Unit 1

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1.3 Law of Supply and Demand

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Introduction

What is Economics?

Prof. Lionel Robbins defines economics as “Science which studies human behaviour as a relationship between ends and scarce means which have alternative uses.”

Features

- The wants of a human are unlimited
- It has an alternative use of scarce resources.
- It is an efficient use of resources.
- It is needed for optimisation, i.e., best allocation of resources.

Flow in an Economy

In modern economy, money facilitate the process of exchange and has removed the difficulties of barter system. Money acts as a medium of exchange.

Flow in an Economy : Explanation

- Households and businesses are the two majorentities in a simple economy. Business organizations use various economicresources like land, labour and capital which are provided by householdsto produce consumer goods and services which will be used by them.Business organizations make payment of money to the households forreceiving various resources. The households in turn make payment of money to business organizations for receiving consumer goods and services.This cycle shows the interdependence between the two major entities in a simple economy

Flow in an Economy

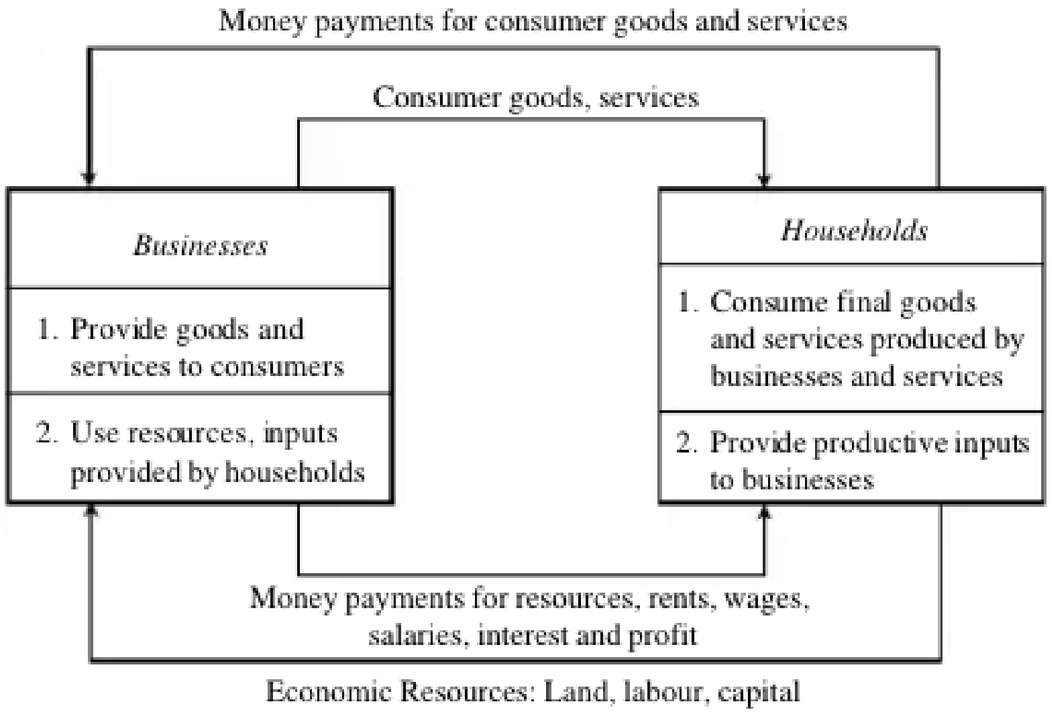

Fig 1: Flow of goods, services, resources and money payments in a simple economy

Demand and Supply

Human wants are unlimited and recurring in the nature, whereas means available to satisfy them are limited. Therefore, a rational consumer has to make optimal use of available resources. The demand and supply analysis provides a framework within which these decisions have to be made

Desire, Want, Demand - Difference

- Desire is just a wish on the part of the consumer to possess a commodity
- If the desire to possess a commodity is backed by the purchasing power and the consumer is also willing to buy that commodity, it becomes want.
- The demand, on the other hand is the wish of the consumer to get a definite quantity of a commodity at a given price in the market backed by a sufficient purchasing power.

Demand and Supply

Determinants of Demand

- Price of the commodity in question
- Prices of other related commodities
- Income of the consumers
- Taste of the consumers

Demand Function

- Demand function refers to the rule that shows how the quantity demanded depends upon above factors.
- A demand function can be shown as: Dx = f(Px, Py, Pz, M,T)
- where, Dx is quantity demanded of X commodity, Px is the price of X commodity, Py is the price of substitute commodity, Pz is price of a complement good, M stands for income, T is the taste of the consumer

Demand and Supply

Note

If all the factors influencing the demand for a commodity X vary simultaneously, the picture would be highly complicated. Therefore, normally we allow only one of the factors to change, assuming that all other factors remain unchanged ('ceteris paribus' other things remaining equal).

Demand Function

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Demand and Supply

- **Price of the commodity:** Normally, higher the price of the commodity, the lower the demand of the commodity. This is the law of demand. Example? Graph?
- **Size of the consumer's income:** When the increase in income leads to an increase in the quantity demanded, the commodity is called a 'normal good'. If an increase in income leads to a fall in the quantity demanded, we call that commodity an 'inferior good'. Example? Graph?
- **Prices of other commodities:** A consumer's demand for a commodity may also be influenced by the prices of some other commodities. Some are complementary goods, which are consumed along with the commodity in question while others may be used in place of this commodity. This category is called substitutes. Demand bears inverse relationship with prices of complements and direct relationship with prices of substitutes. Example:Tea and coffee are substitutes and a car and petrol are example of a pair of complementary goods.

Demand and Supply

- **Taste of the consumer** : If a consumer has developed a taste for a particular commodity, he/she will demand more of that commodity. Similarly, if a consumer has changed his taste against a particular commodity, less of it will be demanded at any particular price. This development of tastes may be related to seasons of the year as well. Example: Demand of sanitisers / masks during Covid, Demand of umbrella during monsoon, demand of icecream in summers.

Determinants of Market Demand

The factors determining the demand for a commodity in a market are the same as those which determine the demand for the commodity on the part of a consumer. Besides that two additional factors are also to be included. These two factors are:

- Size of population
- Income Distribution

Demand and Supply

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Size of population

All other factors remaining unchanged, the greater is the size of the population, more of a commodity will be demanded.

Income Distribution

People in different income groups show marked differences in their preferences. So if larger share out of national income goes to the rich, demand for the luxury goods may rise and a rise in income share of the poor will increase demand for the wage goods.

Demand and Supply

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Law of Demand

The inverse relationship between the quantity of a commodity and its price, given all other factors that influence the demand is called 'law of demand. It gives us a demand curve that slopes downwards to the right.

The Demand Schedule

A demand schedule is a table that records quantities demanded at different prices. This schedule, on being recorded on a two dimensional axes system, gives us a demand curve.

The Demand Curve

The demand curve graphically shows the relationship between the quantity of a good that consumers are willing to buy and the price of the good

Demand and Supply

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Table 1 : Demand Schedule of a Consumption of Apples

Price of Apple per Kg. (in Rs.)	Quantity Demanded of Apples (in Kg. per week)
100	15
200	12
300	8
400	3

We can easily infer that as price of an apple rises quantity demanded by the consumer is falling.

Demand and Supply

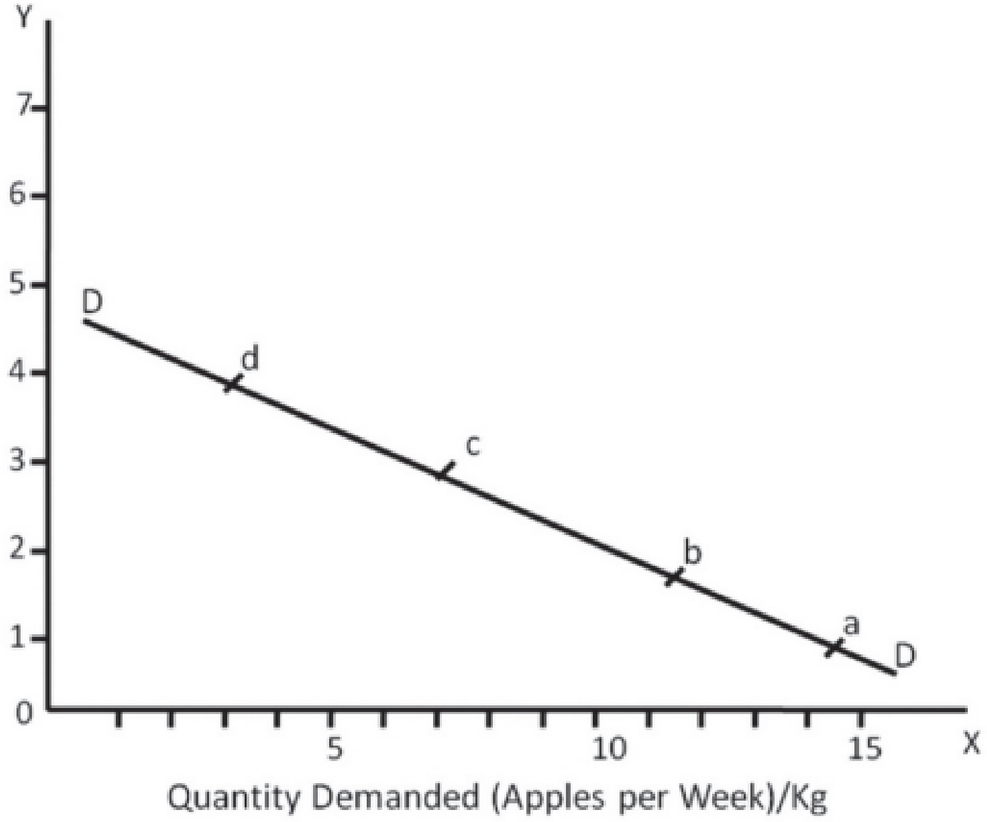

Figure 2: Demand Curve

In this figure, on the Y-axis, price of an apple in rupees in measured and on the X-axis the quantity demanded of apples per week is measured. The first combination of Table is shown by point a where at Rs. 100 per kg 15 units of apples are demanded. Similarly points b, c, d represent combinations of Rs. 200 price - 12 quantity demanded, Rs. 300 price - 8 quantity demanded and Rs. 400 price - 3 quantity demanded, respectively. The joining together of points a, b, c, and d give us the demand curve, DD

Demand and Supply

The most important feature of a demand curve is that it slopes downward from left to right. Whether a demand curve is a straight line or a curve depends on how much quantity demanded rises with the fall of its price or how much quantity demanded falls with the rise in the price of the commodity.

If we record demand schedules of two or more consumers of a commodity on the same axes, we can get a number of demand curves. Horizontal summation of those curves gives us the market demand curve

Market demand curve is a horizontal summation of individual demand curves

Demand and Supply

Table 2 : Market Demand

Price (Rs)	Quantity Demanded by			Market Demand
	Household A		Household B	
3	4	+	5	=9
4	3	+	4	=7
5	2	+	3	=5
6	1	+	2	=3

Demand and Supply

Why does a Demand Curve Slope Downwards?

Law of demand states that there is an inverse relationship between the price of a commodity and its quantity demanded. The reasons of downward sloping demand curve are:

Substitution Effect:

Substitution effect results from a change in the relative price of a commodity. Suppose a Pepsi Can and a Coke Can both are priced at Rs. 90 and Rs. 20 each. If the price of Coke is raised to Rs. 25, and the price of Pepsi is not changed, Pepsi will become relatively cheaper to Coke, i.e. although the absolute price of Pepsi has not changed, the relative price of Pepsi has gone down. The change in the relative price of commodity causes substitution effect.

Demand and Supply

Why does a Demand Curve Slope Downwards?

Similarly, if price of mango falls, the rest of the fruits will appear costlier, in comparison with mango. So in both the cases above, the quantity demanded of relatively costlier items will register a decline.

Income Effect

This is the effect of a change in total purchasing power of the money income of the consumer. As price of mango falls the purchasing power of the given money income rises, or his real income rises. Thus, he can buy more of the mangoes with the same money income. His demand for any other commodities may also rise. This is called the 'income effect'. A commodity with positive income effect is called a 'normal good'. It shows a positive or direct relationship between the income and the quantity demanded.

Demand and Supply

Why does a Demand Curve Slope Downwards?

When rise in income leads to a fall in the quantity demanded, we have a case of negative income effect. Such goods are called the 'inferior goods.

Price Effect

Price Effect is the sum total of the substitution effect and income effect, i.e.

PE = SE + IE

where PE = Price Effect

SE = Substitution Effect

IE = Income Effect

It is important to note that substitution effect and income effect operate simultaneously with the change in the price of the commodity. 'Substitution effect', and 'income effect' taken together give 'price effect.' We can identify three cases.

Demand and Supply

Why does a Demand Curve Slope Downwards?

1. Substitution effect always operates in a manner such that as price falls, quantity demanded of this commodity increases. If along with substitution effect, we take income effect and if that happens to be positive (a case of normal commodity) the law of demand will necessarily apply
2. Given substitution effect, if income effect is negative (a case of an 'inferior commodity') the law of demand can still apply provided the substitution effect outweighs or is more powerful than the negative income effect, and
3. Given substitution effect, if income effect is negative and it outweighs or is more powerful than the substitution effect, the law of demand will not hold good.

Demand and Supply

Giffen Good

A case where negative income effect outweighs substitution effect is possible when we have ‘Giffen good’ named after the Robert Giffen who first talked of such paradox. Here a fall in the price of a commodity does not lead to a rise in its demand, it may result in a fall in demand for this commodity

Demand and Supply

Change in Quantity Demanded vs Change in Demand

When the demand for a commodity changes because of the change in its price, it is called ‘change in quantity demanded’. On the other hand, when the change in demand is due to the factors other than its price cause a change it is called ‘change in demand

Expansion and Contraction in Demand

The change in quantity demanded of a commodity is called the expansion in demand if a fall in the price causes the quantity demanded to rises. Conversely, if with a rise in the price of a commodity, its quantity demand falls, we call it contraction in demand.These can be represented in the form of a movement on a demand curve, as shown in Fig in next slide

Demand and Supply

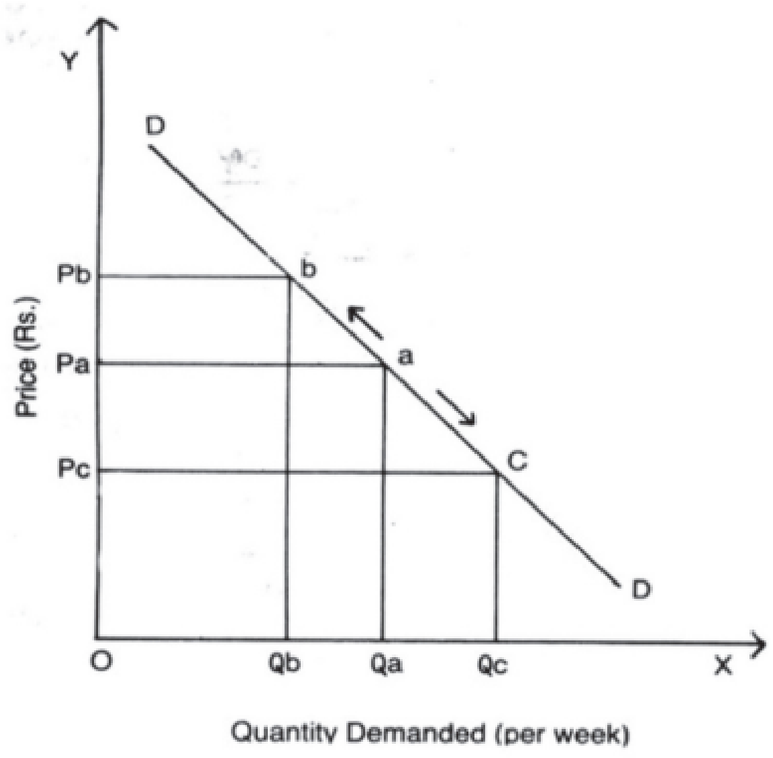

Fig3: Quantity Demanded (per week)

DD is the demand curve. At point 'a' on the demand curve we find that at price OPa, OQa of a commodity is demanded. As price falls to OPc, demand becomes OQc. This movement from point a to point c on the demand curve DD is referred to as 'extension in demand'. Similarly when price of a commodity rises to OPb, demand falls to OQb. Thus, the movement from a to b on the demand curve DD is known as 'contraction in demand'

Demand and Supply

Change in Demand

Change in demand takes place when the whole demand scenario undergoes a change. This change occurs due to a change in any determinant of demand other than the price of that commodity.

Change in demand may take two forms:

- Increase in demand
    - Graphically, increase in demand results in rightward shift of the whole demand curve.
- Decrease in demand
    - decrease in demand results in leftward shift of the demand curve.

Demand and Supply

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Demand and Supply

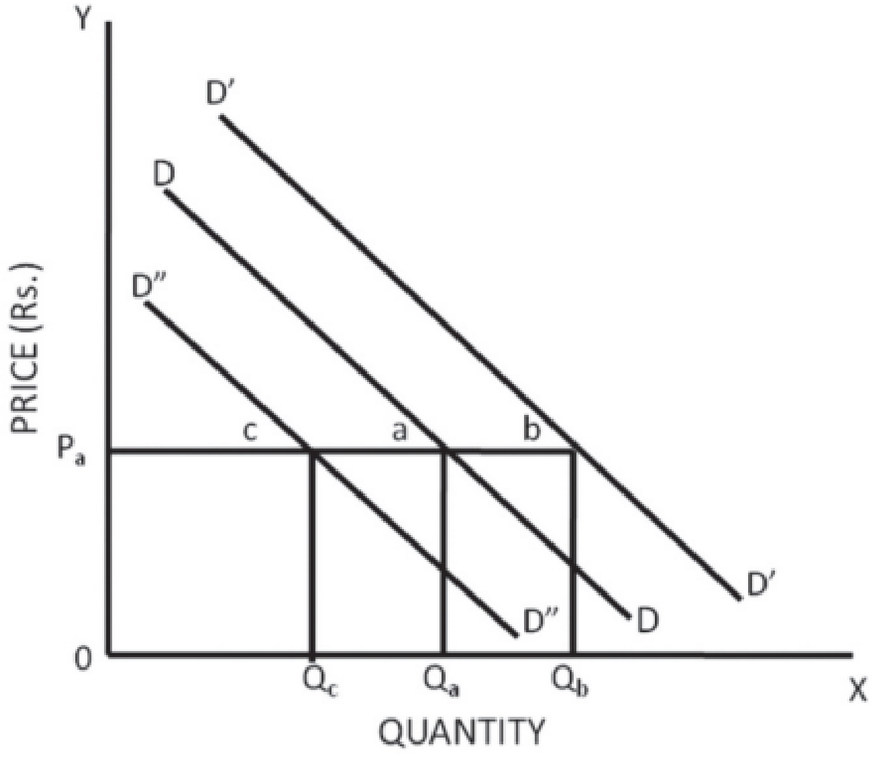

Figure 4: Shift in Demand

At price Pa, at point ‘a’ on DD, quantity demanded is OQa. At the same price, quantity demanded rises to OQb at point b on the demand curve D'D'. This is called ‘increase in demand’. Similarly, at price OPa the quantity demanded comes down to OQc on point ‘c’ of demand curve D"D". This change in quantity demanded is ‘decrease in demand’. The shift of the demand curve to the right shows ‘increase in demand’ and a movement of the demand curve to the left of the initial demand curve is a ‘decrease in demand

Demand and Supply

Many factors can shift a demand curve. Some of them are:

1) A rise in income of the consumer can enables him to demand more of a commodity at a given price and a fall in income will generally force him to curtail his demand.

2) A rightward shift in the demand curve can also take place because of increase in price of a substitute. Similarly, a leftward shift in the demand curve can be because of decrease in price of a substitute

3) If the consumer develops a taste for a commodity, he may demand more of it even if the price remains unchanged, shifting the demand curve to the right. On the other hand, a leftward shift in the demand curve can indicate that our consumer has started disliking the commodity.

Demand and Supply

Concept of Supply

Supply refers to the quantity of commodity hat producers are willing to sell at different prices per unit of time. Just like demand, the word supply also has some distinguishing features which are given below:

- The supply of a commodity indicates the offered quantities. In fact, current supply can be different from current production, the difference is accounted for by the changes in the inventories or the stock
- Like the demand, the supply is also with reference to the price at which that quantity is supplied. If the price is not mentioned, our statement would not carry any economic meaning
- The supply is a flow. It has a time unit attached therewith. The supply has to be per day/week or month.

Formally, supply of a commodity refers to the quantity that a producer is willing to sell at different prices

Demand and Supply

Determinants of Supply

Price of the commodity supplied: The price is most immediate determinant of supply. A person or firm will make quick check whether the costs will be covered by the price. As the price goes up, a firm/person will be willing to sell larger quantity.

The prices of factors of production or cost of production: These affect the cost of production and possible profits of the firm. A rise in the prices of factors of production discourages the production and supply of the commodity.

Prices of other goods: As the prices of other commodities rise, they become more attractive to produce for a profit maximising firm. Hence supply of commodity whose price is unchanged will decline

Demand and Supply

Determinants of Supply

The state of technology: The improvement in the knowledge about the means and the methods of production lead to lower costs of production and helps increasing output.

Goals of the Producer: The objective with which the producer undertakes production also influences his production and supply decisions.

A simultaneous change in all the determinants makes analysis difficult. Therefore, we talk of a change in only one of the factors, others remaining unchanged to work out effect of that factor on the quantity of the commodity supplied by a firm

Demand and Supply

Law of Supply

A producer aims to maximise profits, the difference between total revenue and total cost. Total revenue is the price of the product multiplied by its quantity sold. Total cost is the cost of production.

$$\text{Profit} = TR - TC$$

$$TR = \text{Total Revenue } (q.p)$$

$$TC = \text{Total Cost } (q.AC)$$

where AC is average cost

A higher price would mean more profits. The producer will supply more at a higher price. Similarly, a producer will supply smaller quantity at a lower price. This is a direct relationship between the price and the quantity supplied of a commodity and is called the 'Law of Supply

Demand and Supply

Here the change in price is the cause and change in supply is the effect. Thus, the supply function is:

$$S = f(P)$$

The supply of a commodity is a function of its price, the price of all other commodities, the prices of factors of production, technology, the objectives of producers and other factors remaining unchanged. So:

$$Qs = f(P1, P2, P3... Pn, F1... Fa, T, G, ...)$$

Where Qs stands for the quantity of the commodity supplied; P1 is the price of that commodity, P2, P3...Pa are the prices of other commodities, F1 ..... Fn are the prices of all factors of production, T is the state of technology, G is the goal of the producer.

Demand and Supply

The Supply Schedule

A supply schedule shows quantities of a commodity that a seller is willing to supply, per unit of time, at each price, assuming other factors remaining constant. A supply schedule of a product based on imaginary data is given in Table illustrating the relationship between price and quantity supplied as given by the law of supply.

Table 3: Supply Schedule

Price (in Rs) per Pen	Quantity Supplied (in thousand) per Month
2	25
3	40
4	50
5	60

Demand and Supply

The schedule presented in Table shows that at Rs. 2 per pen, the producer is willing to supply 25 thousand pens per month. At a higher price of Rs. 3 per pen, he is willing to supply 40 thousand pens per month and so on. This schedule depicts direct relationship between price per pen and quantity supplied of pens per month

The Supply Curve

The supply curve S is a smooth curve drawn through the five points a, b, c, d and e. This curve shows the quantity of pens offered for sale at each price.The supply curve (just like a demand curve) can be linear straight line, or in the shape of an upward slopping curve convex downwards.

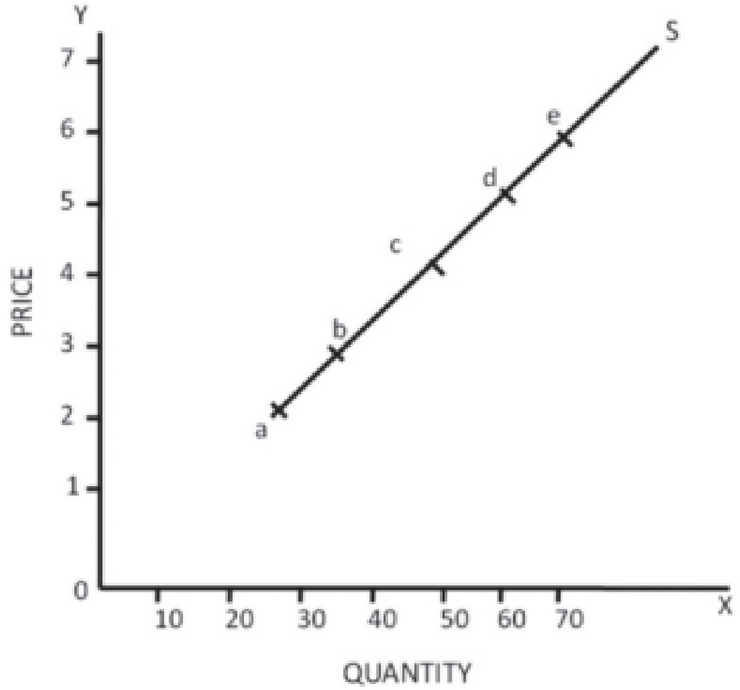

Figure 5: Supply Curve

Demand and Supply

Changes in Supply versus Changes in Quantity Supplied

Changes in Quantity Supplied

There can be changes in the quantity offered for sale due to changes in the price of the commodity only, all other factors remaining constant. This is termed as change in quantity supplied. The change in quantity supplied can be of two types:

- When the price of a commodity falls and its quantity supplied falls. It is termed as 'contraction of supply'.
- When the price of a commodity rises and its quantity supplied rises, provided the law of supply applies, it is termed as "extension of supply".

The contraction, and 'extension' of supply has been shown in the figure

Demand and Supply

Changes in Supply versus Changes in Quantity Supplied

Changes in Quantity Supplied

Start with point b on the supply curve at which price per pen is Rs. 3 and quantity supplied is 30,000 pens. As price per pen falls to Rs. 2, the quantity supplied falls to 20,000. This is contraction of supply. When price of pen rises to Rs. 4, the quantity supplied rises to 40,000. This is extension of supply. On the graph it is the movement from b to a on the supply curve which represents 'contraction of supply'. Similarly, the movement from b to c on the curve represents 'extension of supply'.

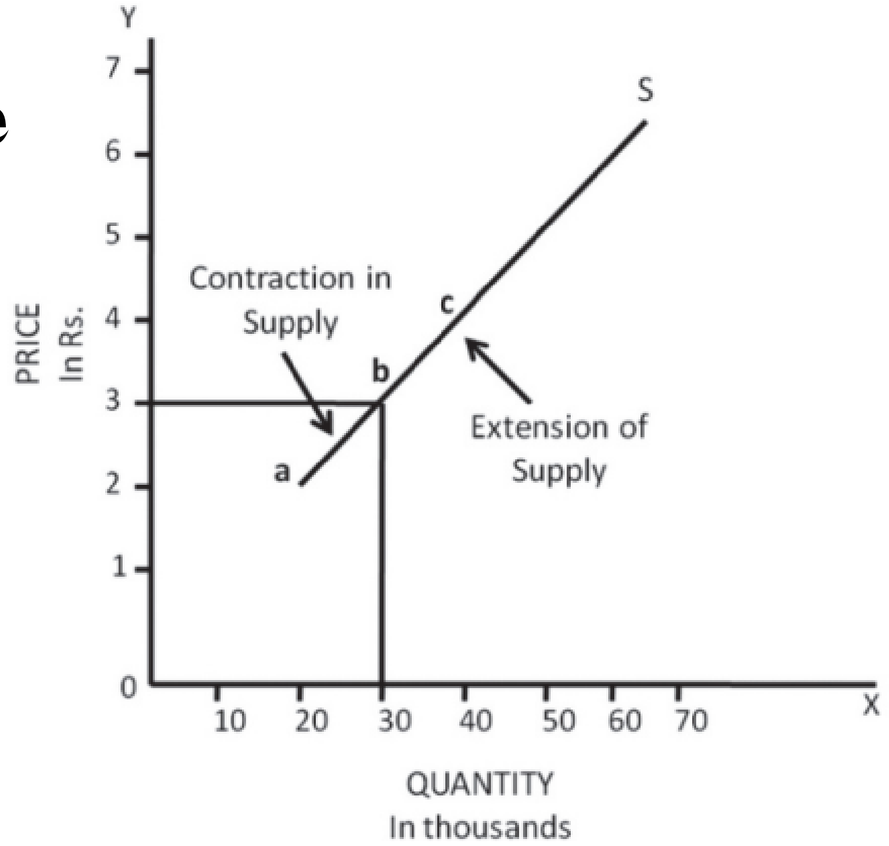

Fig 6 : Changes in Quantity Supplied

Demand and Supply

Changes in Supply versus Changes in Quantity Supplied

Change in Supply

If supply of a commodity undergoes a change because of changes in factors other than the price of the commodity, we call this change in supply. It is usually shown by a shift in the position of the supply curve.

Change in supply can be of two types:

- A decrease in supply: When the quantity of a commodity supplied declines, at the same price it is referred to as a 'decrease in supply'. It implies a leftward shift of the supply curve
- An increase in supply: When the quantity of a commodity supplied increases, at the same price, it is known as an increase in supply. This is shown by a rightward shift in the supply curve.

Demand and Supply

Changes in Supply versus Changes in Quantity Supplied

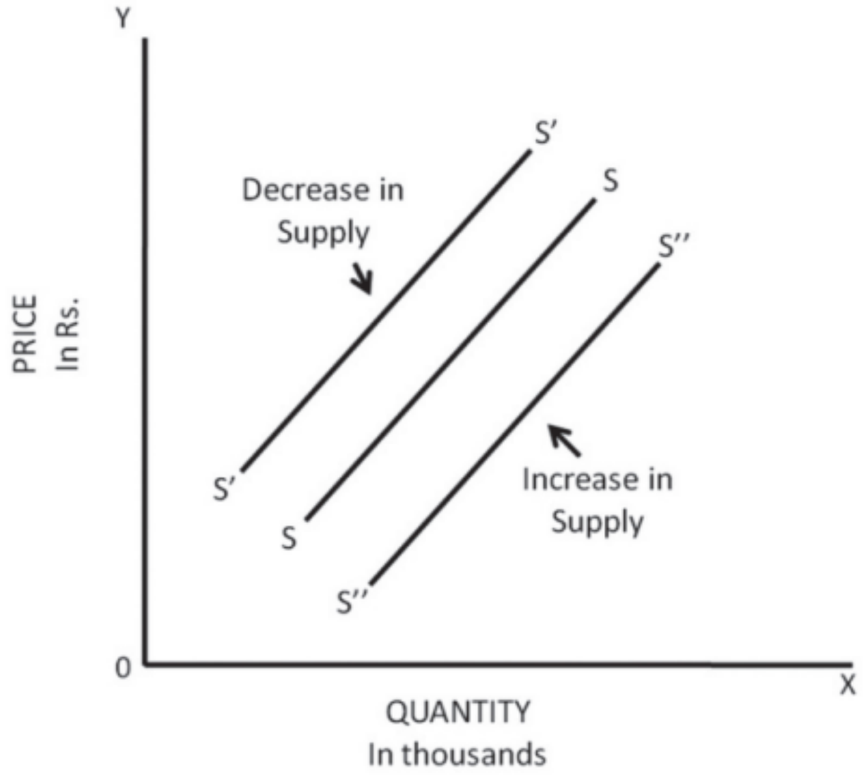

Figure7: Shift in Supply Curve

In short, a rise in supply implies a rightward shift of the supply curve showing that producers are willing to supply more at each price. A fall in supply, on the other hand, implies a leftward shift of the supply curve indicating that producers are willing to supply less at each price

Demand and Supply

Changes in Supply versus Changes in Quantity Supplied

Why the Supply Curve Shifts?

The reasons for the change in supply (both increase and decrease in supply) are:

- Change in the prices of other commodities: A decrease in the prices of other commodities increases the supply of the commodity in question at each price because relative profits from supplying other products fall. An increase in the prices of other commodities decreases the supply of the commodity in question at each price

Demand and Supply

Changes in Supply versus Changes in Quantity Supplied

- Change in the prices of factors of production :An increase in the prices of factors of production used in producing the commodity tends to reduce the supply of the commodity as the cost of production rises but the price is given. Conversely, a decrease in the price of factors of production used in making a commodity leads to an increase in supply, at each price.
- Change in technology: An improvement in technology normally leads to a fall in cost of production and given the price of the product, a producer tends to produce more of that commodity, at each price. Conversely, loss in technical knowledge (the chances of which are meager) leads to a fall in supply.

Demand and Supply

Changes in Supply versus Changes in Quantity Supplied

- **Change or expectation of change in other factors:** Sometimes, supply of a commodity may change because of the change in or expectation of a change in government policies, taxes or rate of interest, fear of war, inequalities of income and wealth which influence the demand pattern. This will affect supply through expectations of the producer about the profits.

Concept of Enginnering 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 systemmay be a diesel engine, a machine working in a shop floor, a furnace, etc

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

The technical efficiency of a diesel engine is as follows:

Concept of Enginnering Economics

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

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

Economic Efficiency

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

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

Concept of Enginnering Economics

Worth' is the annual revenue generated by way of operating the businessand '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 input for the same output
- By a proportionate increase in the output which is more than theproportionate increase in the input
- By a proportionate decrease in the input which is more than theproportionate decrease in the output
- Through simultaneous increase in the output with decrease in the input.

Concept of Enginnering Economics

Definition and Scope of Engineering Economics

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 are 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, inflationadjusted investment decisions, make or buy decisions, inventory control, projectmanagement, value engineering, and linear programming

Elements of Cost

In our day-to-day life we come across the term cost in various contexts. The amount , of money we pay for the purchase of a good or hiring a service is generally considered as cost to us. But for a production unit or fm cost means the amount paid towards purchase of inputs use&in the production of good or service. We have seen in the beginning of this course that there are four factors of production, viz., land, labour, capital and crganisation. Out of these labour (L) and capital (K) are two primary inputs for production

Fixed Cost

Let us consider aproduction process using two inputs K and L only. Here the level of capital input in the form of machines and tools cannot be changed in the short run wlile amount of labouu- can be. The machines once purchased by the firm cannot be disposed off easily.

Elements of Cost

Similarly, the size ofthe building used for production and godown cannot be changed as and when wished. The firm would require a longer period of time to change such inputs. The cost incurred on all fixed inputs by the firm is totalfixed cost or sinqdyJxed cost (FC). Note that whatever be the level of output produced, the fixed cost remains same. Thus fixed cost is constant for a firm. lf the amount of capital used by the firm is KO and its rental price is r, then

$$FC=rKO$$

The fixed cost is also called the overhead cost. When represented in a graph FC curve is a horizontal straight line as given in Figure. The figure indicates that fixed cost remains constant for all levels of output.

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Elements of Cost

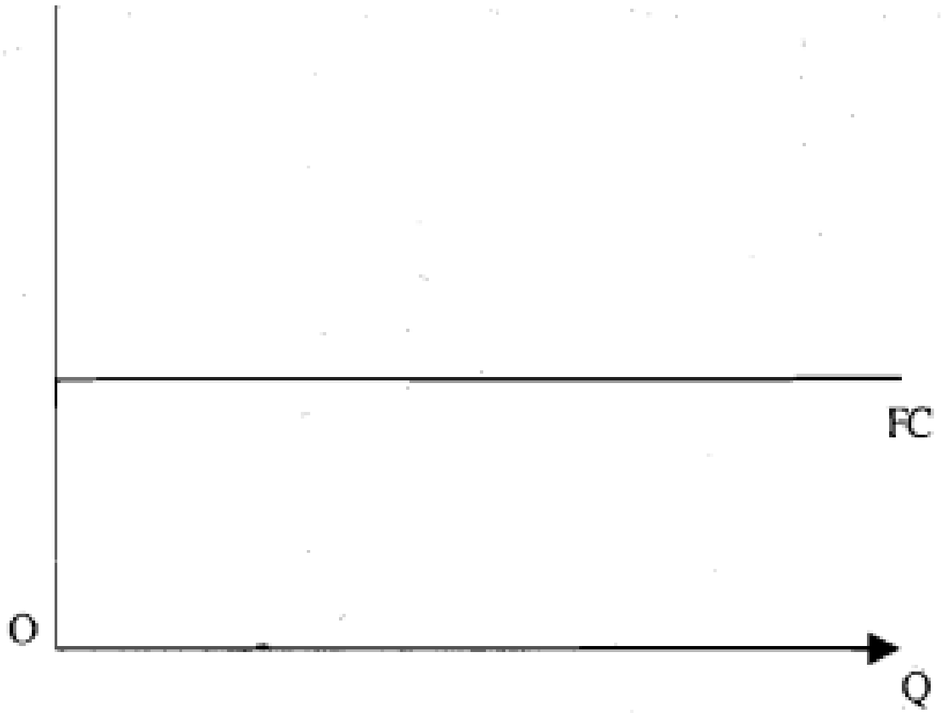


Figure 8: Fixed Cost

Variable Cost: Variable Cost (VC), on the other hand, is the cost incurred on variable inputs. As mentioned above labour is one example ofvariable input. To appreciate the idea of variable input consider the examples like: given the maclines in a factory producing shoes an increase in output can be brought about by increasing the amount of labouur or the quantity of raw materials.

Elements of Cost

Often, labour use of increases with increase in the level of output. Accordingly, the cost of hiring labour also increases. Hence, we see that variable cost depends upon the level of output . If labour is paid a wage rate w and L1 amount of labour is used for producing Q1 units of output, then

$$VC(Q1) = wL1$$

Total Cost

Total cost is the sum of fixed cost and variable cost.

Therefore, we can write:

$$TC(Q1) = FC + VC(Q1)$$

Total cost consists of two components FC and VC. Out of these FC is constant. But VC depends on level of output. Hence, TC also depends on level of output. For a higher level of output TC is higher.

Table 4: Elements of Cost

Q	FC	VC	TC	AFC	AVC	ATC	MC
0	128	0	128	∞	-	∞	-
1	128	56	184	128	56	184	56
2	128	90	218	64	45	109	34
3	128	108	236	42.7	36	78.7	18
4	128	116	244	32	29	61	8
5	128	120	248	25.6	24	49.6	4
6	128	126	254	21.3	21	42.3	6
7	128	140	268	18.3	20	38.3	14
8	128	168	296	16	21	37	28
9	128	216	344	14.22	24	38.22	48
10	128	290	418	12.8	29	41.8	74
11	128	390	618	11.6	35.5	56.1	100

Elements of Cost

Average Fixed Cost: is defined as fixed cost divided by level of output

$$AFC(Q_1) = \frac{FC}{Q_1}$$

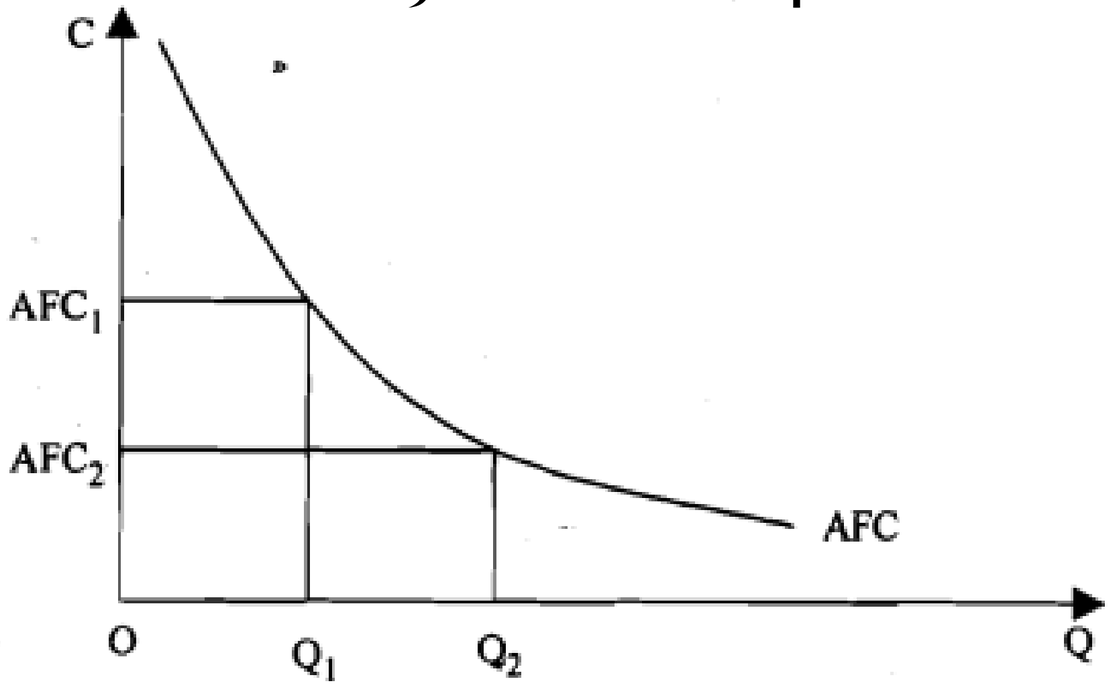


Figure 9: AFC

As you know FC is constant for any level of output. Hence AFC declines as Q increases. It does not touch either axis although moves quite closer. For zero output AFC is infinity. On the other hand for a large quantity of output AFC is negligible

Elements of Cost

Average Variable Cost: It is the variable cost divided by units of output,

$$AVC(Q_1) = \frac{VC}{Q_1}$$

Average Total Cost: Average total cost (ATC) is the sum of AFC and AVC at the level of output under consideration. Suppose at the level Q,

$$ATC(Q_1) = AFC(Q_1) + AVC(Q_1)$$

Elements of Cost

Marginal Cost: Marginal Cost (MC) is the increase in total cost due to production ofan additional unit of output.

$$MC(Q_1) = \frac{\Delta TC}{\Delta Q}$$

$$MC(Q_1) = \frac{\Delta TC}{\Delta Q}$$

Break Even Analysis

Objective

- find the cutoff production volume where a firm will make profit

Numerical Explanation

let s = selling price per unit

v = variable cost per unit

FC = fixed cost per period

Q = volume of production

Total Sales Revenue of the firm: $S = s^*Q$

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

Total Cost = Total variable cost + Fixed cost

$= Q^*v + FC$

Break Even Analysis

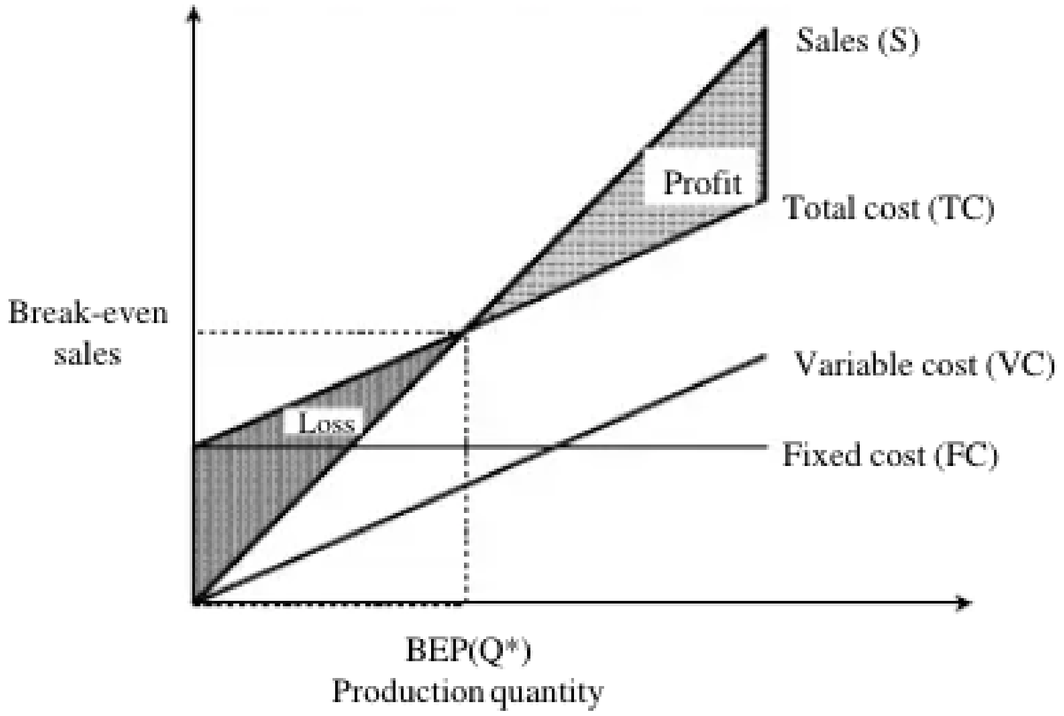
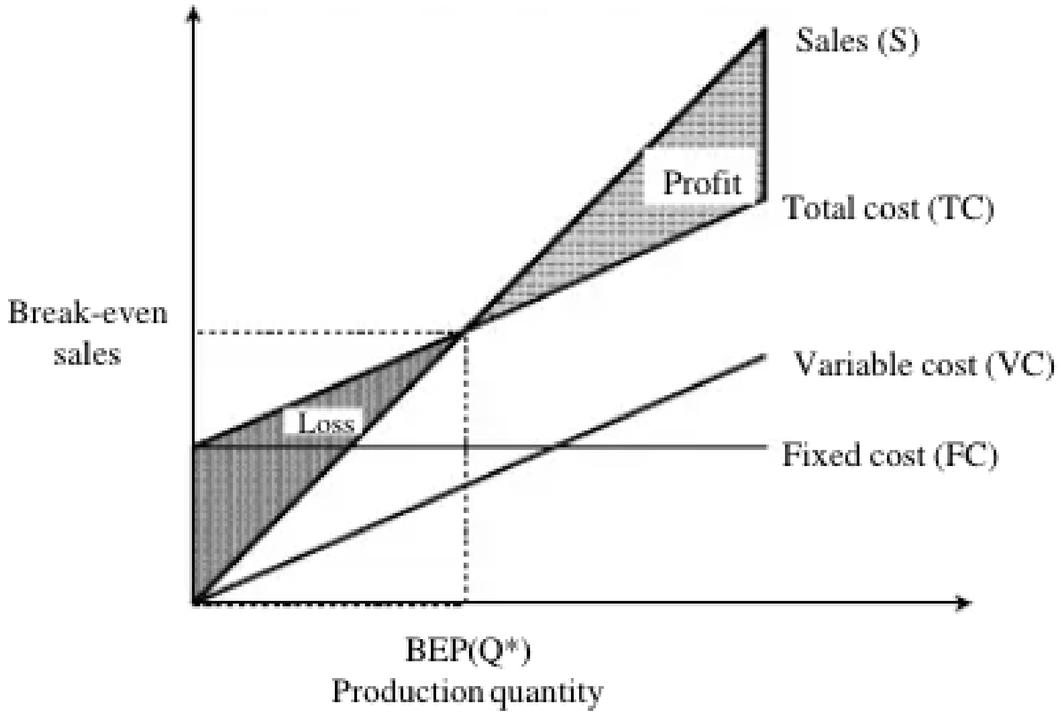


Figure 10: Break Even Analysis

The linear plots of sales and total cost is shown in the figure 1.6.1. The intersection point of the total sales revenue line and total cost line is called as break-even point. The corresponding volume of production on the X -axis isknown as the break-even sales quantity. At the intersection point, the total costis equal to the total revenue. This point is also called the no-loss or no-gainsituation. 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.

Break Even Analysis



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

$$\begin{aligned}\text{Profit} &= \text{Sales} - (\text{Fixed cost} + \text{Variable costs}) \\ &= s \times Q - (FC + v \times Q)\end{aligned}$$

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

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

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

Break Even Analysis

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

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

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

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

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

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

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

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

Break Even Analysis

Numerical Example

Alpha Associates have following details:

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

Find
(a) The break-even sales quantity,
(b) The break-even sales
(c) If the actual production quantity is 60,000, find (i) contribution; a
(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

Break Even Analysis

Numerical Example

(a) Break-even quantity $= \dfrac{FC}{s - v} = \dfrac{20{,}00{,}000}{200 - 100}$

$= 20{,}00{,}000/100 = 20{,}000$ units

(b) Break-even sales $= \dfrac{FC}{s - v} \times s$ (Rs.)

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

$= \dfrac{20{,}00{,}000}{100} \times 200 =$ Rs. 40,00,000

(c) (i) Contribution = Sales – Variable cost

$= s \times Q - v \times Q$

$= 200 \times 60{,}000 - 100 \times 60{,}000$

$= 1{,}20{,}00{,}000 - 60{,}00{,}000$

= Rs. 60,00,000

Break Even Analysis

Numerical Example

METHOD I

M.S. = Sales – Break-even sales

= 60,000 × 200 – 40,00,000

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

METHOD II

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

Profit = Sales – $(FC + v \times Q)$

= 60,000 × 200 – (20,00,000 + 100 × 60,000)

= 1,20,00,000 – 80,00,000

= Rs. 40,00,000

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

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

Profit / Volume (P/V) Ratio

Numerical Example

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

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:

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

Profit / Volume (P/V) Ratio

Numerical Example

Consider the following data for the 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.

Profit / Volume (P/V) Ratio

Numerical Example

Solution

(a) Contribution = Sales – Variable costs

= Rs. 1,20,000 – Rs. 45,000

= Rs. 75,000

(b) Profit = Contribution – Fixed cost

= Rs. 75,000 – Rs. 25,000

= Rs. 50,000

(c) BEP

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

$$= \frac{75{,}000}{1{,}20{,}000} \times 100 = 62.50\%$$

$$\text{BEP} = \frac{\text{Fixed cost}}{P/V \text{ ratio}} = \frac{25{,}000}{6250} \times 100 = \text{Rs. } 40{,}000$$

$$\text{M.S.} = \frac{\text{Profit}}{P/V \text{ ratio}} = \frac{50{,}000}{6250} \times 100 = \text{Rs. } 80{,}000$$

Profit / Volume (P/V) Ratio

Numerical Example

Consider the following data for the 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.

Profit / Volume (P/V) Ratio

Numerical Example

Solution

(a) Contribution = Sales – Variable costs
= Rs. 80,000 – Rs. 35,000
= Rs. 45,000

(b) Profit = Contribution – Fixed cost
= Rs. 45,000 – Rs. 15,000
= Rs. 30,000

(c) BEP

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

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

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

Interest Formula and Applications

What is interest rate?

Interest rate is the rental value of money. It represents the growth of capital perunit period. The period may be a month, a quarter, semiannual or a year

Example

An interest rate 15% compounded annually means that for every hundred rupeesinvested now, an amount of Rs. 15 will be added to the account at the end of the first year. So, the total amount at the end of the first year will be Rs. 115.At the end of the second year, again 15% of Rs. 115, i.e. Rs. 17.25 will be addedto the account. Hence the total amount at the end of the second year will beRs. 132.25. The process will continue thus till the specified number of years

Interest Formula and Applications

Time Value of Money

If an investor invests a sum of Rs 100 in a fixed deposit for five years with an interest rate of 15% compounded annually, the accumulated amount at the end of every year is shown in Table 5

Table 5: Time Value of Money

(amount of deposit = Rs. 100.00)

Year end	*Interest* (Rs.)	*Compound amount* (Rs.)
0		100.00
1	15.00	115.00
2	17.25	132.25
3	19.84	152.09
4	22.81	174.90
5	26.24	201.14

Interest Formula and Applications

The formula to find the future worth in the third column is

$$F = P \times (1 + i)^n$$

where

P = principal amount invested at time 0,
F = future amount,

i = interest rate compounded annually,
n = period of deposit.

The maturity value at the end of the fifth year is Rs. 201.14. This means thatthe amount Rs. 201.14 at the end of the fifth year is equivalent to Rs. 100.00at time 0 (i.e. at present). This is diagrammatically shown in Fig. 10. This explanation assumes that the inflation is at zero percentage

Interest Formula and Applications

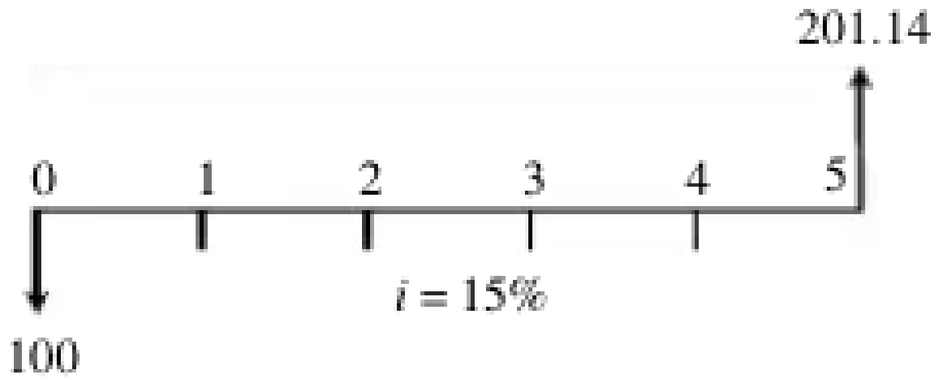


Fig 10: Time Value of Money

Question: If we want Rs. 100.00 at the end of the nth year, what is the amount that we should depositnow at a given interest rate, say 15%?

Interest Formula and Applications

Table 6: Present Worth

End of year (n)	*Present worth*	*Compound amount after n year(s)*
0		100
1	86.96	100
2	75.61	100
3	65.75	100
4	57.18	100
5	49.72	100
6	43.29	100
7	37.59	100
8	32.69	100
9	28.43	100
10	24.72	100

The formula to find the present worth in the second column is

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

Interest Formula and Applications

From Table 1.8.2 it is clear that if we want Rs. 100 at the end of the fifth year, we should now deposit an amount of Rs. 49.72. Similarly, if we want Rs. 100.00 at the end of the 10th year, we should now deposit an amount of Rs. 24.72

Application in Real Life

A person has received a prize from a finance company during the recentfestival contest. But the prize will be given in either of the following two modes:

1. Spot payment of Rs. 24.72 or
2. Rs. 100 after 10 years from now (this is based on 15% interest ratecompounded annually)

Interest Formula and Applications

Application in Real Life

If the prize winner has no better choice that can yield more than 15%interest rate compounded annually, and if 15% compounded annually is the common interest rate paid in all the finance companies, then it makes no difference whether he receives Rs. 24.72 now or Rs. 100 after 10 years.

On the other hand, let us assume that the prize winner has his own business wherein he can get a yield of 24% interest rate (more than 15%) compounded annually, it is better for him to receive the prize money of Rs. 24.72 at present and utilize it in his business. If this option is followed, the equivalent amount for Rs. 24.72 at the end of the 10th year is Rs. 212.45. This example clearly demonstrates the time value of money.

Interest Formula and Applications

Interest Formulas

Interest rate can be classified in **Simple Interest Rate and Compound Interest Rate.** In simple interest, the interest is calculated, based on the initial deposit forevery interest period. In this case, calculation of interest on interest is notapplicable. In compound interest, the interest for the current period is computedbased on the amount (principal plus interest up to the end of the previousperiod) 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 A1 at the end of period 1

Interest Formula and Applications

Single Payment Compound Amount

Objective:

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 cashflow diagram shown in figure 11.

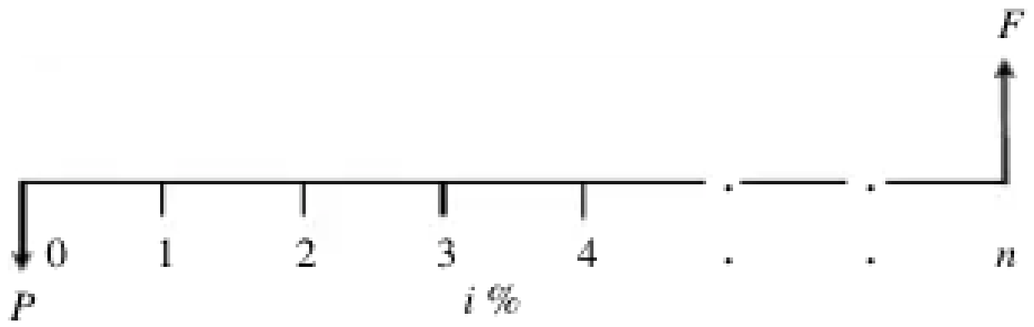


Fig: 11: Cashflow Diagram of Single Payment Compund Amount

Interest Formula and Applications

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.

Numerical Example:

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:

$$\begin{aligned} P &= \text{Rs. } 20{,}000 \\ i &= 18\% \text{ compounded annually} \\ n &= 10 \text{ years} \\ F &= P(1 + i)^n = P(F/P, i, n) \\ &= 20{,}000\ (F/P, 18\%, 10) \\ &= 20{,}000 \times 5.234 = \text{Rs. } 1{,}04{,}680 \end{aligned}$$

Interest Formula and Applications

Single Payment Present Worth Amount

Objective: 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

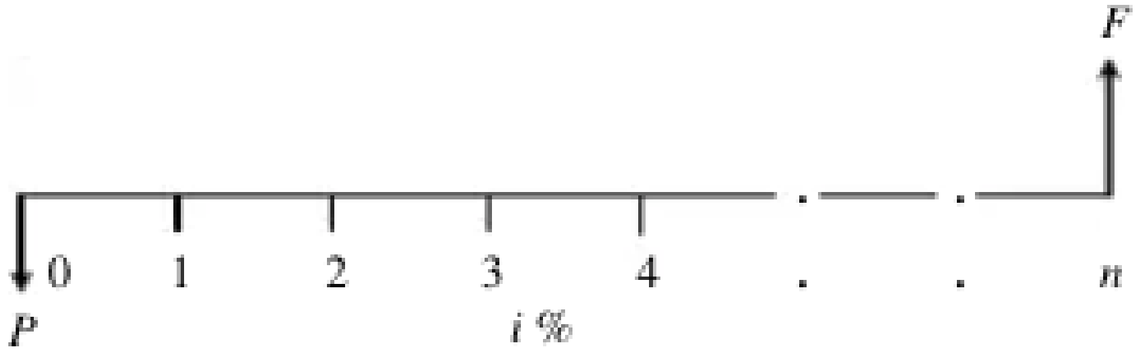


Fig : 12: Cash flow diagram of single-payment present worth amount

Interest Formula and Applications

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.*

Numerical Example

A person wishes to have a future sum of Rs. 1,00,000 for hisson's education after 10 years from now. What is the single-payment that heshould deposit now so that he gets the desired amount after 10 years? The bank gives 15% interest rate compounded annually

Interest Formula and Applications

Single Payment Present Worth Amount

Solution

$$
\begin{aligned}
F &= \text{Rs. } 1{,}00{,}000 \\
i &= 15\%, \text{ compounded annually} \\
n &= 10 \text{ years} \\
P &= F/(1+i)^n = F(P/F, i, n) \\
&= 1{,}00{,}000\,(P/F, 15\%, 10) \\
&= 1{,}00{,}000 \times 0.2472 \\
&= \text{Rs. } 24{,}720
\end{aligned}
$$

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

Interest Formula and Applications

Equal-Payment Series Compound Amount

Objective

to find the future worth of n equal payments which are made at the end of every interest period till the end of the nth interest period at an interest rate of compounded at the end of eachinterest period.

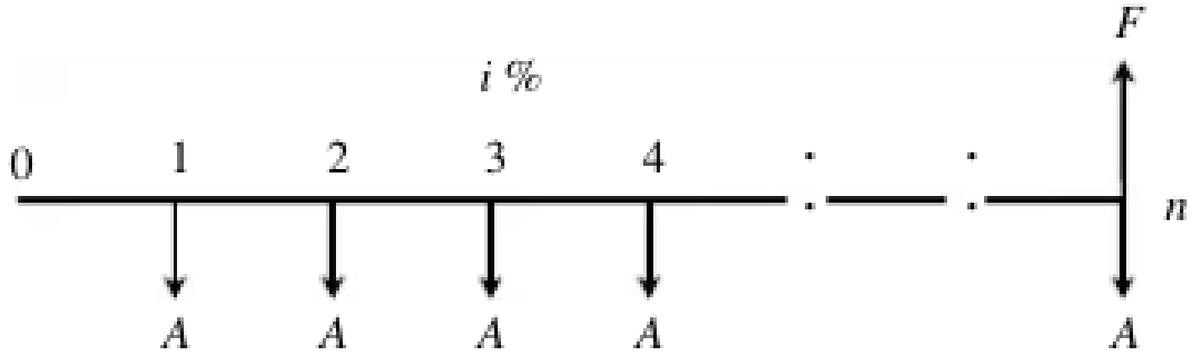


Fig: 13 : Cash flow diagram of equal-payment series compound amount.

Interest Formula and Applications

Equal-Payment Series Compound Amount

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*.

Numerical Example

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 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 whenhe is 60 years old.

Interest Formula and Applications

Equal-Payment Series Compound Amount

Numerical Example

Solution

$$A = \text{Rs. } 10{,}000$$
$$n = 25 \text{ years}$$
$$i = 20\%$$
$$F = ?$$

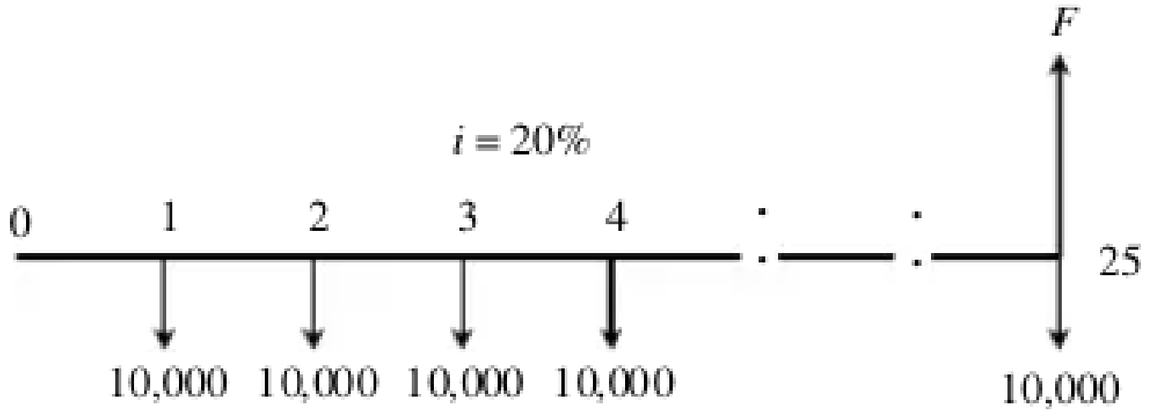


Fig 14 : Cash flow diagram of equal-payment series compound amount.

Interest Formula and Applications

Equal-Payment Series Compound Amount

Numerical Example

$$
\begin{aligned}
F &= A\,\frac{(1+i)^n - 1}{i} \\
&= A(F/A,\ i,\ n) \\
&= 10{,}000(F/A,\ 20\%,\ 25) \\
&= 10{,}000 \times 471.981 \\
&= \text{Rs. } 47{,}19{,}810
\end{aligned}
$$

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

Interest Formula and Applications

Equal-Payment Series Sinking Fund

Objective

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 nth interest periodat an interest rate of i

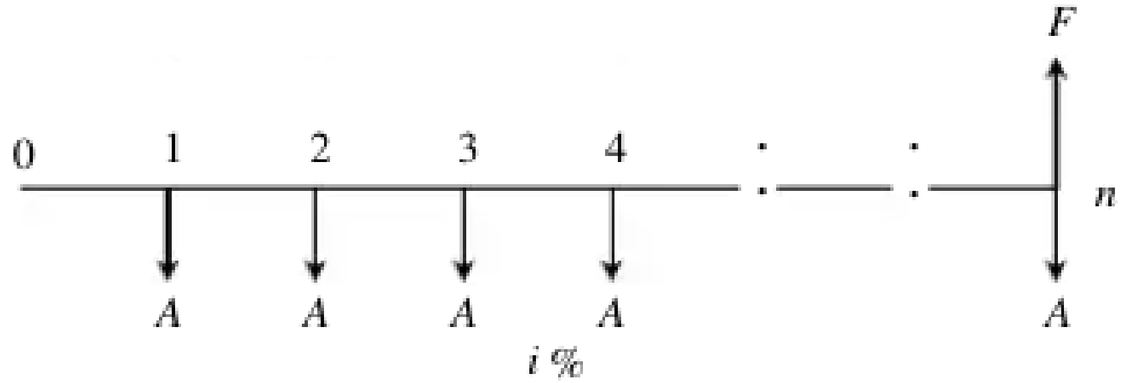


Fig: 15 : Cash flow diagram of equal-payment series sinking fund.

Interest Formula and Applications

Equal-Payment Series Sinking Fund

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 nth 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.*

Numerical Example

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 everyyear for the next 15 years at an interest rate of 18% compounded annually. Findthe equivalent amount that must be deposited at the end of every year for the next 15 years

Interest Formula and Applications

Equal-Payment Series Sinking Fund

Solution

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

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

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

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

$$= \text{Rs. } 8{,}200$$

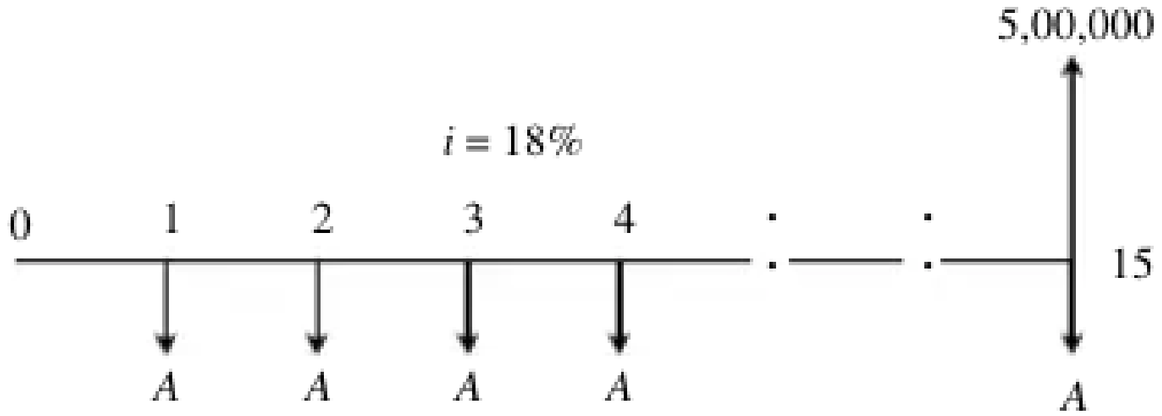


Fig: 16 : Cash flow diagram of equal-payment series sinking fund

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

Interest Formula and Applications

Equal-Payment Series Present Worth Amount

Objective

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 compounded at the end of every interest period.

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.*

Interest Formula and Applications

Equal-Payment Series Present Worth Amount

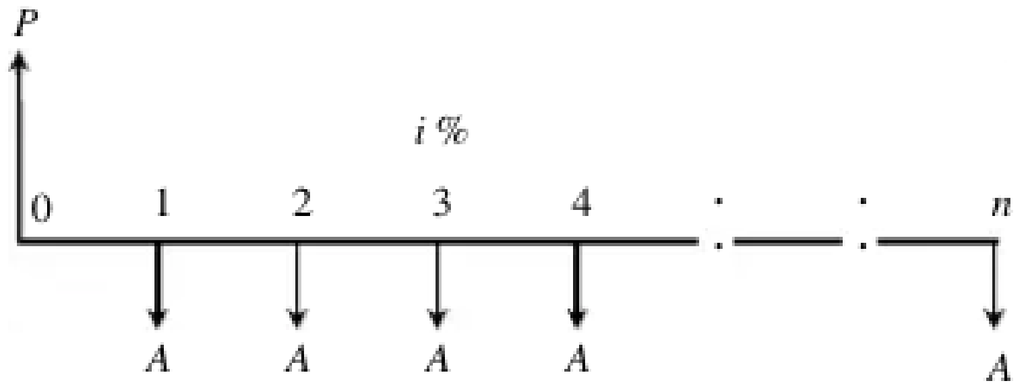


Fig 17: Equal Payment Series Present Worth Method

Example

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 growat the rate of 15% annually. Find the single-payment that must be made now asthe reserve amount.

Interest Formula and Applications

Equal-Payment Series Present Worth Amount

Solution

A = Rs. 10,00,000
i = 15%
n = 20 years
P = ?

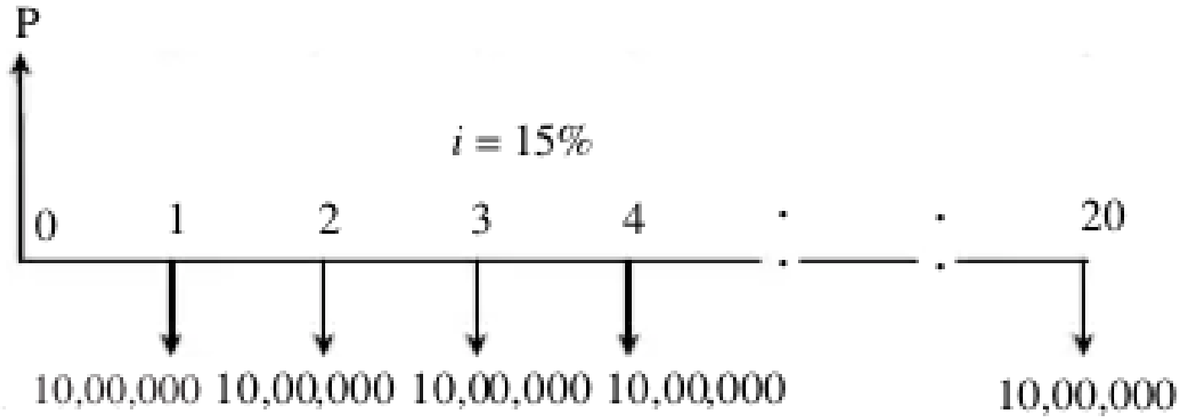


Fig 18. : Cash flow diagram of equal-payment series present worth amount

Interest Formula and Applications

Equal-Payment Series Present Worth Amount

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

$$= 10{,}00{,}000 \times (P/A, 15\%, 20)$$

$$= 10{,}00{,}000 \times 6.2593$$

$$= \text{Rs. } 62{,}59{,}300$$

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

Interest Formula and Applications

Equal - Payment Series Capital Recovery Amount

Objective

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

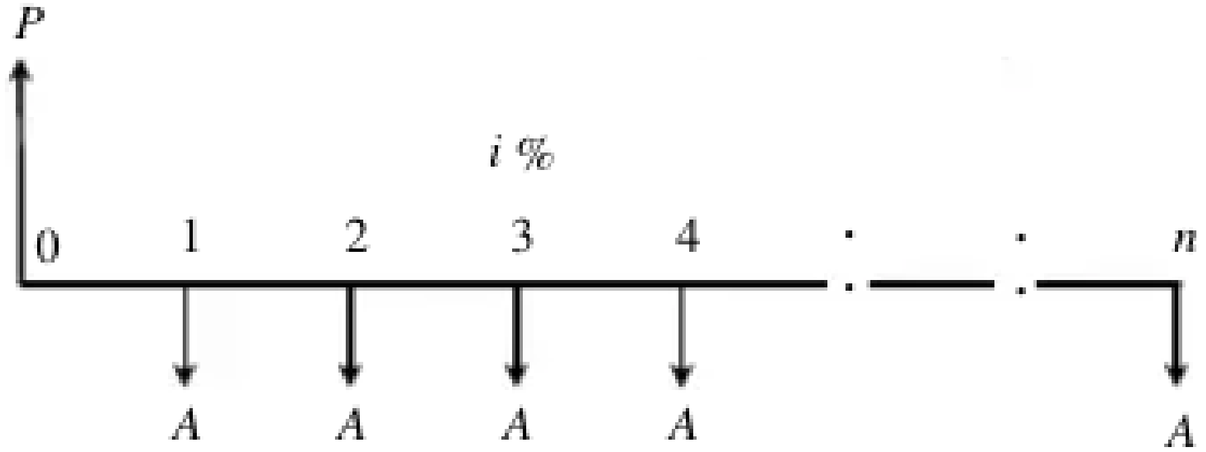


Fig 19: Cash flow diagram of equal-payment series capital recovery amount

Interest Formula and Applications

Equal - Payment Series Capital Recovery Amount

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*.

Numerical Example

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 instalments. Find the instalment amount that the company has to pay to the bank

Interest Formula and Applications

Equal - Payment Series Capital Recovery Amount

Solution

$P = \text{Rs. } 10{,}00{,}000$

$i = 18\%$

$n = 15 \text{ years}$

$A = ?$

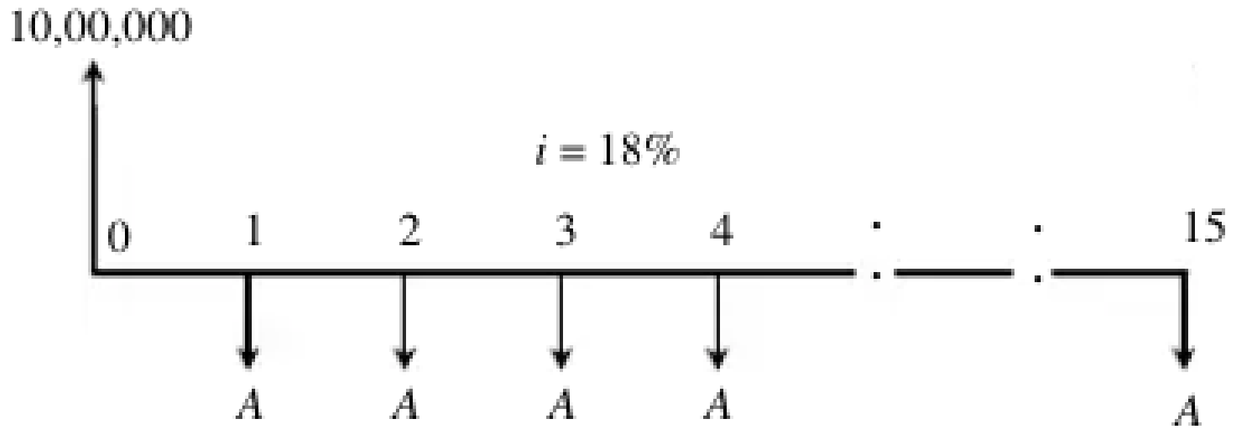


Fig 20: Cash flow diagram of equal-payment series capital recovery amount

Interest Formula and Applications

Equal - Payment Series Capital Recovery Amount

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

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

$$= 10{,}00{,}000 \times (0.1964)$$

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

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

Assignment

1. Define economics. Also discuss the flow of goods, services, resources and money payments in a simple economy with the help of a suitable diagram. (5 Marks)
2. Given the demand function

   q = 90 – 3P

   a. at what price, no one will be willing to buy any commodity?

   b. what will be the quantity demanded, if the commodity is given free
3. Explain Law of Demand and why demand curve is downward sloping
4. Does a change in taste leads to a movement along the demand curve?
5. Producers supply more at a higher price. Why?
6. Why does a supply curve usually slope upwards to the right?
7. Discuss the factors which influence demand and supply?
8. Distinguish between technical efficiency and economic efficiency by giving examples
9. Define break-even point. Draw a break-even chart and explain itscomponents

Assignment

10. Krishna Company Ltd. has the following details:

Fixed cost = Rs. 40,00,000

Variable cost per unit = Rs. 300

Selling price per unit = Rs. 500

Find

(a)The break-even sales quantity

(b)The break-even sales

(c)If the actual production quantity is 1,20,000, find the following

i) Contribution

ii) Margin of safety by all methods

Assignment

11. Explain the time value of money.
12. Give practical applications of various interest formulas.
13. A person deposits a sum of Rs. 1,00,000 in a bank for his son's educationwho will be admitted to a professional course after 6 years. The bank pays15% interest rate, compounded annually. Find the future amount of thedeposited money at the time of admitting his son in the professional course.
14. A person needs a sum of Rs. 2,00,000 for his daughter's marriage whichwill take place 15 years from now. Find the amount of money that he shoulddeposit now in a bank if the bank gives 18% interest, compounded annually
15. A person who is just 30 years old is planning for his retired life. He plansto invest an equal sum of Rs. 10,000 at the end of every year for the next30 years starting from the end of next year. The bank gives 15% interestrate, compounded annually. Find the maturity value of his account when heis 60 years old

Assignment

16. A company is planning to expand its business after 5 years from now. Theexpected money required for the expansion programme is Rs. 5,00,00,000.The company can invest Rs. 50,00,000 at the end of every year for the nextfive years. If the assured rate of return of investment is 18% for thecompany, check whether the accumulated sum in the account would besufficient to meet the fund for the expansion programme. If not, find thedifference in amounts for which the company should make some otherarrangement after 5 years.

17. A financial institution introduces a plan to pay a sum of Rs. 15,00,000 after10 years at the rate of 18%, compounded annually. Find the annualequivalent amount that a person should invest at the end of every year for
the next 10 years to receive Rs. 15,00,000 after 10 years from the institution

Assignment

18) A company is planning to expand its business after 5 years from now.The money required for the expansion programme is Rs. 4,00,00,000.What annual equivalent amount should the company deposit at the endof every year at an interest rate of 15% compounded annually to getRs. 4,00,00,000 after 5 years from now?

19)A company wants to set-up a reserve which will help it to have an annual equivalent amount of Rs. 15,00,000 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 as the reserve amount now.

20) An automobile company recently advertised its car for a down payment of Rs. 1,50,000. Alternatively, the car can be taken home by customers withoutmaking any payment, but they have to pay an equal yearly amount of Rs. 25,000 for 15 years at an interest rate of 18%, compounded annually.Suggest the best alternative

Assignment

21) A company takes a loan of Rs. 20,00,000 to modernize its boiler section.The loan is to be repaid in 20 equal installments at 12% interest rate,compounded annually. Find the equal installment amount that should bepaid for the next 20 years.

22) A bank gives loan to a company to purchase an equipment which is worthof Rs. 5,00,000, at an interest rate of 18% compounded annually. Thisamount should be repaid in 25 yearly equal installments. Find theinstallment amount that the company has to pay to the bank.