worth of the small business is Rs. 47,293.36.

## FUTURE WORTH METHOD

### INTRODUCTION

In the future worth method of comparison of alternatives, the future worth of various alternatives will be computed. Then, the alternative 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.

### REVENUE-DOMINATED CASH FLOW DIAGRAM

A generalized revenue-dominated cash flow diagram to demonstrate the future worth method of comparison is presented in Fig. 5.1.

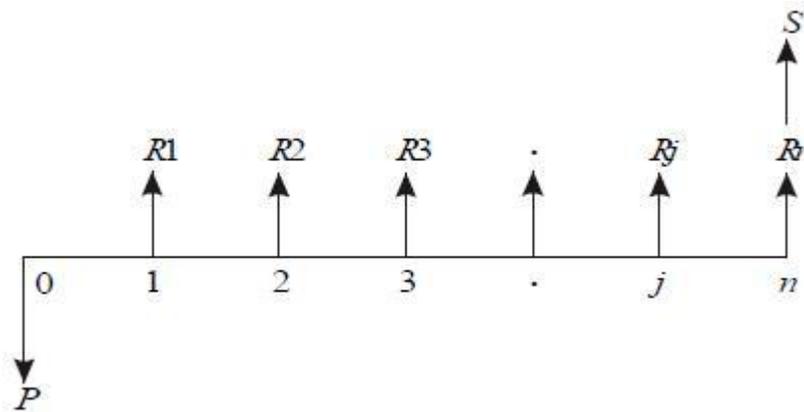


Fig. 5.1 Revenue-dominated cash flow diagram.

In Fig. 5.1,  $P$  represents an initial investment,  $R_j$  the net-revenue at the end of the  $j$ th year, and  $S$  the salvage value at the end of the  $n$ th year.

The formula for the future worth of the above cash flow diagram for a given interest rate,  $i$  is

$$FW(i) = -P(1+i)^n + R_1(1+i)^{n-1} + R_2(1+i)^{n-2} + \dots + R_j(1+i)^{n-j} + \dots + R_n + S$$

In the above formula, the expenditure is assigned with negative sign and the revenues are assigned with positive sign. If we have some more alternatives which are to be compared with this alternative, then the corresponding future worth amounts are to be computed and compared. Finally, the alternative with the maximum future worth amount should be selected as the best alternative.

### COST-DOMINATED CASH FLOW DIAGRAM

A generalized cost-dominated cash flow diagram to demonstrate the future worth method of comparison is given in Fig. 5.2.

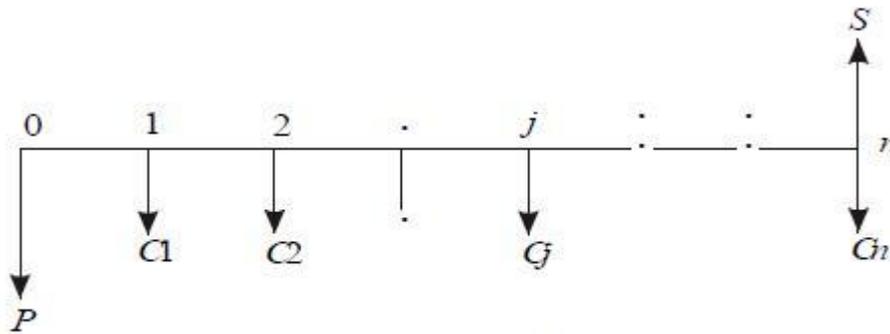


Fig. 5.2 Cost-dominated cash flow diagram.

In Fig. 5.2,  $P$  represents an initial investment,  $C_j$  the net cost of operation and maintenance at the end of the  $j$ th year, and  $S$  the salvage value at the end of the  $n$ th year. The formula for the future worth of the above cash flow diagram for a given interest rate,  $i$  is

$$FW(i) = P(1 + i)^n + C_1(1 + i)^{n-1} + C_2(1 + i)^{n-2} + \dots + C_j(1 + i)^{n-j} + \dots + C_n - S$$

In this formula, the expenditures are assigned with positive sign and revenues with negative sign. If we have some more alternatives which are to be compared with this alternative, then the corresponding future worth amounts are to be computed and compared. Finally, the alternative with the minimum future worth amount should be selected as the best alternative.

### 5.4 EXAMPLES

In this section, several examples highlighting the applications of the future worth method of comparison are presented.

**EXAMPLE 5.1** Consider the following two mutually exclusive alternatives:  
At  $i = 18\%$ , select the best alternative based on future worth method of comparison.

Alternative	End of year				
	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

**Solution Alternative A**

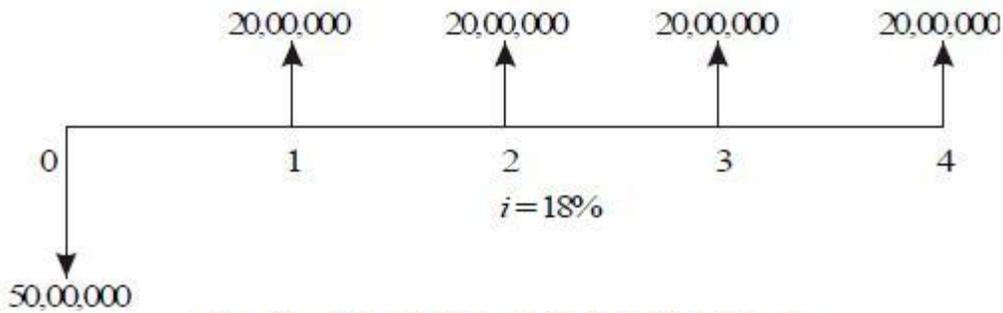
Initial investment,  $P = \text{Rs. } 50,00,000$

Annual equivalent revenue,  $A = \text{Rs. } 20,00,000$

Interest rate,  $i = 18\%$ , compounded annually

Life of alternative A = 4 years

The cash flow diagram of alternative A is shown in Fig. 5.3.



**Fig. 5.3** Cash flow diagram for alternative A.

The future worth amount of alternative B is computed as

$$FWA(18\%) = -50,00,000(F/P, 18\%, 4) + 20,00,000(F/A, 18\%, 4) = -50,00,000(1.939) + 20,00,000(5.215)$$

$$= \text{Rs. } 7,35,000$$

**Alternative 2—Build soft ice-cream stand**

First cost = Rs. 36,00,000

Net annual income = Annual income – Annual property tax

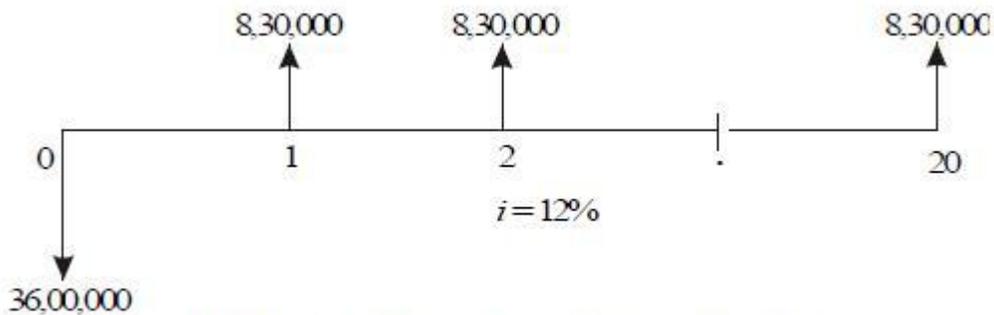
$$= \text{Rs. } 9,80,000 - \text{Rs. } 1,50,000$$

$$= \text{Rs. } 8,30,000$$

Life = 20 years

Interest rate = 12%, compounded annually

The cash flow diagram for this alternative is shown in Fig. 5.6.



**Fig. 5.6** Cash flow diagram for alternative 2.

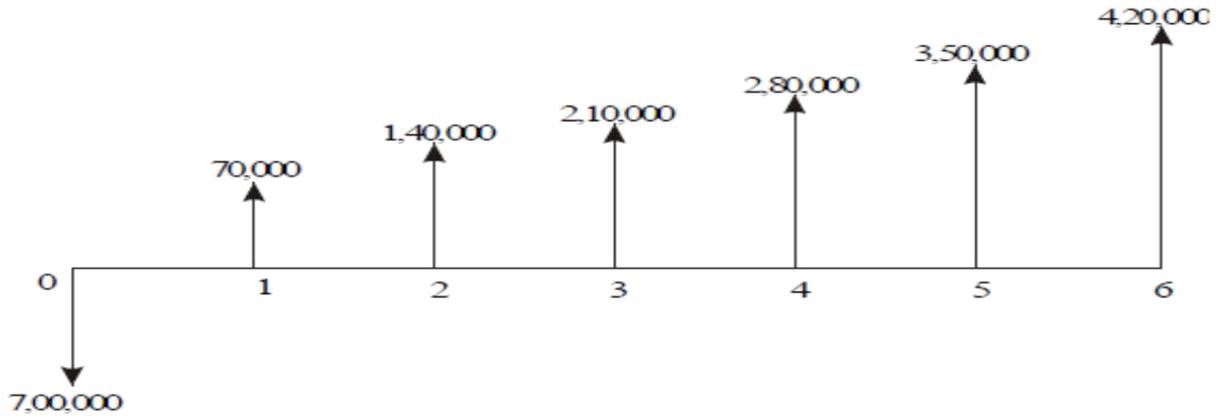


Fig. 5.8 Cash flow diagram for alternative 2.

The future worth of alternative 2 is calculated as

$$\begin{aligned}
 FW_2(12\%) &= -36,00,000(F/P, 12\%, 20) + 8,30,000(F/A, 12\%, 20) \\
 &= -36,00,000(9.646) + 8,30,000(72.052) \\
 &= \text{Rs. } 2,50,77,560
 \end{aligned}$$

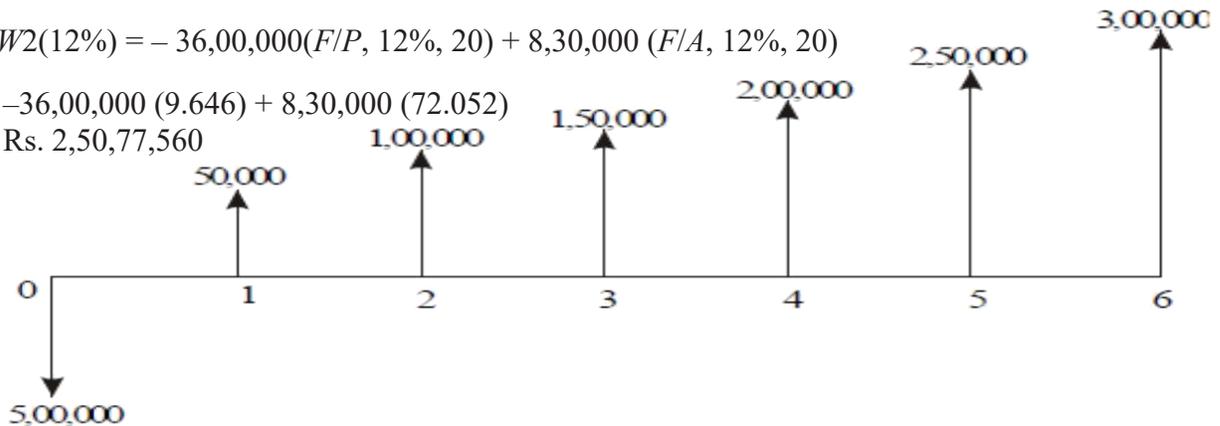


Fig. 5.7 Cash flow diagram for alternative 1.

The future worth of alternative 1 is greater than that of alternative 2. Thus, building the gas station is the best alternative.

**EXAMPLE 5.3** The cash flow diagram of two mutually exclusive alternatives are given in Figs. 5.7 and 5.8.

(a) Select the best alternative based on future worth method at  $i = 8\%$ .

(b) Rework part (a) with  $i = 9\%$  and  $20\%$

(a) **Evaluation at  $i = 8\%$**

**Alternative 1**—This comes under equal payment gradient series.

$$P = \text{Rs. } 5,00,000$$

$$A_1 = \text{Rs. } 50,000$$

$$G = \text{Rs. } 50,000$$

$$i = 8\% \quad n = 6 \text{ years}$$

The formula for the future worth of alternative 1 is

$$FW1(8\%) = -P(F/P, 8\%, 6) + [A1 + G(A/G, 8\%, 6)] \times (F/A, 8\%, 6)$$

$$= -5,00,000(1.587) + [50,000 + 50,000(2.2764)] \times 7.336$$

$$= -79,35,000 + 1,63,820 \times 7.336$$

$$= -79,35,000 + 12,01,784$$

$$= \text{Rs. } 4,08,283.52$$

**Alternative 2—This comes under equal payment gradient series.**

$$P = \text{Rs. } 7,00,000$$

$$A1 = \text{Rs. } 70,000$$

$$G = \text{Rs. } 70,000$$

$$i = 8\%$$

$$n = 6 \text{ years}$$

The formula for the future worth of alternative 2 is

$$FW2(8\%) = -P(F/P, 8\%, 6) + [A1 + G(A/G, 8\%, 6)] \times (F/A, 8\%, 6)$$

$$FW2(8\%) = -7,00,000 \times 1.587 + [70,000 + 70,000 \times 2.2764] \times 7.336$$

$$= -11,10,900 + 16,82,497$$

$$= \text{Rs. } 5,71,596.93$$

The future worth of alternative 2 is more than that of alternative 1. Therefore, alternative 2 must be selected.

**(b) (i) Evaluation at  $i = 9\%$ :**

**Alternative 1**

$$P = \text{Rs. } 5,00,000 \quad A1 = \text{Rs. } 50,000 \quad G = \text{Rs. } 50,000 \quad n = 6 \text{ years}$$

The formula for the future worth of alternative 1 is as follows:

$$FW1(9\%) = -P(F/P, 9\%, 6) + [A1 + G(A/G, 9\%, 6)] \times (F/A, 9\%, 6)$$

$$= -5,00,000 (1.677) + [50,000 + 50,000 (2.2498)] \times 7.523$$

$$= -8,38,500 + 12,22,412.27$$

$$= \text{Rs. } 3,83,912.27$$

**Alternative 2**

$$P = \text{Rs. } 7,00,000 \quad A1 = \text{Rs. } 70,000 \quad G = \text{Rs. } 70,000 \quad n = 6 \text{ years}$$

The formula for the future worth of the alternative 2 is

$$\begin{aligned} FW2(9\%) &= -P(F/P, 9\%, 6) + [A1 + G(A/G, 9\%, 6)] \times (F/A, 9\%, 6) \\ &= -7,00,000 \times 1.677 + [70,000 + 70,000 \times 2.2498] \times 7.523 \\ &= -11,73,900 + 17,11,377.18 \\ &= \text{Rs. } 5,37,477.18 \end{aligned}$$

The future worth of alternative 2 is more than that of alternative 1. Therefore, alternative 2 must be selected

**(ii) Evaluation at  $i = 20\%$ : Alternative 1**

$$P = \text{Rs. } 5,00,000 \quad A1 = \text{Rs. } 50,000 \quad G = \text{Rs. } 50,000 \quad n = 6 \text{ years}$$

The formula for the future worth of alternative 1 is

$$\begin{aligned} FW1(20\%) &= -P(F/P, 20\%, 6) + [A1 + G(A/G, 20\%, 6)] \times (F/A, 20\%, 6) \\ &= -5,00,000(2.986) + [50,000 + 50,000 (1.9788)] \times 9.93 \\ &= -14,93,000 + 14,78,974.20 \\ &= \text{Rs. } -14,025.80 \end{aligned}$$

The negative sign of the future worth amount indicates that alternative 1 incurs loss.

**Alternative 2**

$$P = \text{Rs. } 7,00,000 \quad A1 = \text{Rs. } 70,000 \quad G = \text{Rs. } 70,000 \quad n = 6 \text{ years}$$

The formula for the future worth of alternative 2 is

$$\begin{aligned} FW2(20\%) &= -P(F/P, 20\%, 6) + [A1 + G(A/G, 20\%, 6)] \times (F/A, 20\%, 6) \\ &= -7,00,000 \times 2.986 + [70,000 + 70,000 \times 1.9788] \times 9.93 \\ &= -20,90,200 + 20,70,563.88 \\ &= \text{Rs. } -19,636.12 \end{aligned}$$

The negative sign of the above future worth amount indicates that alternative 2 incurs loss.

Thus, none of the two alternatives should be selected.

**EXAMPLE 5.4** M/S Krishna Castings Ltd. is planning to replace its annealing furnace. It has received tenders from three different original manufacturers of annealing furnace. The details are as follows.

	<i>Manufacturer</i>		
	1	2	3
Initial cost (Rs.)	80,00,000	70,00,000	90,00,000
Life (years)	12	12	12
Annual operation and maintenance cost (Rs.)	8,00,000	9,00,000	8,50,000
Salvage value after 12 years	5,00,000	4,00,000	7,00,000

Which is the best alternative based on future worth method at  $i = 20\%$ ?

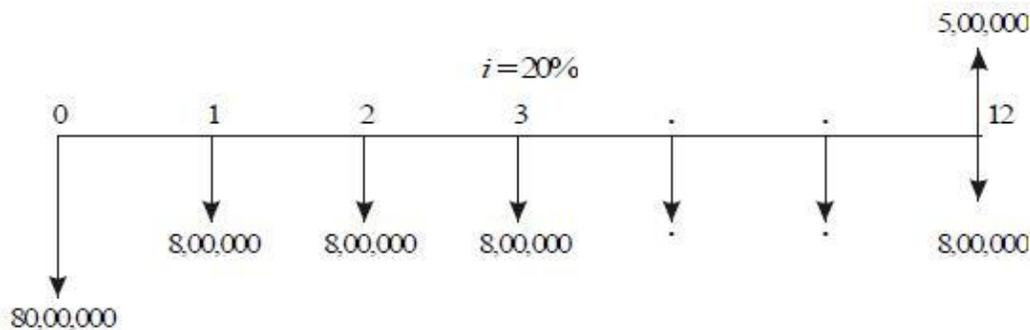
**Solution Alternative 1—Manufacturer 1**

First cost,  $P = \text{Rs. } 80,00,000$  Life,  $n = 12$  years

Annual operating and maintenance cost,  $A = \text{Rs. } 8,00,000$

Salvage value at the end of furnace life = Rs. 5,00,000

The cash flow diagram for this alternative is shown in Fig. 5.9.



**Fig. 5.9** Cash flow diagram for manufacturer 1.

The future worth amount of alternative 1 is computed as

$$\begin{aligned}
 FW1(20\%) &= 80,00,000 (F/P, 20\%, 12) + 8,00,000 (F/A, 20\%, 12) - 5,00,000 \\
 &= 80,00,000(8.916) + 8,00,000 (39.581) - 5,00,000 \\
 &= \text{Rs. } 10,24,92,800
 \end{aligned}$$

**Alternative 2—Manufacturer 2**

First cost,  $P = \text{Rs. } 70,00,000$

Life,  $n = 12$  years

Annual operating and maintenance cost,  $A = \text{Rs. } 9,00,000$

Salvage value at the end of furnace life =  $\text{Rs. } 4,00,000$

The cash flow diagram for this alternative is given in Fig. 5.10.

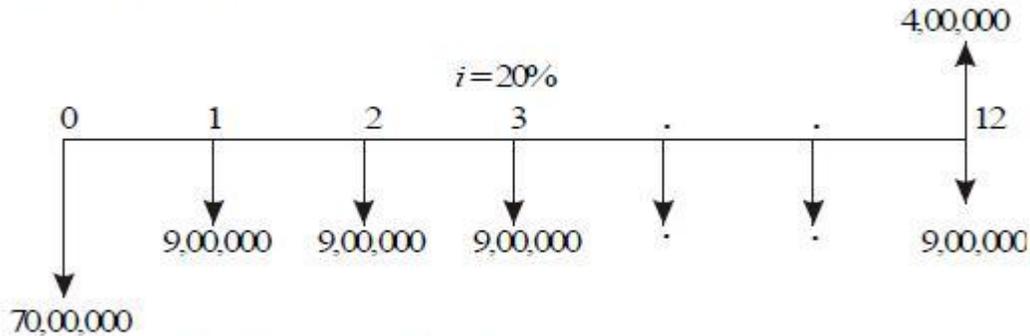


Fig. 5.10 Cash flow diagram for manufacturer 2.

The future worth amount of alternative 2 is computed as

$$FW2(20\%) = 70,00,000(F/P, 20\%, 12) + 9,00,000(F/A, 20\%, 12) - 4,00,000$$

$$= 70,00,000(8.916) + 9,00,000(39.581) - 4,00,000$$

$$= \text{Rs. } 9,76,34,900$$

**Alternative 3—Manufacturer 3**

First cost,  $P = \text{Rs. } 90,00,000$

Life,  $n = 12$  years

Annual operating and maintenance cost,  $A = \text{Rs. } 8,50,000$

Salvage value at the end of furnace life =  $\text{Rs. } 7,00,000$

The cash flow diagram for this alternative is illustrated in Fig. 5.11.

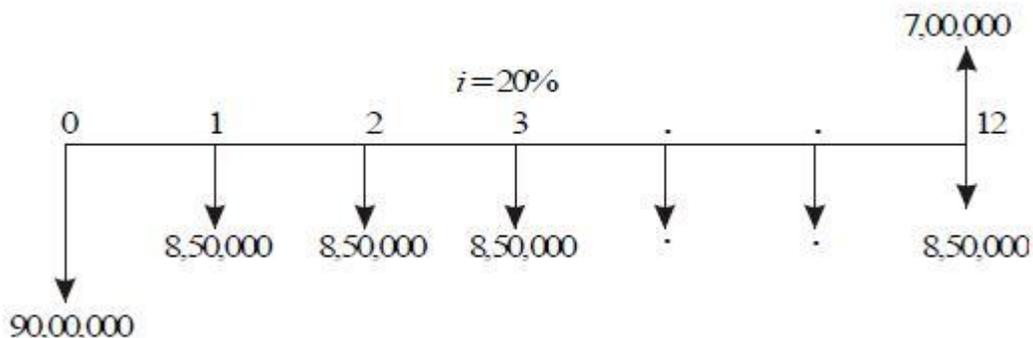


Fig. 5.11 Cash flow diagram for manufacturer 3.

The future worth amount of alternative 3 is calculated as

$$\begin{aligned}
 FW_3(20\%) &= 90,00,000(F/P, 20\%, 12) + 8,50,000(F/A, 20\%, 12) - 7,00,000 \\
 &= 90,00,000(8.916) + 8,50,000(39.581) - 7,00,000 \\
 &= \text{Rs. } 11,31,87,850
 \end{aligned}$$

The future worth cost of alternative 2 is less than that of the other two alternatives. Therefore, M/s. Krishna castings should buy the annealing furnace from manufacturer 2.

**EXAMPLE 5.5** A company must decide whether to buy machine *A* or machine *B*:

	<i>Machine A</i>	<i>Machine B</i>
Initial cost	Rs. 4,00,000	Rs. 8,00,000
Useful life, in years	4	4
Salvage value at the end of machine life	Rs. 2,00,000	Rs. 5,50,000
Annual maintenance cost	Rs. 40,000	0

At 12% interest rate, which machine should be selected? (Use future worth method of comparison).

**Solution Machine A**

Initial cost of the machine,  $P = \text{Rs. } 4,00,000$

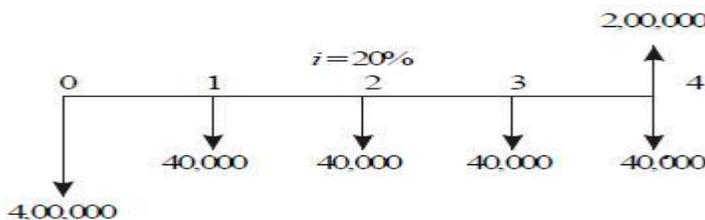
Life,  $n = 4$  years

Salvage value at the end of machine life,  $S = \text{Rs. } 2,00,000$

Annual maintenance cost,  $A = \text{Rs. } 40,000$

Interest rate,  $i = 12\%$ , compounded annually.

The cash flow diagram of machine *A* is given in Fig. 5.12.



**Fig. 5.12** Cash flow diagram for machine *A*.

The future worth function of Fig. 5.12 is

$$\begin{aligned} FWA(12\%) &= 4,00,000 \times (F/P, 12\%, 4) + 40,000 \times (F/A, 12\%, 4) - 2,00,000 \\ &= 4,00,000 \times (1.574) + 40,000 \times (4.779) - 2,00,000 \\ &= \text{Rs. } 6,20,760 \end{aligned}$$

### **Machine B**

Initial cost of the machine,  $P = \text{Rs. } 8,00,000$

Life,  $n = 4$  years

Salvage value at the end of machine life,  $S = \text{Rs. } 5,50,000$

Annual maintenance cost,  $A = \text{zero}$ .

Interest rate,  $i = 12\%$ , compounded annually.

The cash flow diagram of the machine B is illustrated in Fig. 5.13.

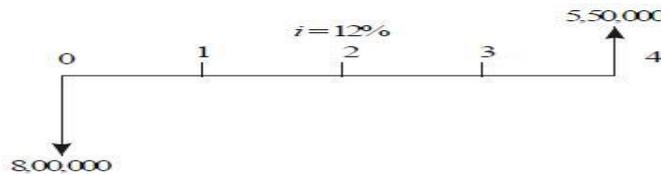


Fig. 5.13 Cash flow diagram for machine B.

The future worth function of Fig 5.13 is

$$\begin{aligned} FWB(12\%) &= 8,00,000 \times (F/P, 12\%, 4) - 5,50,000 \\ &= 8,00,000 \times (1.574) - 5,50,000 \\ &= \text{Rs. } 7,09,200 \end{aligned}$$

The future worth cost of machine A is less than that of machine B. Therefore, machine A should be selected.

# ANNUAL EQUIVALENT METHOD

## INTRODUCTION

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 the case of costbased comparison will be selected as the best alternative.

## REVENUE-DOMINATED CASH FLOW DIAGRAM

A generalized revenue-dominated cash flow diagram to demonstrate the annual equivalent method of comparison is presented in Fig. 6.1.

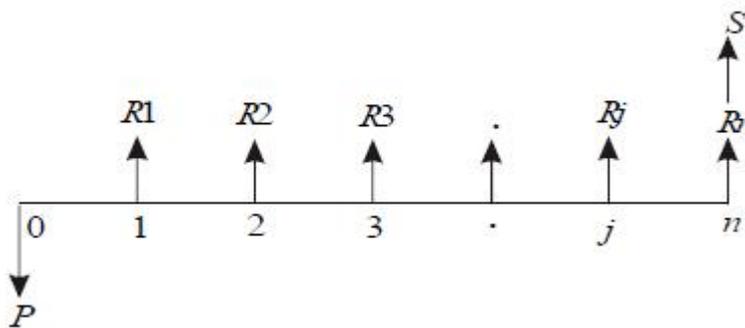


Fig. 6.1 Revenue-dominated cash flow diagram.

In Fig. 6.1,  $P$  represents an initial investment,  $R_j$  the net revenue at the end of the  $j$ th year, and  $S$  the salvage value at the end of the  $n$ th year.

The first step is to find the net present worth of the cash flow diagram using the following expression for a given interest rate,  $i$ :

$$PW(i) = -P + R_1/(1+i)^1 + R_2/(1+i)^2 + \dots \\ + R_j/(1+i)^j + \dots + R_n/(1+i)^n + S/(1+i)^n$$

In the above formula, the expenditure is assigned with a negative sign and the revenues are assigned with a positive sign.

In the second step, the annual equivalent revenue is computed using the following formula:

$$A = PW(i) \frac{i(1+i)^n}{(1+i)^n - 1}$$

$$= PW(i) (A/P, i, n)$$

where  $(A/P, i, n)$  is called *equal payment series capital recovery factor*.

If we have some more alternatives which are to be compared with this alternative, then the corresponding annual equivalent revenues are to be computed and compared. Finally, the alternative with the maximum annual equivalent revenue should be selected as the best alternative.

### COST-DOMINATED CASH FLOW DIAGRAM

A generalized cost-dominated cash flow diagram to demonstrate the annual equivalent method of comparison is illustrated in Fig. 6.2.

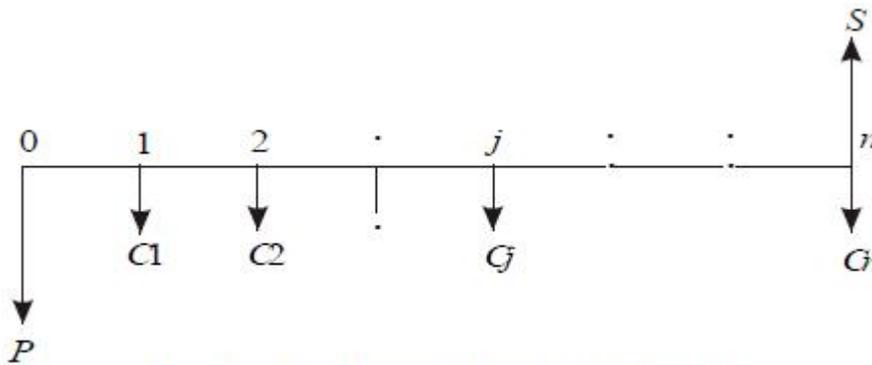


Fig. 6.2 Cost-dominated cash flow diagram.

In Fig. 6.2,  $P$  represents an initial investment,  $C_j$  the net cost of operation and maintenance at the end of the  $j$ th year, and  $S$  the salvage value at the end of the  $n$ th year.

The first step is to find the net present worth of the cash flow diagram using the following relation for a given interest rate,  $i$ .

$$PW(i) = P + C1/(1+i)^1 + C2/(1+i)^2 + \dots$$

$$+ Cj/(1+i)^j + \dots + Cn/(1+i)^n - S/(1+i)^n$$

In the above formula, each expenditure is assigned with positive sign and the salvage value with negative sign. Then, in the second step, the annual equivalent cost is computed using the following equation:

$$A = PW(i) \frac{i(1+i)^n}{(1+i)^n - 1}$$

$$= PW(i) (A/P, i, n)$$

where  $(A/P, i, n)$  is called as equal-payment series capital recovery factor.

As in the previous case, if we have some more alternatives which are to be compared with this alternative, then the corresponding annual equivalent costs are to be computed and compared. Finally, the alternative with the minimum annual equivalent cost should be selected as the best alternative.

If we have some non-standard cash flow diagram, then we will have to follow the general procedure for converting each and every transaction to time zero and then convert the net present worth into an annual equivalent cost/ revenue depending on the type of the cash flow diagram. Such procedure is to be applied to all the alternatives and finally, the best alternative is to be selected.

### **ALTERNATE APPROACH**

Instead of first finding the present worth and then figuring out the annual equivalent cost/revenue, an alternate method which is as explained below can be used. In each of the cases presented in Sections 6.2 and 6.3, in the first step, one can find the future worth of the cash flow diagram of each of the alternatives.

Then, in the second step, the annual equivalent cost/revenue can be obtained by using the equation:

$$A = F \frac{i}{(1+i)^n - 1}$$

$$= F(A/F, i, n)$$

where  $(A/F, i, n)$  is called *equal-payment series sinking fund factor*.

## EXAMPLES

In this section, the application of the annual equivalent method is demonstrated with several numerical examples.

**EXAMPLE 6.1** A company provides a car to its chief executive. The owner of the company is concerned about the increasing cost of petrol. The cost per litre of petrol for the first year of operation is Rs. 21. He feels that the cost of petrol will be increasing by Re.1 every year. His experience with his company car indicates that it averages 9 km per litre of petrol. The executive expects to drive an average of 20,000 km each year for the next four years. What is the annual equivalent cost of fuel over this period of time?. If he is offered similar service with the same quality on 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**

Average number of km run/year = 20,000 km

Number of km/litre of petrol = 9 km

Therefore,

Petrol consumption/year =  $20,000/9 = 2222.2$  litre

Cost/litre of petrol for the 1st year = Rs. 21

Cost/litre of petrol for the 2nd year = Rs. 21.00 + Re. 1.00  
= Rs. 22.00

Cost/litre of petrol for the 3rd year = Rs. 22.00 + Re. 1.00  
= Rs. 23.00

Cost/litre of petrol for the 4th year = Rs. 23.00 + Re. 1.00  
= Rs. 24.00

Fuel expenditure for 1st year =  $2222.2 \times 21 =$  Rs. 46,666.20

Fuel expenditure for 2nd year =  $2222.2 \times 22 =$  Rs. 48,888.40

Fuel expenditure for 3rd year =  $2222.2 \times 23 =$  Rs. 51,110.60

Fuel expenditure for 4th year =  $2222.2 \times 24 =$  Rs. 53,332.80

The annual equal increment of the above expenditures is Rs. 2,222.20 (G).

The cash flow diagram for this situation is depicted in Fig. 6.3.

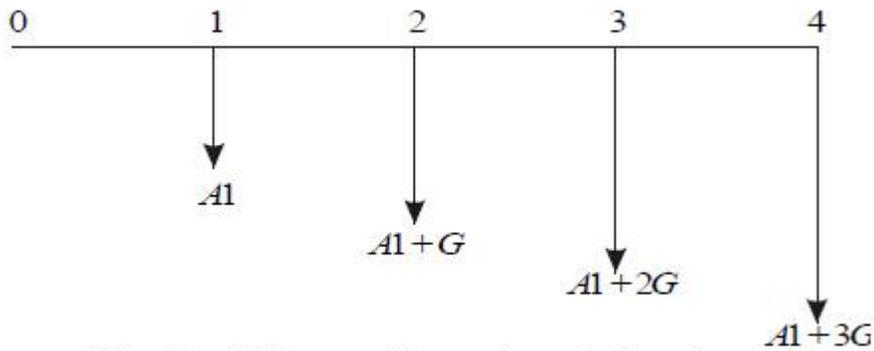


Fig. 6.3 Uniform gradient series cash flow diagram.

In Fig. 6.3,  $A1 = \text{Rs. } 46,666.20$  and  $G = \text{Rs. } 2,222.20$

$$\begin{aligned}
 A &= A1 + G(A/G, 18\%, 4) \\
 &= 46,666.20 + 2222.2(1.2947) \\
 &= \text{Rs. } 49,543.28
 \end{aligned}$$

The proposal of using the company car by spending for 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. Therefore, the company should continue to provide its own car to its executive.

**EXAMPLE 6.2** A company is planning to purchase an advanced machine centre. Three original manufacturers have responded to its tender whose particulars are tabulated as follows:

<i>Manufacturer</i>	<i>Down payment</i> (Rs.)	<i>Yearly equal installment</i> (Rs.)	<i>No. of installments</i>
1	5,00,000	2,00,000	15
2	4,00,000	3,00,000	15
3	6,00,000	1,50,000	15

Determine the best alternative based on the annual equivalent method by assuming  $i = 20\%$ , compounded annually.

**Solution Alternative 1**

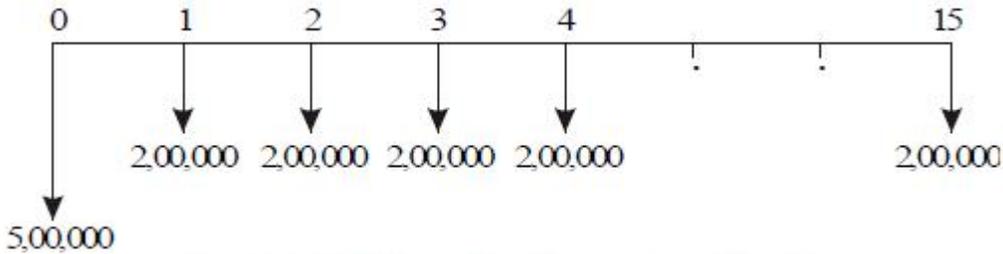
Down payment,  $P = \text{Rs. } 5,00,000$

Yearly equal installment,  $A = \text{Rs. } 2,00,000$

$n = 15$  years

$i = 20\%$ , compounded annually

The cash flow diagram for manufacturer 1 is shown in Fig. 6.4.



**Fig. 6.4** Cash flow diagram for manufacturer 1.

The annual equivalent cost expression of the above cash flow diagram is

$$\begin{aligned} AE1(20\%) &= 5,00,000(A/P, 20\%, 15) + 2,00,000 \\ &= 5,00,000(0.2139) + 2,00,000 \\ &= 3,06,950 \end{aligned}$$

### **Alternative 2**

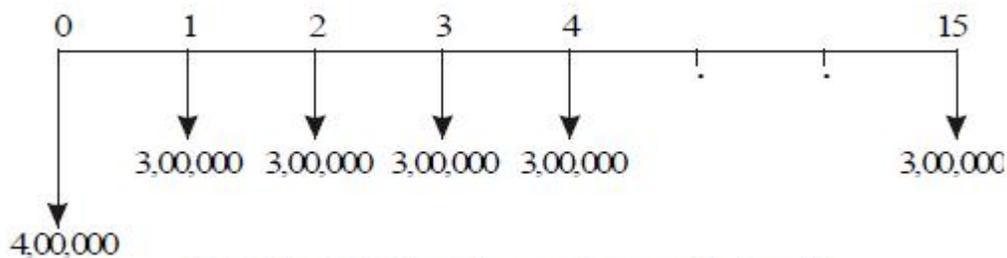
Down payment,  $P = \text{Rs. } 4,00,000$

Yearly equal installment,  $A = \text{Rs. } 3,00,000$

$n = 15$  years

$i = 20\%$ , compounded annually

The cash flow diagram for the manufacturer 2 is shown in Fig. 6.5.



**Fig. 6.5** Cash flow diagram for manufacturer 2.

The annual equivalent cost expression of the above cash flow diagram is

$$\begin{aligned} AE2(20\%) &= 4,00,000(A/P, 20\%, 15) + 3,00,000 \\ &= 4,00,000(0.2139) + 3,00,000 \\ &= \text{Rs. } 3,85,560. \end{aligned}$$

### **Alternative 3**

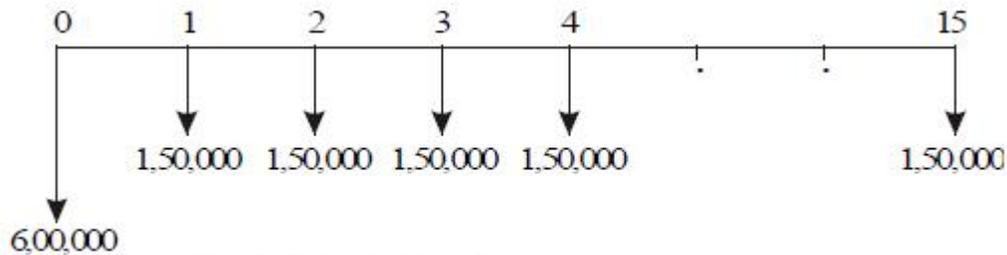
Down payment,  $P = \text{Rs. } 6,00,000$

Yearly equal installment,  $A = \text{Rs. } 1,50,000$

$n = 15$  years

$i = 20\%$ , compounded annually

The cash flow diagram for manufacturer 3 is shown in Fig. 6.6.



**Fig. 6.6** Cash flow diagram for manufacturer 3.

The annual equivalent cost expression of the above cash flow diagram is

$$AE_3(20\%) = 6,00,000(A/P, 20\%, 15) + 1,50,000$$

$$= 6,00,000(0.2139) + 1,50,000$$

$$= \text{Rs. } 2,78,340.$$

The annual equivalent cost of manufacturer 3 is less than that of manufacturer 1 and manufacturer 2. Therefore, the company should buy the advanced machine centre from manufacturer 3.

**EXAMPLE 6.3** A company invests in one of the two mutually exclusive alternatives. The life of both alternatives is estimated to be 5 years with the following investments, annual returns and salvage values.

	<i>Alternative</i>	
	A	B
Investment (Rs.)	- 1,50,000	- 1,75,000
Annual equal return (Rs.)	+ 60,000	+ 70,000
Salvage value (Rs.)	+ 15,000	+ 35,000

Determine the best alternative based on the annual equivalent method by assuming  $i = 25\%$ .

**Solution Alternative A**

Initial investment,  $P = \text{Rs. } 1,50,000$  , Annual equal return,  $A = \text{Rs. } 60,000$

Salvage value at the end of machine life,  $S = \text{Rs. } 15,000$

Life = 5 years, Interest rate,  $i = 25\%$ , compounded annually

The cash flow diagram for alternative A is shown in Fig. 6.7.

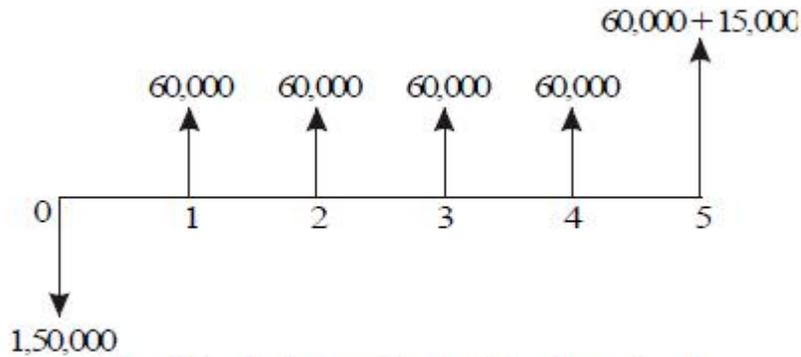


Fig. 6.7 Cash flow diagram for alternative A.

The annual equivalent revenue expression of the above cash flow diagram is as follows:

$$\begin{aligned}
 AEA(25\%) &= -1,50,000(A/P, 25\%, 5) + 60,000 + 15,000(A/F, 25\%, 5) \\
 &= -1,50,000(0.3718) + 60,000 + 15,000(0.1218) \\
 &= \text{Rs. } 6,057
 \end{aligned}$$

**Alternative B**

Initial investment,  $P = \text{Rs. } 1,75,000$

Annual equal return,  $A = \text{Rs. } 70,000$

Salvage value at the end of machine life,  $S = \text{Rs. } 35,000$

Life = 5 years

Interest rate,  $i = 25\%$ , compounded annually

The cash flow diagram for alternative B is shown in Fig. 6.8.

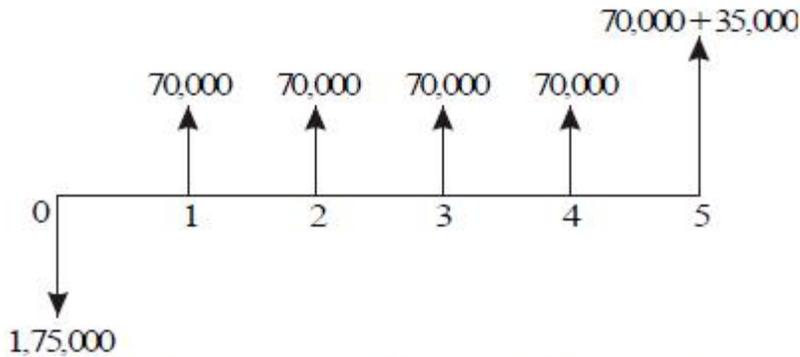


Fig. 6.8 Cash flow diagram for alternative B.

The annual equivalent revenue expression of the above cash flow diagram is

$$\begin{aligned}
 AEB(25\%) &= -1,75,000(A/P, 25\%, 5) + 70,000 + 35,000(A/F, 25\%, 5) \\
 &= -1,75,000(0.3718) + 70,000 + 35,000(0.1218) \\
 &= \text{Rs. } 9,198
 \end{aligned}$$

The annual equivalent net return of alternative B is more than that of alternative A. Thus, the company should select alternative B.

**EXAMPLE 6.4** A certain individual firm desires an economic analysis to determine which of the two machines is attractive in a given interval of time. The minimum attractive rate of return for the firm is 15%. The following data are to be used in the analysis:

	<i>Machine X</i>	<i>Machine Y</i>
First cost	Rs. 1,50,000	Rs. 2,40,000
Estimated life	12 years	12 years
Salvage value	Rs. 0	Rs. 6,000
Annual maintenance cost	Rs. 0	Rs. 4,500

Which machine would you choose? Base your answer on annual equivalent cost.

**Solution Machine X**

First cost,  $P = \text{Rs. } 1,50,000$

Life,  $n = 12$  years

Estimated salvage value at the end of machine life,  $S = \text{Rs. } 0$ .

Annual maintenance cost,  $A = \text{Rs. } 0$ .

Interest rate,  $i = 15\%$ , compounded annually.

The cash flow diagram of machine X is illustrated in Fig. 6.9.



Fig. 6.9 Cash flow diagram for machine X.

The annual equivalent cost expression of the above cash flow diagram is

$$AEX(15\%) = 1,50,000(A/P, 15\%, 12)$$

$$= 1,50,000(0.1845)$$

$$= \text{Rs. } 27,675$$

### **Machine Y**

First cost,  $P = \text{Rs. } 2,40,000$

Life,  $n = 12$  years

Estimated salvage value at the end of machine life,  $S = \text{Rs. } 60,000$

Annual maintenance cost,  $A = \text{Rs. } 4,500$

Interest rate,  $i = 15\%$ , compounded annually.

The cash flow diagram of machine Y is depicted in Fig. 6.10.

The annual equivalent cost expression of the above cash flow diagram is

$$AEY(15\%) = 2,40,000(A/P, 15\%, 12) + 4,500 - 6,000(A/F, 15\%, 12)$$

$$= 2,40,000(0.1845) + 4,500 - 6,000(0.0345)$$

$$= \text{Rs. } 48,573$$

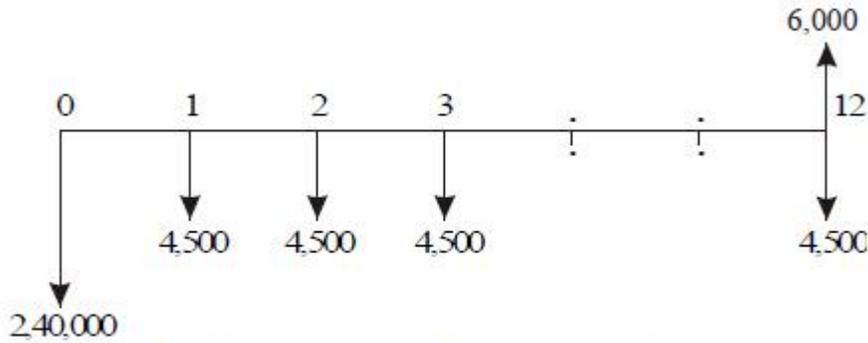


Fig. 6.10 Cash flow diagram for machine Y.

The annual equivalent cost of machine X is less than that of machine Y. So, machine X is the more cost effective machine.

**EXAMPLE 6.5** Two possible routes for laying a power line are under study. Data on the routes are as follows:

		<i>Around the lake</i>	<i>Under the lake</i>
Length		15 km	5 km
First cost	(Rs.)	1,50,000/km	7,50,000/km
Useful life	(years)	15	15
Maintenance cost	(Rs.)	6,000/km/yr	12,000/km/yr
Salvage value	(Rs.)	90,000/km	1,50,000/km
Yearly power loss	(Rs.)	15,000/km	15,000/km

If 15% interest is used, should the power line be routed around the lake or under the lake?

**Solution Alternative 1— Around the lake**

$$\text{First cost} = 1,50,000 \times 15 = \text{Rs. } 22,50,000$$

$$\text{Maintenance cost/yr} = 6,000 \times 15 = \text{Rs. } 90,000$$

$$\text{Power loss/yr} = 15,000 \times 15 = \text{Rs. } 2,25,000$$

$$\text{Maintenance cost and power loss/yr} = \text{Rs. } 90,000 + \text{Rs. } 2,25,000$$

$$= \text{Rs. } 3,15,000$$

$$\text{Salvage value} = 90,000 \times 15 = \text{Rs. } 13,50,000$$

The cash flow diagram for this alternative is shown in Fig. 6.11

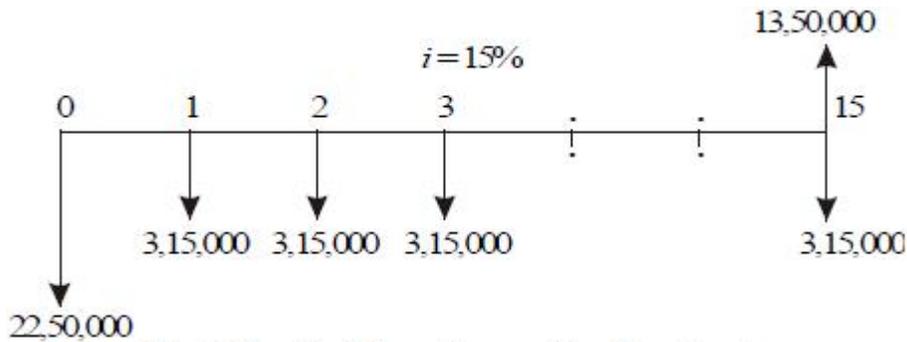


Fig. 6.11 Cash flow diagram for alternative 1

The annual equivalent cost expression of the above cash flow diagram is

$$\begin{aligned}
 AE1(15\%) &= 22,50,000(A/P, 15\%, 15) + 3,15,000 - 13,50,000(A/F, 15\%, 15) \\
 &= 22,50,000(0.1710) + 3,15,000 - 13,50,000(0.0210) \\
 &= \text{Rs. } 6,71,400
 \end{aligned}$$

**Alternative 2—Under the lake**

First cost = 7,50,000 x 5 = Rs. 37,50,000

Maintenance cost/yr = 12,000 x 5 = Rs. 60,000

Power loss/yr = 15,000 x 5 = Rs. 75,000

Maintenance cost and power loss/yr = Rs. 60,000 + Rs. 75,000

= Rs. 1,35,000

Salvage value = 1,50,000 x 5 = Rs. 7,50,000

The cash flow diagram for this alternative is shown in Fig. 6.12.

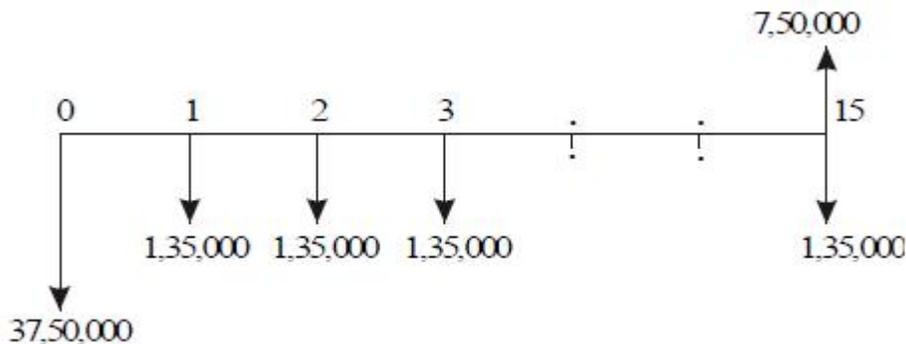


Fig. 6.12 Cash flow diagram for alternative 2.

The annual equivalent cost expression of the above cash flow diagram is

$$\begin{aligned}
 AE2(15\%) &= 37,50,000(A/P, 15\%, 15) + 1,35,000 - 7,50,000(A/F, 15\%, 15) \\
 &= 37,50,000(0.1710) + 1,35,000 - 7,50,000(0.0210) \\
 &= \text{Rs. } 7,60,500
 \end{aligned}$$

The annual equivalent cost of alternative 1 is less than that of alternative 2. Therefore, select the route around the lake for laying the power line.

**EXAMPLE 6.6** A suburban taxi company is analyzing the proposal of buying cars with diesel engines instead of petrol engines. The cars average 60,000 km a year with a useful life of three years for the petrol taxi and four years for the diesel taxi. Other comparative details are as follows:

	<i>Diesel</i>	<i>Petrol</i>
Vehicle cost (Rs.)	3,90,000	3,60,000
Fuel cost per litre (Rs.)	8	20
Mileage in km/litre	30	20
Annual repairs (Rs.)	9,000	6,000
Annual insurance premium (Rs.)	15,000	15,000
Resale value at the end of vehicle life (Rs.)	60,000	90,000

Determine the more economical choice if interest rate is 20%, compounded annually.

**Solution Alternative 1— Purchase of diesel taxi**

Vehicle cost = Rs. 3,90,000

Life = 4 years

Number of litres/year  $60,000/30 = 2,000$  litres

Fuel cost/yr =  $2,000 \times 8 = \text{Rs. } 16,000$

Fuel cost, annual repairs and insurance premium/yr  
 = Rs. 16,000 + Rs. 9,000 + Rs. 15,000 = Rs. 40,000

Salvage value at the end of vehicle life = Rs. 60,000

The cash flow diagram for alternative 1 is shown in Fig. 6.13.

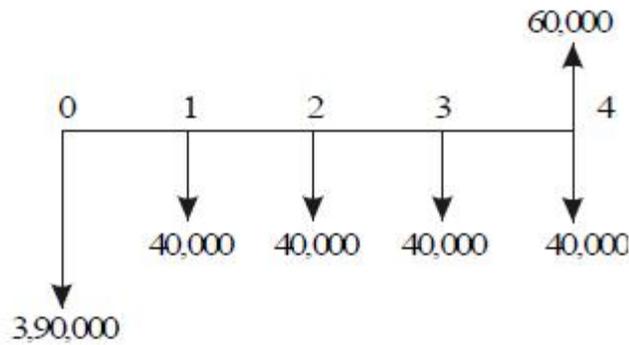


Fig. 6.13 Cash flow diagram for alternative 1.

The annual equivalent cost expression of the above cash flow diagram is

$$\begin{aligned}
 AE(20\%) &= 3,90,000(A/P, 20\%, 4) + 40,000 - 60,000(A/F, 20\%, 4) \\
 &= 3,90,000(0.3863) + 40,000 - 60,000(0.1863) \\
 &= \text{Rs. } 1,79,479
 \end{aligned}$$

**Alternative 2— Purchase of petrol taxi**

Vehicle cost = Rs. 3,60,000

Life = 3 years, Number of litres/year  $60,000/20 = 3,000$  litres

Fuel cost/yr =  $3,000 \times 20 = \text{Rs. } 60,000$

Fuel cost, annual repairs and insurance premium/yr

$$= \text{Rs. } 60,000 + \text{Rs. } 6,000 + \text{Rs. } 15,000 = \text{Rs. } 81,000$$

Salvage value at the end of vehicle life = Rs. 90,000

The cash flow diagram for alternative 2 is shown in Fig. 6.14.

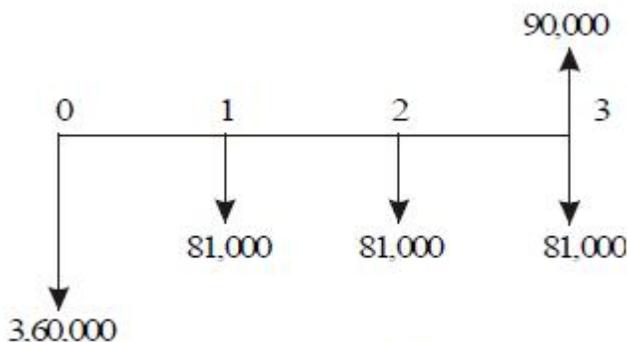


Fig. 6.14 Cash flow diagram for alternative 2.

The annual equivalent cost expression of the above cash flow diagram is

$$\begin{aligned} AE(20\%) &= 3,60,000(A/P, 20\%, 3) + 81,000 - 90,000(A/F, 20\%, 3) \\ &= 3,60,000(0.4747) + 81,000 - 90,000(0.2747) \\ &= \text{Rs. } 2,27,169 \end{aligned}$$

The annual equivalent cost of purchase and operation of the cars with diesel engine is less than that of the cars with petrol engine. Therefore, the taxi company should buy cars with diesel engine. (*Note:* Comparison is done on common multiple lives of 12 years.)

**EXAMPLE 6.7** Ramu, a salesman, needs a new car for use in his business. He expects that he will be promoted to a supervisory job at the end of third year and so his concern now is to have a car for the three years he expects to be “on the road”. The company will reimburse their salesman each month the fuel cost and maintenance cost. Ramu has decided to drive a low-priced automobile. He finds, however, that there are two different ways of obtaining the automobile. In either case, the fuel cost and maintenance cost are borne by the company.

(a) Purchase for cash at Rs. 3,90,000.

(b) Lease a car. The monthly charge is Rs. 10,500 on a 36-month lease payable at the end of each month. At the end of the three-year period, the car is returned to the leasing company. Ramu believes that he should use a 12% interest rate compounded monthly in determining which alternative to select. If the car could be sold for Rs. 1,20,000 at the end of the third year, which option should he use to obtain it?

***Alternative 1—Purchase car for cash***

Purchase price of the car = Rs. 3,90,000

Life = 3 years = 36 months

Salvage value after 3 years = Rs. 1,20,000

Interest rate = 12% (nominal rate, compounded annually)

= 1% compounded monthly

The cash flow diagram for alternative 1 is shown in Fig. 6.15.

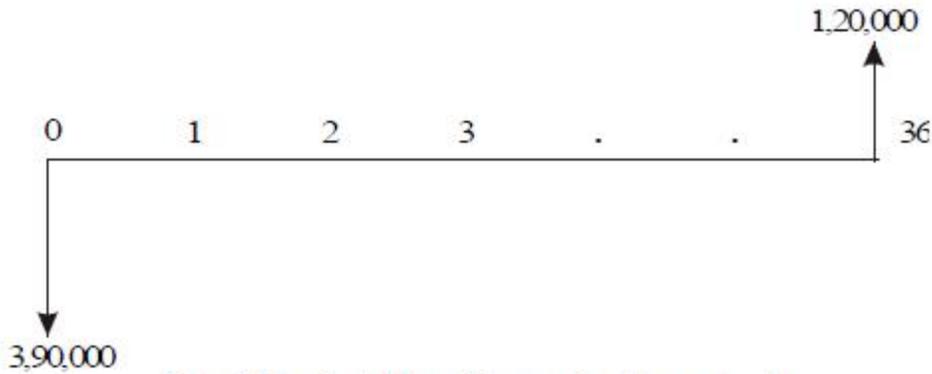


Fig. 6.15 Cash flow diagram for alternative 1.

The monthly equivalent cost expression  $[ME(1\%)]$  of the above cash flow diagram is

$$\begin{aligned}
 ME(1\%) &= 3,90,000(A/P, 1\%, 36) - 1,20,000(A/F, 1\%, 36) \\
 &= 3,90,000(0.0332) - 1,20,000(0.0232) \\
 &= \text{Rs. } 10,164
 \end{aligned}$$

**Alternative 2—Use of car under lease**

Monthly lease amount for 36 months = Rs. 10,500

The cash flow diagram for alternative 2 is illustrated in Fig. 6.16.

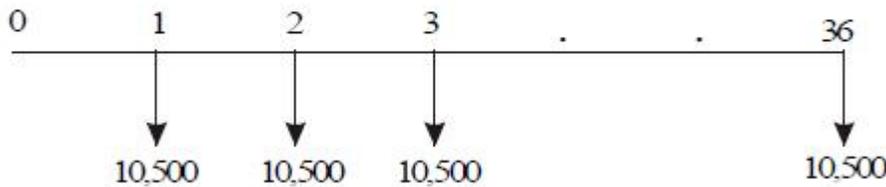


Fig. 6.16 Cash flow diagram for alternative 2.

Monthly equivalent cost = Rs.10,500.

The monthly equivalent cost of alternative 1 is less than that of alternative 2. Hence, the salesman should purchase the car for cash.

**EXAMPLE 6.8** A company must decide whether to buy machine A or machine B.

	<i>Machine A</i>	<i>Machine B</i>
Initial cost (Rs.)	3,00,000	6,00,000
Useful life (years)	4	4
Salvage value at the end of machine life (Rs.)	2,00,000	3,00,000
Annual maintenance (Rs.)	30,000	0

At 15% interest rate, which machine should be purchased?

**Solution Machine A**

Initial cost = Rs. 3,00,000

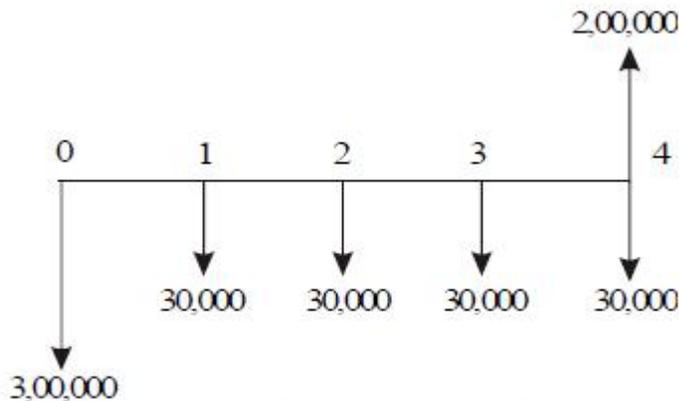
Useful life (years) = 4

Salvage value at the end of machine life = Rs. 2,00,000

Annual maintenance = Rs. 30,000

Interest rate = 15%, compounded annually

The cash flow diagram of machine A is depicted in Fig. 6.17.



**Fig. 6.17** Cash flow diagram for machine A.

The annual equivalent cost expression of the above cash flow diagram is

$$AE(15\%) = 3,00,000(A/P, 15\%, 4) + 30,000 - 2,00,000(A/F, 15\%, 4)$$

$$= 3,00,000(0.3503) + 30,000 - 2,00,000(0.2003)$$

$$= \text{Rs. } 95,030$$

### **Machine B**

Initial cost = Rs. 6,00,000

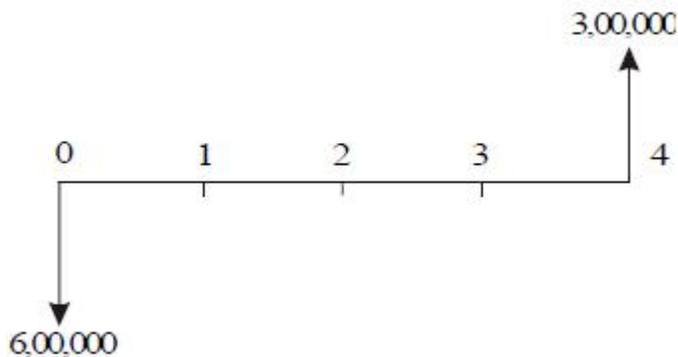
Useful life (years) = 4

Salvage value at the end of machine life = Rs. 3,00,000

Annual maintenance = Rs. 0.

Interest rate = 15%, compounded annually

The cash flow diagram of machine B is illustrated in Fig. 6.18.



**Fig. 6.18** Cash flow diagram for machine B.

The annual equivalent cost expression of the above cash flow diagram is

$$AE(15\%) = 6,00,000(A/P, 15\%, 4) - 3,00,000(A/F, 15\%, 4)$$

$$= 6,00,000(0.3503) - 3,00,000(0.2003)$$

$$= \text{Rs. } 1,50,090$$

Since the annual equivalent cost of machine A is less than that of machine B, it is advisable to buy machine A.

**EXAMPLE 6.9** Jothi Lakshimi has arranged to buy some home recording equipment. She estimates that it will have a five year useful life and no salvage value at the end of equipment life. The dealer, who is a friend has offered Jothi Lakshimi two alternative ways to pay for the equipment.

(a) Pay Rs. 60,000 immediately and Rs. 15,000 at the end of one year.

(b) Pay nothing until the end of fourth year when a single payment of Rs. 90,000 must be made.

If Jothi Lakshimi believes 12% is a suitable interest rate, which alternative

is the best for her?

**Solution Alternative 1**

Down payment = Rs. 60,000

Payment after one year = Rs. 15,000

The cash flow diagram for alternative 1 is shown in Fig. 6.19.

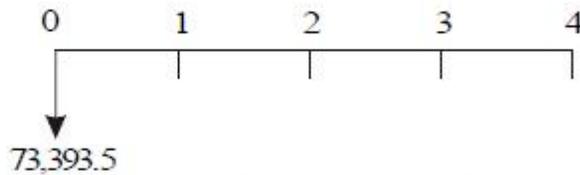


**Fig. 6.19** Cash flow diagram for alternative 1.

The present worth equation of the above cash flow diagram is

$$\begin{aligned} PW(12\%) &= 60,000 + 15,000(P/F, 12\%, 1) \\ &= 60,000 + 15,000(0.8929) \\ &= 73,393.50 \end{aligned}$$

The above present worth is represented in Fig. 6.20.



**Fig. 6.20** Resultant cash flow diagram.

The annual equivalent expression of the above cash flow diagram is

$$\begin{aligned} AE(12\%) &= 73,393.5(A/P, 12\%, 4) \\ &= 73,393.5(0.3292) \\ &= \text{Rs. } 24,161.14 \end{aligned}$$

**Alternative 2**

Payment after four years = Rs. 90,000

The cash flow diagram for alternative 2 is shown in Fig. 6.21.

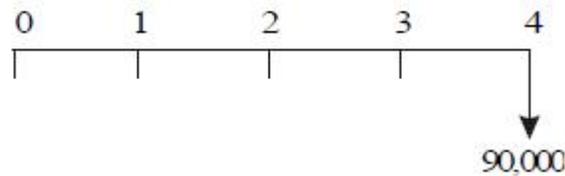


Fig. 6.21 Cash flow diagram of alternative 2.

The annual equivalent cost expression of the above cash flow diagram is

$$\begin{aligned}
 AE(12\%) &= 90,000(A/F, 12\%, 4) \\
 &= 90,000(0.2092) \\
 &= \text{Rs. } 18,828
 \end{aligned}$$

The annual equivalent cost of alternative 2 is less than that of alternative 1. Hence, Jothi Lakshimi should select alternative 2 for purchasing the home equipment.

**EXAMPLE 6.10** A transport company has been looking for a new tyre for its truck and has located the following alternatives:

<i>Brand</i>	<i>Tyre warranty (months)</i>	<i>Price per tyre (Rs.)</i>
A	12	1,200
B	24	1,800
C	36	2,100
D	48	2,700

If the company feels that the warranty period is a good estimate of the tyre life and that a nominal interest rate (compounded annually) of 12% is appropriate, which tyre should it buy?

**Solution** In all the cases, the interest rate is 12%. This is equivalent to 1% per month.

**Brand A**

Tyre warranty = 12 months

Price/tyre = Rs. 1,200

The cash flow diagram for brand A is shown in Fig. 6.22.

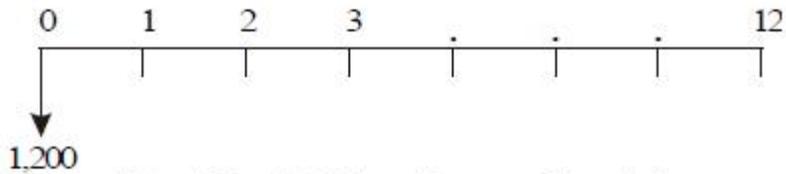


Fig. 6.22 Cash flow diagram of brand A.

The annual equivalent cost expression of the above cash flow diagram is

$$AE(1\%) = 1,200(A/P, 1\%, 12)$$

$$= 1,200(0.0888)$$

$$= \text{Rs. } 106.56$$

### **Brand B**

Tyre warranty = 24 months

Price/tyre = Rs. 1,800

The cash flow diagram for brand B is shown in Fig. 6.23.

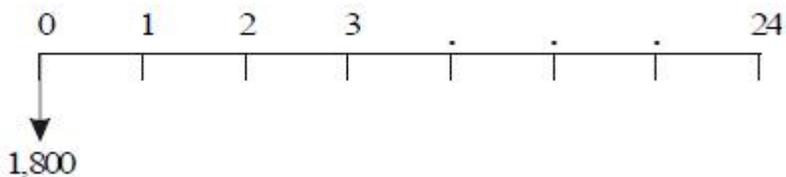


Fig. 6.23 Cash flow diagram of brand B.

The annual equivalent cost expression of the above cash flow diagram is

$$AE(1\%) = 1,800(A/P, 1\%, 24)$$

$$= 1,800(0.0471)$$

$$= \text{Rs. } 84.78$$

### **Brand C**

Tyre warranty = 36 months

Price/tyre = Rs. 2,100

The cash flow diagram for brand C is shown in Fig. 6.24.

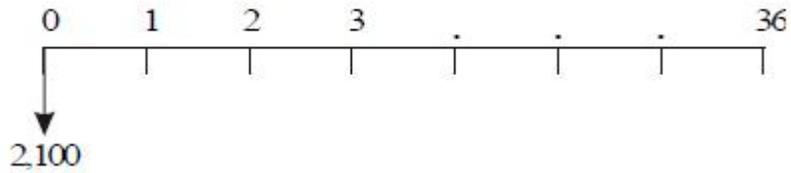


Fig. 6.24 Cash flow diagram of brand C.

The annual equivalent expression of the above cash flow diagram is

$$\begin{aligned}
 AE(1\%) &= 2,100(A/P, 1\%, 36) \\
 &= 2,100(0.0332) \\
 &= \text{Rs. } 69.72
 \end{aligned}$$

### **Brand D**

Tyre warranty = 48 months

Price/tyre = Rs. 2,700

The cash flow diagram for brand D is shown in Fig. 6.25.

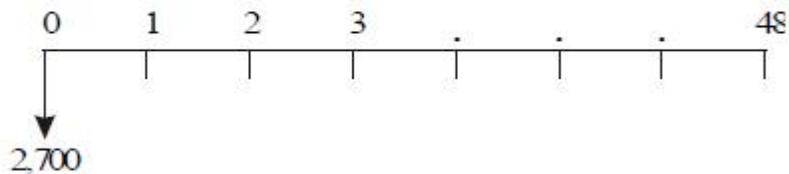


Fig. 6.25 Cash flow diagram of brand D.

The annual equivalent cost expression of the above cash flow diagram is

$$\begin{aligned}
 AE(1\%) &= 2,700(A/P, 1\%, 48) \\
 &= 2,700 (0.0263) \\
 &= \text{Rs. } 71.01
 \end{aligned}$$

Here, minimum common multiple lives of tyres are considered. This is 144 months. Therefore, the comparison is made on 144 month's basis. The annual equivalent cost of brand C is less than that of other brands. Hence, it should be used in the vehicles of the trucking company. It should be replaced four times during the 144-month period.

# RATE OF RETURN METHOD

## INTRODUCTION

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. In this type of analysis, the expenditures are always assigned with a negative sign and the revenues/inflows are assigned with a positive sign.

A generalized cash flow diagram to demonstrate the rate of return method of comparison is presented in Fig. 7.1.

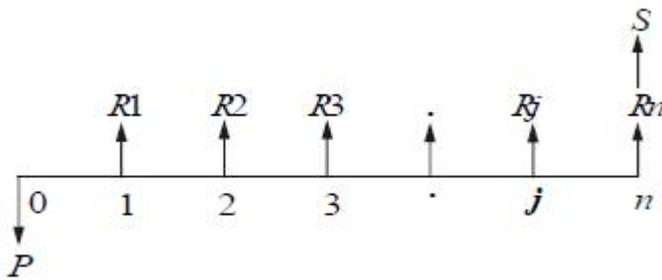


Fig. 7.1 Generalized cash flow diagram.

In the above cash flow diagram,  $P$  represents an initial investment,  $R_j$  the net revenue at the end of the  $j$ th year, and  $S$  the salvage value at the end of the  $n$ th 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,  $i$ .

$$PW(i) = -P + R1/(1+i)^1 + R2/(1+i)^2 + \dots \\ + Rj/(1+i)^j + \dots + Rn/(1+i)^n + S/(1+i)^n$$

Now, the above function is to be evaluated for different values of  $i$  until the present worth function reduces to zero, as shown in Fig. 7.2.

In the figure, the present worth goes on decreasing when the interest rate is increased. The value of  $i$  at which the present worth curve cuts the  $X$ -axis is the rate of return of the given proposal/project. It will be very difficult to find the exact value of  $i$  at which the present worth function reduces to zero.

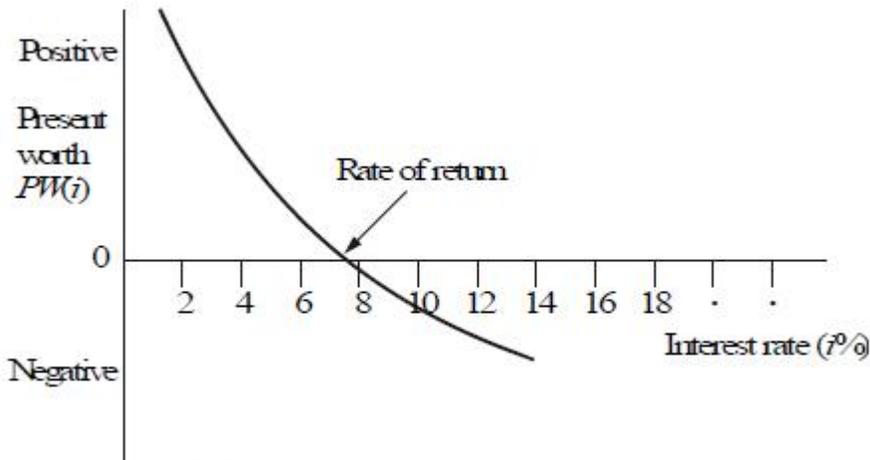


Fig. 7.2 Present worth function graph.

So, one has to start with an intuitive value of  $i$  and check whether the present worth function is positive. If so, increase the value of  $i$  until  $PW(i)$  becomes negative. Then, the rate of return is determined by interpolation method in the range of values of  $i$  for which the sign of the present worth function changes from positive to negative.

### EXAMPLES

In this section, the concept of rate of return calculation is demonstrated with suitable examples.

**EXAMPLE 7.1** A person is planning a new business. The initial outlay and cash flow pattern for the new business are as listed below. The expected life of the business is five years. Find 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

Initial investment = Rs. 1,00,000

Annual equal revenue = Rs. 30,000  
 Life = 5 years

The cash flow diagram for this situation is illustrated in Fig. 7.3.

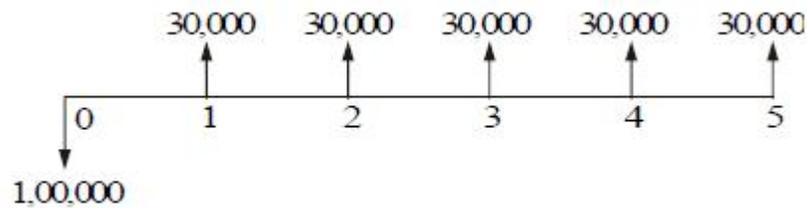


Fig. 7.3 Cash flow diagram.

The present worth function for the business is

$$PW(i) = -1,00,000 + 30,000(P/A, i, 5)$$

When  $i = 10\%$ ,

$$PW(10\%) = -1,00,000 + 30,000(P/A, 10\%, 5)$$

$$= -1,00,000 + 30,000(3.7908)$$

$$= \text{Rs. } 13,724.$$

When  $i = 15\%$ ,

$$PW(15\%) = -1,00,000 + 30,000(P/A, 15\%, 5)$$

$$= -1,00,000 + 30,000(3.3522)$$

$$= \text{Rs. } 566.$$

When  $i = 18\%$ ,

$$PW(18\%) = -1,00,000 + 30,000(P/A, 18\%, 5)$$

$$= -1,00,000 + 30,000(3.1272)$$

$$= \text{Rs. } -6,184$$

$$i = 15\% + \frac{566 - 0}{566 - (-6184)} \times (3\%)$$

$$= 15\% + 0.252\%$$

$$= 15.252\%$$

Therefore, the rate of return for the new business is 15.252%.

**EXAMPLE 7.2** A company is trying to diversify its business in a new product line. The life of the project is 10 years with no salvage value at the end of its life. The initial outlay of the project is Rs. 20,00,000. The annual net profit is Rs. 3,50,000. Find the rate of return for the new business.

**Solution**

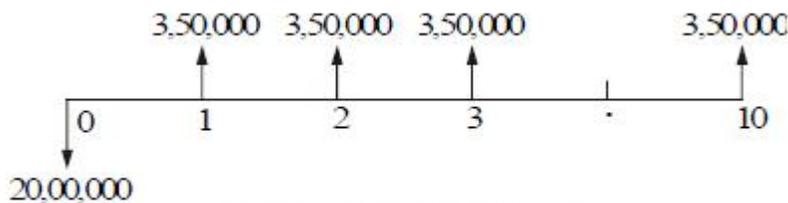
Life of the product line ( $n$ ) = 10 years

Initial outlay = Rs. 20,00,000

Annual net profit = Rs. 3,50,000

Scrap value after 10 years = 0

The cash flow diagram for this situation is shown in Fig. 7.4.



**Fig. 7.4** Cash flow diagram.

The formula for the net present worth function of the situation is

$$PW(i) = -20,00,000 + 3,50,000(P/A, i, 10)$$

When  $i = 10\%$ ,

$$PW(10\%) = -20,00,000 + 3,50,000(P/A, 10\%, 10)$$

$$= -20,00,000 + 3,50,000(6.1446)$$

$$= \text{Rs. } 1,50,610.$$

When  $i = 12\%$ ,

$$PW(12\%) = -20,00,000 + 3,50,000(P/A, 12\%, 10)$$

$$= -20,00,000 + 3,50,000(5.6502)$$

$$= \text{Rs. } -22,430.$$

$$i = 10\% + \frac{1,50,610 - 0}{1,50,610 - (-22,430)} \times (2\%)$$

$$= 11.74 \%$$

Therefore, the rate of return of the new product line is 11.74%

**EXAMPLE 7.3** A firm has identified three mutually exclusive investment proposals whose details are given below. The life of all the three alternatives is estimated to be five years with negligible salvage value. The minimum attractive rate of return for the firm is 12%.

	<i>Alternative</i>		
	<i>A1</i>	<i>A2</i>	<i>A3</i>
<b>Investment</b>	Rs. 1,50,000	Rs. 2,10,000	Rs. 2,55,000
<b>Annual net income</b>	Rs. 45,570	Rs. 58,260	Rs. 69,000

Find the best alternative based on the rate of return method of comparison.

**Solution**

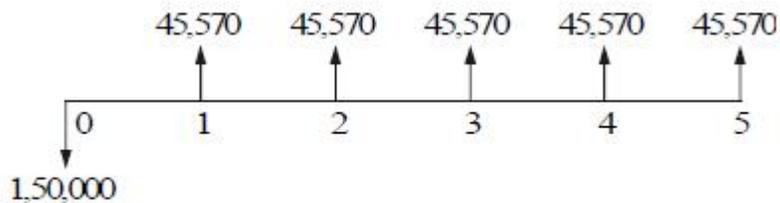
**Calculation of rate of return for alternative A1**

Initial outlay = Rs. 1,50,000

Annual profit = Rs. 45,570

Life = 5 years

The cash flow diagram for alternative A1 is shown in Fig. 7.5.



**Fig. 7.5** Cash flow diagram for alternative A1.

The formula for the net present worth of alternative A1 is given as

$$PW(i) = -1,50,000 + 45,570(P/A, i, 5)$$

When  $i = 10\%$ ,

$$PW(10\%) = -1,50,000 + 45,570(P/A, 10\%, 5)$$

$$= -1,50,000 + 45,570(3.7908)$$

$$= \text{Rs. } 22,746.76$$

When  $i = 12\%$ ,

$$PW(12\%) = -1,50,000 + 45,570(P/A, 12\%, 5)$$

$$= -1,50,000 + 45,570(3.6048)$$

$$= \text{Rs. } 14,270.74$$

When  $i = 15\%$ ,

$$\begin{aligned}PW(15\%) &= -1,50,000 + 45,570(P/A, 15\%, 5) \\ &= -1,50,000 + 45,570(3.3522) \\ &= \text{Rs. } 2,759.75\end{aligned}$$

When  $i = 18\%$ ,

$$\begin{aligned}PW(18\%) &= -1,50,000 + 45,570(P/A, 18\%, 5) \\ &= -1,50,000 + 45,570(3.1272) \\ &= \text{Rs. } -7,493.50\end{aligned}$$

Therefore, the rate of return of the alternative  $A1$  is

$$\begin{aligned}i &= 15\% + \frac{2,759.75 - 0}{2,759.75 - (-7,493.50)} \times (3\%) \\ &= 15\% + 0.81\% \\ &= 15.81\%\end{aligned}$$

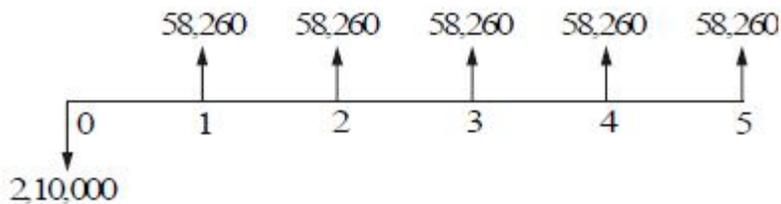
#### ***Calculation of rate of return for alternative $A2$***

Initial outlay = Rs. 2,10,000

Annual profit = Rs. 58,260

Life of alternative  $A2 = 5$  years

The cash flow diagram for alternative  $A2$  is shown in Fig. 7.6.



**Fig. 7.6** Cash flow diagram for alternative  $A2$ .

The formula for the net present worth of this alternative is

$$PW(i) = -2,10,000 + 58,260 (P/A, i, 5)$$

When  $i = 12\%$ ,

$$\begin{aligned}PW(12\%) &= -2,10,000 + 58,260(P/A, 12\%, 5) \\ &= -2,10,000 + 58,260(3.6048) \\ &= \text{Rs. } 15.6\end{aligned}$$

When  $i = 13\%$ ,

$$\begin{aligned}PW(13\%) &= -2,10,000 + 58,260(P/A, 13\%, 5) \\ &= -2,10,000 + 58,260 (3.5172) \\ &= \text{Rs. } -5,087.93\end{aligned}$$

Therefore, the rate of return of alternative  $A2$  is

$$\begin{aligned}i &= 12\% + \frac{15.65 - 0}{15.65 - (-5,087.93)} \times (1\%) \\ &= 12\% + 0\% \\ &= 12\%\end{aligned}$$

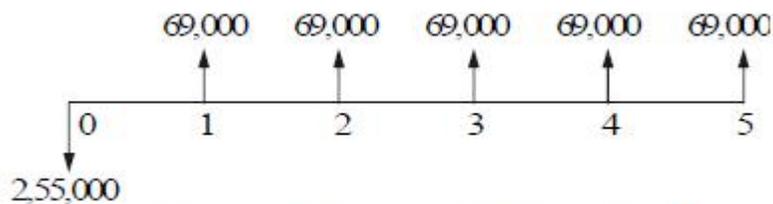
### **Calculation of rate of return for alternative $A3$**

Initial outlay = Rs. 2,55,000

Annual profit = Rs. 69,000

Life of alternative  $A3 = 5$  years

The cash flow diagram for alternative  $A3$  is depicted in Fig. 7.7.



**Fig. 7.7** Cash flow diagram for alternative  $A3$ .

The formula for the net present worth of this alternative  $A3$  is

$$PW(i) = -2,55,000 + 69,000(P/A, i, 5)$$

When  $i = 11\%$ ,

$$\begin{aligned}PW(11\%) &= -2,55,000 + 69,000(P/A, 11\%, 5) \\ &= -2,55,000 + 69,000 (3.6959) \\ &= \text{Rs. } 17.1\end{aligned}$$

When  $i = 12\%$ ,

$$\begin{aligned}PW(12\%) &= -2,55,000 + 69,000(P/A, 12\%, 5) \\ &= -2,55,000 + 69,000 (3.6048) \\ &= \text{Rs. } -6,268.80\end{aligned}$$

Therefore, the rate of return for alternative  $A3$  is

$$i = 11\% + \frac{17.1 - 0}{17.1 - (-6,268.80)} \times 1\%$$

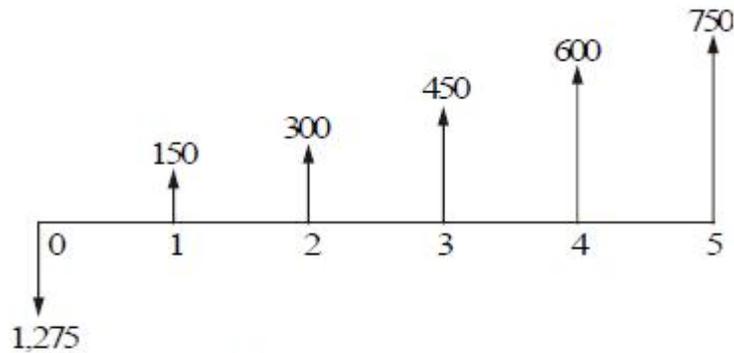
$$= 11\%$$

The rates of return for the three alternatives are now tabulated

Alternative	$A1$	$A2$	$A3$
Rate of return	15.81%	12%	11%

From the above data, it is clear that the rate of return for alternative  $A3$  is less than the minimum attractive rate of return of 12%. So, it should not be considered for comparison. The remaining two alternatives are qualified for consideration. Among the alternatives  $A1$  and  $A2$ , the rate of return of alternative  $A1$  is greater than that of alternative  $A2$ . Hence, alternative  $A1$  should be selected.

**EXAMPLE 7.4** For the cash flow diagram shown in Fig. 7.8, compute the rate of return. The



**Fig. 7.8** Cash flow diagram.

amounts are in rupees.

**Solution** For the positive cash flows of the problem,

$$A1 = \text{Rs. } 150, G = \text{Rs. } 150$$

The annual equivalent of the positive cash flows of the uniform gradient series is given by

$$A = A1 + G(A/G, i, n)$$

$$= 150 + 150(A/G, i, 5)$$

The formula for the present worth of the whole diagram

$$= -1,275 + [150 + 150(A/G, i, 5)] \_ (P/A, i, 5)$$

$$PW(10\%) = -1,275 + [150 + 150(A/G, 10\%, 5)] \_ (P/A, 10\%, 5)$$

$$= -1,275 + [150 + 150(1.8101)] \_ (3.7908)$$

$$= \text{Rs. } 322.88$$

$$PW(12\%) = -1,275 + [150 + 150(A/G, 12\%, 5)] \_ (P/A, 12\%, 5)$$

$$= -1,275 + [150 + 150(1.7746)] \_ (3.6048)$$

$$= \text{Rs. } 225.28$$

$$PW(15\%) = -1,275 + [150 + 150(A/G, 15\%, 5)] \_ (P/A, 15\%, 5)$$

$$= -1,275 + [150 + 150(1.7228)] \_ (3.3522)$$

$$= \text{Rs. } 94.11$$

$$PW(18\%) = -1,275 + [150 + 150(A/G, 18\%, 5)] \_ (P/A, 18\%, 5)$$

$$= -1,275 + [150 + 150(1.6728)] \_ (3.1272)$$

$$= \text{Rs. } -21.24$$

Therefore, the rate of return for the cash flow diagram is

$$i = 15\% + \frac{94.11 - 0}{94.11 - (-21.24)} \times 3\%$$

$$= 15\% + 2.45\% = 17.45\%$$

**EXAMPLE 7.5** A company is planning to expand its present business activity. It has two alternatives for the expansion programme and the corresponding cash flows are tabulated below. Each alternative has a life of five years and a negligible salvage value. The minimum attractive rate of return for the company is 12%. Suggest the best alternative to the company.

	<i>Initial investment</i> (Rs.)	<i>Yearly revenue</i> (Rs.)
Alternative 1	5,00,000	1,70,000
Alternative 2	8,00,000	2,70,000

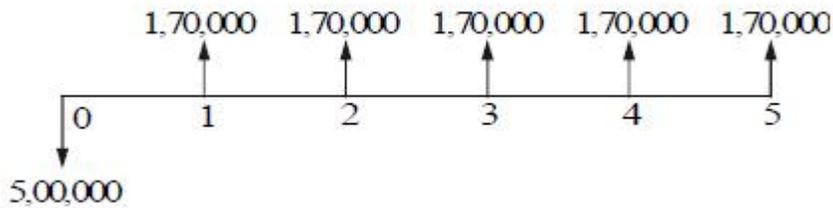
**Solution Alternative 1**

Initial outlay = Rs. 5,00,000

Annual revenue = Rs. 1,70,000

Life of alternative 1 = 5 years

The cash flow diagram for alternative 1 is illustrated in Fig. 7.9.



**Fig. 7.9** Cash flow diagram for alternative 1.

The formulae for the net present worth of alternative 1 are as follows:

$$PW1(i) = -5,00,000 + 1,70,000(P/A, i, 5)$$

$$PW1(15\%) = -5,00,000 + 1,70,000(P/A, 15\%, 5)$$

$$= -5,00,000 + 1,70,000(3.3522)$$

$$= \text{Rs. } 69,874$$

$$PW1(17\%) = -5,00,000 + 1,70,000(P/A, 17\%, 5)$$

$$= -5,00,000 + 1,70,000(3.1993)$$

$$= \text{Rs. } 43,881$$

$$PW1(20\%) = -5,00,000 + 1,70,000(P/A, 20\%, 5)$$

$$= -5,00,000 + 1,70,000(2.9906)$$

$$= \text{Rs. } 8,402$$

$$PW1(22\%) = -5,00,000 + 1,70,000(P/A, 22\%, 5)$$

$$= -5,00,000 + 1,70,000(2.8636)$$

$$= \text{Rs. } -13,188$$

Therefore, the rate of return of alternative 1 is

$$i = 20\% + \frac{8,402 - 0}{8,402 - (-13,188)} \times 2\%$$

$$= 20.78\%$$

### Alternative 2

Initial outlay = Rs. 8,00,000

Annual revenue = Rs. 2,70,000

Life = 5 years

The cash flow diagram for alternative 2 is depicted in Fig. 7.10.

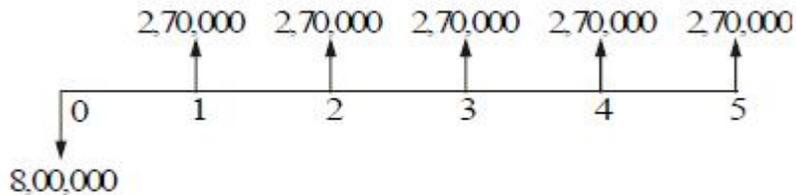


Fig. 7.10 Cash flow diagram for alternative 2.

The formula for the net present worth of alternative 2 is:

$$PW2(i) = -8,00,000 + 2,70,000(P/A, i, 5)$$

$$PW2(20\%) = -8,00,000 + 2,70,000(P/A, 20\%, 5)$$

$$= -8,00,000 + 2,70,000(2.9906)$$

$$= \text{Rs. } 7,462$$

$$PW2(22\%) = -8,00,000 + 2,70,000(P/A, 22\%, 5)$$

$$= -8,00,000 + 2,70,000(2.8636)$$

$$= \text{Rs. } -26,828$$

Thus, the rate of return of alternative 2 is

$$i = 20\% + \frac{7,462 - 0}{7,462 - (-26,828)} \times 2\%$$
$$= 20.435\%$$

Since the rate of return of alternative 1 is greater than that of the alternative 2, select alternative 1.

